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BMP Retrofit Pilot Program

OPERATION MAINTENANCE AND MONITORING PLAN DISTRICT 11

VOLUME II –APPENDICES BMP STORMWATER MONITORING FIELD GUIDANCE

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CALTRANS
BMP RETROFIT PILOT PROGRAM

DISTRICT 11, SAN DIEGO

BMP OPERATION, MAINTENANCE, AND MONITORING PLAN

VOLUME II

APPENDIX I-A

EXTENDED DETENTION BASINS

September 1999

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1.0 INTRODUCTION

The Caltrans Best Management Practice (BMP) Retrofit Pilot Program is a comprehensive water quality monitoring study to evaluate the removal of contaminants in stormwater runoff from Caltrans roads and facilities through a series of BMP pilot installations. The overall objectives of this portion of the program are to document BMP contaminant removal efficiency and technical feasibility.

This Appendix of the Operations, Maintenance, and Monitoring Plan (OMM) applies to Extended Detention Basins (EDB). Refer to the consultant's monitoring equipment manuals and stormwater monitoring Standard Operating Procedures (SOPs) for details related to equipment installation, equipment maintenance, and storm monitoring. Maintenance, safety, documentation, and storm monitoring tasks will be carried out according to the procedures detailed in this plan. Additional measures may be necessary due to unforeseen or temporary changes to the work environment at these sites.

1.1 Retrofit BMP Description

An EDB is a depression or enclosed area used to detain stormwater for 48 to 72-hour periods so constituents are removed by particulate settling. Properly maintained EDBs are allowed to become dry between storms.

Runoff fills an EDB until it reaches an outlet riser connected to a discharge conveyance. The riser and conveyance is designed to handle flows that are generated from less than 1-year or 25-year storm events determined by site characteristics. Discharge from greater than 1-year or 25-year storm events will spill into a second outlet riser. The EDBs have been designed to optimally treat total runoff from storm events that are less than a 1-year average storm.

1.2 Evaluating BMP Performance

To effectively evaluate the performance of an EDB pilot facility, the following objectives will be met:

- Determine the quantity of runoff treated by the BMP.
- Determine the reduction (or change) in analyte concentrations between the influent and the effluent from the BMP.
- Determine and document the level of effort required to maintain the BMP at optimal effectiveness (i.e., treatment of stormwater runoff for storm events producing up to the 1-year, 24-hour peak flow).
- Determine and document the level of effort required to control vectors of human disease and nuisance insects, rodents, and vegetation at the BMP.

- Determine and document BMP performance evaluation criteria relative to the qualitative benefits of the BMP.

To effectively estimate the removal of contaminants from an EDB, the quantity and quality of runoff entering the EDB will be compared to the quantity and quality of water discharged from the EDB. These data will allow a direct estimate of the total reduction in mass loadings for a variety of contaminants.

The effectiveness of an EDB is also related to the implementation of strict maintenance procedures and the documentation of empirical observations. Items such as erosion and bank stability, maintenance of storage volumes, discharge rates, trash build-up, and infiltration capability may directly effect the performance of this EDB.

1.3 Deployment Criteria

Stormwater samples will be collected from the EDBs for up to ten storm events over a two wet seasons, weather permitting. Storms targeted for sampling will be separated by a minimum of 48 hours (72 hours preferably). This facility will be inspected per the guidelines given in Section 4.0 of the *Field Guidance Notebook* (*FGN*), which include a mandatory inspection after every storm greater than 0.50 inch.

Based on the rainfall requirements needed to generate monitorable flows in and out of the pilots, Caltrans has developed a refined monitoring team deployment criteria. The refined deployment criteria defines when to chase storms based on season, storm forecasts, and the current count of successfully monitored storms.

The deployment season, in which monitoring teams remain "on-call" and fully staffed, will be restricted to the portion of the year when rainfall is most probable and better predictable. Summer showers are not seen as predictable events, and dry watersheds and BMPs will retain more water which results in less effluent.

The deployment season will start on October 1. The season shall end after 3 weeks of dry weather where less than 0.2" of rainfall occurs in the San Diego area, but end no sooner than April 1 and not later than May 30th. This approach will provide a plan that adjusts to wet or dry springs.

The following criteria will decrease false starts, while allowing teams to continue to chase storms based on promising storm forecasts. The criteria will be used for pilots, regardless of drainage area size or land use.

“Forecast-Unlikely” set to less than 0.25 inch rain and less than 50% probability, (Decision = "No Go")

"Forecast-Marginal" set to 0.25 inch or greater and 50 –75% probability, (Caltrans Decision)

"Forecast-Highly Probable" set to 0.25 inch or greater and greater than 75% probability. (Decision = "Go")

Forecast information will be gathered as indicated in the OMM manuals (e.g., internet sources). As always, if conditions happen to allow paired samples to be successfully taken for any storm larger than 0.1 inch, that sampling would be considered as a successful event, which would count towards fulfilling Scoping Study requirements.

When a specific pilot is successfully monitored for the total required storms per the applicable Scoping Study, the decision to further deploy to monitor that pilot will fall to Caltrans and no commitment to monitor beyond the terms of the Scoping Studies can be made at this time.

1.4 Data Collection and Compilation

1.4.1 Data Requirements

The following data will be collected to assess the performance and maintenance aspects of an EDB:

- Water quality and quantity data of runoff into and discharge from the detention basin from flow-composite samples and grab (as soon as possible after the start of runoff) samples for at least 10 storm events during two wet seasons, weather permitting.
- Rainfall data recorded as a function of time, from all rainfall events during the study period.
- Observations of water quality, weather, antecedent conditions, spills, etc.
- Documentation records of inspections and maintenance activities performed.
- Vector monitoring and management data.
- Records of vector control measures taken.
- Vegetation management records.
- Continuous water basin level data

1.4.2 Data Management

The consultants will be responsible for data management. Overall management of the data will be consistent with established Caltrans procedures for stormwater monitoring projects.

The consultant's Sample Control group will be responsible for tracking the analytical process to assure that laboratories are meeting the required turnaround times and are

providing a complete deliverable package. Sample Control will also be responsible for accumulating copies of site visit logs, inspection logs, facility maintenance records, vector control sampling data, and logged rainfall and hydrographic data. Sample Control will receive the original hard and electronic copies from the laboratory, system managers, and field crews, and verify completeness and log dates of receipt. A copy of the data sets and log sheets will be filed in Sample Control's central filing system and another copy will be provided to the Database Manager. The originals will then be transferred to the Task Order Manager and filed with other project documentation to maintain complete project records.

Laboratories, system managers, and vector control crews will be requested to provide data in both hard copy and electronic formats. The forms of electronic submittals will be provided to the laboratories to ensure that the files can be imported into the project database with a minimum of editing. A relational database will be used for data. Laboratory data will be maintained and managed using Microsoft Excel® and Microsoft Access®. Files from the influent and effluent monitoring stations will be stored in the same database system and be linked to the laboratory database. The sampling system files will include rainfall, sampling, and flow data. Site characteristics will be stored in a separate file and linked to both the chemical and sampling system files to enable useful data queries.

Data will be submitted to Caltrans based on "Caltrans Statewide Data Management Plan—Data Reported Protocol and Database," a technical memorandum dated 23 April 1998 from Larry Walker Associates to task order managers.

1.4.3 Data Analysis

Differences in storm characteristics, which can lead to differences in analyte loadings of monitored storm events, will be evaluated for each year of monitoring. Specific storm parameters such as total rainfall, average intensity, peak intensity, and antecedent conditions will be measured to determine if these parameters correlate with analyte concentrations and loads in stormwater discharges.

Contingent on the amount and quality of actual data collected, influent and effluent sampling results will be characterized by descriptive statistics and statistical comparisons between the influent and effluent. Event mean concentrations (EMCs) will be measured for each water quality parameter at both locations. Annual statistics based upon assumed log-normal distributions also will be calculated for each water quality parameter.

Differences in mean concentrations of analytes between storm events and locations will be considered to be statistically significant at $P \leq 0.10$. Although the acceptable level of alpha error is typically set at $P \leq 0.05$, this decision level was increased due to the relatively high coefficients of variation (CV) encountered with stormwater data.

Care will be taken to guard against false positive or negatives, so that widely varying storm event characteristics will not result in misinterpretation of the stormwater runoff data.

Widely varying storm event characteristics will be considered when evaluating BMP efficiencies based on stormwater runoff data. Empirical observations, maintenance activities, and vector control activities will be compiled and compared to water quality and quantity data.

1.5 Encroachment Permit and Restrictions

Visitation to an EDB requires a Caltrans Encroachment Permit. Copies of the EDB permits are located in Tab 9 of the *FGN*. These permits list access and safety requirements along with any restrictions. The respective Caltrans District Encroachment Permit Office will be contacted for further information and direction (phone numbers can be found under Tab 2 in the *FGN* portion of the Volume II OMM Plan).

2.0 OPERATION AND MAINTENANCE

2.1 Operation and Maintenance Needs

The operational and maintenance needs of an EDB are:

- Dispersion of alluvial sediment deposition at inlet structures thus limiting the extended localized ponding of water
- Periodic sediment removal in accordance with the 18" depth threshold or 10% of the storage volume (which ever is less) and the WMI Operation and Maintenance guide.
- Monitoring of the basin to ensure it is completely and properly drained.
- Outlet riser cleaning. Vegetation management to prevent marsh vegetation from taking hold, and to limit habitat for disease-carrying fauna.
- Removal of graffiti, grass trimmings, weeds, tree prunings, leaves, litter, and debris.
- Preventative maintenance on monitoring equipment.
- Vegetative stabilization of eroding banks and basal areas.

2.2 Inspection Frequency

The facility will be inspected and inspection visits will be completely documented (refer to Tab 4 of the *FGN*):

- Once a month at a minimum.
- After every large storm (after every storm monitored or those storms with more than 0.50 inch of precipitation).
- On a weekly basis during extended periods of wet weather.

2.3 Aesthetic and Functional Maintenance

Functional maintenance is important for performance and safety reasons. Aesthetic maintenance is important for public acceptance of stormwater facilities.

Both forms of maintenance will be combined into an overall Stormwater Management System Maintenance Program. Maintenance activities will be carried out by each EDB's respective consultant. Maintenance items are included in the checklist/log forms found in Tab 5 of the *FGN*. Maintenance activities will conform to the practices specified in this plan.

2.3.1 Aesthetic Maintenance

The following activities will be included in the aesthetic maintenance program:

- **Graffiti Removal.** Graffiti will be removed in a timely manner to improve the appearance of an EDB, and to discourage additional graffiti or other acts of vandalism.
- **Grass Trimming.** Trimming of grass will be done around fences, the basin, outlet structures, and sampling structures. More specifics on vegetation management are given in Section 4.0.
- **Weed Control.** Weeds will be removed through mechanical means. More specifics on vegetation management are given in Section 4.0.

2.3.2 Functional Maintenance

Functional maintenance has two components:

- Preventive maintenance.
- Corrective maintenance.

Preventive Maintenance

Preventive maintenance that will be done on a regular basis is detailed in the checklists contained in Tab 5 of the *FGN*. Preventive maintenance activities to be instituted at an EDB are:

- **Mowing.** Vegetation in the EDB will be kept at the average maximum height of 18 inches to prevent the establishment of marsh vegetation, the stagnation of water, and the development of faunal habitats. More specifics on vegetation management are given in Section 4.0.
- **Trash and Debris.** During each inspection and maintenance visit to the site, debris and trash removal will be conducted to reduce the potential for inlet and outlet structures and other components from becoming clogged and inoperable during storm events.
- **Sediment Management.** Alluvial deposits at the inlet structures may create zones of ponded water. Upon these occurrences these deposits will be graded within the EDB in an effort to maintain the functionality of the BMP. Sediment grading will be accomplished by manually raking the deposits.
- **Sediment Removal.** Surface sediments will be removed when sediment accumulation is greater than 18-inches or 10 percent of the basin volume, whichever is less. Vegetation removed with any surface sediment excavation activities will be replaced through reseeding. Disposal of sediments is discussed in Section 2.6 and will comply with applicable local, county, state, or federal requirements.

- **Mechanical Components.** Regularly scheduled maintenance will be performed on valves, fence gates, locks, and access hatches in accordance with the manufacturers' recommendations. Mechanical components will be operated during each maintenance inspection to assure continued performance.
- **Elimination of Mosquito Breeding Habitats.** The most effective mosquito control program is one that eliminates potential breeding habitats. Mosquito control measures are discussed more in Section 3.0.

Corrective Maintenance

Corrective maintenance is required on an emergency or non-routine basis to correct problems and to restore the intended operation and safe function of an EDB. Corrective maintenance activities include:

- **Removal of Debris and Sediment.** Sediment, debris, and trash, which threaten the ability of an EDB to store or convey water, will be removed immediately and properly disposed of (see Section 2.6 and 5.7).
- **Structural Repairs.** Repairs to any structural component of an EDB will be made promptly (e.g., within 10 working days). Designers and contractors will conduct repairs where structural damage has occurred.
- **Embankment and Slope Repairs.** Damage to the embankments and slopes will be repaired quickly (e.g., within 10 working days).
- **Elimination of Mosquito Breeding Areas.** Consult Appendix IV for controlling mosquitoes.
- **Erosion Repair.** Where a reseeding program has been ineffective, or where other factors have created erosive conditions (i.e., pedestrian traffic, concentrated flow, etc.), corrective steps will be taken to prevent loss of soil and any subsequent danger to the performance of an EDB. There are a number of corrective actions than can be taken. These include erosion control blankets, riprap, sodding, or reduced flow through the area. Design engineers will be consulted to address erosion problems if the solution is not evident.
- **Fence Repair.** Timely repair of fences (e.g., within 10 working days) will be done to maintain the security of the site.
- **Elimination of Trees and Woody Vegetation.** Woody vegetation will be removed from embankments. See Section 4.0 for further information on vegetation management.
- **Elimination of Animal Burrows.** Animal burrows will be filled and steps taken to remove the animals if burrowing problems continue to occur (filling and compacting). If the problem persists, vector control specialists will be consulted regarding removal steps. This consulting is necessary as the threat of rabies in some areas may necessitate the animals being destroyed rather than relocated.
- **General Facility Maintenance.** In addition to the above elements of corrective maintenance, general corrective maintenance will address the overall facility and its

associated components. If corrective maintenance is being done to one component, other components will be inspected to see if maintenance is needed.

2.4 Maintenance Frequency

The maintenance indicator document, included as Appendix V, lists the schedule of maintenance activities to be implemented at a pilot EDB.

2.5 Equipment, Resources, and Tools Needed

The following resources and equipment are needed by inspection personnel:

- A Locke level or other surveying equipment.
- Industrial strength flashlight.
- Crowbar.
- Tape measure and other measuring device (e.g., survey rod) to determine surface sediment accumulation depths.
- Local erosion, sediment control, or stormwater management handbooks.
- Trash removal equipment.
- Sediment manipulation/removal equipment (e.g., shovels, rakes, 5-gallon buckets).
- Rain and foul weather gear and other personal protective equipment (PPE).
- This Appendix and *FGN*.
- Copies of necessary inspection reports and forms.
- Encroachment permit.
- Business cards or other identification.
- Camera to document field conditions.
- Orange vest and hardhat.
- Maintenance logs.
- Leather gloves.
- Safety glasses.
- Safety boots.
- Pen or pencil.

Except for the items contained on site, the maintenance contractors will supply equipment, tools, and resources required for maintenance activities at an EDB. At a minimum, these contractors will supply the following:

- Heavy earth moving equipment (loaders, backhoes, graders, draglines, and vacuum equipment).
- Dump trucks, equipment transports, and other hauling equipment.
- Shovels, picks, rakes, wheel barrels, and other hand tools.
- Pumps.

- Mechanics tools.
- Concrete tools.
- Vegetation maintenance equipment (hand and tractor lawn mowers, gas trimmers, seed and fertilizer spreaders, pesticide and herbicide sprayers, leaf blowers, chain saws, pruning sheers, hedge trimmers, and wood chippers).
- Painting equipment (brushes, rollers, and sprayers).
- Locke level or survey equipment, tape measures, and sediment probes.
- Other necessary safety equipment (gloves, boots, hard hats, reflective vests, safety glasses, traffic control lighting, and confined space entry equipment).

These items will be supplied to the maintenance contractors by the consultants responsible for the BMP:

- This Appendix, *FGN* and approved BMP facility plans.
- Encroachment Permit.
- Logbook containing Maintenance Logs.

The following items for maintenance and inspection activities will be supplied on site:

- Graduated PVC poles for gauging sediment depth will be installed at three locations within the basin.
- A staff gauge will be installed to determine basin depth and to calibrate monitoring equipment.
- Trash containers will be located on site.

2.6 Debris and Sediment Disposal

Caltrans is responsible for any hazardous waste generated at an EDB as the owner/generator. Consultants responsible for operating, maintaining, and monitoring the EDBs will be responsible for the removal, testing, and disposal of the hazardous waste by independent contractors. Disposal of sediment, debris, and trash will be contracted out in accordance with local, county, state, and federal waste control programs. Potential disposal service contractors are listed in Table 2.1.

Table 2.1
Waste Disposal Services in Southern California

Laidlaw/Rollins (OPC) 5765 Alba Street Los Angeles, CA 92011 Ph: (213) 585-5063 Fax: (213) 589 5443 EPA: CAD050806850	Laidlaw Environmental Services 5295 S. Garvey Rd. Westmoreland, CA 92281 Ph: (619) 334-9400 Fax: (619) 344-9405 EPA: CAD000633164
TSM Recovery and Recycling 3422 W. Pico Blvd. Los Angeles, CA 90019 Ph: (213) 735-9443 EPA: CAD108040858	Pacific Resource Recovery 3150 E. Pico Blvd. Los Angeles, CA 90023 Ph: (800) 499-7145 Fax: (213) 780-9940 EPA: CAD008252405
Demenno Kerdoon Environmental Services 3650 E. 26th Street Los Angeles, CA 90023 Ph: (213) 268-5056 Fax: (213) 268-9672 EPA: CAD080033681	U.S. Filter Recovery Services 5375 S. Boyle Ave. Vernon, CA 99058 Ph: (213) 277-1500 Fax: (213) 588-0094 EPA: CAD097030993

Prior to disposal, sediments will be characterized to determine the extent and type of chemical contamination. Evidence of oil and grease, antifreeze, solvents, fuel, hydrogen sulfide, and any other noxious substance will be noted. Observations will be used to determine if more than the standard analyte list of analytes is required. The standard analyte list (found in Table 5.2) is based on highway analytes that have a strong potential to exceed California Code of Regulations Title 22 hazardous waste criteria (State of California, 1985). Methods used to sample sediments are discussed in Subsection 5.7. While analytical results are pending, the removed sediments will be stockpiled on site at a minimum distance of 100 feet from the basin and property boundary. Hay bales or silt barriers will be placed around the perimeter of the pile, and piles will be covered with plastic and stabilized with sandbags. Separate piles will be used for sediments suspected to be contaminated.

2.7 Hazardous Wastes

Suspected hazardous wastes will be analyzed to determine disposal options. Hazardous materials generated on site will be handled and disposed of according to local, state, and federal regulations. A solid or liquid waste is considered a hazardous waste if it exceeds the criteria listed in the California Code of Federal Regulations, Title 22, Article 11 (State of California, 1985).

2.8 Checklist for Inspectors and Operation and Maintenance Personnel

Facility Inspection and Observational checklists or logs will be filled out during each visit to an EDB**.** These will be kept in a field logbook to ensure that the EDB is maintained at optimum levels throughout the monitoring period. One field logbook will contain storm monitoring data sheets and instrument calibration logs (Tab 6 of the *FGN*). A second logbook will contain Facility Inspection Checklists and Maintenance Log

Sheets. A third logbook will be kept for vector control and management logsheets (Appendix IV of Volume II).

Refer to Forms C through F (in Tabs 4 and 5 of the *FGN*) for checklists related to the inspection and maintenance requirements of an EDB.

3.0 VECTOR CONTROL AND MANAGEMENT

Constructing retrofit pilot BMPs will modify the existing stormwater drainage systems. Because such retrofitting may create opportunities for disease carrying organisms to flourish, insects (such as mosquitoes and midges) or rodents may have to be controlled. Vector control and abatement will be performed in accordance with Appendix IV and by subcontracted Vector Control Districts.

4.0 VEGETATION MANAGEMENT

The three main reasons for having a vegetation management program for an EDB are:

1) Uncontrolled vegetation may affect the performance.
2) Maintaining vegetation is necessary to prevent the facility from becoming a public "eye sore."
2) Maintaining vegetation is key to controlling mosquito populations and other vector and nuisance organisms.

4.1 Management for Optimal BMP Performance

Maintenance and control of vegetation is essential to the optimal operation and performance of an EDB. The basin will be seeded with low-growing grasses. Detention basin vegetation will be maintained at an average height of 12 inches.

The condition of the vegetation will be inspected on a monthly basis at a minimum. These inspections will insure that the vegetation within the basin floor is kept relatively short, that the vegetation protecting the slopes is kept healthy and continuous, and that undesirable plant species do not take root. Shorter vegetation on the basin floor will optimize the treatment capacity, the residence time of runoff, and will aid in vector control. Maintaining a healthy and continuous cover of vegetation on the slopes will minimize erosion. Preventing undesirable plant species from taking root will prevent plants with large root systems from damaging the embankments. See Section 2.0 for details on controlling vegetation.

4.2 Management for Optimal Vector Control

If vegetation (such as cattails, bulrush, willows, etc.) develops within an EDB, problems may occur with vector control. Controlling vegetation and standing water is preferred to enacting vector management programs.

If vegetation control is needed, cut vegetation must not be left in the detention basin. If this material is flooded, by-products of decomposition will be attractive to egg-laying female mosquitoes and will provide food resources for mosquito larvae. Mulching of cut vegetation into the basin is also not a viable alternative.

4.3 Maintenance Requirements

Mowing, trimming, and pruning are the preferred means for controlling vegetation at an EDB. Controlling standing water will also be essential to controlling vegetation. Burning will not be allowed, and the use of herbicides will not be allowed because they can de-

vegetate slopes and embankments for extended periods of time, and have detrimental effects to the quality of runoff treated at the facility.
When equipment is used to remove vegetation, care will be taken to prevent ruts, holes, and an uneven basin floor. Such depressions can cause standing water that will create problems of vector control.

Maintenance activities that will be conducted on landscaped vegetation include:

- Weeding.
- Pruning.
- Replacement of dead or dying plants.

Vegetation removed from an EDB facility will be promptly hauled off and disposed of properly. Cut vegetation will not be stockpiled on site, especially within the basin.

4.4 Checklists

During the routine vegetation inspections of an EDB, the Facility Inspection Checklist (Form C, Tab 4) will be completely filled out and signed by the inspector. This checklist incorporates necessary vegetation inspection requirements. A Maintenance Activity Checklist (Form E, Tab 5) will be filled out for maintenance activities performed.

5.0 SAMPLING AND MONITORING

This section details the monitoring equipment to be used at an EDB, sampling protocols, analytes to be tested, and quality assurance/quality control guidelines.

5.1 Equipment Installation

Runoff flows into an EDB, and fills the basin, and then discharges into an outlet riser. The EDB and its conveyance will handle flows that are generated from less than 1-year or 25-year storm events. Some discharge from greater than 1-year 25-year stormwater events may spill into a second outlet, if designed so. Discharge into the 1-year or 25-year outlet, if it occurs, will not be monitored. When discharge into the second outlet occurs, it will be documented through basin level records and observation logs.

The influent sampling point will be located upstream of the inlet into the basin and will be accessed through a manhole. The effluent sampling point will be located downstream of the outlet (see *FGN* site maps). Access to the discharge conveyance will be through a manhole. Confined space procedures will be followed when accessing the sampling points (see Appendix II, Health and Safety Plan).

The inflow and outflow conveyances for each EDB will be equipped with a flow measuring device (either a flume or an area/velocity meter) and a sample intake. The flumes will incorporate some sort of depth measuring device. The flumes will be cast into the conveyances during the construction phase. The flow sensors will be installed using manufacturer supplied hardware and in accordance to the manufacturers specifications. Sampler intakes will be mounted in each conveyance upstream of flumes or downstream of velocity/depth sensors. Stainless steel fasteners will be used to secure the intakes to the invert of the conveyances.

Sampler intakes will be mounted in each conveyance at least 0.6 m upstream of the flume or 1.2 m downstream of the velocity/depth sensors. Stainless-steel concrete anchors will be used to secure the intakes to the invert of the conveyances.

Sensor wires and intake tubing will be routed through conduit from the manholes to equipment enclosures positioned on level ground near each manhole. The equipment enclosures will house the data logger/controller assemblies, samplers, cellular modem equipment, flow metering electronics, and batteries. A rain gauge will be mounted on a pole located adjacent to the inlet equipment enclosure. This pole will also support a cellular phone antenna and solar panel.

The components of each automatic sampling system used will undergo calibration and verification during installation and during maintenance and pre-storm visits.

There are several design specifications that were considered in designing the sampling points. The location at which flow will be measured will be at least 10 pipe diameters downstream and five pipe diameters upstream (or ten and five times the maximum anticipated head height) of any outfall, obstruction, inlet, or change in direction of the conveyance. The slope of the conveyance leading to the flow measuring point is 2% or less. These two requirements are to insure that the flow is fully developed and is subcritical at the point where flow is measured. Only experienced field crews will install monitoring equipment.

5.1.1 Water Quality Samplers

The water quality samplers to be used at an EDB will be automatic and composed of a peristaltic pump, a liquid detector, and a base to hold a sample bottle and ice. Each time a pre-determined volume of liquid passes the sampling point, the data logger/controller will signal the pump to deliver a self-calibrated sample volume. The suction hose used with the sampler will be 3/8-inch pure Teflon® tubing. Therefore, the sampler will be equipped with 3/8-inch silicon peristaltic tubing and a 3/8-inch stainless steel or Teflon® intake strainer of low-flow design. Strainers will be attached to the invert of each conveyance using stainless-steel fasteners. Samples will be collected into borosilicate glass bottles.

The materials used in the collection of stormwater samples will meet strict criteria to prevent any form of contamination of the sample. These materials will allow for both inorganic and organic trace toxicant analyses from the same sampler and composite bottle. Only Teflon® and the highest grade of borosilicate glass are suitable for both trace metal and organic analyses from the same composite sample bottle. Bottles will be cleaned according to USEPA-approved protocols consistent with approved methodology for analysis of stormwater samples (USEPA, 1983). Sample hoses will be replaced and decontaminated annually, prior to the wet season. They will not be cleaned after each storm event. These bottles and hoses will be evaluated through a blanking process to verify that the composite bottles and sample hoses are contamination-free and appropriately cleaned for both analyses of inorganic and organic analytes.

5.1.2 Cleaning Procedures for Composite Bottles

Bottles will be:

1. Rinsed three times with warm tap water.
2. Scrubbed with a clean plastic brush.
3. Soaked in a 2% detergent (e.g., Contrad®) solution for at least 48-hours.
4. Rinsed three times with tap water.
5. Rinsed five times with Milli-Q or equivalent water, rotating the bottle to ensure contact with the entire inside surface.
6. Rinsed three times with hexane while rotating the bottle, and then air-dried.
7. Rinsed six times with Milli-Q water.

8. Soaked in 2N nitric acid for a minimum of 24-hours.
9. Rinsed six times with Milli-Q water.

5.1.3 Cleaning Procedures for Teflon® Hose and Other Sampling Equipment

Teflon® hose and other sampling equipment will be:

1. Teflon hose will be rinsed three times with a 2% Micro® solution or equivalent. Other sampling equipment will be washed with a 2% Micro® solution and a clean plastic brush.
2. Rinsed three times with warm tap water.
3. Rinsed three times with Milli-Q or equivalent water.
4. Rinsed three times with 2N nitric acid.
5. Soaked at least 24-hours in 2N nitric acid.
6. Rinsed three times with Milli-Q water.

5.1.4 Flow Monitoring

A flow-proportioned sample is a composite of individual sample aliquots that are collected for each set volume of water that passes by a sampling point. To obtain a valid composite sample, direct flow measurements will be made to control the sampling interval. At an EDB, both primary and secondary flow metering devices will be used. A primary flow-measuring device is a hydraulic structure (e.g., flume) inserted into a channel that changes the level of liquid in or near the structure. By knowing the shape and dimensions of the hydraulic structure, flow through or over the structure is related to the liquid level by a mathematical relationship. A secondary flow metering device measures both liquid velocity and depth. Primary devices are preferable, unless hydraulic characteristics prohibit them.

A primary flow measuring discharge flume will be used at the discharge sampling point. A lookdown level meter will be used in conjunction with the discharge flume. This meter contains an ultrasonic transducer. This transducer will be suspended in a location that is clear of obstructions, at a known distance above the invert of the conveyance, and approximately 0.3 meters above the maximum expected water height. The sensor will be mounted far enough away from the sidewalls and rungs of ladders in the manhole to prevent reflections of sound energy from them to be misinterpreted as energy reflected off the surface of the water.

Because the influent sampling point will most likely be submerged during storms, an area-velocity (AV) flow meter (or equivalent) will be installed. These meters will have single-point, internally-mounted, low profile depth and velocity sensors. A pressure transducer that senses gauge pressure will be used to measure depth. The pressure transducer will be vented to atmospheric pressure. The pressure transducer can be separate or integral to the velocity sensor. The velocity sensor will operate using the

Doppler principal for measurement. The depth and velocity sensors will be secured to the invert of the conveyance using a mounting ring supplied by the manufacturer. This same meter will record basin water levels for depths greater than 10 cm.

5.1.5 Rain Gauge

A rain gauge having a "tipping bucket" design that incorporates a small "bucket" which holds a known amount of rainfall will be used onsite. When the bucket is filled, it tips the water out, momentarily closes a switch, and then resets itself and starts the process again. The data logger/controller counts each switch closure to accumulate rainfall totals. The rain gauges used will tip after every 0.01 inch of rain.

5.1.6 Power

The source of primary power for both sampling systems will be 12-volt deep-cycle marine batteries. A separate battery will be used to power the autosamplers, modems, and flow meters. Solar panels will be used to maintain the charge on the batteries.

5.1.7 Telecommunications

Cellular modem transceivers will be used to provide remote telecommunication access to the monitoring equipment. The ability to access a sampling station, monitor the status of the station in real-time, modify storm criteria, download new programs, and recover data allows for more cost effective, efficient monitoring.

A high performance base station antenna with filter will be installed; the filter will be installed from the lead-in of the antenna to prevent damage to the sampling station equipment due to nearby lightning strikes.

5.1.8 Equipment Enclosures

Both steel and walk-in fiberglass enclosures will be used to house the samplers and associated electronic equipment. These enclosures are to be bolted to the concrete pads and are to be locked to secure the monitoring equipment.

5.2 Maintenance and Calibration

A complete maintenance program will be performed at an EDB after each storm event during the monitoring period, or in the absence of rain, on a monthly basis. Maintenance will include checking the performance of the equipment, checking power supplies, inspecting and clearing intake structures, cleaning contaminated equipment, and performing necessary equipment calibrations. Calibrations will be conducted in accordance to specifications in the individual component manuals.

Stormwater equipment maintenance visits will be thoroughly documented. Written documentation includes the action taken at a site as well as the date performed. Accurate and thorough records of station visits will be maintained to aid in the evaluation of an EDB's performance. The log illustrated in Form F in Tab 5 of the *FGN* will be used to document maintenance and calibrations. If any program parameters are changed, the log shown on Form I, J1 and/or J2 in Tab 6 in the *FGN* will be completed.

5.3 Preparation and Logistics

Success of the sampling effort requires careful preparation and planning to assure that high quality samples are obtained in association with each storm event.

5.3.1 Weather Tracking

Weather tracking will be the responsibility of the Task Order Manager and Storm Control personnel. During the wet weather season, the weather will be continually monitored with increased frequency as incoming systems are predicted. Sources of weather information to be used to track incoming storms include the following: National Weather Service, Weather Watch Service, Weather Network (WeatherNet), the Alert system from San Diego County, public broadcast information available on the Weather Channel and local news stations, and radar and satellite images downloaded from the Internet (e.g., www.weather.com).

5.3.2 Mobilization and Staffing

A staffing plan, which designates personnel and equipment for each facet of the storm monitoring, will be developed as soon as a potential event is forecast. Crews will consist of two individuals. The staffing plan will include the following information:

- Personnel needed for each position.
    - Storm Control
    - Shift Leader
    - Crew Chiefs
    - Crew Assistants
- Shift and zone (pilot facilities manned by a single crew) designations.
- Equipment mobilization.
- Communication channels.

Equipment needed for stormwater sampling includes sampling equipment, sampling containers, safety equipment, personal rain gear, Storm Kits, and vehicles equipped with some type of mobile communication and highway safety equipment (see lists). The necessary equipment will be loaded into the appropriate vehicles early in the storm preparation sequence.

Storm Kit Equipment List

- Keypad/display.
- 9-pin cable from keypad to data logger.
- Full set of keys (on floatable bobber).
- Flashlights (2).
- Maps for required areas.
- Large flat screwdriver.
- Small flat screwdriver.
- Umbrella.
- High quality alkaline D-cell batteries.
- Spare sample labels.
- Pencils and indelible markers.
- Desiccant (packages and jar).
- Diagonal clipper.
- Electrical tape.
- Cable ties (assorted sizes).
- Utility knife.
- Ziploc baggies (assorted sizes).
- Labeling tape.
- Polyethylene gloves.
- Rubber bands.

Storm Mobilization List

- Storm kit.
- Log books.
- pH meter.
- Paper towels.
- DI (de-ionized) water squirt bottles.
- Tape gun with clear tape.
- pH grab bottles.
- Spare sample labels.
- Ice scoop.
- Sample control paperwork.
- Extra fine indelible markers.
- 20 liter bottles in 10 gallon containment buckets.
- Grab sample bottles.
- Coolers and ice.
- Grab pole.
- DI water (3-gallon jug).
- Two-way radio or cellular phone.
- Personal rain gear.
- Any necessary safety gear.
- Trash bags

Communication Channels

Communication channels will be established for personnel to contact each other before and during a storm event. Phone lists with home and work numbers and other key contacts will be made available to potential crew members. Two-way radio or cellular telephone communication links to field crews are essential for efficient stormwater monitoring.

5.3.3 Monitoring Station Preparation

Prior to a storm event, the EDB monitoring stations will be made ready to sample. This preparation includes entering the correct “Volume to Sample” values, setting the autosampler and the data logger to sampling mode, pre-icing the composite sample bottle, and performing a general equipment inspection. The *FGN* will be consulted for specific details on station preparation.

Determination of Volume to Sample

The latest weather forecast prior to each storm event will be examined to determine the proper "Volume to Sample" value to enter into the system. The amount of expected rainfall, how the station performed during the previous storm and how much water is needed for analysis at the station for each storm event will be taken into consideration.

The "Volume to Sample" is entered as a number with units in kilo-cubic feet (kcf). To determine this number, the drainage area in acres and the runoff coefficient, which is a number that reflects the permeability of the land in the study area, is listed below. Use the following equation to determine the volume of water expected at an EDB for a given rainfall:

A x B x C x 3.63 = volume in kcf

Where:

A = inches of rain
B = drainage area in acres
C = runoff coefficient for land area
3.63 = conversion factor: acre-inches to kilo-cubic feet

To determine how much water will pass the station between samples, divide this result by the number of samples needed to satisfy the water volume requirement for the analysis. A table will be supplied in the field logbook that indicates the Volume to Sample value needed to collect the correct sample amount of water for the amount of expected rainfall.

After the proper Volume to Sample value is determined, it will be entered into the system before the rainfall starts. The runoff value will generally be entered from the remote computer. The value can also be entered upon arrival at the site before the system has entered storm mode. It is important that this value is accurate as possible; if the value is too high, the system will not collect enough water to be analyzed, and if the value is too low, the system may sample too fast to be monitored effectively (i.e., the percent storm capture will drop).

Prepare Sampler

The autosampler will be reset and programmed to take 78, 250-ml aliquots. Also other user-entered parameters (tubing length, head height, bottle size, composite sample, sample upon one pulse, and enabled liquid detector) will be set correctly.

During each site visit, the state of the System Status Flags (switches) and Program Signature will also be recorded. These provide important information on the current sampling mode and overall integrity of the site program.

Ice Sample Bottle

The sample bottle will be iced after the decision has been made to monitor the storm and prior to initial sample collection. If this is not possible, the bottle will be iced immediately upon the first visit.

General Inspection

A brief physical inspection of the equipment will be made to make certain that there are no obvious problems such as broken conduit or a kinked hose. If possible, the intake will be cleared of debris; at sites with confined entry access, this is only possible if the safety requirements listed in Appendix II are met.

Documentation

Upon each site visit, whether during storm mode or not, records of the visit will be accurately recorded on the field form (Form I of Tab 5 in the *FGN*). Whenever possible, any data being recorded by the sampling system (for example, time or current stage) will be verified. If any program parameters are changed, a program parameter log (Forms J1 and J2 of Tab 6 in the *FGN*) will be filled out. Also, once during each storm event visit, the Empirical Observation Checklist will be completed (Tab 6, Form H in the *FGN*).

General Visitation Data

During each station visit, several display locations will be recorded. The log sheets will be used as a guide to the proper display locations to record. The following data will be recorded at both the influent and effluent stations:

- Flume Stage (ft)
- AV Meter Stage (ft)
- Velocity (f/s)
- Flume Q (flow in cfs)
- AV Meter Q (flow in cfs)
- Station ID
- Data Logger Battery Voltage
- Flow Meter Battery Voltage
- Cellular Equipment Battery Voltage

Storm Visitation Data

Additional data will be recorded in the logbooks during storm monitoring, including:

- Volume (kcf)
  This is the volume of water that passed the station during the previous execution Interval (one minute).
- Storm Sum
  This indicates the accumulated runoff volume in kilo cubic feet (kcf) that has passed the station since the last sample.
- Percent Storm Capture
  This indicates the percent of the storm effectively sampled by the system, and it provides a quick evaluation of the quality of the monitoring.
- Volume to Sample
  This value indicates the runoff volume (in kcf) that will pass the station before the system will take the next sample.
- Sample Count
  This number indicates the number of samples taken in the current bottle. It automatically re-zeroes every time a bottle is filled.
- Total Rain (inches)
  The total rainfall in inches since the start of the storm. This is accumulated each time that the rain bucket tips.
- Max Flow (day)
  This indicates the Julian day on which the maximum flow occurred.
- Max Flow (time)
  When this number is positive, it indicates that the system was sampling during peak stage. If this number is negative, sampling did not occur during the peak stage because the bottle was full.
- Max Stage (feet)
  This indicates the height of the maximum stage during the current storm.
- Max Flow (cfs)
  This indicates the maximum flow rate during the current storm.
- Storm Volume (kcf)
  This indicates the total volume of water that has flowed past the station since the beginning of the storm.
- Storm Volume Sampled (kcf)
  This indicates the total volume of water that flowed past the station while the system has been in storm mode.

After the data have been recorded, the system will be placed in low power mode and the keyboard unplugged.

5.4 Storm Monitoring

A priority objective of storm monitoring is to maximize the percent storm capture of the composite sample. This will be accomplished by ensuring that a composite bottle does not fill without being changed immediately. If a bottle does fill, the full sample bottle will be replaced and the system will be reset. To determine approximately when the bottle will fill and to ensure that the sampling process is not interrupted, the Storm Sum and the Volume to Sample will be evaluated. By examining how quickly the Storm Sum value is approaching the Volume to Sample value, the approximate time until the next sample is taken can be determined, as well as the approximate time until the bottle fills. The monitoring crew will be aware of the current status of each station in each of its BMP pilot facilities to determine which one will fill a bottle first so they can be on site as the bottle fills. If the station has been set properly for the amount of rainfall, changing the composite bottle will not be necessary. Volume to Sample settings will take into account the volume of sample required to meet analytical needs. This study requires approximately 3 liters of sample to meet these needs.

The data logger pulses the autosampler to take a sample when the accumulated Storm Sum equals the Volume to Sample. The storm sum is then reset to zero and the process is repeated. This continues until the storm ends or the bottle fills. Ideally, the Volume to Sample value will be accurate for the amount of rainfall, and the bottle will not need to be changed during the storm. If, however, the rainfall is different than that predicted, a bottle may fill before the end of the storm. If this occurs, sampling will halt until the bottle is changed and the system is reset. Until the system is reset, part of the storm is not being sampled, and the percent capture will show a decrease. It is therefore imperative that the system is reset and the sample bottle is changed immediately to maintain 100% storm capture.

5.4.1 Storm Procedure

Upon arrival at a station during a storm event, the status of the composite sample bottle will be checked immediately. If it is not necessary to change the bottle at that time, the appropriate data on the log sheets will be recorded and the necessary physical measurements and observations will be taken. An approximate time that the bottle will fill will be determined, and, depending on how much time is available, the next station will be visited or the team will wait until the bottle fills.

If the sample bottle is full, the system will be reset immediately, and the bottle replaced. When the bottle has been changed, the necessary station data will be filled in on Form I, Tab 6, in the *FGN*.

5.4.2 Sample Bottle Replacement

The removal of the sample bottle from the sampler requires great care; the bottles are heavy when full and are very slippery when wet, as well as being expensive and fragile. More importantly, if the sample is lost or contaminated, the effort and expense of the storm monitoring process is wasted. Two people will be present to ensure the security of the bottle and of the sample itself. Extreme care will be taken not to kink the intake hose when handling the sampler.

The bottle number will be recorded in the logbook and the bottle will be labeled appropriately. When a new bottle has been put in place, it will be re-iced and the sampler reset to continue sampling. Full bottles will be kept iced.

5.4.3 Storm Monitoring Office

The main objective of the Storm Monitoring Office is to update field crews on the status of their stations. This will greatly reduce the amount of time a crew will spend driving during storms. The monitoring of stations from a remote computer consists of calling each station and recording certain data for evaluation. When it is determined that a sampling system is close to filling a bottle, a field crew will be called and alerted to the status of the station. Remote interrogation of the storm stations will be logged using Form K of Tab 6 in the *FGN*.

Generally, the Storm Monitoring Office is also the storm control position. This means that critical decisions regarding the status of storm monitoring are made with input from the Storm Monitoring Office.

Therefore, this position requires awareness of the latest weather forecasts to make informed decisions on the continued monitoring of the storm.

5.4.4 Post Sampling Procedures

Declaring the end of a storm event may be difficult at an EDB as the basin may hold water for longer than 48 hours and effluent flow may continue out of the basin. Thus, storm events can overlap. If storm events begin to overlap, two criteria will be used to either continue sampling or end sampling. If the effluent has 75% storm capture or more and 8 or more sample aliquots, monitoring will stop and the stations will be shut down. If the effluent has less than 75% storm capture or less than 8 sample aliquots, the influent and effluent sampling will continue monitoring the event until the event stops raining.

After a storm event has ended, the stations need to be shut down. The station will be left ready for the next storm event in case there is insufficient time for a maintenance visit

between storms. The following items will be taken care of, and everything will be well documented in the field logbook.

1. The storm monitoring program will be reset to prepare for another storm event.
2. The sample bottle will be replaced and the sampler reset.
3. The station will be physically inspected to determine if any damage was sustained during the storm event. The flow sensor will be inspected to determine if it is blocked by debris, or the intake is clogged. (This is only possible if confined space requirements are met).
4. The data will be retrieved. This will be done via modem from the remote monitoring computer.
5. Battery voltages will be checked; batteries that are low will be replaced.
6. An Empirical Observation Checklist will be completed (Form H Tab 6 of the *FGN*) one time during the event.

Data Retrieval

Data will be retrieved (dumped) from the data logger after each storm event during the storm season, and, during dry weather, approximately every month.

Chain of Custody Forms

When the grab samples have been collected, the paperwork will be filled out to ensure a smooth transfer of samples to the analytical laboratory. Chain-of-custody forms will be filled out in detail describing the type of sample, the quantity of samples, and the time that the samples were collected. These forms will accompany the samples to the laboratory.

5.4.5 Evaluation

Upon termination of a storm event monitoring, evaluation of the influent and effluent stations' performance will be documented and reviewed before the samples collected are deemed valid. Evaluation of a monitoring station's performance is based on the answers to the following questions:

- Was the storm representative of the effectiveness range of the EDB?
- Was capture of peak flow or runoff achieved at both sampling points?
- Did the equipment perform as designed throughout the duration of the storm event?
- Did the samplers accurately collect equal and reliable storm sample aliquots?
- Did the EDB work as designed?

5.4.6 Grab Sampling

Total petroleum hydrocarbons (TPH) and bacteriological (fecal coliform) grab samples are unsuitable for collection by automatic means, and will be collected for two storms each monitoring year. TPH is inappropriate because some material adheres to the surface of the tubing and the composite sample container. Automatic sampling for bacteria is inappropriate because the sampling equipment is not sterile after installation and exposure to the elements. Because these analytes are unsuitable for collecting using an automated approach, they will be collected as a first-flush grab sample from both the influent and effluent during each monitored event.

It is imperative that collected grab samples are transferred to a designated meeting location immediately after the sampling has been completed. Chain-of-custody forms for the samples will be completed and transport of the samples to the analytical laboratory will be coordinated to ensure that samples are handled and analyzed within the proper holding times to the extent possible.

It is essential that the following sample handling protocols be followed when collecting grab samples to keep contamination to a minimum:

- Turn the vehicle engine OFF to minimize exposure of the sample to exhaust fumes.
- Keep sample containers in clean coolers until sampling is actually initiated.
- Store filled sample bottles in clean coolers at 4°C.
- Keep the bottle lid clean and free of debris while the bottle is open.

Grab samples will be collected as near to the sampling point as possible. When unable to collect a sample near the intake, one will be collected as near the center of flow as possible or in an area of sufficient velocity to ensure good mixing. Both sampling points require a grab pole to collect the necessary grab samples. Containers will be fitted snugly into the bottle holder and the bottles will be seated on the upstream side of the grab pole to reduce potential contamination. The bottle will be filled with the mouth of the bottle faced into the current, if possible. Also, the bottle will be labeled before it is filled as it is nearly impossible to write on wet bottles, the station will be listed on the bottle to coincide with the station sampled.

Each type of grab sample may require special treatment to ensure the quality of the sample and the safety of the sampler. The preservative in the sample bottles is usually a concentrated acid, so care will be taken that the preservative does not come into contact with the skin. Gloves will be worn when handling sample containers. Both types of grab samples are discussed below.

TPH analyses will be performed for diesel, gasoline, and oil fractions and reported separately for each. Samples to be analyzed for TPH gasoline fraction will be preserved with a concentrated acid (HCl), while TPH diesel and oil containers are unpreserved. The

sample bottles will be filled to below the neck and just above the shoulder. The bottle will not be overfilled because the preservative will be washed out. If the bottle is just slightly overfilled, a small amount of sample will be poured off after the preservative has mixed with the sample. A small amount of headspace is required in the containers to allow for expansion if the sample freezes while iced during shipping. These grab samples will be collected as soon as possible after runoff is detected.

Fecal Coliform samples are preserved with a small sodium thiosulfate tablet. To retain the tablet while sampling, it will be removed from the container when it is dipped into the flow. The bacteria bottle will be turned over causing the tablet to fall onto the cap of the bottle; the cap will be removed and set somewhere that will prevent it from becoming contaminated (out of the rain). The sample bottle will be filled to the shoulder, the cap tipped so the tablet falls into the sample and the cap secured to the bottle. Storm control will direct the field crews as to when to collect this grab sample.

Attempts will be made to maintain the 6-hour holding time for bacteria to the extent practical. However, storm field conditions and safety concerns may prove this holding time infeasible. A maximum holding time of 24 hours will be followed, in accordance with "Standard Methods for the Examination of Water and Wastewater," 18th Edition.

5.5 Sample Tracking and Handling

Samples, regardless of their matrix, will be kept properly chilled and transferred to the analytical laboratory within holding times to achieve the highest quality data possible. To ensure proper tracking and handling of the samples, documentation will accompany the samples from the initial pickup to the final extractions and analysis. This documentation includes: Chain-of-Custody Forms (see Form M of Tab 7 in the *FGN*). These forms or equivalent will be used to track and handle samples.

Collected samples will be labeled with the following information:

- Project name.
- Date.
- Time.
- EDB name and number.
- Sampling location.
- Preservative.
- Collector's initials.
- Sample I.D. number.
- Analyte(s) to be analyzed.
- Grab or composite sample

The analytical suite for each station depends upon the total volume of water collected for the storm event. A Priority Analysis Sheet will be used in conjunction with a Sample Bottle Evaluation to determine the analytical suite for each station, based on the volume of water collected at that station, the volume to sample, and the percent storm capture.

Duplicate and QA/QC samples will be collected for the media sampled, where possible. Duplicate and QA/QC samples will be prepared from the volume of the sample collected. The crews collecting the samples will be fully briefed on the procedures for collecting QA/QC samples, and will be familiar with the sample identification numbering scheme for these samples because they are to be submitted to the laboratory as blind samples. These samples will be labeled, recorded on the Chain-of-Custody Form, and transported to the analytical laboratory.

Grab samples will be transported to the appropriate laboratory as soon as the grab sampling is completed, whereas the sample bottles for composite samples are transferred at the end of the storm event. Samples will be properly logged on the chain-of-custody form and kept chilled in coolers. There will also be a field duplicate and extra water collected for QA/QC samples. These QA/AC grab samples will be collected at one of each consultant's BMPs during each storm event monitored. The sampling stations will be selected by Storm Control for collecting the duplicate grab samples. The crews monitoring the stations will be fully briefed on the procedures for collecting QA/QC samples, and will be familiar with the sample identification numbering scheme for these samples because they are to be submitted to the laboratory as blind samples. These samples will be labeled, recorded on the chain-of-custody form, and transported to the analytical laboratory.

Each sample collected will receive a unique alphanumeric code (sample I.D. number) for tracking. This code will be standard for samples and contain information as to the station, date, and sequential monitoring event number. The following is an example of this code:

SITE No.-IN-32898-001

Where:

Site No. = Site number of BMP site.
IN = Influent sampling point at the site; EF = effluent sampling point.
32898 = Julian day and year
001= First storm event monitored during this program at this location

If multiple bottles are used or needed, the last data field will indicate the bottle number and the total bottles in that sampling event (i.e., 001-1/3, 001-2/3, 001-3/3 for a three-bottle collection scheme).

A set of QA/QC samples will be provided with each type of sample. The analytical laboratory may also require additional QA/QC samples if one type of analysis is to be run in more than one batch.

Duplicate and QA/QC samples will be analyzed for the same standard analytes as the field samples. Most field QA/QC samples are submitted blind to the analytical laboratory, however, additional sample volumes provided to the laboratory for laboratory replicates or matrix spikes and matrix spike duplicates will be clearly identified. The main types of QA/QC samples that will be utilized for this study are as follows:

Duplicate Analyses - These analyses will be performed on one sample each monitoring year (i.e., 1998/1999 and 1999/2000) and will require an additional set of sample containers. Duplicate samples will be analyzed for the full list of analytes. The results will allow evaluation of sampling error introduced by both field sampling and laboratory analyses by showing the reproducibility of the sample collection and analyses. Duplicate samples will be sent "blind" to the laboratories.

Duplicate samples will be identified by adding 500 to the sequential storm event number. For example, a duplicate sample for the site identified above will be:

SITE No.-IN-32898-501

Blanks - These are for field as well as laboratory samples. Blanks help verify that the equipment and the sample containers are not contaminated, and the sampling techniques used are non-contaminating. Core soil and surface sediment collection equipment will be rinsed with reagent grade analyte free deionized water separately. The collected rinsates will be analyzed for the full list of analytes for the primary samples. Blanks will also be run on the analytical equipment. Rinsate blanks will be run on two samplers used by each consultant at one of their BMPs prior to the installation of the equipment. Each time a batch of composite bottles is cleaned, five percent of those bottles will be blanked. Each time a batch of filters is purchased five percent of those filters will be blanked.

Equipment rinsate blanks will be identified by adding 600 to the sequential storm event number. For example, an equipment rinsate blank collected from the monitoring equipment from the site identified above will be:

SITE No.-IN-32898-601

Field blanks will be identified by adding 700 to the sequential storm event number. For example, a field blank collected at the site identified above will be:

SITE No.-IN-32898-701

Matrix Spike and Matrix Duplicate Spike (MS/MSD) - The laboratory will require additional sample volumes for analyses that require matrix spikes and matrix spike duplicates to evaluate precision and accuracy of the laboratory analytical method, and to evaluate any matrix interference. MS/MSDs are analyzed for their analyte(s) and then spiked with a known amount of analyte(s). One MS/MSD sample will be run on metal samples collected during each event sampled, if enough sample volume has been collected.

MS/MSD samples will be indicated on Chain-of-Custody Forms by clearly identifying that the sample is for MS/MSD purposes.

Laboratory Replicate/Split - This QA/QC analysis will require additional sample volumes. It is a duplicate analysis performed on the same sample and evaluates the repeatability (precision) of the analytical laboratories' results. One split sample will be run from one of each consultant's BMP sampling locations during each storm event sampled and analyzed for the full list of analytes.

Laboratory replicate/split samples will be indicated on chain-of-custody forms by clearly identifying that the sample is for laboratory replicate/split sample purposes.

5.6 Laboratory Selection, Sample Container Preparation, and Analytical Methods

5.6.1 Laboratory Selection

The selected laboratories have extensive experience with environmental samples and have the ability to provide expeditious analysis. Selected laboratories are certified by the California Department of Health Services for the requested analyses. Refer to Tab 2 in the *FGN* for specific laboratory listings.

5.6.2 Holding Times, Sample Bottles, and Preparation

The laboratories will be responsible for providing appropriate sample containers, and when necessary, with preservatives for each analysis. Table 5.1 provides a summary of sample volumes required for each analysis, along with the types of containers, holding times, and preservative. Because additional volumes are necessary for laboratory QA/QC, sample containers will provide at least twice the volume necessary to perform the requested analysis. The volume of the stormwater composite from each site is often the critical factor in determining the volume of sample that can be provided to the laboratory. The Project Task Order Manager and/or Storm Control personnel, in conjunction with the laboratories, will determine the allocation of sample volume for different analyses if sample volumes are not adequate to provide additional volume for each analysis. Table

5.1 lists the analyses along with a priority ranking. Also listed in Table 5.1 are the analytical methods and reporting limits.

5.6.3 Project Reporting Limits

Recommended analytical methods and reporting limits for this project are listed in Table 5.1. The reporting limits in this table are target reporting limits. In some cases, reporting limits may need to be adjusted due to limited sample volumes or potential matrix interference. In such cases, appropriate data qualifiers will be applied to the associated data.

5.6.4 Laboratory Data Package Deliverables

Laboratories will be required to provide a three-week turnaround on deliverables. The deliverable package will include a hard copy and electronic data files. The hard copy will include standard narratives identifying any analytical or QA/QC problems and corrective actions. The electronic data files will contain information found in the hard copy reports submitted by the laboratories. Individual data sets will be submitted as either Microsoft Excel workbook files or as Microsoft Access database files in accordance with the Caltrans Data Management Plan – Data Reporting Protocol and Database (CTSW-TM-98-005). Each consultant will be responsible for laboratory coordination and data management.

5.7 Sediment Sampling

As part of the maintenance program, sediment will be removed from the BMP when flows are hydraulically impeded. It is anticipated that sediment will accumulate relatively slowly over time. However, should sediment deposit in a rapid manner, an intermediate step of stockpiling may become necessary before offsite disposal. Section 5.7.1 provides procedures to be used when assessing potential sediment contamination in the event intermediate onsite storage is necessary.

This section describes the sample collection procedures and analyses for assessing the quality of sediment removed from an EDB for disposal. Evidence of oil and grease, antifreeze, solvents, fuel, hydrogen sulfide, and any other noxious substance will be noted. Observations will be used to determine if more than the standard list of analytes is required. Observations will be documented on a checklist form (Form G in the *FGN*). The standard list (Table 5.2) is based on highway contaminants that have the potential to exceed hazardous waste criteria. After laboratory analysis, results will be compared to regulatory limits listed in California Code of Regulations (CCR) Title 22, Section 66261.24 and Department of Toxic Substances Control (DTSC) variances. Based on this evaluation, proper disposal methods will be chosen.

Table 5.1
Stormwater Matrix
Analytical Parameters, Methodologies, Reporting Limits, Holding Times, Container Volumes and Types, and Preservation

Analyte	Priority Rank	Reporting Limit	Units	Analytical Technique	Method Number	Holding Time	Minimum Sample Volume	Preferred Volume and Container Type[1]	Preservation
Conventionals									
pH	1	0.1	Unit	Electrode	EPA 150.1	Immediately[2]	100 mL	1-100 mL glass/plastic	4°C
Specific Conductance	1	1.0	µmhos/cm	Electrometric	EPA 120.1	Immediately[2]	500 mL	1-500 mL glass/plastic	4°C
Hardness	5	2	mg/L	Titrimetric/ Colorimetric	EPA 130.2	6 months	100 mL	1-200 mL glass/plastic	HNO_3 to pH<2, 4°C
Total Suspended Solids	1	1	mg/L	Dried Filter Weight	EPA 160.2	7 days[3]	1 L	1-500 mL glass/plastic	4°C
Nutrients									
Nitrate-Nitrogen	2	0.01	mg/L	Colorimetric Ion Chromatography	EPA 353.3 EPA 300.0	28 days 48 hours	200 mL 200 mL	1-500 mL plastic 1-500 mL plastic	4°C and H_2SO_4 to pH<2 4°C
Total Kjeldahl Nitrogen	3	0.1	mg/L	Titrimetric/ Colorimetric	EPA 351.3	28 days	500 mL	1-1L plastic	4°C and H_2SO_4 to pH<2
Total Phosphorus	4	0.002	mg/L	Colorimetric	EPA 365.3	28 days	100 mL	1-250 mL plastic	4°C and H_2SO_4 to pH<2
Total/Dissolved Metals[4],[5]									
Copper	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Lead	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Zinc	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Organics[6]									
Total Petroleum Hydrocarbons – Diesel/Oil	Grab	250/200	µg/L	GC	EPA 8015M	14 days	1 L	2-1L amber glass	4°C
Total Petroleum Hydrocarbons - Gasoline	Grab	50	µg/L	GC	EPA 8015M	14 days	2-40 mL	3-40 mL VOA vials	4°C, HCl to pH<2
Bacteria[6]									
Fecal Coliform	Grab	2	MPN/100 mL	Multiple-tube	SM 9221E	6 hours[7]	50 mL	1-100 mL plastic	4°C

1. Analytes with the same preservative can be combined into a single container if the same laboratory is performing the analyses.
2. pH and Specific Conductance will be measured by the laboratory immediately upon receipt of the samples.
3. 7 days based upon limit for measuring TSS/no regulatory limit.
4. Total and dissolved metals samples are collected in separate containers. Only the total metals container will receive nitric acid.
5. Dissolved metals will be filtered in the laboratory prior to acidification.
6. Total Petroleum Hydrocarbon and Fecal Coliform grab samples will be collected for two storms per year.
7. Attempts will be made to maintain the 6-hour holding time for bacteria samples to the extent possible. When not possible, a maximum holding time of 24 hours will be followed in accordance with "Standard Methods for the Examination of Water and Wastewater," 18th Edition.

5.7.1 Sediment Collection

Procedures in EPA Publication *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)* provide a method for determining the mean concentration of a given contaminant within a soil mass and the appropriate number of samples necessary to calculate this mean to the specified confidence interval. Initial sampling will generate a minimum number of samples/analyses as described below. Additional sample analyses may be required to meet the confidence levels given in *SW-846*, therefore archiving of samples will be necessary. Archived samples will be appropriately preserved and analyzed within the maximum holding time specified in Table 5.2. None of the samples will be allowed to be composited. The Quality Assurance/Quality Control (Appendix III) describes the QA/QC objectives for sediment samples. The minimum number of discrete samples initially required is given below:

- Drums: A minimum of one sample will be collected from each drum.
- Stockpiles less than 10 cubic yards: A minimum of two samples will be collected, one from each half of the stockpile. Sampling points will be selected randomly within each half.
- Stockpiles from 10-20 cubic yards: A minimum of three samples will be collected, one from each third of the stockpile. Sampling points will be selected randomly within each third.
- Stockpiles from 20-100 cubic yards: A minimum of four samples will be collected, one from each quarter of the stockpile. Sampling points will be selected randomly within each quarter.
- Stockpiles from 100-500 cubic yards: A minimum of one sample for each 25 cubic yard portion will be collected. The stockpile will be sectioned into 25 cubic yard portions to obtain a minimum of one sample for each 25 cubic yard portion. Sampling points will be selected randomly within each 25 cubic yard portion of the stockpile.

Random samples will be selected from locations on a three-dimensional grid. If the presence of materials such as boulders, debris, etc. hinder this process, the sample will be collected as close as possible to the randomly selected point without altering the essence of the random selection process. The following steps will be used to collect sediment samples:

1. Don personal protective equipment.
2. Locate the sample point in the stockpile or drum.
3. Collect the sample using a soil probe or equivalent. Ensure that the sample is collected at the correct depth and location that was randomly selected.
4. Fill one 8-ounce glass jar with a portion of the sample and close the container with the cap, using care not to aerate (volatilize) the sample. This jar will be labeled and analyzed for TPH and VOC.

5. Homogenize the other portion of the sample in a disposable bowl using a disposable spatula or spoon. Fill a second 8-ounce glass jar with this portion of the sample and close the container with the cap. This sample will be labeled and analyzed for metals.
6. Wipe the outside of each sample container with a clean paper towel.
7. Record the sampler's initials, date, and time on the pre-labeled sample bottle.
8. Place the sample containers in individual zip-top plastic bags and seal the bags.
9. Immediately pack the samples into a chilled cooler.
10. Record the required information on the Chain-of-Custody Form.
11. Document the sampling event, recording information in the designated field logbook.
12. Repeat the above steps until the minimum number of samples has been collected.

5.7.2 Sediment Analyses

Unless observations indicate additional testing, sediment samples submitted to the laboratory will be analyzed for the list of analytes in Table 5.2 using CCR, Title 22 criteria (State of California, 1985). This table also lists the required reporting limits, analytical holding times, required preservation, and container sizes and types. Laboratory turn around times and data deliverables will be same as those for the stormwater samples.

5.8 Empirical Observations

5.8.1 Purpose of Empirical Observations

Performance assessments of BMP facilities cannot be fully ascertained through analytical methods. "Empirical" observations are also critical in determining the overall performance of implemented water quality management practices and in ensuring that the practices are maintained at optimum levels. Other factors such as maintenance activities, environmental variability, and physical processes, which cannot be determined analytically, can greatly influence the performance of a particular BMP. Some of these factors such as rainfall quantity, rainfall intensity, and basin retention times can, and, will be assessed through physical measurements. Other components such as trash build-up, sediment deposition, and runoff appearance can best be assessed through careful documented observations.

Table 5.2
Sediment Matrix (Disposal)
Analytical Parameters, Methodologies, Reporting Limits, Holding Times, Container Volumes and Types, and Preservation

Parameter	Method	Units	Reporting Limit	Maximum Holding Time	Preservation	Container Size/Type(1)
Total Petroleum Hydrocarbons (TPH)	EPA 418.1	mg/kg	10	28 days	$4^{o}C$	8 oz glass jar
Volatile Organic Compounds	EPA 8260B	mg/kg	SW – 846 (5) requirements	14 days	$4^{o}C$	8 oz glass jar
California Code of Regulations (CCR), Title 22 Metals(2):	EPA 6020/7471	mg/kg	SW – 846 (5) requirements	180 days 28 days for mercury	$4^{o}C$	8 oz glass jar
California Code of Regulations (CCR), Title 22 Waste Extraction Test (WET) Metals(3):	STLC Extraction	mg/L	SW – 846 (5) requirements	180 days 28 days for mercury	$4^{o}C$	NA
Toxicity Characteristic Leaching Procedure (TCLP) Metals(4):	TCLP 1311	mg/L	SW – 846 (5) requirements	180 days 28 days for mercury	$4^{o}C$	NA

(1) Each sample will be collected in two 8 oz glass jars
(2) California Code of Regulation (CCR), Title 22 Metals (Sb, As, Ba, Be, Cd, Cr (total), Co, Cu, Hg, Pb, Mo, Ni, Se, Ag, Tl, V, and Zn). Initial waste characterization results may lead to a shorter list of metals for subsequent sediment disposal.
(3) Any sample for total metals that are below the Total Threshold Limit Concentration [TTLC] but exceed the ten times Soluble Threshold Limit Concentration (STLC) will be further analyzed using the WET procedure. WET extracts will be analyzed only for metals which exceed the ten times STLC criteria. Sediments associated with total metal results that exceed TTLC values are automatically considered hazardous and therefore do not need to undergo the WET procedure.
(4) If any of the WET-soluble concentrations are equal to or greater than the TCLP regulatory thresholds, analyze the waste by TCLP. "Test Methods for Evaluating Solid Waste, Physical /Chemical Methods". SW-846, Update III.(SW-846)

5.8.2 Guidelines

Observations will be succinct but also complete. For an EDB performance evaluation, the following observations will be taken at the influent location, basin, and effluent location:

- Rainfall (start and end times, time since last rain, and intensity indication)
- Water level
- Visual evidence of short circuiting of basin flow (for wet weather visits)
- Description of amount and location of sediment accumulation in basin
- Evidence of scouring or resuspension near basin inlet (operation of energy dissipators)
- Water quality appearance (visual, olfactory) to make a rough assessment of changes in water quality.
- Predominant type of litter found in basin
- Change in litter accumulation and location since previous visit
- Condition/clogging of outlet structure
- Evidence of erosion in natural channels below basin outfall
- Condition of basin floor/ formation of low areas with permanent pools
- Degree and type of vegetation establishment in the basin
- Stability of basin slopes/evidence of erosion
- Condition of vegetation surrounding basin
- Evidence of vandalism of equipment or basin structures
- Presence of unpleasant odors

5.8.3 Checklist for Sampling and Monitoring Personnel

Form H in Tab 6 of the *FGN* provides a checklist (log form) that will be completed by sampling and monitoring personnel during each storm event visit to the facility.

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CALTRANS
BMP RETROFIT PILOT PROGRAM

DISTRICT 11, SAN DIEGO

BMP OPERATION, MAINTENANCE, AND MONITORING PLAN

VOLUME II

APPENDIX I-B
INFILTRATION BASINS

September 1999

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TABLES

2.1 Waste Disposal Services in Southern California

5.1 Groundwater Matrix (Groundwater Monitoring Well) Analytical Parameters, Methodologies, Reporting Limits, Holding Times, Container Volumes and Types, and Preservation

5.2 Soil and Sediment Matrix for BMP Performance Evaluation Analytical Parameters, Methodologies, Reporting Limits, Holding Times, Container Volumes and Types, and Preservation

5.3 Sediment Matrix for Disposal Purposes Analytical Parameters, Methodologies, Reporting Limits, Holding Times, Container Volumes and Types, and Preservation

FIGURES

1.1 Overview of an Infiltration Basin

1.0 INTRODUCTION

The Caltrans Best Management Practice (BMP) Retrofit Pilot Program is a comprehensive water quality monitoring study to evaluate the removal of contaminants in stormwater runoff from Caltrans roads and facilities through a series of BMP pilot installations. The overall objectives of this portion of the program are to document BMP contaminant removal efficiency and technical feasibility.

This Appendix of the Operations, Maintenance, and Monitoring Plan (OMM) applies to the Infiltration Basin (IB). Refer to the consultant's monitoring equipment manuals and stormwater monitoring Standard Operating Procedures (SOPs) for details related to equipment installation, equipment maintenance, and storm monitoring. Maintenance, safety, documentation, and storm monitoring tasks will be carried out according to the procedures detailed in this plan. Additional measures may be necessary due to unforeseen or temporary changes to the work environment at these sites.

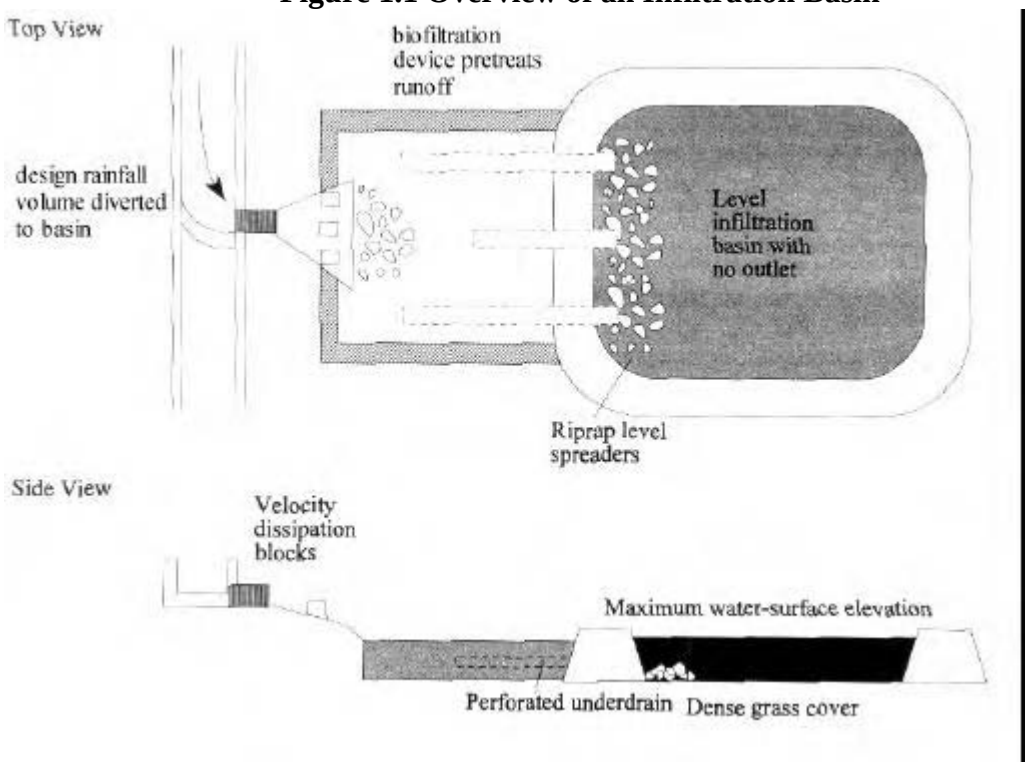
1.1 Retrofit BMP Description

An IB is a depression used to detain stormwater for short periods until it percolates to the groundwater table or dissipates through evapotranspiration. Properly maintained IBs are expected to become dry between storms.

An IB functions as a BMP through filtration of runoff and adsorption of pollutants using site vegetation and soils. IBs containing a level invert, healthy vegetation, and permeable soil properties are ideal. Based on site geology and groundwater depth, a groundwater well will be used at the District 11 IB to determine if pollutant removal mechanisms have an impact on the groundwater.

Runoff fills an IB until it reaches capacity. Afterwards, runoff either bypasses the facility or discharges through a spillway. Energy dissipaters are designed into IBs in order to reduce runoff velocities entering the basin, trap sediments, and spread the runoff evenly throughout the basin floor. The IBs for the BMP Retrofit Pilot Program have been designed to collect runoff from up to 1-year, 24-hour storm events.

Figure 1.1 Overview of an Infiltration Basin



1.2 Evaluating BMP Performance

To effectively evaluate the performance of an IB pilot facility, the following objectives will be met:

- Determine the quantity of runoff treated by the BMP.
- Determine basin level fluctuations and degree and rate of infiltration.
- Determine and document the level of effort required to maintain the BMP at optimal effectiveness (i.e., treatment of stormwater runoff for storm events producing up to the 1-year, 24-hour peak flow).
- Determine and document the level of effort required to control vectors of human disease and nuisance insects, rodents, and vegetation at the BMP.
- Determine effects, if any, on the groundwater.
- Determine the concentration of pollutants removed through deposition.
- Determine and document BMP performance evaluation criteria relative to the qualitative benefits of the BMP.

An IB infiltrates stormwater to the subsurface, resulting in disallowing stormwater runoff to discharge to receiving waters. Thus, the effectiveness of an IB is related to the rate or efficiency of infiltration. To determine infiltration efficiency, the water level within the basin will be constantly monitored. Since surface sediment deposition affects infiltration

rates, deposition rates will also be monitored along with the concentration of pollutants removed through deposition.

The effectiveness of an IB is also related to the implementation of maintenance procedures and the documentation of empirical observations. Items such as erosion and bank stability, maintenance of storage volumes, trash build-up, clogging, and vegetative health may directly affect the performance of an IB.

An IB contains ponded water for varying periods of time. As such, the potential to produce vectors of human disease and nuisance insects, rodents, and excessive vegetation exists.

1.3 Deployment Criteria

Stormwater samples will be collected from the IB for up to eight storm events over ~~a~~ two wet seasons, weather permitting. Storms targeted for sampling will be separated by a minimum of 48 hours (72 hours preferably). This facility will be inspected per the guidelines given in Section 4.0 of the *Field Guidance Notebook* (*FGN*), which include a mandatory inspection after every storm greater than 0.50 inch.

Based on the rainfall requirements needed to generate monitorable flows in and out of the pilots, Caltrans has developed a refined monitoring team deployment criteria. The refined deployment criteria defines when to chase storms based on season, storm forecasts, and the current count of successfully monitored storms.

The deployment season, in which monitoring teams remain "on-call" and fully staffed, will be restricted to the portion of the year when rainfall is most probable and better predictable. Summer showers are not seen as predictable events, and dry watersheds and BMPs will retain more water which results in less effluent.

The deployment season will start on October 1. The season shall end after 3 weeks of dry weather where less than 0.2" of rainfall occurs in the San Diego area, but end no sooner than April 1 and not later than May 30th. This approach will provide a plan that adjusts to wet or dry springs.

The following criteria will decrease false starts, while allowing teams to continue to chase storms based on promising storm forecasts. The criteria will be used for pilots, regardless of drainage area size or land use.

“Forecast-Unlikely” set to less than 0.25” rain and less than 50% probability, (Decision = "No Go")

“Forecast-Highly Probable” set to 0.25” or greater and greater than 75% probability. (Decision = "Go")

Forecast information will be gathered as indicated in the OMM manuals (e.g., internet sources). As always, if conditions happen to allow paired samples to be successfully taken for any storm larger than 0.1", that sampling would be considered as a successful event, which would count towards fulfilling Scoping Study requirements.

When a specific pilot is successfully monitored for the total required storms per the applicable Scoping Study, the decision to further deploy to monitor that pilot will fall to Caltrans and no commitment to monitor beyond the terms of the Scoping Studies can be made at this time.

1.4 Data Collection and Compilation

1.4.1 Data Requirements

The following data will be collected to assess the performance and maintenance aspects of an IB:

- Continuous basin level data, recorded as a function of time, from rainfall events during the study period.
- Rainfall data, recorded as a function of time, from rainfall events during the study period.
- Determine the quantity of runoff treated by the BMP.
- Documentation of inspection and maintenance records.
- Determine basin level fluctuations and degree and rate of infiltration.
- Empirical observations of stormwater runoff and BMP performance, etc.
- Determine and document the level of effort required to maintain the BMP at optimal effectiveness (i.e., treatment of stormwater runoff for storm events producing up to the 1-year, 24-hour peak flow).
- Vegetation management records.
- Determine and document the level of effort required to control vectors of human disease and nuisance insects, rodents, and vegetation at the BMP.
- Determine effects, if any, on the groundwater.
- Determine the concentration of pollutants removed through deposition.

1.4.2 Data Management

Consultants will be responsible for data management. Overall management of the data will be consistent with established Caltrans procedures for stormwater monitoring projects and this manual.

The consultant’s Sample Control Section will be responsible for tracking the analytical process to assure that laboratories are meeting the required turnaround times and are providing a complete deliverable package. Sample Control will also be responsible for accumulating copies of site visit logs, inspection logs, facility maintenance records,

vector control sampling data, and logged rainfall and hydrographic data. Sample Control will receive the original hard and electronic copies from the laboratory, system managers, and field crews, and verify completeness and log dates of receipt. A copy of the data sets and log sheets will be filed in Sample Control's central filing system and another copy will be provided to the consultant's Database Manager. The originals will then be transferred to the Task Order Manager and filed with other project documentation to maintain complete project records.

Laboratories, system managers, and vector control crews will provide data in both hard copy and electronic formats. The forms of electronic submittals will be provided to the laboratories to ensure that the files can be imported into the project database with a minimum of editing. A relational database will be used for data. Laboratory data will be maintained and managed using Microsoft Excel® and Microsoft Access®. Files from the basin level monitoring station data will be stored in the same database system and be linked to the laboratory database (core soil, surface sediment, and groundwater) analytical results. The basin level files will include rainfall data. Site characteristics will be stored in a separate file and linked to both the chemical and basin level files to enable useful data queries. Site characteristics will be stored in a separate file and linked to both the chemical and sampling system files to enable useful data queries.

Data will be submitted to Caltrans in accordance with "Caltrans Statewide Data Management Plan—Data Reporting Protocol and Database," a technical memorandum dated 23 April 1998 from Larry Walker Associates to Task Order Managers.

1.4.3 Data Analysis

Descriptive statistics and statistical comparisons between baseline and storm season groundwater monitoring data will be performed to characterize subsurface impacts. Constituent concentrations will be measured for each water quality parameter from each sampling episode.

Annual surface sediment quality data will be used to estimate total pollutant removal through deposition. Empirical observations, maintenance activities, and vector control activities will be compiled and compared to groundwater and surface sediment quantity data (see Appendix IV for vector control).

1.5 Encroachment Permit and Restrictions

Visitation to an IB requires a Caltrans Encroachment Permit. A copy of the IB permit is located in Tab 9 of the *FGN*. This permit lists access and safety requirements along with any restrictions. The respective Caltrans District Encroachment Permit Office will be contacted for further information and direction (phone numbers can be found under Tab 2 in the *FGN* portion of the Volume II OMM Plan).

2.0 OPERATION AND MAINTENANCE

2.1 Operation and Maintenance Needs

The operational and maintenance needs of an IB are:

- Maintenance of healthy grass communities to enhance infiltration of stormwater runoff.
- Maintenance of grass height at approximately 12 in, with subsequent removal of trimmings
- Removal of excessive fine grain surface sediment deposits that clog the IB, measure greater than 18 inches in depth, take up 10% of the storage volume, or destroy the vegetation.
- Dispersion of alluvial sediment deposition at inlet structures thus limiting the extended localized ponding of water.
- Timely repair of embankments and slopes. Contributing drainage areas will be kept stabilized.
- Erosion repair.
- Monitoring of episodic oil and grease clogging and subsequent removal of contaminated surface sediment which threatens the health of the vegetation.
- Removal of standing water which may contribute to the development of aquatic plant communities or mosquito breeding areas (see Appendix IV for details). If standing water remains in the IB for more than 72 hours, then maintenance is required. The cause of the standing water will be determined. Some possibilities are:
  1. Clogging: when the facility is dry, sediments will be removed.
  2. Seasonal water table conditions: an outlet system may be required to be retrofitted if the problem is not transient.
- Removal of graffiti, grass trimmings, and debris, weed control, and painting.
- Preventive maintenance on monitoring equipment.

2.2 Inspection Frequency

The facility will be inspected and inspection visits will be completely documented at the following frequencies (refer to Section 2.8):

- Once a month at a minimum.
- After every large storm (after every storm monitored or those storms with more than 0.50 inch of precipitation).
- On a weekly basis during extended periods of wet weather.

2.3 Aesthetic and Functional Maintenance

Aesthetic maintenance is important for public acceptance of stormwater facilities. Functional maintenance is important for performance and safety reasons.

Both forms of maintenance will be combined into an overall Stormwater Management System Maintenance Program. Maintenance activities will be carried out by the consultant. Maintenance items are included in the checklist/logs found in the *FGN*. Maintenance activities will conform to practices specified in this manual.

2.3.1 Aesthetic Maintenance

The following activities will be included in the aesthetic maintenance program:

- **Graffiti Removal.** Graffiti will be removed in a timely manner to improve the appearance of the IB and its related monitoring equipment, and to discourage additional graffiti or other acts of vandalism.
- **Grass Trimming.** Trimming of grass will be done around fences and sampling structures.
- **Weed Control.** Weeds will be removed through mechanical means. Herbicides will not be used because these chemicals may impact the water quality monitoring. More specifics on vegetation management are given in Section 4.0.

2.3.2 Functional Maintenance

Functional maintenance has two components:

1. Preventive maintenance
2. Corrective maintenance

Preventive Maintenance

Preventive maintenance that will be done on a regular basis is detailed in the checklists in Section 2.8. Preventive maintenance activities to be instituted at an IB are:

- **Trash and Debris.** During each inspection and maintenance visit to the site, debris and trash removal will be conducted.
- **Sediment Removal**. Surface sediments will be removed when sediment accumulation is greater than 18-inches or 10 percent of the basin volume, whichever is less. Vegetation removed with any surface sediment excavation activities will be replaced through reseeding. Disposal of sediments is discussed in Section 2.6 and will comply with applicable local, county, state, or federal requirements.
- **Sediment Management.** Alluvial deposits at the inlet structures may create zones of ponded water. Upon these occurrences, these deposits will be graded within the IB to

maintain the functionality of the BMP. Sediment grading will be accomplished by manually raking the deposits.

- **Vegetation.** 90% coverage of bare soil with native grasses will be maintained in an IB at a height of approximately 12 in.
- **Mechanical and Electronic Components.** Regularly scheduled maintenance will be performed on fences, gates, locks, and sampling and monitoring equipment in accordance with the manufacturers' recommendations. Electronic and mechanical components will be operated during each maintenance inspection to assure continued performance.
- **Fertilization and Irrigation**. The vegetation seed mix has been designed so that fertilization and irrigation are not necessary. Therefore, fertilizers and irrigation will not be used to maintain the vegetation cover. If the vegetation does not survive without fertilization and irrigation, then Caltrans will work with the Plaintiff to discuss options for maintaining the BMP.
- **Elimination of Mosquito Breeding Habitats.** The most effective mosquito control program is one that eliminates potential breeding habitats. Mosquito control measures are discussed further in Appendix IV.

Corrective Maintenance

Corrective maintenance is required on an emergency or non-routine basis to correct problems and to restore the intended operation and safe function of an IB. Corrective maintenance activities include:

- **Removal of Debris and Sediment.** Visibly contaminated surface sediment, debris, and trash, which threaten to clog the facility or destroy its vegetation, will be removed immediately and properly disposed of (refer to Section 2.6). Temporary arrangements may be necessary for handling the sediments until a permanent arrangement is made.
- **Removal of Standing Water.** Standing water (for more than 72 hours) will be removed to minimize the risk of development of aquatic plant communities or mosquito breeding areas.
- **Structural Repairs.** When necessary, repairs to structural components of an IB will be made promptly (e.g., within ten working days). Qualified individuals (i.e., the designers or contractors) will conduct repairs where structural damage has occurred.
- **Embankment and Slope Repairs.** When necessary, damage to the embankments and slopes of IBs will be repaired promptly (e.g., within ten working days).
- **Elimination of Mosquito Breeding Areas.** Consult Appendix IV for controlling mosquitoes.
- **Elimination of Trees and Woody Vegetation.** Woody terrestrial and wetland vegetation (which consists of willows (*Salix spp*.) mule fat (*baccharis salicifolia*), cottonwood (*populus fremontii*), western sycamore *(plantanus racemoa*) and emergent large stature monocots (including the genera *Cyperus, Juncus, Scirpus*, and

Typha) will be removed from embankments and inverts. See Section 4.0 for further information on vegetation management.

- **Erosion Repair.** Where a reseeding program has been ineffective, or where other factors have created erosive conditions (i.e., pedestrian traffic, concentrated flow, etc.), corrective steps will be taken to prevent loss of soil and any subsequent danger to the performance of an IB. There are a number of corrective actions that can be taken. These include erosion control blankets, riprap, sodding, or reduced flow through the area. Designers or contractors will be consulted to address erosion problems if the solution is not evident.
- **Fence Repair.** Fence repair will be done promptly (e.g., within the next ten working days).
- **Elimination of Animal Burrows.** Animal burrows will be filled and steps taken to remove the animals if burrowing problems continue to occur (filling and compacting). If the problem persists, vector control specialists will be consulted regarding removal steps. This consulting is necessary as the threat of rabies in some areas may necessitate the animals being destroyed rather than relocated. If the BMP performance is affected, abatement will begin immediately according to the directions in Appendix V. Otherwise, abatement will be performed annually in September.
- **General Facility Maintenance.** In addition to the above elements of corrective maintenance, general corrective maintenance will address the overall facility and its associated components. If corrective maintenance is being done to one component, other components will be inspected to see if maintenance is needed.

2.4 Maintenance Frequency

The maintenance indicator document, included as Appendix V, lists the schedule of maintenance activities to be implemented at an infiltration basin.

2.5 Equipment, Resources, and Tools Needed

The following resources, equipment, and tools are needed by inspection personnel:

- A Locke level or other surveying equipment.
- Industrial strength flashlight.
- Crowbar.
- Tape measure and other measuring device (e.g., survey rod) to determine surface sediment accumulation depths.
- Local erosion, sediment control, or stormwater management handbooks.
- Trash removal equipment.
- Sediment manipulation/removal equipment (e.g., shovels, rakes, 5-gallon buckets).
- Rain and foul weather gear and other personal protective equipment (PPE).
- This Appendix and *FGN*.
- Copies of necessary inspection reports and forms.

- Encroachment permit.
- Business cards or other identification.
- Camera to document field conditions.
- Orange vest and hardhat.
- Maintenance logs.
- Leather gloves.
- Safety glasses.
- Safety boots.
- Pen or pencil.

Except for the items contained onsite, the maintenance contractors will supply equipment, tools, and resources required for maintenance activities at an IB. At a minimum, these contractors will supply the following:

- Earth moving equipment (loaders, backhoes, graders, draglines, and vacuum equipment).
- Dump trucks, equipment transports, and other hauling equipment.
- Shovels, picks, rakes, wheel barrels, and other hand tools.
- Pumps.
- Mechanics tools.
- Concrete tools.
- Vegetation maintenance equipment (hand and tractor lawn mowers, gas trimmers, seed spreaders, leaf blowers, chain saws, pruning sheers, hedge trimmers, and wood chippers).
- Painting equipment (brushes, rollers, and sprayers).
- Locke level or survey equipment, tape measures, and sediment probes.
- Safety equipment (gloves, boots, hard hats, reflective vests, safety glasses, traffic control lighting, and confined space entry equipment).
- Camera with film.

To be supplied by consultant to the maintenance contractors:

- This Appendix, *FGN* and approved BMP facility plans.
- Encroachment Permit.
- Logbook containing Maintenance Logs.

No items for maintenance and inspection activities will be left onsite.

2.6 Debris and Sediment Disposal

Waste generated at IBs is ultimately the responsibility of Caltrans because they are the owner/generator. Consultants responsible for operating, maintaining, and monitoring the

IBs will be responsible for removal, testing, and disposal of waste material. Disposal of sediment, debris, and trash will comply with applicable local, county, state, and federal waste control programs. Table 2.1 shows a few possible disposal services for waste material.

Table 2.1
Waste Disposal Services in Southern California

Laidlaw / Rollins (OPC) 5765 Alba Street Los Angeles, CA 92011 Ph: (213) 585-5063 Fax: (213) 589 5443 EPA: CAD050806850	Laidlaw Environmental Services 5295 S. Garvey Rd. Westmoreland, CA 92281 Ph: (619) 334-9400 Fax: (619) 344-9405 EPA: CAD000633164
TSM Recovery and Recycling 3422 W. Pico Blvd. Los Angeles, CA 90019 Ph: (213) 735-9443 EPA: CAD108040858	Pacific Resource Recovery 3150 E. Pico Blvd. Los Angeles, CA 90023 Ph: (800) 499-7145 Fax: (213) 780-9940 EPA: CAD008252405
Demenno Kerdoon Environmental Services 3650 E. 26th Street, Los Angeles, CA 90023 Ph: (213) 268-5056 Fax: (213) 268-9672 EPA: CAD080033681	U.S. Filter Recovery Services 5375 S. Boyle Ave., Vernon, CA 99058 Ph: (213) 277-1500 Fax: (213) 588-0094 EPA: CAD097030993

Prior to disposal, removed surface sediments will be inspected to determine the extent and type of chemical contamination. Evidence of oil and grease, antifreeze, solvents, fuel, hydrogen sulfide, and any other noxious substance will be noted. Observations will be used to determine if more than the standard analyte list is required. The standard analyte list (Table 5.3) is based on highway contaminants that have potential to exceed California Code of Regulations (CCR), Title 22 hazardous waste criteria. Methods used to sample surface sediments are discussed in Section 5.7. While analytical results are pending, the removed surface sediments will be stored in 55-gallon drums or stockpiled onsite at a minimum distance of 100 feet from the basin and property boundary, in an area protected from vehicular traffic. Hay bales or silt barriers will be placed around the perimeter of stockpiles only, and stockpiles will be covered with plastic and stabilized with sandbags. Separate drums or stockpiles will be used to contain sediments suspected to be differently contaminated.

2.7 Hazardous Waste

Suspected hazardous wastes will be analyzed to determine disposal options. Hazardous waste generated onsite will be handled and disposed of according to applicable local, state, and federal regulations. A solid or liquid waste is considered a hazardous waste if it exceeds the criteria listed in the CCR, Title 22, Article 11 (State of California, 1985).

2.8 Checklist for Inspectors and Operation and Maintenance Personnel

Facility Inspection and Observational checklists or logs will be filled out during each visit to an IB. These will be kept in a field logbook to ensure that the IB is maintained at optimum levels throughout the monitoring period. One field logbook will contain storm monitoring data sheets and instrument calibration logs (Tab 6 of the FGN). A second logbook will contain Facility Inspection Checklists and Maintenance Log Sheets. A third logbook will be kept for vector control and management logsheets (Appendix IV of Volume II).

Refer to Forms C through F (Tabs 4 and 5 in the *FGN*) for checklists related to the inspection and maintenance requirements of a BMP.

3.0 VECTOR CONTROL

Constructing retrofit pilot BMPs will modify the existing stormwater drainage systems. Because such retrofitting may create opportunities for disease carrying organisms to flourish, insects (such as mosquitoes and midges) or rodents may have to be controlled. Vector control and abatement will be performed in accordance with Appendix IV and by subcontracted Vector Control Districts.

4.0 VEGETATION MANAGEMENT

The three main reasons for having a vegetation management program for an IB are:

1. Uncontrolled vegetation may affect the IB performance.
2. Maintaining vegetation is necessary to prevent the facility from becoming a public "eye sore".
3. Maintaining vegetation is key to controlling mosquito populations and other vector and nuisance organisms.

4.1 Management for Optimal BMP Performance

Maintenance and control of vegetation is essential to the optimal operation and performance of an IB. The IB will be seeded with low-growing grasses, which eliminates the need for irrigation and fertilization.

The condition of the vegetation will be inspected on a monthly basis at a minimum. These inspections will ensure that the IB vegetation is kept relatively short (approximately 12 inches), that the vegetation protecting the slopes is kept healthy and continuous, and that undesirable plant species (e.g., woody vegetation) do not take root. Shorter vegetation on the basin floor will optimize the treatment capacity, the percolation rate, and will aid in vector control. Maintaining healthy and continuous vegetation on the slopes will minimize erosion. Preventing undesirable plant species from taking root will prevent plants with large root systems from damaging the embankments. See Section 2.0 for details on controlling vegetation.

4.2 Management for Optimal Vector Control

Dead vegetation that is inundated will create conditions favorable for the proliferation of vectors. Thatch that contains standing water during the slow percolation process into the basin floor will be attractive to egg-laying mosquitoes and will provide larvae with both food and protection from larvivorous predators. Thatch that accumulates during wet periods will dry out during the extended periods without rain in late spring through summer. Dried thatch is unlikely to aid infiltration upon reinundation and, due to the breakdown of dried material into small particles, may inhibit infiltration or decrease the performance lifetime of the design. Although, the rainy season in southern California (approximately December through March) does not tend to overlap with peak activity for mosquitoes (April until November) and standing water may not present a serious vector problem after a winter storm event, the standing water resulting from vernal and autumnal rains could create a serious vector problem if water remains in the basin for 10-14 days. Isolated rain events during the summer would also be problematic; warmer temperatures would decrease the period for which standing water is a problem to

approximately 7-10 days. Upon reinundation, the bacterial degradation of the dried thatch will present conditions extremely attractive to vectors of encephalitides.

If vegetation such as cattails, bulrush, or willows develops within an IB, problems may occur with vector control. Controlling vegetation and standing water is preferred to enacting vector management programs (please refer to Appendix IV of Volume II for further information).

4.3 Maintenance Requirements

Mowing, trimming, and pruning are the preferred means for controlling vegetation at an IB. Controlling standing water will also be essential to controlling vegetation.

When equipment is used to remove vegetation, care will be taken to minimize ruts, holes, and an uneven IB floor. Such depressions can cause standing water that will create problems of vector control.

Additionally, the maintenance activities at the IB will be carried out in a fashion that minimizes soil compaction.

Maintenance activities that will be conducted on vegetation include:

- Weeding.
- Pruning.
- Replacement of dead or dying plants.

The vegetation seed mix has been designed so that fertilization and irrigation is not necessary. Fertilizers and irrigation will not be used to maintain the vegetation. If the vegetation does not survive without fertilization and irrigation, then Caltrans will work with the Plaintiff to discuss options for maintaining the BMP. Burning will not be allowed, and the use of herbicides will not be allowed because they can de-vegetate slopes and embankments for extended periods of time, and have detrimental effects to the quality of runoff treated at the facility.

Vegetation removed from an IB will be promptly hauled off and disposed of properly. Cut vegetation will not be stockpiled onsite, especially in the IB.

4.4 Checklists

During the routine vegetation inspections of the IB Inspection Checklists (Tab 4, Form C in the *FGN*) will be completely filled out and signed by the inspector. These checklists incorporate necessary vegetation inspection requirements. BMP Site Maintenance Activity Checklists (Tab 5, Form E in the *FGN*) will be filled out for maintenance activities performed.

5.0 SAMPLING AND MONITORING

This section details the monitoring equipment to be used at an IB, sampling protocols, analytes to be tested, and quality assurance/quality control guidelines.

5.1 Equipment Installation

This subsection details the monitoring equipment specific to the Retrofit Pilot program IBs. Since runoff infiltrates through the pond, inflow and effluent quantity and quality will not be quantified. Instead, ground water quality, sediment deposition rates and quality, and infiltration rates will be monitored. Infiltration rates will be estimated by constantly monitoring basin levels and rainfall.

The depth of water inside the IBs will be measured using a bubbler level meter. Basin water depth data will be continuously logged with a data logger/controller. A staff gauge will be installed in each basin for calibration of the depth sensor.

Bubbler tubing will be routed through 25 mm conduit from the water level monitoring point to an equipment enclosure. The equipment enclosures will house the data logger/controller assemblies, cellular modem equipment, and batteries. A rain gauge will be mounted on a 4 m tall, 50 mm diameter pole located adjacent to each equipment enclosure. These poles will also support cellular phone antennas and solar panels.

5.1.1 Rain Gauge

A rain gauge having a “tipping bucket” design that incorporates a small “bucket” which holds a known amount of rainfall will be used onsite. When the bucket is filled, it tips the water out, momentarily closes a switch, and then resets itself and starts the process again. The data logger/controller counts each switch closure to accumulate rainfall totals. The rain gauges used will tip after every 0.01 inch of rain.

5.1.2 Power

The source of primary power for the instrumentation will be 12-volt deep-cycle marine batteries. Solar panels will be used to maintain the charge on the batteries.

5.1.3 Telecommunications

Cellular modem transceivers will be used to provide remote telecommunication access to the monitoring equipment. The ability to access a sampling station, monitor the status of the station in real-time, modify storm criteria, download new programs, and recover data allows for more cost effective, efficient monitoring.

A high performance base station antenna with filter will be installed; the filter will be installed from the lead-in of the antenna to prevent damage to the sampling station equipment due to nearby lightning strikes.

5.1.4 Equipment Enclosures

Steel enclosures will be used to house the samplers and associated electronic equipment. These enclosures will be bolted to concrete pads and will be locked to secure the monitoring equipment.

5.2 Maintenance and Calibration

A complete maintenance program will be performed at an IB after each large storm event during the monitoring period, or in the absence of rain, on a monthly basis. Maintenance will include checking the performance of the equipment, checking power supplies, cleaning contaminated equipment, and performing necessary equipment calibrations. Calibrations will be conducted in accordance to specifications in the individual component manuals.

Stormwater equipment maintenance visits will be thoroughly documented. Written documentation includes the action taken at a site as well as the date performed. Accurate and thorough records of station visits will be maintained to aid in the evaluation of an IB's performance. The log illustrated in Form F in Tab 5 of the *FGN* will be used to document maintenance and calibrations. If any program parameters are changed, the log shown on Form I, J1 and/or J2 in Tab 6 in the *FGN* will be completed.

5.3 Groundwater Well Monitoring

At the District 11 Infiltration Basin, the groundwater level is extremely close to the surface, a few feet in the winter and less than 10 feet in the summer. Therefore, only a groundwater monitoring well will be used for periodic measurements of groundwater quality. The lack of separation between the surface and groundwater levels makes the use of a lysimeter impractical.

5.3.1 Equipment Selection and Description

The groundwater well casings are perforated in the water table zone with 0.01-inch slots. A filter pack consisting of 2/12 sand was placed around most of the perforated zone at each well. A bentonite chip annular seal was placed above the filter packs and hydrated. The space above the bentonite chips was sealed with a sodium bentonite/cement grout. Lockable well protectors and monument covers were installed above the ground surface.

Before sampling, the wells will be purged of 3 case volumes using a disposable Teflon or stainless-steel bailer with a bottom emptying device. Water levels and well stabilization parameters will be monitored during the purging and sampling process. Water levels will be measured using a water level indicator. Conductivity, pH and, temperature will be measured using either a single unit that can quantify three parameters, individual units specifically for each parameter or any combination. Turbidity quantification will be acquired using a nephelometer. Water quality instruments will be calibrated with known standards prior to use.

Water purged from the wells will be placed into marked DOT 17 E drums. These drums will be stored on-site for later disposal. Proper disposal of the groundwater depends on the results of the laboratory analyses.

5.3.2 Groundwater Sampling

This section discusses the procedures for well purging and sampling at an IB facility. Baseline sampling is scheduled to occur immediately after construction of each IB. Each well will be sampled two additional times during each storm season after significant rainfall events (once in December/January and once in February/March). Storm season analytical results will be compared to the baseline analytical results.

Groundwater Purging and Collection

The water level and the depth of the well will be measured using a water level indicator. These values will be used to calculate the required purge volume. Each well will be allowed to equilibrate with atmospheric pressure before the water elevation is measured.

Using a Teflon or stainless-steel bailer, a minimum of three submerged case volumes will be removed during purging of the monitoring well. During the purging process, the electrical conductivity, pH, turbidity, and temperature of the water will be measured at the beginning, in between each volume purged, and at the end of purging. These data will be recorded on the field visitation log (Tab 6, Form I in the *FGN*). Once the well is sufficiently purged and the measured parameters are stabilized, the well will be considered ready for sampling.

Well purging will continue until the following parameters have stabilized. Stabilized conditions will be defined as follows:

1.	Electrical conductivity	± 10 percent
2.	pH	± 0.4 units
3.	Temperature	± 2 °C

Measurements will be collected during the purging process. Turbidity will be compared to historic conditions for the well as well as stabilization.

After purging, a groundwater sample will be collected using a decontaminated stainless steel or disposable Teflon bailer with a bottom-emptying device. Care will be taken when lowering and raising the bailer to minimize the turbulence of the water within the well. Sample bottles will be filled completely, then capped, labeled, and placed in a cooler with ice immediately after sample collection. After samples have been collected, the static water level will be measured. Water level probes will be decontaminated between uses in compliance with the appropriate decontamination procedures.

Information pertaining to the groundwater sampling will be recorded in the field logbook and appropriate log sheets.

5.4 Weather Tracking

Observations of the IB performance will be conducted four times during the 1998/1999 storm season and four times during the 1999/2000 storm season. For this reason, careful tracking of the weather must be conducted. Weather tracking will be the responsibility of the Task Order Manager and Storm Control personnel. During the wet weather season, the weather will be continually monitored with increased frequency as incoming systems are predicted.

Sources of weather information to be used to track incoming storms include the National Weather Service, Weather Watch Service, Weather Network (WeatherNet), the Alert system from San Diego County, public broadcast information available on the Weather Channel and local news stations, and radar and satellite images downloaded from the Internet (e.g., www.weather.com).

5.5 Storm Mobilization and Staffing

A staffing plan will be developed as soon as a potential storm event is forecast. Crews will consist of two individuals. The staffing plan will include the following information:

- Personnel needed for each position.
    - Storm Control
    - Shift Leader
    - Crew Chiefs
    - Crew Assistants
- Shift and zone (pilot facilities manned by a single crew) designations.
- Equipment mobilization.
- Communication channels.

5.5.1 Storm Monitoring Equipment

Equipment needed for stormwater observations includes safety equipment, personal rain gear, Storm Kits, and vehicles equipped with some type of mobile communication, and highway safety equipment (see lists). The necessary equipment will be loaded into the appropriate vehicles early in the storm preparation sequence.

Storm Kit Equipment List

- Keypad/display
- Full set of keys (on floatable bobber)
- Maps for required areas
- Small flat screwdriver
- High quality alkaline D-cell batteries
- Pencils and indelible markers
- Diagonal clipper
- Cable ties (assorted sizes)
- Ziplock baggies (assorted sizes)
- Powder-free nitrile gloves
- 9-pin cable from keypad to data logger
- Flashlights (2)
- Large flat screwdriver
- Umbrella
- Spare sample labels
- Desiccant (for bubbler)
- Electrical tape
- Utility knife
- Labeling tape
- Rubber bands

Storm Mobilization List

- Storm Kit
- Paper towels
- Two-way radio or cellular phone
- Any necessary safety gear
- Log books
- Extra fine indelible markers
- Personal rain gear

5.5.2 Communication Channels

Communication channels will be established for personnel to contact each other before and during a storm event. A telephone tree will be used to facilitate contacting field

personnel and other key individuals. Phone lists with home and work numbers and other key contacts will be made available to potential crew members. Two-way radio or cellular telephone communication links to field crews are essential for efficient monitoring.

5.6 Soil and Sediment Sampling for BMP Performance Evaluation

Core soil and surface sediment samples will be collected from within the IB and will be used in part to evaluate the BMP's performance. A baseline set of nine core soil samples will be collected from within the IB following completion of its construction. Annual sampling of core soil and surface sediment will be performed at the same locations following the end of the 1998/1999 and 1999/2000 wet seasons. Samples will be analyzed for constituents listed in Table 5.2. In addition, surface sediment accumulation rate within the IB and surface sediment grain size distribution will be determined by making measurements at the end of each wet season.

Nine cores will be collected from locations on an equilateral basin grid (superimposed over the basin) to quantify annual sediment accumulation and quality data. If the presence of materials such as boulders, debris, etc. hinders the application of this process or if there is a lack of sediment, the cores will be collected as close as possible to the selected point. Each of the nine cores will be collected using a hand-held, stainless steel soil probe, or equivalent. The cores will be driven 1 m [3.28 ft] below the sediment surface and recovered. Using the log shown in Form H2 in Tab 6 in the *FGN*, soil borings will be logged for depth of penetration and recovery, location, and geotechnical characteristics. Each core will then be subdivided into three sections as follows:

1. Section 1 is from the sediment surface to the surface of the native soils.
2. Section 2 is from 0.3 m [0.98 ft] to 0.5 m [1.64 ft] below the surface of the native soils
3. Section 3 is from 0.6 m [1.97 ft] to 0.8 m [2.62 ft] below the surface of the native soils.

Use the following steps in collecting sediment and soil samples:

1. Don personal protective equipment.
2. Locate the sample locations within the IB.
3. Using a transit, determine the sediment surface elevation from a referenced benchmark on the IB embankment.
4. Collect the core samples at the nine locations using a soil probe or equivalent. Ensure that the sample is collected to a depth of 1 m [3.28 ft] below the original IB floor elevation and in the correct location. Record the sediment depth at each location. Discard soil below the bottom sample interval (i.e., soil below 1 m [3.28 ft] from the IB floor).

5. Record sample characteristics, and subdivide each core into three sections as described above.
6. Deposit each selection of each core into stainless steel mixing bowls.
7. Homogenize the sample in each bowl.
8. Fill four 8-ounce glass jars and close the containers with the caps. One jar will be labeled and analyzed for Total Petroleum Hydrocarbons (TPH); one jar will be labeled and analyzed for metals; the remaining two jars will be combined in the laboratory and analyzed for grain size.
9. Wipe the outside of each sample container with a clean paper towel.
10. Record initials, date, and time on the pre-labeled sample bottle.
11. Place the sample containers in individual zip-top plastic bags and seal the bags.
12. Immediately pack the samples into a chilled cooler.
13. Record the required information on the Chain-of-Custody Form (Tab 7, Form M in the *FGN*).
14. Document the sampling event, recording information in the designated field logbook.

5.7 Sediment Sampling and Testing for Disposal Purposes

As part of the maintenance program, sediment will be removed from the BMP when flows are hydraulically impeded. It is anticipated that sediment will accumulate relatively slowly over time. However, should sediment deposit in a rapid manner, an intermediate step of stockpiling may become necessary before offsite disposal. Section 5.7.1 provides procedures to be used when assessing potential sediment contamination in the event that intermediate onsite storage is necessary.

This subsection describes the sample collection procedures and analyses for assessing the quality of surface sediment removed from an IB for disposal. Evidence of oil and grease, antifreeze, solvents, fuel, hydrogen sulfide, and any other noxious substance will be noted. Observations will be used to determine if more than the standard list of analytes is required. Observations will be documented on a checklist form (Tab 5, Form G in the *FGN*). The standard list (Table 5.3) is based on highway contaminants that have the potential to exceed hazardous waste criteria. After laboratory analysis, results will be compared to regulatory limits listed in California Code of Regulations (CCR) Title 22, Section 66261.24 and Department of Toxic Substances Control (DTSC) variances. Based on this evaluation, proper disposal methods will be chosen.

5.7.1 Sediment Collection

Procedures in EPA Publication *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)* provide a method for determining the mean concentration of a given contaminant within a soil mass and the appropriate number of samples necessary to calculate this mean to the specified confidence interval. Initial sampling will generate a minimum number of samples/analyses as described below. Additional sample analyses may be required to meet the confidence levels given in

SW-846, therefore archiving of samples will be necessary. Archived samples will be appropriately preserved and analyzed within the maximum holding time specified in Table 5.3. None of the samples will be allowed to be composited. The Quality Assurance/Quality Control (Appendix III) describes the QA/QC objectives for surface sediment samples. The minimum number of discrete samples initially required is given below:

- *Drums:* A minimum of one sample will be collected from each drum.
- *Stockpiles less than 10 cubic yards:* A minimum of two samples will be collected, one from each half of the stockpile. Sampling points will be selected randomly within each half.
- *Stockpiles from 10-20 cubic yards*: A minimum of three samples will be collected, one from each third of the stockpile. Sampling points will be selected randomly within each third.
- *Stockpiles from 20-100 cubic yards*: A minimum of four samples will be collected, one from each quarter of the stockpile. Sampling points will be selected randomly within each quarter.
- *Stockpiles from 100-500 cubic yards:* A minimum of one sample for each 25 cubic yard portion will be collected. The stockpile will be sectioned into 25 cubic yard portions to obtain a minimum of one sample for each 25 cubic yard portion. Sampling points will be selected randomly within each 25 cubic yard portion of the stockpile.

Random samples will be selected from locations on a three-dimensional grid. If the presence of materials such as boulders, debris, etc. hinder this process, the sample will be collected as close as possible to the randomly selected point without altering the essence of the random selection process. The following steps will be used to collect surface sediment samples:

1. Don personal protective equipment.
2. Locate the sample point in the stockpile or drum.
3. Collect the sample using a soil probe or equivalent. Ensure that the sample is collected at the correct depth and location that was randomly selected.
4. Fill one 8-ounce glass jar with a portion of the sample and close the container with the cap, using care not to aerate (volatilize) the sample. This jar will be labeled and analyzed for TPH and VOC.
5. Homogenize the other portion of the sample in a disposable bowl using a disposable spatula or spoon. Fill a second 8-ounce glass jar with this portion of the sample and close the container with the cap. This sample will be labeled and analyzed for metals.
6. Wipe the outside of each sample container with a clean paper towel.
7. Record the sampler's initials, date, and time on the pre-labeled sample bottle.
8. Place the sample containers in individual zip-top plastic bags and seal the bags.
9. Immediately pack the samples into a chilled cooler.
10. Record the required information on the Chain-of-Custody Form.

11. Document the sampling event, recording information in the designated field logbook.
12. Repeat the above steps until the minimum number of samples has been collected.

5.7.2 Sediment Analyses

Unless observations indicate additional testing, surface sediment samples submitted to the laboratory will be analyzed for analytes listed in Table 5.3 using (CCR) Title 22 criteria (State of California, 1985). This table also lists the required reporting limits, analytical holding times, required preservation, and container sizes and types. Laboratory turn around times and data deliverables will be same as those for soil and groundwater samples.

5.8 Documentation

Upon each site visit, whether during a storm or not, records of the visit will be accurately recorded on the field log form (Tab 6, Form I in the *FGN*). Whenever possible, any data being recorded by the system (e.g., basin level) will be verified. If any program parameters are changed, the log shown as Form J in Tab 6 in the *FGN* will be completed. Also, once during each storm event visit, the Empirical Observation Checklist will be completed (Tab 6, Form H1 in the *FGN*).

5.8.1 General Visitation Data

During each station visit, several data logger display locations will be recorded. The log sheets will be used as a guide for the proper display locations to record. The following data will be recorded at the IB facility:

- Basin Stage
- Staff Gauge Stage
- Station ID
- Data Logger Battery Voltage
- Bubbler Level Meter Battery Voltage
- Cellular Equipment Battery Voltage

5.8.2 Storm Visitation Data

Additional data will be recorded in the logbook during storm monitoring. The log sheet will be used to determine the necessary information. The following is a summary of this data:

- Total Rain (inches)
  This cumulative data is updated each time the rain bucket tips.

- Max Stage (feet)
  This indicates the height of the maximum basin level during the current storm.
- Basin Water Level (ft)
  Instantaneous water level within the IB.
- 15 min. Change in Basin Water Level (ft)
  This indicates the change in basin water level during the previous 15-minute period. Positive means increase and negative means decrease.
- Previous 1-Hour Infiltration Rate (cf/hour)
  Estimated rate of infiltration based on decrease in basin level. Only valid during periods of no rain.

After datalogger data has been recorded, the system will be placed in low power mode and the keyboard unplugged.

5.9 Sample Tracking and Handling

Samples, regardless of their matrix, will be kept properly chilled and transferred to the analytical laboratory within holding times to achieve the highest quality data possible. To ensure proper tracking and handling of the samples, documentation will accompany the samples from the initial pickup to the final extractions and analysis. This documentation includes: Chain-of-Custody forms as required (see Form M, Tab 7, *FGN* for example forms). These forms or equivalent will be used to track and handle samples.

Collected samples will be labeled with the following information:

- Date.
- Time.
- Project name.
- IB name and number.
- Influent or effluent sampling location.
- Preservative.
- Matrix.
- Collector's initials.
- Sample I.D. number.
- Analyte(s) to be analyzed.
- Grab or composite sample.

The analytical suite for each station depends upon the total volume of water collected for the storm event. A Priority Analysis Sheet will be used in conjunction with a Sample Bottle Evaluation to determine the analytical suite for each station, based on the volume of water collected at that station, the volume to sample, and the percent storm capture. When the storm has been evaluated and samples from each station accounted for, a duplicate station and a QA/QC station will be selected based on stormwater volumes

available. Duplicate and QA/QC samples will be prepared from the combined volume of the sample collected at the selected duplicate and QA/QC station.

Duplicate and QA/QC sample bottles will be labeled, recorded on the Chain-of-Custody form, and transported to the analytical laboratory.

Grab samples will be transported to the appropriate laboratory as soon as the grab sampling is completed, whereas the sample bottles for the composite samples are transferred at the end of the storm event. Samples will be properly logged on the Chain-of-Custody form and kept chilled in coolers. There will also be a field duplicate and extra water collected for QA/QC samples. These QA/QC grab samples will be collected at one of each consultant's BMPs during each storm event monitored. The sampling stations will be selected by Storm Control for collecting the duplicate grab samples. The crews monitoring the stations will be fully briefed on the procedures for collecting QA/QC samples, and will be familiar with the sample identification numbering scheme for these samples because they are to be submitted to the laboratory as blind samples. These samples will be labeled, recorded on the Chain-of-Custody form, and transported to the analytical laboratory.

Each sample collected will receive a unique alphanumeric code (sample I.D. number) for tracking. This code will be standard for samples and contain information as to the station, date, and sequential monitoring event number. The following is an example of this code:

SITE No.-IN-32898-001

Where:

Site No. = Site number of BMP site.
IN = Influent sampling point at the site; EF = effluent sampling point.
32898 = Julian day and year
001= First storm event monitored during this program at this location

If multiple bottles are used or needed to capture a single event, the last data field will indicate the bottle number and the total bottles in that sampling event (i.e., 001-1/3, 001-2/3, 001-3/3 for a three-bottle collection scheme).

A set of QA/QC samples will be provided with each type of sample analyzed for each storm event. The analytical laboratory may also require additional QA/QC samples if one type of analysis is to be run in more than one batch.

Duplicate samples, MS/MSDs, and replicate/splits need not be from the same station. However, per storm event (or batch run), these QA/QC samples will be analyzed for the standard analytes as field samples. Most field QA/QC samples are submitted blind to the analytical laboratory, however, additional sample volumes provided to the laboratory for laboratory replicates or matrix spikes and matrix spike duplicates will be clearly

identified. The main types of QA/QC samples that will be utilized for this study are as follows:

Duplicate Analyses - These analyses will be performed for both grab samples and composite samples and will require an additional set of sample containers to be sub-sampled. The results will allow evaluation of sampling error introduced by both field sampling and laboratory analyses by showing the reproducibility or precision of the sample collection and analyses. Duplicate samples will be sent "blind" to the laboratories. One duplicate sample will be collected from one of each consultant's sampling locations during each storm event sampled and analyzed for the full list of analytes.

Duplicate samples will be identified by adding 500 to the sequential storm event number. For example, a duplicate sample for the same site above will be:

SITE No.-IN-32898-501

Blanks - These are for field as well as laboratory samples. Blanks help verify that the equipment and the sample containers are not contaminated, and the sampling techniques used are non-contaminating. Reusable sample bottles, Teflon® tubing, and filters will be rinsed with reagent grade analytes free deionized water separately. The collected rinsates will be analyzed for the full list of analytes for the composited samples. Blanks will also be run on the analytical equipment. Rinsate blanks will be run on two samplers used by each consultant at one of their BMPs prior to the installation of the equipment. Each time a batch of composite bottles is cleaned, five percent of those filters will be blanked.

Equipment rinsate blanks will be identified by adding 600 to the sequential storm event number. For example, an equipment rinsate blank collected from the monitoring equipment from the same site above will be:

SITE No.-IN-32898-601

Field blanks will be identified by adding 700 to the sequential storm event number. For example, field blank collected at the same site above will be:

SITE No.-IN-32898-701

Matrix Spike and Matrix Duplicate Spike (MS/MSD) – The laboratory will require additional sample volumes for analyses that require matrix spikes and matrix spike duplicates to evaluate precision and accuracy of the laboratory analytical method, and to evaluate any matrix interference. MS/MSDs are analyzed for their analyte(s) and then spiked with a known amount of analyte(s). One MS/MSD sample will be run on metal and TPH samples from one of each consultant's sampling locations during each storm event sampled.

MS/MSD samples will be indicated on Chain-of-Custody forms by clearly identifying that the sample is for MS/MSD purposes.

Laboratory Replicate/Split – This QA/QC analysis will require additional sample volumes. It is a duplicate analysis performed on the same sample and evaluates the repeatability (precision) of the analytical laboratories' results. One split sample will be run from one of each consultant's BMP sampling locations during each storm event sampled and analyzed for the full list of analytes.

Laboratory replicate/split samples will be indicated on Chain-of-Custody forms by clearly identifying that the sample is for laboratory replicate/split sample purposes.

5.10 Decontamination Procedures

Sampling equipment will be decontaminated according to the following procedures:

1. Rinse three times with a 2% Micro® solution or equivalent. Wash other equipment with 2% Micro® solution and a clean plastic brush.
2. Rinse three times with warm tap water.
3. Rinse three times with Milli-Q or equivalent water.
4. Rinse three times with 2N nitric acid.
5. Soak at least 24-hours in 2N nitric acid.
6. Rinse three times with Milli-Q water.

5.11 Laboratory Selection, Sample Container Preparation, and Analytical Methods

5.11.1 Laboratory Selection

Laboratories selected will have extensive experience with groundwater, surface sediment, and core soil samples and have the ability to provide rapid response to meet critical holding time requirements for analytes requiring expeditious analysis. Laboratories will be certified by the California Department of Health Services for the requested analyses.

5.11.2 Holding Times, Sample Bottles, and Preparation

The laboratories will be responsible for providing appropriate sample containers and, when necessary, with preservatives for each analysis. Tables 5.1, 5.2, and 5.3 provide a summary of sample volumes required for each analysis, along with the types of containers, holding times, and preservative. Because additional volumes are necessary for laboratory QA/QC, sample containers will provide at least twice the volume necessary to perform the requested analysis. Also listed in Tables 5.1, 5.2, and 5.3 are the analytical methods and reporting limits.

5.11.3 Project Reporting Limits

Recommended analytical methods and reporting limits for this project are listed in Tables 5.1, 5.2, and 5.3. The reporting limits in this table are target reporting limits. In some cases, reporting limits may need to be adjusted due to limited sample volumes or potential matrix interference. In such cases, appropriate data qualifiers will be applied to the associated data.

5.11.4 Laboratory Data Package Deliverables

Laboratories will be required to provide a three-week turnaround on deliverables. The deliverable package will include a hard copy and electronic data files. The hard copy will include standard narratives identifying any analytical or QA/QC problems and corrective actions. The electronic data files will contain information found in the hard copy reports submitted by the laboratories. Individual data sets will be submitted as either Microsoft Excel® Workbook files or as Microsoft Access® database files. Each consultant will be responsible for laboratory coordination and data management. Data management will be consistent with "Caltrans Data Management Plan – Data Reporting Protocol and Database," Doc. I.D. CTSW-98-005.

Table 5.1
Groundwater Matrix (Groundwater Monitoring Well)
Analytical Parameters, Methodologies, Reporting Limits, Holding Times, Container Volumes and Types, and Preservation

Analyte	Priority Rank	Reporting Limit	Units	Analytical Technique	Method Number	Holding Time	Minimum Sample Volume	Preferred Volume and Container Type[1]	Preservation
Conventionals									
pH	1	0.1	Unit	Electrode	EPA 150.1	Immediately[2]	100 mL	1-100 mL glass/plastic	4°C
Specific Conductance	1	1.0	µmhos/cm	Electrometric	EPA 120.1	Immediately[2]	500 mL	1-500 mL glass/plastic	4°C
Hardness	5	2	mg/L	Titrimetric/ Colorimetric	EPA 130.2	6 months	100 mL	1-200 mL glass/plastic	HNO_3 to pH<2, 4°C
Total Suspended Solids	1	1	mg/L	Dried Filter Weight	EPA 160.2	7 days[3]	1 L	1-500 mL glass/plastic	4°C
Nutrients									
Nitrate-Nitrogen	2	0.01	mg/L	Colorimetric Ion Chromatography	EPA 353.3 EPA 300.0	28 days 48 hours	200 mL 200 mL	1-500 mL plastic 1-500 mL plastic	4°C and H_2SO_4 to pH<2 4°C
Total Kjeldahl Nitrogen	3	0.1	mg/L	Titrimetric/ Colorimetric	EPA 351.3	28 days	500 mL	1-1L plastic	4°C and H_2SO_4 to pH<2
Total Phosphorus	4	0.002	mg/L	Colorimetric	EPA 365.3	28 days	100 mL	1-250 mL plastic	4°C and H_2SO_4 to pH<2
Total/Dissolved Metals[4],[5]									
Copper	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Lead	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Zinc	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Organics[6]									
Total Petroleum Hydrocarbons – Diesel/Oil	Grab	250/200	µg/L	GC	EPA 8015M	14 days	1 L	2-1L amber glass	4°C
Total Petroleum Hydrocarbons - Gasoline	Grab	50	µg/L	GC	EPA 8015M	14 days	2-40 mL	3-40 mL VOA vials	4°C, HCl to pH<2
Bacteria[6]									
Fecal Coliform	Grab	2	MPN/100 mL	Multiple-tube	SM 9221E	6 hours[7]	50 mL	1-100 mL plastic	4°C

1. Analytes with the same preservative can be combined into a single container if the same laboratory is performing the analyses.
2. pH and Specific Conductance will be measured by the laboratory immediately upon receipt of the samples.
3. 7 days based upon limit for measuring TSS/no regulatory limit.
4. Total and dissolved metals samples are collected in separate containers. Only the total metals container will receive nitric acid.
5. Dissolved metals will be filtered in the laboratory prior to acidification.
6. Total Petroleum Hydrocarbon and Fecal Coliform grab samples will be collected for two storms per year.
7. Attempts will be made to maintain the 6-hour holding time for bacteria samples to the extent possible. When not possible, a maximum holding time of 24 hours will be followed in accordance with "Standard Methods for the Examination of Water and Wastewater," 18th Edition.

Table 5.2
Soil and Sediment Matrix for BMP Performance Evaluation
Analytical Parameters, Methodologies, Reporting Limits, Holding Times, Container Volumes and Types, and Preservation

Parameter	Method	Units	Reporting Limit	Maximum Holding Time	Preservation	Container Size/Type (1)
Total Petroleum Hydrocarbons (TPH)	418.1 (IR) / 1664 HEM	mg/kg	10	28 days	4°C	8-oz glass jar
Total Metals: - Copper - Lead - Zinc	6020	mg/kg	 2.5 0.3 2.0	180 days	4°C	2-8-oz glass jar
Grain Size Distribution: (Method of Tests for Sieve Analysis of Fine and Course Aggregates)	Caltrans Test 202	---	---	---	---	2 8-oz glass jars (500 ± 25 grams)

1. Each sample will be collected in four 8-oz glass jars

Table 5.3
Sediment Matrix (Disposal)
Analytical Parameters, Methodologies, Reporting Limits, Holding Times, Container Volumes and Types, and Preservation

Parameter	Method	Units	Reporting Limit	Maximum Holding Time	Preservation	Container Size/Type(1)
Total Petroleum Hydrocarbons (TPH)	EPA 418.1	mg/kg	10	28 days	4^oC	8 oz glass jar
Volatile Organic Compounds	EPA 8260B	mg/kg	SW – 846 (5) requirements	14 days	4^oC	8 oz glass jar
California Code of Regulations (CCR), Title 22 Metals(2)	EPA 6020/7471	mg/kg	SW – 846 (5) requirements	180 days 28 days for mercury	4^oC	8 oz glass jar
California Code of Regulations (CCR), Title 22 Waste Extraction Test (WET) Metals(3)	STLC Extraction	mg/L	SW – 846 (5) requirements	180 days 28 days for mercury	4° C	NA
Toxicity Characteristic Leaching Procedure (TCLP) Metals(4)	TCLP 1311	mg/L	SW – 846 (5) requirements	180 days 28 days for mercury	4° C	NA

(1) Each sample will be collected in two 8 oz glass jars

(2) California Code of Regulation (CCR), Title 22 Metals (Sb, As, Ba, Be, Cd, Cr (total), Co, Cu, Hg, Pb, Mo, Ni, Se, Ag, Tl, V, and Zn). Initial waste characterization results may lead to a shorter list of metals for subsequent sediment disposal.

(3) Any sample for total metals that are below the Total Threshold Limit Concentration [TTLC] but exceed the ten times Soluble Threshold Limit Concentration (STLC) will be further analyzed using the WET procedure. WET extracts will be analyzed only for metals which exceed the ten times STLC criteria. Sediments associated with total metal results that exceed TTLC values are automatically considered hazardous and therefore do not need to undergo the WET procedure.

(4) If any of the WET-soluble concentrations are equal to or greater than the TCLP regulatory thresholds, analyze the waste by TCLP. "Test Methods for Evaluating Solid Waste, Physical /Chemical Methods". SW-846, Update III.(SW-846)

5.12 Empirical Observations

5.12.1 Purpose of Empirical Observations

Performance assessments of BMP facilities cannot be fully ascertained through analytical methods. "Empirical" observations are also critical in determining the overall performance of implemented water quality management practices and in ensuring that the practices are maintained at optimum levels. Other factors such as maintenance activities, environmental variability, and physical processes, which cannot be determined analytically, can greatly influence the performance of a particular BMP. Some of these factors such as rainfall quantity, rainfall intensity, and infiltration rate can, and, will be assessed through physical measurements. Other components such as trash build-up, surface sediment deposition, and runoff appearance can be best assessed through careful documented observations.

5.12.2 Guidelines

Observations will be succinct but also complete. For an IB performance evaluation, the following observations will be taken at the influent location, within the IB, and within the basin:

- Meteorological characteristics (present and preceding period).
- Hydrologic and hydraulic characteristics (flowing and/or standing water).
- Inlet conditions (problems affecting performance).
- Water quality appearance (visual, olfactory).
- Solids deposition (trash and debris, sediments, organics) and resuspension.
- Erosion.
- Vegetation condition.
- Infiltration surface condition (signs of potential clogging).
- Mosquitoes and other vectors.
- Structural condition of facility.
- Monitoring equipment condition.

5.12.3 Checklist for Sampling and Monitoring Personnel

Form H1 in Tab 6 in the *FGN* provides a checklist (log form) that will be completed by sampling and monitoring personnel during each storm event visit to the facility.

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CALTRANS
BMP RETROFIT PILOT PROGRAM

DISTRICT 11, SAN DIEGO

BMP OPERATION, MAINTENANCE, AND MONITORING PLAN

VOLUME II

APPENDIX I-C
SAND FILTERS

September 1999

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TABLES

2.1 Waste Disposal Services in Southern California
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FIGURES

1.1 Overview of a Sand Filter Type I
1.2 Overview of a Sand Filter Type II

1.0 INTRODUCTION

The Caltrans Best Management Practice (BMP) Retrofit Pilot Program is a comprehensive water quality monitoring study to evaluate the removal of contaminants in stormwater runoff from Caltrans roads and facilities through a series of BMP pilot installations. The overall objectives of this portion of the program are to document BMP contaminant removal efficiency and technical feasibility of retrofitting Caltrans facilities with water quality controls.

This Appendix of the Operations, Maintenance, and Monitoring Plan (OMM) applies to Sand Filters (SF). Refer to Volume I of the Operations, Maintenance, and Monitoring Plan for the Caltrans BMP Retrofit Pilot Program for project-specific requirements and procedures. Refer to the consultant's monitoring equipment manuals and stormwater monitoring Standard Operating Procedures (SOPs) for details related to equipment installation, equipment maintenance, and storm monitoring. Maintenance, safety, documentation, and storm monitoring tasks will be carried out according to the procedures detailed in this plan. Additional measures may be necessary due to unforeseen or temporary changes to the work environment at these sites.

1.1 Retrofit BMP Description

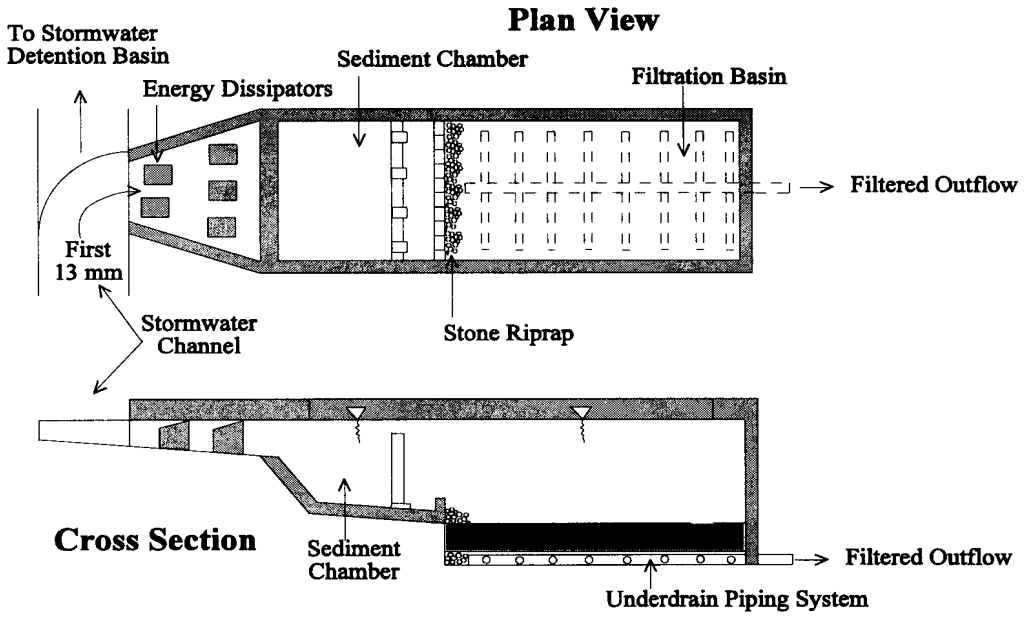
An SF uses sand as a filter medium. This type of filter removes pollutants through filtration, and sedimentation.

There are two types of SFs for the Retrofit Pilot Program. The first type (Type I) was designed by the City of Austin (1998), and the second type (Type II) is of a Delaware design (Young et al., 1996). The Type I SF has an open top and it incorporates a pre-treatment sedimentation basin. Runoff enters and fills the sedimentation basin. When a certain level is reached, runoff discharges through an outlet riser to an another basin containing filter media. The Type II SF is an enclosed, precast unit with a chamber used for sedimentation and energy dissipation and a second chamber containing filter media. Runoff is distributed to the first chamber through an inlet manifold. It then enters the second chamber over a series of weirs. Overflow and bypass capabilities and energy dissipaters are common components of both types of SFs. SFs should not be installed at locations with a large sedimentation potential. Refer to Figures 1.1 and 1.2 for typical schematics of an SF.

The SF BMPs are designed to treat runoff from 1-year, 24-hour (or less) storm events. Some runoff from larger storms will bypass the facility. The larger the storm the more runoff is bypassed. Optimal treatment will occur for longer, less intense storms. Important considerations in the design, operation, maintenance, and management of SFs can be found in a guidance manual prepared for the U.S. EPA (Watershed Management Institute, Inc., 1997).

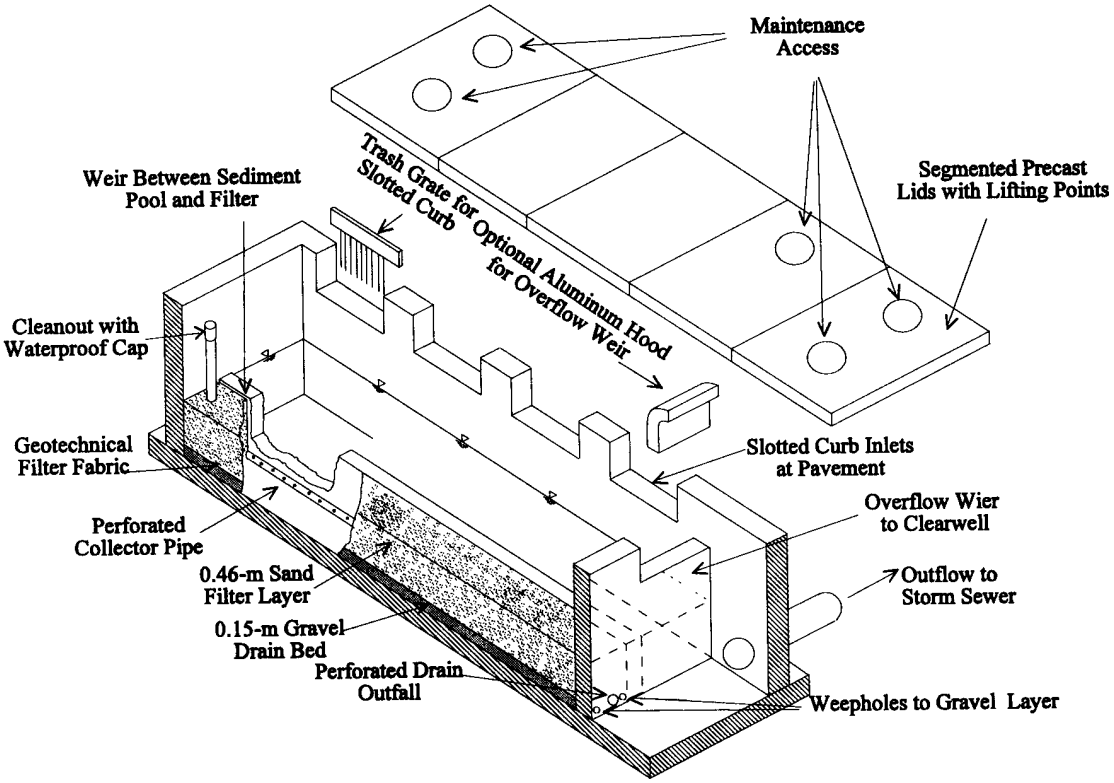
An SF retains water for varying periods of time. As such, the potential to produce vectors of human disease and habitats for nuisance insects, rodents, and vegetation exists.

Figure 1.1 Overview of a Sand Filter Type I



Austin Sand Filter

Figure 1.2 Overview of a Sand Filter Type II



Delaware Sand Filter

1.2 Evaluating BMP Performance

To effectively evaluate the performance of an SF pilot facility, the following objectives will be met:

- Determine the quantity of runoff treated by the SF.
- Determine the reduction (or change) in concentrations between the influent to and the effluent from the SF.
- Determine and document the level of effort required to maintain the SF at optimal effectiveness.
- Determine and document the level of effort required to control vectors and nuisance insects, rodents, and vegetation at the SF.
- Determine and document the evaluation of BMP performance criteria relative to the qualitative benefits.

To effectively estimate the removal of contaminants from an SF, the quantity and quality of runoff entering the SF will be compared to the quantity and quality of water discharged from the SF. These data will allow a direct estimate of the total reduction in mass loadings for a variety of contaminants.

The effectiveness of an SF is also related to the implementation of strict maintenance procedures and the documentation of empirical observations. Items such as maintenance of storage volumes, discharge rates, sediment and trash build-up, and clogging may directly effect the performance of an SF.

1.3 Deployment Criteria

Stormwater samples will be collected from the SFs for up to eight storm events over a two wet seasons, weather permitting. Storms targeted for sampling will be separated by a minimum of 48 hours (72 hours preferably). This facility will be inspected per the guidelines given in Section 4.0 of the *Field Guidance Notebook* (*FGN*), which include a mandatory inspection after every storm greater than 0.50 inch.

Based on the rainfall requirements needed to generate monitorable flows in and out of the pilots, Caltrans has developed a refined monitoring team deployment criteria. The refined deployment criteria defines when to chase storms based on season, storm forecasts, and the current count of successfully monitored storms.

The deployment season, in which monitoring teams remain "on-call" and fully staffed, will be restricted to the portion of the year when rainfall is most probable and better predictable. Summer showers are not seen as predictable events, and dry watersheds and BMPs will retain more water which results in less effluent.

The deployment season will start on October 1. The season shall end after 3 weeks of dry weather where less than 0.2" of rainfall occurs in the San Diego area, but end no sooner than April 1 and not later than May 30th. This approach will provide a plan that adjusts to wet or dry springs.

The following criteria will decrease false starts, while allowing teams to continue to chase storms based on promising storm forecasts. The criteria will be used for pilots, regardless of drainage area size or land use.

“Forecast-Unlikely” set to less than 0.25” rain and less than 50% probability, (Decision = "No Go")

“Forecast-Marginal” set to 0.25” or greater and 50 –75% probability, (Caltrans Decision)

“Forecast-Highly Probable” set to 0.25” or greater and greater than 75% probability. (Decision = "Go")

Forecast information will be gathered as indicated in the OM&M manuals (e.g., internet sources). As always, if conditions happen to allow paired samples to be successfully taken for any storm larger than 0.1", that sampling would be considered as a successful event, which would count towards fulfilling Scoping Study requirements.

When a specific pilot is successfully monitored for the total required storms per the applicable Scoping Study, the decision to further deploy to monitor that pilot will fall to Caltrans and no commitment to monitor beyond the terms of the Scoping Studies can be made at this time.

1.4 Data Collection and Compilation

1.4.1 Data Requirements

The following data will be collected to assess the performance and maintenance aspects of an SF facility:

- Water quality and quantity data of runoff into and discharge from the detention basin from flow-composite samples and first-flush grab (as soon as possible after the start of runoff) samples for at least eight storm events during two wet seasons.
- Rainfall data recorded as a function of time, from rainfall events during the study period.
- Observations of water quality, weather, antecedent conditions, spills, BMP operation, etc.
- Documentation records of inspections and maintenance activities performed.
- Vector monitoring and abatement data.
- Records of vector control measures taken.
- Vegetation management records for Type I SF.

1.4.2 Data Management

Consultants will be responsible for data management. Overall management of the data will be consistent with established Caltrans procedures for stormwater monitoring projects.

The consultant's Sample Control group will be responsible for tracking the analytical process to assure that laboratories are meeting the required turnaround times and are providing a complete deliverable package. Sample Control will also be responsible for accumulating copies of site visit logs, inspection logs, facility maintenance records, vector control sampling data, and logged rainfall and hydrographic data. Sample Control will receive the original hard and electronic copies from the laboratory, system managers, and field crews, and verify completeness and log dates of receipt. A copy of the data sets and log sheets will be filed in Sample Control's central filing system and another copy will be provided to the Database Manager. The originals will then be transferred to the Task Order Manager and filed with other project documentation to maintain complete project records.

Laboratories, system managers, and vector control crews will be requested to provide data in both hard copy and electronic formats. The forms of electronic submittals will be provided to the laboratories to ensure that the files can be imported into the project

database with a minimum of editing. A relational database will be used for data. Laboratory data will be maintained and managed using Microsoft Excel® and Microsoft Access®. Files from the influent and effluent monitoring stations will be stored in the same database system and be linked to the laboratory database. The sampling system files will include rainfall, sampling, and flow data. Site characteristics will be stored in a separate file and linked to both the chemical and sampling system files to enable useful data queries.

After each storm event monitored, data will be submitted to Caltrans based on "Caltrans Statewide Data Management Plan—Data Reported Protocol and Database," a technical memorandum dated 23 April 1998 from Larry Walker Associates to task order managers.

1.4.3 Data Analysis

Differences in storm characteristics, which can lead to differences in analyte loadings of monitored storm events, will be evaluated for each year of monitoring. Specific storm parameters such as total rainfall, average intensity, peak intensity, and antecedent conditions will be measured to determine if these parameters correlate with analyte concentrations and loads in stormwater discharges.

Contingent on the amount and quality of actual data collected, influent and effluent sampling results will be characterized by descriptive statistics and statistical comparisons. Event mean concentrations (EMCs) will be measured for each water quality parameter at both sampling points. Annual statistics based upon assumed log-normal distributions also will be calculated for each water quality parameter.

Differences in mean concentrations of analytes between storm events and locations will be considered to be statistically significant at $P \leq 0.10$. Although the acceptable level of alpha error is typically set at $P \leq 0.05$, this decision level was increased due to the relatively high coefficients of variation (CV) encountered with stormwater data.

Care will be taken to guard against false positive or negatives, so that widely varying storm event characteristics will not result in misinterpretation of the stormwater runoff data.

Widely varying storm event characteristics will be considered when evaluating BMP efficiencies based on stormwater runoff data. Empirical observations, maintenance activities, and vector control activities will be compiled and compared to water quality and quantity data.

1.5 Encroachment Permit and Restrictions

Visitation of an SF requires a Caltrans Encroachment Permit (Exhibit 9.3, Tab 9, *FGN*). Encroachment Permits will be made by either making an addendum to an existing permit or by applying for a new permit. A brief description of the project, site location, and any traffic control measures will be submitted with the application. The Caltrans District Encroachment Permit Office will be contacted for further information and direction (phone numbers can be found under Tab 2 in the *FGN* portion of the Volume II OMM Plan).

2.0 OPERATION AND MAINTENANCE

2.1 Operation and Maintenance Needs

The operational and maintenance needs of an SF are:

- Periodic removal of one to two inches of sand from the surface of the filter when drain time exceeds 48 hours or when loading rate drops below 9 ft/day.
- Refilling filter with sand to 18 inches (original depth) once the depth has dropped to 12 inches.
- Monitoring of episodic oil and grease clogging with subsequent removal of clogged sediment.
- Removal of sediment from sediment chamber when it begins to clog the orifices of the perforated riser (type I SF) or reaches 12 inches in depth (type II SF).
- Removal of standing water that may develop into a mosquito breeding area.
- Removal of graffiti, vegetation, and debris.
- Preventative maintenance on monitoring equipment.

2.2 Inspection Frequency

The facility will be inspected and inspection visits will be completely documented (refer to Section 2.8):

- Once a month at a minimum.
- After every large storm (after every storm monitored or those storms with more than 0.5 inches of precipitation).
- On a weekly basis during extended periods of wet weather.

2.3 Aesthetic and Functional Maintenance

Functional maintenance is important for performance and safety reasons. Aesthetic maintenance is important for public acceptance of stormwater facilities.

Both forms of maintenance will be combined into an overall Stormwater Management System Maintenance Program. Maintenance activities will be managed by the monitoring consultant. Maintenance items are included in the checklist/log forms found under Tab 5 of the *FGN*. Maintenance activities will conform to the practices specified in this plan.

2.3.1 Aesthetic Maintenance

The following activities will be included in the aesthetic maintenance program:

- **Graffiti Removal.** Graffiti will be removed in a timely manner to improve the appearance of the filter and its related monitoring equipment, and to discourage additional graffiti or other acts of vandalism.

- **Weed Control.** Weeds will be removed through mechanical means. Herbicides will not be used because these chemicals may impact the water quality monitoring.

2.3.2 Functional Maintenance

Functional maintenance has two components:

1. Preventive maintenance.
2. Corrective maintenance.

Preventive Maintenance

Preventive maintenance that will be done on a regular basis is detailed in the checklists contained in Form E, under Tab 5 of the *FGN*. Preventive maintenance activities to be performed on SFs are:

- **Trash and Debris.** Debris and trash will be removed to reduce the potential for outlet structures and other components from becoming clogged and inoperable during storm events.
- **Sediment Removal**. Sediments will be removed as needed to optimize performance of the filter. Disposal of sediments is discussed in Section 2.6 and will comply with local, county, state, or federal requirements.
- **Standing Water Removal.** Standing water will be removed as needed to preclude the development of mosquito breeding areas.
- **Mechanical Components.** Maintenance will be performed on valves, fence gates, locks, and access hatches in accordance with the manufacturers' recommendations. Mechanical components will be operated during each maintenance inspection to assure continued performance.

Corrective Maintenance

Corrective maintenance is required on an emergency or non-routine basis to correct problems and to restore the intended operation and safe function of SFs. Corrective maintenance activities include:

- **Removal of Debris and Sediment.** Visibly contaminated sediment, debris, and trash, which clog the filter, will be removed immediately and properly disposed of (see Section 2.6).
- **Structural Repairs.** Repairs to any structural component of an SF will be made promptly (e.g., within 10 working days). Designers and contractors will conduct repairs where structural damage has occurred.
- **Fence Repair.** Timely repair of fences (e.g., within 10 working days) will be done to maintain the security of the site. This pertains only to those sites not within maintenance yards.

- **General Facility Maintenance.** In addition to the above elements of corrective maintenance, general corrective maintenance will address the overall facility and its associated components. If corrective maintenance is being done to one component, other components will be inspected to see if maintenance is needed.

2.4 Maintenance Frequency

The maintenance indicator document, included as Appendix V, lists the schedule of maintenance activities to be implemented at a Sand Filter.

2.5 Equipment, Resources, and Tools Needed

Resources and the following equipment are needed by inspection personnel:

- Gloves, safety hat, safety glasses, safety boots, pen or pencil, and approved facility plans.
- Flashlight.
- Crowbar.
- Tape measure and other measuring device (survey rod), such as a clear PVC tube, to determine sediment accumulation depths and / or visible contamination depths.
- Local erosion, sediment control, or stormwater management handbooks.
- Rain and foul weather gear and other personal protection equipment (PPE).
- Confined space entry gear (where appropriate).
- Trash removal equipment.
- Sediment manipulation/removal equipment (i.e., shovels, rakes, 5 gallon buckets).
- This Appendix and *FGN*.
- Maintenance logs.
- Copies of necessary inspection reports and forms.
- Encroachment permit.
- Business cards or other identification.
- Camera to document field conditions.

Except for the items contained on site, the maintenance contractors will supply equipment, tools, and resources required for maintenance activities at SFs. At a minimum, these contractors will supply the following:

- Shovels, picks, rakes, wheel barrels, and other hand tools.
- Mechanics tools.
- Concrete tools.
- Painting equipment (brushes, rollers, and sprayers).
- Tape measures and sediment probes.
- Other necessary safety equipment (gloves, boots, hard hats, reflective vests, safety glasses, traffic control lighting, and confined space entry equipment).
- Pumps.
- Camera with film.

The consultants will supply to the maintenance contractors:

- This Appendix, *FGN*, and approved facility plans.
- Encroachment Permit.
- Logbook containing maintenance safety logs.

2.6 Debris and Sediment Disposal

Caltrans is responsible for any hazardous waste generated at SFs as the owner/generator. Consultants responsible for operating, maintaining, and monitoring the SFs will be responsible for their removal and disposal of waste material by independent contractors. Disposal of sediment, debris, and trash will be contracted out in accordance with local, county, state, and federal waste control programs. Potential disposal services contractors are listed in Table 2.1.

Table 2.1
Waste Disposal Services in Southern California

Laidlaw / Rollins (OPC) 5765 Alba Street Los Angeles, CA 92011 Ph: (213) 585-5063 Fax: (213) 589 5443 EPA: CAD050806850	Laidlaw Environmental Services 5295 S. Garvey Rd. Westmoreland, CA 92281 Ph: (619) 334-9400 Fax: (619) 344-9405 EPA: CAD000633164
TSM Recovery and Recycling 3422 W. Pico Blvd. Los Angeles, CA 90019 Ph: (213) 735-9443 EPA: CAD108040858	Pacific Resource Recovery 3150 E. Pico Blvd. Los Angeles, CA 90023 Ph: (800) 499-7145 Fax: (213) 780-9940 EPA: CAD008252405
Demenno Kerdoon Environmental Services 3650 E. 26th Street Los Angeles, CA 90023 Ph: (213) 268-5056 Fax: (213) 268-9672 EPA: CAD080033681	U.S. Filter Recovery Services 5375 S. Boyle Ave. Vernon, CA 99058 Ph: (213) 277-1500 Fax: (213) 588-0094 EPA: CAD097030993

Prior to disposal, sediments will be characterized to determine the extent and type of chemical contamination. Evidence of oil and grease, antifreeze, solvents, fuel, hydrogen sulfide, and any other noxious substance will be noted. Observations will be used to determine if more than the standard analyte list of analytes is required. The standard analyte list (found in Table 5.2) is based on highway analytes that have a strong potential to exceed California Code of Regulations, Title 22 hazardous waste criteria (State of California, 1985). Methods used to sample sediments are discussed in Subsection 5.7. Dependent on quantities and site conditions, handling of removed sediments will be determined just prior to the time of removal maintenance. Sediments suspected to be contaminated will be kept separate. Onsite storage of sediments will be avoided to the extent possible. Disposal contractors will be preferred to immediately transport sediments offsite for disposal at the time of removal.

2.7 Hazardous Waste

Suspected hazardous wastes will be analyzed to determine disposal options. Hazardous materials generated on site will be handled and disposed of according to local, state, and federal regulations. A solid or liquid waste is considered a hazardous waste if it exceeds the criteria listed in the California Code of Regulations, Title 22, Article 11 (State of California, 1985).

2.8 Checklist for Inspectors and Operation and Maintenance Personnel

Facility Inspection and Observational checklists or logs will be filled out during each visit to an SF. These will be kept in a record book (field logbook) to ensure that the SF is maintained at optimum levels throughout the monitoring period. One field logbook will contain storm monitoring data sheets and instrument calibration logs (Tab 6 of the FGN). A second logbook will contain Facility Inspection Checklists and Maintenance Log Sheets. A third logbook will be kept for vector control and management logsheets (Appendix IV of Volume II).

Refer to Forms C through F, under Tabs 4 and 5 of the *FGN* for checklists related to the inspection and maintenance requirements of a Sand Filter.

3.0 VECTOR CONTROL AND MANAGEMENT

Constructing retrofit pilot BMPs will modify the existing stormwater drainage systems. Because such retrofitting may create opportunities for disease carrying organisms to flourish, insects (such as mosquitoes and midges) or rodents may have to be controlled. Vector control and abatement will be performed in accordance with Appendix IV and by subcontracted Vector Control Districts.

4.0 VEGETATION MANAGEMENT

The main reasons for having a vegetation management program for an SF is:

- Uncontrolled vegetation at an SF may affect the performance.
- Maintaining vegetation may be necessary to prevent the facility from becoming a public "eyesore."
- Maintaining vegetation is key to controlling mosquito populations and other vector and nuisance organisms.

4.1 Management for Optimal BMP Performance

Maintenance and control of vegetation is essential to the optimal operation and performance of a Type I SF. Because Type II SFs are enclosed and vegetation within the BMP will not develop. Inspections will be conducted on a monthly basis for the presence of vegetation within the sedimentation and filter media chambers of a Type I SF. These inspections are to insure that no vegetation establishes within the SF. Vegetation will reduce treatment capacity and may also clog the filter media. See Section 2.0 for details on controlling vegetation.

4.2 Maintenance of Aesthetic Vegetation

Within the fence-line surrounding an SF, trees, shrubs, and/or flowering plants may be planted or exist for aesthetic purposes if the site lends itself to landscaping activities (i.e. it is not paved). The overall health of these plants will be inspected along with the facility inspection. Maintenance activities that will be conducted on landscaped vegetation include:

- Weeding.
- Pruning.
- Replacement of dead or dying plants.

Vegetation removed from an SF facility will be promptly hauled off and disposed of properly. Cut vegetation will not be stockpiled on site.

4.3 Checklists

During the routine vegetation inspections of the filters, the Facility Inspection Checklist (Form C, Tab 4, *FGN*) will be completely filled out and signed by the inspector. This checklist incorporates necessary vegetation inspection requirements. A Maintenance Activity Checklist (Form E, Tab 5, *FGN*) will be filled out for maintenance activities performed.

5.0 SAMPLING AND MONITORING

This section details the monitoring equipment to be used at an SF, sampling protocols, analytes to be tested, and quality assurance/quality control guidelines.

5.1 Equipment Installation

The inflow and outflow conveyances for each SF will be equipped with a flow measuring device (either a flume or an area/velocity meter or both) and a sample intake. Flumes were cast into the conveyances during the construction phase. The flumes will incorporate some sort of depth measuring sensor. Flow sensors will be installed using manufacturer supplied hardware and in accordance to the manufacturers specifications. Sampler intakes will be mounted in each conveyance upstream of flumes or downstream of velocity/depth sensors. Stainless steel fasteners will be used to secure the intakes to the invert of the conveyances.

Flow measurement points were selected at locations that minimized flow measurement errors resulting from turbulence and surcharges. The following design specifications were considered during the engineering of the sampling points at each SF. The location at which flow will be measured will be at least 10 pipe diameters downstream and five pipe diameters upstream (or ten and five times the maximum anticipated head height) of any outfall, obstruction, inlet, or change in direction of the conveyance. The slope of the conveyance leading to the flow measuring point will be 2% or less. These two requirements were considered to insure that flow is fully developed and is subcritical at the point where flow is measured.

Sensor wires and intake tubing will be routed through conduit from the manholes to equipment enclosures positioned on level ground near each manhole. The equipment enclosures will house the data logger/controller assemblies, samplers, cellular modem equipment, flow metering electronics, and batteries. A rain gauge will be mounted on a pole located adjacent to the inlet equipment enclosure. This pole will also support a cellular phone antenna and solar panel.

Components of each automatic sampling system used will undergo calibration and verification during installation and during maintenance and pre-storm visits.

5.1.1 Water Quality Samplers

The water quality samplers to be used at the SF facilities will be automatic and composed of a peristaltic pump, a liquid detector, and a base to hold a sample bottle and ice. Each time a pre-determined volume of liquid passes the sampling point, the data logger/controller will signal the pump to deliver a self-calibrated sample volume. The suction hose used with the sampler will be 3/8-inch pure Teflon® tubing. Therefore, the sampler will be equipped with 3/8-inch silicon peristaltic tubing and a 3/8-inch stainless

steel or Teflon® intake strainer of low-flow design. Strainers will be attached to the invert of each conveyance using stainless-steel fasteners. Samples will be collected into borosilicate glass bottles.

Materials used in the collection of stormwater samples will meet strict criteria to prevent any form of contamination of the sample. These materials will allow for both inorganic and organic trace toxicant analyses from the same sampler and composite bottle. Only Teflon® and the highest grade of borosilicate glass are suitable for both trace metal and organic analyses from the same composite sample bottle. Bottles will be cleaned according to procedure described below. Sample hoses will be replaced and decontaminated annually, prior to the wet season. They will not be cleaned after each storm event. These bottles and hoses will be evaluated through an extensive blanking process to verify that the composite bottles and sample hoses are contamination-free and appropriately cleaned for both of inorganic and organic analyses.

Cleaning Procedures for Composite Bottles

Bottles will be:

1. Rinsed three times with warm tap water.
2. Scrubbed with a clean plastic brush.
3. Soaked in a 2% detergent (e.g., Contrad®) solution for at least 48-hours.
4. Rinsed three times with tap water.
5. Rinsed five times with Milli-Q or equivalent water, rotating the bottle to ensure contact with the entire inside surface.
6. Rinsed three times with hexane while rotating the bottle, and then air-dried.
7. Rinsed six times with Milli-Q water.
8. Soaked in 2N nitric acid for a minimum of 24 hours.
9. Rinsed six times with Milli-Q water.

Cleaning Procedures for Teflon® Hose and Other Sampling Equipment

Teflon® hose and other sampling equipment will be:

1. Teflon hose will be rinsed three times with a 2% Micro® solution or equivalent. Other sampling equipment will be washed with a 2% Micro® solution and a clean plastic brush.
2. Rinsed three times with warm tap water.
3. Rinsed three times with Milli-Q or equivalent water.
4. Rinsed three times with 2N nitric acid.
5. Soaked at least 24-hours in 2N nitric acid.
6. Rinsed three times with Milli-Q water.

5.1.2 Flow Monitoring

A flow-proportioned sample is a composite of individual sample aliquots that are collected for each set volume of water that passes by a sampling point. To obtain a valid composite sample, direct flow measurements will be made to control the sampling interval. At each SF, both primary and secondary flow metering devices will be used. A primary flow measuring device is a hydraulic structure (e.g., flume) inserted into a channel that changes the level of liquid in or near the structure. By knowing the shape and dimensions of the hydraulic structure, flow through or over the structure is related to the liquid level by a mathematical relationship. A secondary flow-metering device measures both liquid velocity and depth. Primary devices are preferable, unless hydraulic characteristics prohibit them.

Bubbler level meters will be used in conjunction with the flumes at locations not protected by manholes. To measure water depth, a stainless steel tube is mounted to the invert of the flume. Compressed air is fed into the tube, and the hydrostatic pressure in the tube is measured and converted to stage. Bubblers are slightly less accurate than ultrasonic look-down depth sensors, but they are not affected by wind, waves, and surface foam.

Because the influent sampling point will most likely be submerged during storms and because back-watering may occur at the discharge sampling points, an area-velocity (AV) flow meter (or equivalent) will be installed at most sampling points. These meters will have single-point, internally mounted, low profile depth and velocity sensors. A pressure transducer that senses gauge pressure will be used to measure depth. The pressure transducer will be vented to atmospheric pressure. The pressure transducer can be separate or integral to the velocity sensor. The velocity sensor will operate using the Doppler principal for measurement velocity and stage or instantaneous flow data will be transmitted to the data logger/controller upon query commands found in the data logger software.

5.1.3 Rain Gauge

A rain gauge having a “tipping bucket” design that incorporates a small “bucket” which holds a known amount of rainfall will be used onsite. When the bucket is filled, it tips the water out, momentarily closes a switch, and then resets itself and starts the process again. The data logger/controller counts each switch closure to accumulate rainfall totals. The rain gauges used will tip after every 0.01 inch of rain.

5.1.4 Power

Power for the monitoring stations will be either from 110v AC (15 amp) or 12 volt batteries. If primary power is from batteries, a separate battery will be used to individually power the autosamplers, modems, and flow meters. Batteries will also be

used at the AC sites as back-up. A solar panel, mounted on a pole, will be installed at each site to help keep the batteries charged.

5.1.5 Telecommunications

Cellular modem transceivers will be used to provide remote telecommunication access to the monitoring equipment. The ability to access a sampling station, monitor the status of the station in real-time, modify storm criteria, download new programs, and recover data allows for more cost effective, efficient monitoring. In addition, modem communication allows for remote initiation of sampling within minutes.

For each SF sampling point, a high performance base station antenna will be installed at the top of a mast that also supports a rain gauge (at one sampling point per BMP) and a solar panel. A filter will be installed in the lead-in from the antenna to prevent damage to the sampling station equipment due to nearby lightning strikes.

5.1.6 Equipment Enclosures

Walk-in fiberglass enclosures will be used to house the samplers and associated electronic equipment. These enclosures are to be bolted to the concrete pads and are to be locked to secure the monitoring equipment.

5.2 Maintenance and Calibration

A complete maintenance program will be performed at each SF after each storm event during the monitoring period, or in the absence of rain, on a monthly basis. Maintenance will include checking the performance of the equipment, checking power supplies, inspecting and clearing intake structures, cleaning contaminated equipment, and performing necessary equipment calibrations. Calibrations will be conducted in accordance to specifications in the individual component manuals.

Stormwater equipment maintenance visits will be thoroughly documented. Written documentation includes the action taken at a site as well as the date performed. Accurate and thorough records of station visits will be maintained to aid in the evaluation of an SF's performance. The log illustrated in Form F in Tab 5 of the *FGN* will be used to document maintenance and calibrations. If any program parameters are changed, the log shown on Form I, J1 and/or J2 in Tab 6 in the *FGN* will be completed.

5.3 Preparation and Logistics

Success of the sampling effort requires careful preparation and planning to assure that high quality samples are obtained in association with each storm event.

5.3.1 Weather Tracking

Weather tracking will be the responsibility of the Task Order Manager and Storm Control personnel. During each storm season, the weather will be continually monitored with increased frequency as incoming systems are predicted. Sources of weather information to be used to track incoming storms include the National Weather Service, Weather Watch Service, Weather Network (WeatherNet), the Alert system from San Diego County, public broadcast information available on the Weather Channel and local news stations, and radar and satellite images downloaded from the Internet (e.g., www.weather.com).

5.3.2 Mobilization and Staffing

A staffing plan, which designates personnel and equipment for each facet of the storm monitoring, will be developed as soon as a potential event is forecast. Crews will consist of two individuals. The staffing plan will include the following information:

- Personnel needed for each position.
  - Storm Control
  - Shift Leader
  - Crew Chiefs
  - Crew Assistants
- Shift and zone (pilot facilities manned by a single crew) designations.
- Equipment mobilization.
- Communication channels.

Equipment needed for stormwater sampling includes sampling equipment, sampling containers, safety equipment, personal rain gear, Storm Kits, and vehicles equipped with some type of mobile communication and highway safety equipment (see lists). Necessary equipment will be loaded into the appropriate vehicles early in the storm preparation sequence.

<u>Storm Kit Equipment List</u>

- Keypad/display.
- 9-pin cable from keypad to data logger.
- Full set of keys (on floatable bobber).
- Flashlights (2).
- Maps for required areas.
- Large flat screwdriver.
- Small flat screwdriver.
- Umbrella.
- High quality alkaline D-cell batteries.
- Spare sample labels.
- Pencils and indelible markers.
- Desiccant (packages and jar).Diagonal clipper.
- Electrical tape.
- Cable ties (assorted sizes).
- Utility knife.
- Ziploc baggies (assorted sizes).
- Labeling tape.
- Polyethylene gloves.
- Rubber bands.

Storm Mobilization List

- Storm kit.
- Log books.
- pH meter.
- Paper towels.
- DI (de-ionized) water squirt bottles.
- Tape gun with clear tape.
- pH grab bottles.
- Spare sample labels.
- Ice scoop.
- Sample control paperwork.
- Extra fine indelible markers.
- 20 liter bottles in 10 gallon containment buckets.
- Grab sample bottles.
- Coolers and ice.
- Grab pole.
- DI water (3-gallon jug).
- Two-way radio or cellular phone.
- Personal rain gear.
- Any necessary safety gear.

Communication Channels

Communication channels will be established for personnel to contact each other before and during a storm event. A telephone tree will be used to facilitate contacting field personnel and other key individuals. Phone lists with home and work numbers and other key contacts will be made available to potential crew members. Two-way radio or cellular telephone communication links to field crews are essential for efficient stormwater monitoring.

5.3.3 Monitoring Station Preparation

Prior to a storm event, the SF monitoring stations will be made ready to sample. This preparation includes entering the correct “Volume to Sample” values, setting the autosampler and the data logger to sampling mode, pre-icing the composite sample bottle, and performing a general equipment inspection. Section 5 of the *FGN* will be consulted for specific details on station preparation.

Determination of Volume to Sample

The latest weather forecast prior to each storm event will be examined to determine the proper "Volume to Sample" value to enter into the system. The amount of expected rainfall, how the station performed during the previous storm and how much water is needed for analysis at the station for each storm event will be taken into consideration.

The "Volume to Sample" is entered as a number with units in kilo-cubic feet (kcf). To determine this number, the drainage area in acres and the runoff coefficient, which is a number that reflects the permeability of the land in the study area, is listed below. Use the following equation to determine the volume of water expected at an SF for a given rainfall:

A x B x C x 3.63 = volume in kcf

Where:

A = inches of rain
B = drainage area in acres
C = runoff coefficient for land area
3.63 = conversion factor: acre-inches to kilo-cubic feet

To determine how much water will pass the station between samples, divide this result by the number of samples needed to satisfy the water volume requirement for analysis. A table is supplied as Exhibit 9.2 of the *FGN* that indicates the Volume to Sample value needed to collect the correct sample amount of water for the amount of expected rainfall.

After the proper Volume to Sample value is determined, it will be entered into the system before the rainfall starts. The runoff value will generally be entered from a remote computer. The value can also be entered upon arrival at the site before the system has entered storm mode. It is important that this value is accurate as possible; if the value is too high, the system will not collect enough water to be analyzed, and if the value is too low, the system may sample too fast to be monitored effectively (i.e., the percent storm capture will drop).

Prepare Sampler

Each autosampler will be reset and programmed to take 78, 250-ml aliquots. Also other user-entered parameters (tubing length, head height, bottle size, composite sample, sample upon one pulse, and enabled liquid detector) will be set correctly.

During each site visit, the state of the System Status Flags (switches) and Program Signature will also be recorded. These provide important information on the current sampling mode and overall integrity of the site program.

Ice Sample Bottle

The sample bottle will be iced after the decision has been made to monitor the storm and prior to initial sample collection. If this is not possible, the bottle will be iced immediately upon the first visit.

General Inspection

A brief physical inspection of the equipment will be made to make certain that there are no obvious problems such as broken conduit or a kinked hose. If possible, the intake will be cleared of debris; at sites with confined entry access, this is only possible if the safety requirements listed in Appendix II are met.

Documentation

Upon each site visit, whether during storm mode or not, records of the visit will be accurately recorded on the field form (Form I of Tab 5 in the *FGN*). Whenever possible, any data being recorded by the sampling system (for example, time or current stage) will be verified. If any program parameters are changed, a program parameter log (Forms J1 and J2 of Tab 6 in the *FGN*) will be filled out. Also once during each storm event visit, the Empirical Observation Checklist will be completed (Tab 6, Form H in the *FGN*).

General Visitation Data

During each station visit, several display locations will be recorded. The log sheets will be used as a guide to the proper display locations to record (Form I, Tab 6, *FGN*). The following data will be recorded at both the influent and effluent stations:

- Flume Stage (ft).
- AV Meter Stage (ft).
- Velocity (f/s).
- Flume Q (flow in cfs).
- AV Meter Q (flow in cfs).
- Station ID.
- Data logger Battery Voltage.
- Flow Meter Battery Voltage.
- Cellular Equipment Battery Voltage.

Storm Visitation Data

Additional data will be recorded in the logbooks during storm monitoring, including:

- Volume (kcf)
  This is the volume of water that passed the station during the previous execution interval (one minute).
- Storm Sum
  This indicates the accumulated runoff volume in kilo cubic feet (kcf) that has passed the station since the last sample.
- Percent Storm Capture
  This indicates the percent of the storm effectively sampled by the system, and it provides a quick evaluation of the quality of the monitoring.
- Volume to Sample
  This value indicates the runoff volume (in kcf) that will pass the station before the system will take the next sample.
- Sample Count
  This number indicates the number of samples taken in the current bottle. It automatically re-zeroes every time a bottle is filled.

- Total Rain (inches)
  The total rainfall in inches since the start of the storm. This is accumulated each time that the rain bucket tips.
- Max Flow (Day)
  The day maximum flow occurred.
- Max Flow (time)
  When this number is positive, it indicates that the system was sampling during peak stage. If this number is negative, sampling did not occur during the peak stage because the bottle was full.
- Max Flow (cfs)
  This indicates the maximum flow rate during the current storm.
- Storm Volume (kcf)
  This indicates the total volume of water that has flowed past the station since the beginning of the storm.
- Storm Volume Sampled (kcf)
  This indicates the total volume of water that flowed past the station while the system has been in storm mode.

After data have been recorded, the system will be placed in low power mode and the keyboard unplugged.

5.4 Storm Monitoring

A priority objective of storm monitoring is to maximize the percent storm capture of the composite sample. This will be accomplished by ensuring that a composite bottle does not fill without being changed immediately. If a bottle does fill, the full sample bottle will be replaced and the system will be reset. To determine approximately when the bottle will fill and to ensure that the sampling process is not interrupted, the Storm Sum and the Volume to Sample will be evaluated. By examining how quickly the Storm Sum value is approaching the Volume to Sample value, the approximate time until the next sample is taken can be determined, as well as the approximate time until the bottle fills. The monitoring crew will be aware of the current status of each station in each of its BMP pilot facilities to determine which one will fill a bottle first so they can be on site as the bottle fills. If the station has been set properly for the amount of rainfall, changing the composite bottle will not be necessary. Volume to Sample settings will take into account the volume of sample required to meet analytical needs. This study requires approximately 3 liters of sample to meet these needs.

The data logger pulses the autosampler to take a sample when the accumulated Storm Sum equals the Volume to Sample. The storm sum is then reset to zero and the process is repeated. This continues until the storm ends or the bottle fills. Ideally, the Volume to Sample value will be accurate for the amount of rainfall, and the bottle will not need to be changed during the storm. If, however, the rainfall is different than that predicted, a bottle

may fill before the end of the storm. If this occurs, sampling will halt until the bottle is changed and the system is reset. Until the system is reset, part of the storm is not being sampled, and the percent capture will show a decrease. It is therefore imperative that the system is reset and the sample bottle is changed immediately to maintain 100% storm capture.

5.4.1 Storm Procedure

Upon arrival at a station during a storm event, the status of the composite sample bottle will be checked immediately. If it is not necessary to change the bottle at that time, the appropriate data on the log sheets will be recorded and the necessary physical measurements and observations will be taken. An approximate time that the bottle will fill will be determined, and, depending on how much time is available, the next station will be visited or the team will wait until the bottle fills.

If the sample bottle is full, the system will be reset immediately, and the bottle replaced. When the bottle has been changed, the necessary station data will be filled in on Form I, Tab 6, in the *FGN*.

5.4.2 Sample Bottle Replacement

The removal of the sample bottle from the sampler requires great care; the bottles are heavy when full and are very slippery when wet, as well as being expensive and fragile. More importantly, if the sample is lost or contaminated, the effort and expense of the storm monitoring process is wasted. In all cases, two people will be present to ensure the security of the bottle and of the sample itself. Extreme care will be taken not to kink the intake hose when handling the sampler.

The bottle number will be recorded in the logbook and the bottle will be labeled appropriately. When a new bottle has been put in place, the sampler reset to continue sampling. Full bottles will be kept iced.

5.4.3 Storm Monitoring Office

The main objective of the Storm Monitoring Office is to update field crews on the status of their stations. This will greatly reduce the amount of time a crew will spend driving during storms. The monitoring of stations from a remote computer consists of calling each station and recording certain data for evaluation. When it is determined that a sampling system is close to filling a bottle, a field crew will be called and alerted to the status of the station. Remote interrogation of the storm stations will be logged (Form K, Tab 6, *FGN*) using the parameters in Forms J1 and J2, Tab 6, *FGN*.

Generally, the Storm Monitoring Office is also the storm control position. This means that critical decisions regarding the status of storm monitoring are made with input from the Storm Monitoring Office.

Therefore, this position requires awareness of the latest weather forecasts to make informed decisions on the continued monitoring of the storm.

5.4.4 Post-Sampling Procedures

Declaring the end of a storm event may be difficult at an SF as the filter may hold water for longer than 48 hours and effluent flow may continue out of the filter. Thus, storm events can overlap. If storm events begin to overlap, two criteria will be used to either continue sampling or end sampling. If the effluent has 75% storm capture or more and 8 or more sample aliquots, monitoring will stop and the stations will be shut down. If the effluent has less than 75% storm capture or less than 8 sample aliquots, the influent and effluent sampling will continue monitoring the event until the event stops raining.

After a storm event has ended, the SF stations need to be shut down. Stations will be left ready for the next storm event in case there is insufficient time for a maintenance visit between storms. The following items will be taken care of, and everything will be well documented in the field logbook.

1) The storm monitoring program will be reset to prepare for another storm event.
2) The sample bottle will be replaced and the sampler reset.
3) The station will be physically inspected to determine if any damage was sustained during the storm event. The flow sensors will be inspected to determine if it is blocked by debris, or the intake is clogged (This is only possible if confined space requirements are met).
4) The data will be retrieved. This will be done via modem from the remote monitoring computer.
5) Battery voltages will be checked; batteries that are low will be replaced.
6) An Empirical Observation Checklist for each sampling point and SF will be completed (see Form H, Tab 6, *FGN*) one time during the event.

Data Retrieval

Data will be retrieved (dumped) from the data logger after each storm event during the storm season, and, during dry weather, approximately every month.

Chain-of-Custody Forms

When the grab samples have been collected, the paperwork will be filled out to ensure a smooth transfer of samples to the analytical laboratory. Chain-of-Custody forms will be filled out in detail describing the type of sample, the quantity of samples, and the time that the samples were collected. These forms will accompany the samples to the laboratory.

5.4.5 Evaluation

Upon termination of a storm event monitoring, evaluation of the influent and effluent stations' performance will be documented and reviewed before the samples collected are deemed valid. Evaluation of a monitoring station's performance is based on the answers to the following questions:

- Was the storm representative of the effectiveness range of the SF?
- Was capture of peak flow or runoff achieved at both sampling points?
- Did the equipment perform as designed throughout the duration of the storm event?
- Did the samplers accurately collect equal and reliable storm sample aliquots?
- Did the SF work as designed?

5.4.6 Grab Sampling

Total petroleum hydrocarbons (TPH) and bacteria (fecal coliform) samples are unsuitable for collection by automatic means, and will be collected for two storms each monitoring year. TPH is inappropriate because some material adheres to the surface of the tubing and the composite sample container. Automatic sampling for bacteria is inappropriate because the sampling equipment is not sterile after installation and exposure to the elements. Because these analytes are unsuitable for collecting using an automated approach, they will be collected as a grab sample from both the influent and effluent during each monitored event. The samples will be collected as close to the onset of discharge as possible.

It is imperative that collected grab samples are transferred to a designated meeting location immediately after the sampling has been completed. Chain-of-Custody forms for the samples will be completed and transport of the samples to the analytical laboratory will be coordinated to ensure that samples are handled and analyzed within the proper holding times to the extent possible.

It is essential that the following sample handling protocols be followed when collecting grab samples to keep contamination to a minimum:

- Turn the vehicle engine OFF to minimize exposure of the sample to exhaust fumes.
- Keep sample containers in clean coolers until sampling is actually initiated.
- Store filled sample bottles in clean coolers at 4°C.
- Keep the bottle lid clean and free of debris while the bottle is open.

Grab samples will be collected as near to the sampling point as possible. When unable to collect a sample near the intake, one will be collected as near the center of flow as possible or in an area of sufficient velocity to ensure good mixing. Both sampling points require a grab pole to collect the necessary grab samples. Containers will be fitted snugly into the bottle holder and the bottles will be seated on the upstream side of the grab pole to reduce potential contamination. The bottle will be filled with the mouth of the bottle

faced into the current, if possible. Also, the bottle will be labeled before it is filled as it is nearly impossible to write on wet bottles. The station will be listed on the bottle to coincide with the station sampled.

Each type of grab sample may require special treatment to ensure the quality of the sample and the safety of the sampler. The preservative in the sample bottles is usually a concentrated acid, so care will be taken that the preservative does not come into contact with the skin. Gloves will be worn when handling sample containers. Both types of grab samples are discussed below.

TPH analyses will be performed for diesel, gasoline, and oil fractions and reported separately for each. Samples to be analyzed for TPH gasoline fraction will be preserved with a concentrated acid (HCl), while TPH diesel and oil containers are unpreserved. The sample bottles will be filled to below the neck and just above the shoulder. The bottle will not be overfilled because the preservative will be washed out. If the bottle is just slightly overfilled, a small amount of sample will be poured off after the preservative has mixed with the sample. A small amount of headspace is required in the containers to allow for expansion if the sample freezes while iced during shipping. These grab samples will be collected as soon as possible after runoff is detected.

Fecal Coliform samples are preserved with a small sodium thiosulfate tablet. To retain the tablet while sampling, it will be removed from the container when it is dipped into the flow. The bacteria bottle will be turned over causing the tablet to fall onto the cap of the bottle; the cap will be removed and set somewhere that will prevent it from becoming contaminated (out of the rain). The sample bottle will be filled to the shoulder, the cap tipped so the tablet falls into the sample, and the cap secured to the bottle. These grab samples will be collected as soon as possible after runoff is detected.

Attempts will be made to maintain the 6-hour holding time for bacteria to the extent practical. However, storm field conditions may prove this holding time infeasible. A maximum holding time of 24 hours will be followed in accordance with the "Standard Methods for the Examination of Water and Wastewater," 18th Edition.

5.5 Sample Tracking and Handling

Samples, regardless of their matrix, will be kept properly chilled and transferred to the analytical laboratory within holding times to achieve the highest quality data possible. To ensure proper tracking and handling of the samples, documentation will accompany the samples from the initial pickup to the final extractions and analysis. This documentation includes: Chain-of-Custody forms as required (see Form M, Tab 7, *FGN* for example forms). These forms or equivalent will be used to track and handle samples.

Collected samples will be labeled with the following information:

- Date.
- Time.
- Project name.
- SF name and number.
- Influent or effluent sampling location.
- Preservative.
- Matrix.
- Collector's initials.
- Sample I.D. number.
- Analyte(s) to be analyzed.
- Grab or composite sample.

The analytical suite for each station depends upon the total volume of water collected for the storm event. A Priority Analysis Sheet will be used in conjunction with a Sample Bottle Evaluation to determine the analytical suite for each station, based on the volume of water collected at that station, the volume to sample, and the percent storm capture. When the storm has been evaluated and samples from each station accounted for, a duplicate station and a QA/QC station will be selected based on stormwater volumes available. Duplicate and QA/QC samples will be prepared from the combined volume of the sample collected at the selected duplicate and QA/QC station.

Duplicate and QA/QC sample bottles will be labeled, recorded on the Chain-of-Custody form, and transported to the analytical laboratory.

Grab samples will be transported to the appropriate laboratory as soon as the grab sampling is completed, whereas the sample bottles for the composite samples are transferred at the end of the storm event. Samples will be properly logged on the Chain-of-Custody form and kept chilled in coolers. There will also be a field duplicate and extra water collected for QA/QC samples. These QA/QC grab samples will be collected at one of each consultant's BMPs during each storm event monitored. The sampling stations will be selected by Storm Control for collecting the duplicate grab samples. The crews monitoring the stations will be fully briefed on the procedures for collecting QA/QC samples, and will be familiar with the sample identification numbering scheme for these samples because they are to be submitted to the laboratory as blind samples. These samples will be labeled, recorded on the Chain-of-Custody form, and transported to the analytical laboratory.

Each sample collected will receive a unique alphanumeric code (sample I.D. number) for tracking. This code will be standard for samples and contain information as to the station, date, and sequential monitoring event number. The following is an example of this code:

SITE No.-IN-32898-001

Where:

Site No. = Site number of BMP site.
IN = Influent sampling point at the site; EF = effluent sampling point.
32898 = Julian day and year
001= First storm event monitored during this program at this location

If multiple bottles are used or needed to capture a single event, the last data field will indicate the bottle number and the total bottles in that sampling event (i.e., 001-1/3, 001-2/3, 001-3/3 for a three-bottle collection scheme).

A set of QA/QC samples will be provided with each type of sample analyzed for each storm event. The analytical laboratory may also require additional QA/QC samples if one type of analysis is to be run in more than one batch.

Duplicate samples, MS/MSDs, and replicate/splits need not be from the same station. However, per storm event (or batch run), these QA/QC samples will be analyzed for the standard analytes as field samples. Most field QA/QC samples are submitted blind to the analytical laboratory, however, additional sample volumes provided to the laboratory for laboratory replicates or matrix spikes and matrix spike duplicates will be clearly identified. The main types of QA/QC samples that will be utilized for this study are as follows:

Duplicate Analyses - These analyses will be performed for both grab samples and composite samples and will require an additional set of sample containers to be sub-sampled. The results will allow evaluation of sampling error introduced by both field sampling and laboratory analyses by showing the reproducibility or precision of the sample collection and analyses. Duplicate samples will be sent “blind” to the laboratories. One duplicate sample will be collected from one of each consultant’s sampling locations during each storm event sampled and analyzed for the full list of analytes.

Duplicate samples will be identified by adding 500 to the sequential storm event number. For example, a duplicate sample for the same site above will be:

SITE No.-IN-32898-501

Blanks - These are for field as well as laboratory samples. Blanks help verify that the equipment and the sample containers are not contaminated, and the sampling techniques used are non-contaminating. Reusable sample bottles, Teflon® tubing, and filters will be rinsed with reagent grade analytes free deionized water separately. The collected rinsates will be analyzed for the full list of analytes for the composited samples. Blanks will also be run on the analytical equipment. Rinsate blanks will be run on two samplers used by

each consultant at one of their BMPs prior to the installation of the equipment. Each time a batch of composite bottles is cleaned, five percent of those filters will be blanked.

Equipment rinsate blanks will be identified by adding 600 to the sequential storm event number. For example, an equipment rinsate blank collected from the monitoring equipment from the same site above will be:

SITE No.-IN-32898-601

Field blanks will be identified by adding 700 to the sequential storm event number. For example, field blank collected at the same site above will be:

SITE No.-IN-32898-701

Matrix Spike and Matrix Duplicate Spike (MS/MSD) – The laboratory will require additional sample volumes for analyses that require matrix spikes and matrix spike duplicates to evaluate precision and accuracy of the laboratory analytical method, and to evaluate any matrix interference. MS/MSDs are analyzed for their analyte(s) and then spiked with a known amount of analyte(s). One MS/MSD sample will be run on metal and TPH samples from one of each consultant's sampling locations during each storm event sampled.

MS/MSD samples will be indicated on Chain-of-Custody forms by clearly identifying that the sample is for MS/MSD purposes.

Laboratory Replicate/Split – This QA/QC analysis will require additional sample volumes. It is a duplicate analysis performed on the same sample and evaluates the repeatability (precision) of the analytical laboratories' results. One split sample will be run from one of each consultant's BMP sampling locations during each storm event sampled and analyzed for the full list of analytes.

Laboratory replicate/split samples will be indicated on Chain-of-Custody forms by clearly identifying that the sample is for laboratory replicate/split sample purposes.

5.6 Laboratory Selection, Sample Container Preparation, and Analytical Methods

5.6.1 Laboratory Selection

The selected laboratories have extensive experience with environmental samples and have the ability to provide rapid response to meet critical holding time requirements for analytes requiring expeditious analysis. Laboratories are certified by the California Department of Health Services for the requested analyses. Refer to Tab 2 in the *FGN* for specific laboratory listings.

5.6.2 Holding Times, Sample Bottles, and Preparation

The laboratories will be responsible for providing appropriate sample containers and, when necessary, with preservatives for each analysis. Table 5.1 provides a summary of sample volumes required for each analysis, along with the types of containers, holding times, and preservative. Because additional volumes are necessary for laboratory QA/QC, sample containers will provide at least twice the volume necessary to perform the requested analysis. The volume of the stormwater composite from each site is often the critical factor in determining the volume of sample that can be provided to the laboratory. The Project Task Order Manager and/or Storm Control personnel, in conjunction with the laboratories, will determine the allocation of sample volume for different analyses if sample volumes are not adequate to provide additional volume for each analysis. Table 5.1 lists the analyses along with a priority ranking. Also listed on Table 5.1 are the analytical methods and reporting limits.

5.6.3 Project Reporting Limits

Recommended analytical methods and reporting limits for this project are listed in Table 5.1. The reporting limits in this table are target reporting limits. In some cases, reporting limits may need to be adjusted due to limited sample volumes or potential matrix interference. In such cases, appropriate data qualifiers will be applied to the associated data.

5.6.4 Laboratory Data Package Deliverables

Laboratories will be required to provide a three-week turnaround on deliverables. The deliverable package will include a hard copy and electronic data files. The hard copy will include standard narratives identifying any analytical or QA/QC problems and corrective actions. The electronic data files will contain information found in the hard copy reports submitted by the laboratories. Individual data sets will be submitted as either Microsoft Excel workbook files or as Microsoft Access database files in accordance with the Caltrans Data Management Plan – Data Reporting Protocol and Database (CTSW-TM-98-005). Each consultant will be responsible for laboratory coordination and data management.

5.7 Sediment Sampling and Testing for Disposal Purposes

As part of the maintenance program, sediment will be removed from the BMP when flows are hydraulically impeded. It is anticipated that sediment will accumulate relatively slowly over time. However, should sediment deposit in a rapid manner, an intermediate step of stockpiling may become necessary before offsite disposal. Section 5.7.1 provides procedures to be used when assessing potential sediment contamination in the event that intermediate onsite storage is necessary.

This subsection describes the sample collection procedures and analyses for assessing the quality of surface sediment removed from the BMP for disposal. Evidence of oil and grease, antifreeze, solvents, fuel, hydrogen sulfide, and any other noxious substance will be noted. Observations will be used to determine if more than the standard list of analytes is required. Observations will be documented on a checklist form (Form G, Tab 5, *FGN*). The standard list (Table 5.2) is based on highway contaminants that have the potential to exceed hazardous waste criteria. After laboratory analysis, results will be compared to regulatory limits listed in California Code of Regulations (CCR) Title 22, Section 66261.24 and Department of Toxic Substances Control (DTSC) variances. Based on this evaluation, proper disposal methods will be chosen.

Table 5.1
Stormwater Matrix
Analytical Parameters, Methodologies, Reporting Limits, Holding Times, Container Volumes and Types, and Preservation

Analyte	Priority Rank	Reporting Limit	Units	Analytical Technique	Method Number	Holding Time	Minimum Sample Volume	Preferred Volume and Container Type[1]	Preservation
Conventionals									
pH	1	0.1	Unit	Electrode	EPA 150.1	Immediately[2]	100 mL	1-100 mL glass/plastic	4°C
Specific Conductance	1	1.0	µmhos/cm	Electrometric	EPA 120.1	Immediately[2]	500 mL	1-500 mL glass/plastic	4°C
Hardness	5	2	mg/L	Titrimetric/ Colorimetric	EPA 130.2	6 months	100 mL	1-200 mL glass/plastic	HNO_3 to pH<2, 4°C
Total Suspended Solids	1	1	mg/L	Dried Filter Weight	EPA 160.2	7 days[3]	1 L	1-500 mL glass/plastic	4°C
Nutrients									
Nitrate-Nitrogen	2	0.01	mg/L	Colorimetric Ion Chromatography	EPA 353.3 EPA 300.0	28 days 48 hours	200 mL 200 mL	1-500 mL plastic 1-500 mL plastic	4°C and H_2SO_4 to pH<2 4°C
Total Kjeldahl Nitrogen	3	0.1	mg/L	Titrimetric/ Colorimetric	EPA 351.3	28 days	500 mL	1-1L plastic	4°C and H_2SO_4 to pH<2
Total Phosphorus	4	0.002	mg/L	Colorimetric	EPA 365.3	28 days	100 mL	1-250 mL plastic	4°C and H_2SO_4 to pH<2
Total/Dissolved Metals[4],[5]									
Copper	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Lead	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Zinc	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Organics[6]									
Total Petroleum Hydrocarbons – Diesel/ Oil	Grab	250/200	µg/L	GC	EPA 8015M	14 days	1 L	2-1L amber glass	4°C
Total Petroleum Hydrocarbons - Gasoline	Grab	50	µg/L	GC	EPA 8015M	14 days	2-40 mL	3-40 mL VOA vials	4°C, HCl to pH<2
Bacteria[6]									
Fecal Coliform	Grab	2	MPN/100 mL	Multiple-tube	SM 9221E	6 hours[7]	50 mL	1-100 mL plastic	4°C

1. Analytes with the same preservative can be combined into a single container if the same laboratory is performing the analyses.
2. pH and Specific Conductance will be measured by the laboratory immediately upon receipt of the samples.
3. 7 days based upon limit for measuring TSS/no regulatory limit.
4. Total and dissolved metals samples are collected in separate containers. Only the total metals container will receive nitric acid.
5. Dissolved metals will be filtered in the laboratory prior to acidification.
6. Total Petroleum Hydrocarbon and Fecal Coliform grab samples will be collected for two storms per year.
7. Attempts will be made to maintain the 6-hour holding time for bacteria samples to the extent possible. When not possible, a maximum holding time of 24 hours will be followed in accordance with "Standard Methods for the Examination of Water and Wastewater," 18th Edition.

5.7.1 Sediment Collection

Procedures in EPA Publication *Test Methods for Evaluating Solid Waste, Physical/ Chemical Methods (SW-846)* provide a method for determining the mean concentration of a given contaminant within a soil mass and the appropriate number of samples necessary to calculate this mean to the specified confidence interval. Initial sampling will generate a minimum number of samples/analyses as described below. Additional sample analyses may be required to meet the confidence levels given in *SW-846*, therefore archiving of samples will be necessary. Archived samples will be appropriately preserved and analyzed within the maximum holding time specified in Table 5.2. None of the samples will be allowed to be composited. The Quality Assurance/Quality Control (Appendix III) describes the QA/QC objectives for surface sediment samples. The minimum number of discrete samples initially required is given below:

- Drums: A minimum of one sample will be collected from each drum.
- Stockpiles less than 10 cubic yards: A minimum of two samples will be collected, one from each half of the stockpile. Sampling points will be selected randomly within each half.
- Stockpiles from 10-20 cubic yards: A minimum of three samples will be collected, one from each third of the stockpile. Sampling points will be selected randomly within each third.
- Stockpiles from 20-100 cubic yards: A minimum of four samples will be collected, one from each quarter of the stockpile. Sampling points will be selected randomly within each quarter.
- Stockpiles from 100-500 cubic yards: A minimum of one sample for each 25 cubic yard portion will be collected. The stockpile will be sectioned into 25 cubic yard portions to obtain a minimum of one sample for each 25 cubic yard portion. Sampling points will be selected randomly within each 25 cubic yard portion of the stockpile.

Random samples will be selected from locations on a three-dimensional grid. If the presence of materials such as boulders, debris, etc. hinder this process, the sample will be collected as close as possible to the randomly selected point without altering the essence of the random selection process. The following steps will be used to collect surface sediment samples:

1. Don personal protective equipment.
2. Locate the sample point in the stockpile or drum.
3. Collect the sample using a soil probe or equivalent. Ensure that the sample is collected at the correct depth and location that was randomly selected.
4. Fill one 8-ounce glass jar with a portion of the sample and close the container with the cap, using care not to aerate (volatilize) the sample. This jar will be labeled and analyzed for TPH and VOC.

Table 5.2
Sediment Matrix (Disposal)
Analytical Parameters, Methodologies, Reporting Limits, Holding Times, Container Volumes and Types, and Preservation

Parameter	Method	Units	Reporting Limit	Maximum Holding Time	Preservation	Container Size/Type(1)
Total Petroleum Hydrocarbons (TPH)	EPA 418.1	mg/kg	10	28 days	4^oC	8 oz glass jar
Volatile Organic Compounds	EPA 8260B	mg/kg	SW – 846 (5) requirements	14 days	4^oC	8 oz glass jar
California Code of Regulations (CCR), Title 22 Metals(2):	EPA 6020/7471	mg/kg	SW – 846 (5) requirements	180 days 28 days for mercury	4^oC	8 oz glass jar
California Code of Regulations (CCR), Title 22 Waste Extraction Test (WET) Metals(3):	STLC Extraction	mg/L	SW – 846 (5) requirements	180 days 28 days for mercury	4° C	NA
Toxicity Characteristic Leaching Procedure (TCLP) Metals(4):	TCLP 1311	mg/L	SW – 846 (5) requirements	180 days 28 days for mercury	4° C	NA

(1) Each sample will be collected in two 8 oz glass jars
(2) California Code of Regulation (CCR), Title 22 Metals (Sb, As, Ba, Be, Cd, Cr (total), Co, Cu, Hg, Pb, Mo, Ni, Se, Ag, Tl, V, and Zn). Initial waste characterization results may lead to a shorter list of metals for subsequent sediment disposal.
(3) Any sample for total metals that are below the Total Threshold Limit Concentration [TTLC] but exceed the ten times Soluble Threshold Limit Concentration (STLC) will be further analyzed using the WET procedure. WET extracts will be analyzed only for metals which exceed the ten times STLC criteria. Sediments associated with total metal results that exceed TTLC values are automatically considered hazardous and therefore do not need to undergo the WET procedure.
(4) If any of the WET-soluble concentrations are equal to or greater than the TCLP regulatory thresholds, analyze the waste by TCLP.
(5) "Test Methods for Evaluating Solid Waste, Physical /Chemical Methods". SW-846, Update III.(SW-846)

5. Homogenize the other portion of the sample in a disposable bowl using a disposable spatula or spoon. Fill a second 8-ounce glass jar with this portion of the sample and close the container with the cap. This sample will be labeled and analyzed for metals.
6. Wipe the outside of each sample container with a clean paper towel.
7. Record the sampler's initials, date, and time on the pre-labeled sample bottle.
8. Place the sample containers in individual zip-top plastic bags and seal the bags.
9. Immediately pack the samples into a chilled cooler.
10. Record the required information on the Chain-of-Custody Form.
11. Document the sampling event, recording information in the designated field logbook.
12. Repeat the above steps until the minimum number of samples has been collected.

5.7.2 Sediment Analyses

Unless observations indicate additional testing, surface sediment samples submitted to the laboratory will be analyzed for analytes listed in Table 5.2 using Title 22 criteria (State of California, 1985). This table also lists the required reporting limits, analytical holding times, required preservation, and container sizes and types. Laboratory turn around times and data deliverables will be the same as those for the stormwater samples.

5.8 Empirical Observations

5.8.1 Purpose of Empirical Observations

Performance assessments of BMP facilities cannot be fully ascertained through analytical methods. "Empirical" observations are also critical in determining the overall performance of implemented water quality management practices and in ensuring that the practices are maintained at optimum levels. Other factors such as maintenance activities, environmental variability, and physical processes, which cannot be determined analytically, can greatly influence the performance of a particular SF. Some of these factors such as rainfall quantity, rainfall intensity, and chamber retention times can, and, will be assessed through physical measurements. Other components such as trash build-up, sediment deposition, and runoff appearance can best be assessed through careful documented observations.

5.8.2 Guidelines

Observations will be succinct but also complete. For an SF performance evaluation, the following observations will be taken at the influent location, chambers, and effluent location:

- Meteorological characteristics (present and preceding period).
- Hydrologic and hydraulic characteristics (flowing and/or standing water).
- Inlet conditions (problems affecting performance).

- Water quality appearance (visual, olfactory) to make a rough assessment of changes in water quality.
- Solids deposition (trash and debris, sediments, organics) and resuspension.
- Treatment medium condition.
- Outlet conditions (problems affecting performance).
- Mosquitoes and other vectors.
- Structural condition of facility.
- Monitoring equipment condition.

5.8.3 Checklist for Sampling and Monitoring Personnel

Refer to Form H, Tab 6, *FGN* for a checklist (log form) that will be completely filled out by sampling and monitoring personnel during each storm event visit to the facility.

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CALTRANS
BMP RETROFIT PILOT PROGRAM

DISTRICT 11, SAN DIEGO

BMP OPERATION, MAINTENANCE, AND MONITORING PLAN

VOLUME II

APPENDIX I-D
BIOFILTRATION STRIP / INFILTRATION TRENCH

September 1999

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FIGURES

1.1 Cross-Section of Infiltration Trench

1.0 INTRODUCTION

The Caltrans Best Management Practice (BMP) Retrofit Pilot Program is a comprehensive water quality monitoring study to evaluate the removal of contaminants in stormwater runoff from Caltrans roads and facilities through a series of BMP pilot installations. The overall objectives of this portion of the program are to document BMP contaminant removal efficiency and technical feasibility.

This Appendix of the Operations, Maintenance, and Monitoring Plan (OMM) applies to the Biofiltration Strip/Infiltration Trench (Strip/IT). Refer to the consultant's monitoring equipment manuals and stormwater monitoring Standard Operating Procedures (SOPs) for details related to equipment installation, equipment maintenance, and storm monitoring. Maintenance, safety, documentation, and storm monitoring tasks will be carried out according to the procedures detailed in this plan. Additional measures may be necessary due to unforeseen or temporary changes to the work environment at these sites.

1.1 Retrofit BMP Description

The Strip, which is a pretreatment BMP, is used upstream of the IT to remove sediment and organic matter. Strips remove pollutants from stormwater runoff as it flows through the vegetated system by filtration, infiltration, adsorption, ion exchange, and biological removal. Strips are broad vegetated surfaces, which receive and discharge flow in relatively thin sheets. Strips are designed to treat stormwater runoff during "water quality storm events" (defined as up to the 1-year, 24-hour peak flows).

The IT is a shallow (0.6 to 3 meters) excavated trench backfilled with course stone aggregate that allows the temporary storage of stormwater runoff in the voids between the aggregate material. After stormwater runoff is temporarily stored in the IT, it percolates into the native soil. Stormwater runoff contaminants are prevented from discharging to receiving waters by (1) collecting and infiltrating runoff to the subsurface and (2) filtering and absorbing contaminants by the IT's aggregate. For an IT to properly function, the percolation rate needs to be maintained. This is accomplished by minimizing the build-up of sediment and organic matter in the IT. Figure 1.1 illustrates a cross-section view of the IT.

The IT is designed to handle the runoff volume from the tributary area that is generated by a 1-year, 24-hour storm event (2.5 cm of rain). After the runoff volume exceeds the capacity of the trench, it is diverted away using an overflow structure.

Figure 1.1 Cross-section of Infiltration Trench

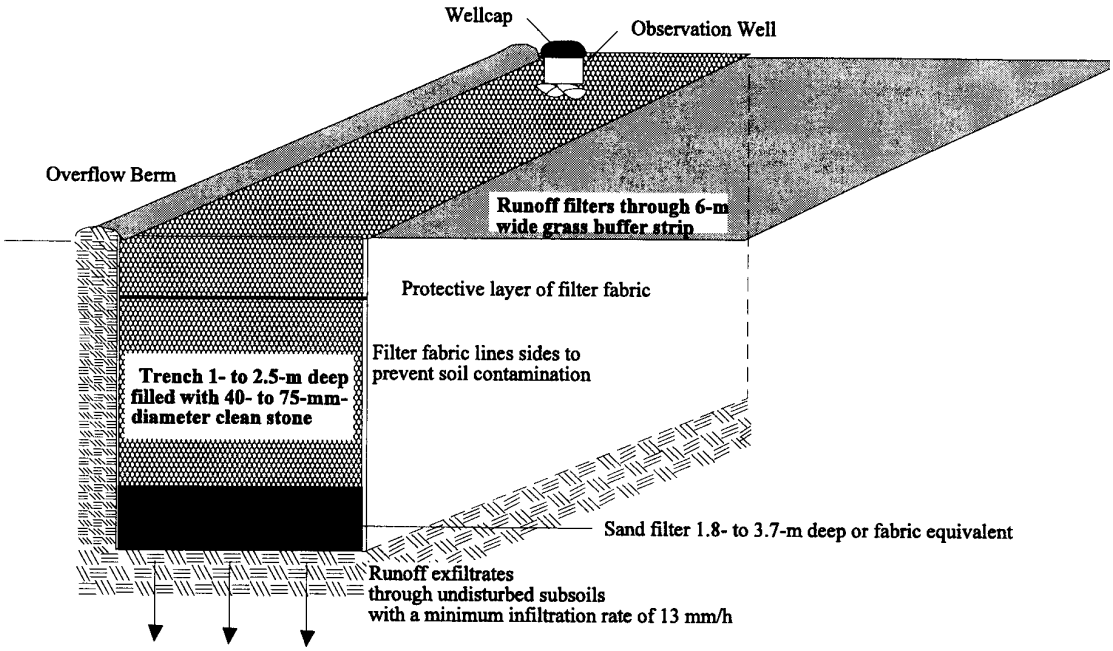


Figure 1.1 Cross-section of an Infiltration Trench

1.2 Evaluating BMP Performance

To effectively evaluate the performance of a Strip/IT pilot facility, the following objectives will be met:

- Determine the quantity of runoff treated/collected by the BMP.
- Determine the percolation rate changes of the trench and native soil over the course of this study.
- Determine the reduction (or change) in analyte concentrations between the influent and the effluent from the BMP.
- Determine the analyte concentrations infiltrating through the IT, into the native soil and into the groundwater.
- Determine and document the level of effort required to maintain the BMP at optimal effectiveness (i.e., treatment of stormwater runoff for storm events producing up to the 1-year, 24-hour peak flow).
- Determine and document the level of effort required to control vectors of human disease and nuisance insects, rodents, and vegetation at the BMP.
- Determine and document BMP performance evaluation criteria relative to the qualitative benefits of the BMP.

To estimate the removal of contaminants from entering receiving waters, the quantity and quality of runoff treated, collected, and infiltrated by the Strip/IT will be obtained using data collected at the up and downstream ends of the Strip, which pretreats runoff entering the IT. These data will allow a direct estimate of the total reduction in mass loadings for a variety of contaminants prior to entering the IT. Water infiltrated to the zone of native soils one to two meters below the IT will be analyzed to determine the potential effects, if any, on the groundwater. As the depth of groundwater at the site is greater than 120 feet, a monitoring well is not used at the District 11 site.

The effectiveness of a Strip/IT is also related to the implementation of maintenance procedures and the documentation of empirical observations. For example, the removal of trash, sediment, and organic matter build-up from Strip/IT, and infiltration capability, may directly affect the performance of a Strip/IT.

1.3 Deployment Criteria

Stormwater samples will be collected from the Strip for up to eight storm events over two wet seasons, weather permitting. Storms targeted for sampling will be separated by a minimum of 48 hours (72 hours preferably). The facility will be inspected per the guidelines given in Section 4.0 of the *Field Guidance Notebook* (*FGN*), which include a mandatory inspection after every storm with rainfall greater than 0.50 inch.

Based on the rainfall requirements needed to generate monitorable flows in and out of the pilots, Caltrans has developed a refined monitoring team deployment criteria. The refined deployment criteria defines when to chase storms based on season, storm forecasts, and the current count of successfully monitored storms.

The deployment season, in which monitoring teams remain "on-call" and fully staffed, will be restricted to the portion of the year when rainfall is most probable and better predictable. Summer showers are not seen as predictable events, and dry watersheds and BMPs will retain more water which results in less effluent.

The deployment season will start on October 1. The season shall end after 3 weeks of dry weather where less than 0.2" of rainfall occurs in the San Diego, but end no sooner than April 1 and not later than May 30th. This approach will provide a plan that adjusts to wet or dry springs.

Further, monitoring teams have suggested that the decision tree for deployment in the OMM manuals be changed to address monitoring experience to date. The following criteria will decrease false starts, while allowing teams to continue to chase storms based on promising storm forecasts. The criteria should be used for all pilots, regardless of drainage area size or land use.

"Forecast-Unlikely" set to less than 0.25" rain and less than 50% probability, (Decision = "No Go")

"Forecast-Marginal" set to 0.25" or greater and 50 –75% probability, (Caltrans Decision)

"Forecast-Highly Probable" set to 0.25" or greater and greater than 75% probability. (Decision = "Go")

Forecast information will be gathered as indicated in the OM&M manuals (i.e. internet sources). As always, if conditions happen to allow paired samples to be successfully taken for any storm larger than 0.1", that sampling would be considered as a successful event, which would count towards fulfilling Scoping Study requirements.

When a specific pilot is successfully monitored for the total required storms per the applicable Scoping Study, the decision to further deploy to monitor that pilot will fall to Caltrans and no commitment to monitor beyond the terms of the Scoping Studies can be made at this time.

Water quality monitoring at the IT consists of collecting pore water samples from the vadose zone. Significant storms producing at least 0.25 inch of rain will be targeted for vadose zone monitoring during the months of December and February 1998/1999 and 1999/2000 for a total of four events. The targeted storms in December and February will also be the same as those targeted for stormwater runoff monitoring at the Strip. This will allow direct comparisons of stormwater runoff data entering the IT from the Strip and in the vadose zone. Percolation rate data will be collected continuously during the 1998/1999 and 1999/2000 storm seasons using a pressure transducer with internal data logger. Visual observations to assess the Strip/IT performance will be conducted during the storm events each storm season.

1.4 Data Collection and Compilation

1.4.1 Data Requirements

The following data will be collected to assess the performance and maintenance aspects of a Strip/IT:

- Water quality and quantity data of runoff discharged into the IT from the pretreatment Strip from flow-composite and first-flush (as soon as possible after the start of runoff) grab samples for at least eight storm events during two wet seasons, weather permitting.
- Rainfall data, recorded as a function of time, from rainfall events during the study period.
- Continuous trench water level data and overflow data.
- Vadose zone water quality sampling data.

- Groundwater well monitoring data collected.
- Observations of water quality, traffic, rainfall, antecedent conditions, spills, etc.
- Documentation records of inspections and maintenance activities performed.
- Vector monitoring and abatement data.
- Records of vector control measures taken.
- Vegetation management records.

1.4.2 Data Management

Consultants will be responsible for data management. Overall management of the data will be consistent with established Caltrans procedures for stormwater monitoring projects and this manual.

The consultant's Sample Control Section will be responsible for tracking the analytical process to assure that laboratories are meeting the required turnaround times and are providing a complete deliverable package. Sample Control will also be responsible for accumulating copies of site visit logs, inspection logs, facility maintenance records, vector control sampling data, and logged rainfall and hydrographic data. Sample Control will receive the original hard and electronic copies from the laboratory, system managers, and field crews, and verify completeness and log dates of receipt. A copy of the data sets and log sheets will be filed in Sample Control's central filing system and another copy will be provided to the consultant's Database Manager. The originals will then be transferred to the Task Order Manager and filed with the other project documentation to maintain complete project records.

Laboratories, system managers, and vector control crews will provide data in both hard copy and electronic formats. The forms of electronic submittals will be provided to the laboratories to ensure that the files can be imported into the project database with a minimum of editing. A relational database will be used for data. Laboratory data will be maintained and managed using Microsoft Excel® and Microsoft Access®. Files from the pretreatment Strip influent and effluent monitoring station will be stored in the same database system and will be linked to the vadose zone monitoring analytical database. The sampling system files will include rainfall, sampling, and flow data. Site characteristics will be stored in a separate file and linked to both the chemical and sampling system files to enable useful data queries.

Data will be submitted to Caltrans based on "Caltrans Statewide Data Management Plan-Data Reported Protocol and Database," a technical memorandum dated 23 April 1998 from Larry Walker Associates to all Task Order Managers.

1.4.3 Data Analysis

Differences in storm characteristics, which can lead to differences in analyte concentrations, will be evaluated for each year of monitoring. Specific storm parameters

such as total rainfall, average intensity, peak intensity, and antecedent conditions will also be measured. Vadose zone and groundwater analytical results will also be evaluated to determine if stormwater discharges to the IT have the potential to impact soil and groundwater.

Contingent on the amount and quality of actual data collected, sampling results for the influent and effluent locations of the Strip will be characterized by descriptive statistics. Statistical comparisons between the influent and effluent will also be performed although the strip will be receiving influent from two different locations. Event mean concentrations (EMCs) will be measured for each water quality parameter at both locations. Annual statistics based upon assumed log-normal distributions also will be calculated for each water quality parameter.

Differences in mean concentrations of analytes between storm events and locations will be considered to be statistically significant at $P \leq 0.10$. Although the acceptable level of alpha error is typically set at $P \leq 0.05$, this decision level was increased due to the relatively high coefficients of variation (CV) encountered with stormwater data.

Water level monitoring data collected using the pressure transducer with data logger will be evaluated to determine the infiltration rate of the trench and native soil. Because the pressure transducer and data logger monitor water level measurements continuously (frequency of 3 seconds or more), a variety of storms will be monitored. Data collected from each storm will be compared to determine their effects on infiltration rates. Infiltration rates during the course of this study will also be evaluated to determine if the IT is properly draining and if maintenance is needed.

Widely varying storm event characteristics will be considered when evaluating BMP efficiencies based on stormwater runoff data. Empirical observations, maintenance activities, and vector control activities will be compiled and compared to water quality and quantity data.

1.5 Encroachment Permit and Restrictions

Visitation to a Strip/IT requires a Caltrans Encroachment Permit. A copy of the Strip/IT permit is located in Tab 9 of the *FGN*. This permit lists access and safety requirements along with any restrictions. The respective Caltrans District Encroachment Permit Office will be contacted for further information and direction (phone numbers can be found under Tab 2 in the *FGN* portion of the Vol. II OMM Plan).

2.0 OPERATION AND MAINTENANCE

2.1 Operation and Maintenance Needs

The operational and maintenance needs of a Strip/IT are:

- Vegetation management at the pretreatment Strip to maintain the hydraulic functioning and efficient removal of trash, sediment, and organic matter.
- Animal and vector control.
- Periodic sediment removal from the pretreatment Strip and IT.
- Trash, debris, grass trimmings, tree prunings, and leaf collection and removal to prevent obstruction of a Strip/IT and monitoring equipment.
- Erosion and structural maintenance to prevent the loss of soil and maintain the performance of the Strip/IT.
- Stabilization of contributing drainage area.
- Removal of standing water which may contribute to the development of aquatic plant communities or mosquito breeding areas (see Appendix IV for details). If standing water remains in the IT for more than 72 hours, then maintenance is required. The cause of the standing water will be determined. Some possibilities are:
  1. Clogging: when facility is dry, sediments will be removed.
  2. Seasonal water table conditions: an outlet system may be required to be retrofitted if the problem is not transient.
- Removal of graffiti.
- Preventative maintenance on sampling and infiltration monitoring equipment.
- Structural maintenance of the IT's sidewalls and filter fabric.

2.2 Inspection Frequency

The facility will be inspected and the inspection visits will be completely documented (refer to Forms C and D in Tab 4):

- Once a month at a minimum.
- After every large storm (after every storm monitored or those storms with more than 0.50 inch of precipitation).
- On a weekly basis during extended periods of wet weather.

2.3 Aesthetic and Functional Maintenance

Aesthetic maintenance is important for public acceptance of stormwater facilities. Functional maintenance is important for performance and safety reasons.

Both forms of maintenance will be combined into an overall Stormwater Management System Maintenance Program. Maintenance activities will be carried out by the

consultant. Maintenance items are included in the checklist/logs found in Tab 5 of the *FGN*. Maintenance activities will conform to practices specified in this manual.

2.3.1 Aesthetic Maintenance

The following activities will be included in the aesthetic maintenance program:

- **Graffiti Removal.** Graffiti will be removed in a timely manner to improve the appearance of a Strip/IT and to discourage additional graffiti or other acts of vandalism.
- **Grass Trimming.** Trimming of grass will be done on the pretreatment Strip to the IT, around fences, at the inlet and outlet structures, and sampling structures. More specifics on vegetation management are given in Section 4.0.
- **Weed Control.** Weeds will be removed through mechanical means. Herbicides will not be used because these chemicals may impact the water quality monitoring. More specifics on vegetation management are given in Section 4.0.

2.3.2 Functional Maintenance

Functional maintenance has two components:

1. Preventive maintenance
2. Corrective maintenance

Preventive Maintenance

Preventive maintenance that will be done on a regular basis is detailed in the checklists in Tab 5 of the *FGN*. Preventive maintenance activities to be instituted at a Strip/IT are:

- **Grass Mowing.** Vegetation within the pretreatment Strip will be kept short to maintain adequate hydraulic functioning and to limit the development of faunal habitats. More specifics on vegetation management are given in Section 4.0.
- **Trash and Debris.** During each inspection and maintenance visit to the site, debris and trash removal will be conducted to prevent the impedance of stormwater through the Strip and to reduce the potential for the IT and its components from becoming clogged and inoperable during storm events.
- **Sediment Removal**. Sediment accumulation, as part of the operation and maintenance program at a Strip/IT, will be monitored once a month during the wet and dry seasons, and after every large storm (0.50 inch). This information will be recorded on Forms CA and CB in Tab 4 of the FGN. The removal of this sediment will be recorded on Forms EA and EB in Tab 5. Additionally, for every storm event, empirical observations (including short circuiting, channeling or ponding, or decline from design performance) of the performance of the Strip/IT will be recorded on Form H in Tab 6 of the *FGN*. If accumulation of debris or sediment is determined to

be the cause of decline in design performance, prompt action (i.e., within ten working days) will be taken to restore the Strip/IT to design performance standards. Actions will include using additional fill and vegetation and/or removing accumulated sediment to correct channeling or ponding in the strip. If sediment is visible at the top of the trench, the top layer of trench, silt, filter fabric and stone will be removed, the stone washed, and the fabric and stone reinstalled into the trench. Characterization and appropriate disposal of sediments is discussed in Section 2.6 and will comply with applicable local, county, state, or federal requirements. The strip will be regraded, if the flow gradient has changed, and then replanted with sod according to the schedule outlined in Table 2.1.

- **Mechanical and Electronic Components.** Regularly scheduled maintenance will be performed on fences, gates, locks, and sampling and monitoring equipment in accordance with the manufacturers' recommendations. Electronic and mechanical components will be operated during each maintenance inspection to assure continued performance.
- **Fertilization and Irrigation**. The vegetation seed mix was designed so that it did not require irrigation or fertilizers. But, if vegetation desiccates, options will be discussed with Caltrans and the Plaintiffs to maintain vegetation.
- **Elimination of Mosquito Breeding Habitats.** The most effective mosquito control program is one that eliminates potential breeding habitats. Mosquito control measures are discussed further in Appendix IV.

Corrective Maintenance

Corrective maintenance is required on an emergency or non-routine basis to correct problems and to restore the intended operation and safe function of a Strip/IT. Corrective maintenance activities include:

- **Removal of Debris and Sediment.** Sediment, debris, trash, and organic matter that impede the infiltration rate (i.e., the infiltration rate drops below the design rate) of an IT and prevent vegetative growth on the pretreatment Strip, will be removed (from the top layer) and properly disposed (see Section 2.6). Temporary arrangements will be made for handling the sediments until a permanent arrangement is made.
- **Structural Repairs.** Repairs to structural component (e.g., filter fabric) of an IT and its inlet structure will be made within 10 working days. Designers or contractors will conduct repairs where structural damage has occurred.
- **Sidewall Repairs**. Damage to an IT will be repaired within 10 working days. Designers or contractors will be consulted before repairs.
- **Elimination of Mosquito Breeding Areas.** Consult Appendix IV for controlling mosquitoes.
- **Erosion Repair.** Where a reseeding program has been ineffective, or where other factors have created erosive conditions (i.e., pedestrian traffic, concentrated flow, etc.), corrective steps will be taken to prevent loss of soil and any subsequent danger to the performance of the pretreatment Strip. There are a number of corrective

actions than can be taken. These include erosion control blankets, riprap, sodding, or reduced flow through the area. Designers or contractors will be consulted to address erosion problems if the solution is not evident.

- **Fence Repair.** Timely repair of fences will be done to maintain the security of the site (e.g., within 10 working days).
- **Elimination of Trees and Woody Vegetation.** Woody terrestrial and wetland vegetation (which consists of willows *(Salix spp)*, mule fat *(baccharis salicifolia)*, cottonwood *(populus fremontii)*, western sycamore *(plantanus racemosa)* and emergent large stature monocots including the genera *Cyperus, Juncus, Scirpus, and Typha)*) will be removed from the Strip. See Section 4.0 for further information on vegetation management.
- **Elimination of Animal Burrows.** Animal burrows will be filled and steps taken to remove the animals if burrowing problems continue to occur (filling and compacting). If the problem persists, vector control specialists will be consulted regarding removal steps. This consulting is necessary as the threat of rabies in some areas may necessitate the animals being destroyed rather than relocated. If the BMP performance is affected, abatement will begin immediately according to the directions in Appendix V. Otherwise, abatement will be performed annually in September.
- **General Facility Maintenance.** In addition to the above elements of corrective maintenance, general corrective maintenance will address the overall facility and its associated components. If corrective maintenance is being done to one component, other components will be inspected to see if maintenance is needed.

2.4 Maintenance Frequency

Appendix V, Maintenance Indicator Document, lists the schedule of maintenance activities to be implemented for a Strip/IT.

2.5 Equipment, Resources, and Tools Needed

The following resources, equipment, and tools are needed by inspection personnel:

- A Locke level or other surveying equipment.
- Industrial strength flashlight.
- Crowbar.
- Tape measure and other measuring device (e.g., survey rod) to determine surface sediment accumulation depths.
- Local erosion, sediment control, or stormwater management handbooks.
- Trash removal equipment.
- Sediment manipulation/removal equipment (e.g., shovels, rakes, 5-gallon buckets).
- Rain and foul weather gear and other personal protective equipment (PPE).
- This Appendix and *FGN*.
- Copies of necessary inspection reports and forms.

- Encroachment permit.
- Business cards or other identification.
- Camera to document field conditions.
- Orange vest and hardhat.
- Maintenance logs.
- Leather gloves.
- Safety glasses.
- Safety boots.
- Pen or pencil.

Except for the items contained onsite, the maintenance contractors will supply the equipment, tools, and resources required for maintenance activities at a Strip/IT. At a minimum, these contractors will supply the following:

- Heavy earth moving equipment (loaders, backhoes, graders, draglines, and vacuum equipment).
- Dump trucks, equipment transports, and other hauling equipment.
- Shovels, picks, rakes, wheel barrels, and other hand tools.
- Pumps.
- Mechanics tools.
- Concrete tools.
- Vegetation maintenance equipment (hand and tractor lawn mowers, gas trimmers, seed and fertilizer spreaders, pesticide and herbicide sprayers, leaf blowers, chain saws, pruning sheers, hedge trimmers, and wood chippers).
- Painting equipment (brushes, rollers, and sprayers).
- Locke level or survey equipment, tape measures, and sediment probes.
- Other necessary safety equipment (gloves, boots, hard hats, reflective vests, safety glasses, traffic control lighting, and confined space entry equipment).

The consultants will supply to the maintenance contractors:

- This Appendix, *FGN*, and approved BMP facility plans.
- Encroachment Permit.
- Maintenance Logs.

No items for maintenance and inspection activities will be left onsite.

2.6 Debris and Sediment Disposal

Hazardous waste generated at a pretreatment Strip and IT is ultimately the responsibility of Caltrans because Caltrans is the owner/generator. Consultants responsible for operating, maintaining, and monitoring the pretreatment Strip and IT will be responsible for removal and disposal of the waste material. Disposal of sediment, debris, and trash

will comply with appropriate local, county, state, and federal waste control programs. Table 2.1 shows a few of the possible disposal services for waste material.

Prior to disposal, removed sediments will be inspected to determine the extent and type of chemical contamination. Evidence of oil and grease, antifreeze, solvents, fuel, hydrogen sulfide, and any other noxious substance will be noted. Observations will be used to determine if more than the standard analyte list is required. The standard analyte list (Table 5.3) is based on highway contaminants that have potential to exceed California Code of Regulations (CCR), Title 22 hazardous waste criteria (State of California, 1985). If any parameter concentration exceeds the maintenance indicators outlined in Table 2.1, the sediment in the strip will be removed and disposed of, appropriately. Methods used to sample sediments are discussed in Subsection 5.11. While analytical results are pending, the removed sediments will be stored in 55-gallon drums or in a stockpile onsite. Separate drums will be used to contain sediments suspected to be differently contaminated.

Table 2.1
Waste Disposal Services in Southern California

Laidlaw / Rollins (OPC) 5765 Alba Street Los Angeles, CA 92011 Ph: (213) 585-5063 Fax: (213) 589 5443 EPA: CAD050806850	Laidlaw Environmental Services 5295 S. Garvey Rd. Westmoreland, CA 92281 Ph: (619) 334-9400 Fax: (619) 344-9405 EPA: CAD000633164
TSM Recovery and Recycling 3422 W. Pico Blvd. Los Angeles, CA 90019 Ph: (213) 735-9443 EPA: CAD108040858	Pacific Resource Recovery 3150 E. Pico Blvd. Los Angeles, CA 90023 Ph: (800) 499-7145 Fax: (213) 780-9940 EPA: CAD008252405
Demenno Kerdoon Environmental Services 3650 E. 26th Street Los Angeles, CA 90023 Ph: (213) 268-5056 Fax: (213) 268-9672 EPA: CAD080033681	U.S. Filter Recovery Services 5375 S. Boyle Ave. Vernon, CA 99058 Ph: (213) 277-1500 Fax: (213) 588-0094 EPA: CAD097030993

2.7 Hazardous Wastes

Suspected hazardous wastes will be analyzed to determine disposal options. Hazardous materials generated onsite will be handled and disposed of according to local, state, and federal regulations. A solid or liquid waste is considered a hazardous waste if it exceeds the criteria listed in the CCR, Title 22, Article 11.

2.8 Checklist for Inspectors and Operation and Maintenance Personnel

Facility Inspection and Observational checklists or logs will be filled out during each visit to a Strip/IT. These will be kept in a record book (field logbook) to ensure that the Strip/IT is maintained at optimum levels throughout the monitoring period. The field logbook will also contain storm monitoring data sheets, and instrument calibration logs. A separate logbook containing Facility Inspection Checklists and Maintenance Log

Sheets will be kept. A separate logbook also will be kept for vector control and management log sheets (Appendix IV of Volume II).

Refer to Forms CA, CB, DA, DB, EA, EB, FA, and FB in Tabs 4 and 5 of the *FGN* for checklists related to the inspection and maintenance requirements of a Strip/IT.

3.0 VECTOR CONTROL AND MANAGEMENT

Constructing retrofit pilot BMPs will modify the existing stormwater drainage systems. Because such retrofitting may create opportunities for disease carrying organisms to flourish, insects (such as mosquitoes and midges) or rodents may have to be controlled. Vector control and abatement will be performed in accordance with Appendix IV and by subcontracted Vector Control Districts.

4.0 VEGETATION MANAGEMENT

The three main reasons for having a vegetation management program for a pretreatment Strip at an IT are:

1. Uncontrolled vegetation may affect a Strip's performance.
2. Maintaining vegetation is necessary to prevent the facility from becoming a public "eye sore".
3. Maintaining vegetation is key to controlling mosquito populations and other vector and nuisance organisms.

4.1 Management for Optimal BMP Performance

Maintenance and control of vegetation is essential to the optimal operation and performance of a Strip. The pretreatment Strip will be seeded with low-growing grasses, which eliminate the need for irrigation and fertilization.

The condition of the vegetation will be inspected on a monthly basis at a minimum. These inspections will ensure that the Strip vegetation is kept at approximately 6 inches, that the vegetation protecting the slopes is kept healthy and continuous, and that undesirable plant species do not take root. Shorter vegetation will optimize the treatment capacity, the hydraulic residence time of runoff, and will aid in vector control. Maintaining healthy and continuous vegetation on the slopes will minimize erosion. Preventing undesirable plant species from taking root will prevent plants with large root systems from damaging the embankments. See Section 2.0 for information on vegetative maintenance.

4.2 Management for Optimal Vector Control

If vegetation such as cattails, bulrush, or willows develops within the pretreatment Strip, problems may occur with vector control. Controlling vegetation and standing water is preferred to enacting vector abatement programs.

If vegetation control is needed, cut vegetation must not be left in the infiltration trench. A potential vector problem might be created when grass clippings are washed into infiltration trench. See Appendix IV of Volume II for more details.

4.3 Maintenance Requirements

Mowing is the preferred means for controlling vegetation at the pretreatment Strip. Controlling standing water will also be essential to controlling vegetation. Burning will not be allowed, and the use of herbicides will not be allowed because they can de-vegetate slopes and embankments for extended periods of time, and have detrimental effects to the quality of runoff treated at the facility.

When equipment is used to remove vegetation, care will be taken to prevent ruts, holes, and an uneven Strip floor. Such depressions can cause standing water that will create problems of vector control.

Additionally, the maintenance activities at the Strip will be carried out in a fashion that minimizes soil compaction.

Maintenance activities that will be conducted on landscaped vegetation include:

- Weeding.
- Mowing.
- Replacement of dead or dying plants.
- Removal of woody vegetation, shrubs, dwarf plantain, pickleweed and emergent wetland vegetation, and large debris.

The vegetation seed mix has been designed so that fertilization and irrigation is not necessary. Fertilizers and irrigation will not be used to maintain the vegetation. If vegetation does not survive without fertilization and irrigation, then Caltrans will work with the Plaintiff to discuss options for maintaining the BMP. Vegetation should be replaced in the Strip if coverage drops below 90%. The quantity of sod required will be assessed in May each year, with resodding of barren spots occurring in November. The sod will be irrigated until it becomes established.

Vegetation removed from the Strip will be promptly hauled off and disposed of properly. Cut vegetation will not be stockpiled onsite, especially in the Strip or IT.

4.4 Checklists

During the routine vegetation inspections of the pretreatment Strip, a BMP Site Inspection Checklists (Tab 4, Form CA in the *FGN*) will be completely filled out and signed by the inspector. These checklists incorporate the necessary vegetation inspection requirements. BMP Site Maintenance Activity Checklists (Tab 5, Form EA in the *FGN*) will be filled out for maintenance activities performed.

5.0 SAMPLING AND MONITORING

This section details the monitoring equipment to be used at a Strip/IT, sampling protocols, analytes to be tested, and quality assurance/quality control guidelines.

5.1 Biofiltration Strip Monitoring Equipment

Stormwater runoff will flow through a transition structure equipped with a flume and will then spread evenly across a Strip. Influent flow will be measured and samples will be collected at this flume. After the runoff flows across the Strip, it will discharge directly into the IT. Effluent flow will be measured and samples will be collected at a separate strip which will collect a different influent and flow past a flume.

Sampler intakes will be mounted in each conveyance approximately 0.6 meters (m) upstream of the flume or 1.2 m downstream of the bubbler tube (flow measurement device). Stainless steel concrete anchors will be used to secure the intakes to the invert of the conveyances.

Flow measurement points were selected at locations that minimized flow measurement errors resulting from turbulence and surcharges. Only experienced field crews will install monitoring equipment. Bubbler and intake tubing will be routed through conduit to equipment enclosures positioned on level ground near each flume. The equipment enclosures will house the data logger/controller assemblies, samplers, cellular modem equipment, flow metering electronics, and batteries.

Components of each automatic sampling system used will undergo calibration and verification during installation and also during maintenance and pre-storm visits.

5.1.1 Biofiltration Strip Water Quality Samplers

The water quality samplers that will be used at a Strip will be automatic and composed of a peristaltic pump, a liquid detector, and a base to hold a sample bottle and ice. Each time a pre-determined volume of liquid passes the sampling point, the data logger/controller will signal the pump to deliver a self-calibrated sample volume. The suction hose used with the sampler will be 3/8-inch pure Teflon® tubing. Therefore, the sampler will be equipped with 3/8-inch silicon peristaltic tubing and a 3/8-inch stainless steel or Teflon® intake strainer of low-flow design. Strainers will be attached to the invert of each conveyance using stainless-steel fasteners. Samples will be collected into borosilicate glass bottles. After the storm event, the laboratory will pour portions of samples from each composite bottle into individual sample bottles, ensuring they are properly composited.

Materials used in the collection of stormwater samples will meet criteria to prevent contamination of the sample. These materials will allow for both inorganic and organic

trace toxicant analyses from the same sampler and sample bottles. Only Teflon® and borosilicate glass are suitable for both trace metal and organic analyses from the same sample bottle. Bottles will be cleaned according to USEPA-approved protocols consistent with approved methodology for analysis of stormwater samples (USEPA, 1983 and subsequent revisions). Sample hoses will be replaced and decontaminated annually, prior to the wet season. They will not be cleaned after each storm event. These bottles and hoses will be evaluated through a blanking process to verify that the sample bottles and sample hoses are decontaminated. Where possible, unused, disposable sampling equipment will be used to eliminate the need for decontamination.

Cleaning Procedures for Sample Bottles

Bottles will be:

1. Rinsed three times with warm tap water.
2. Scrubbed with a clean plastic brush.
3. Soaked in a 2% detergent (e.g., Contrad®) solution for at least 48-hours.
4. Rinsed three times with tap water.
5. Rinsed five times with Milli-Q or equivalent water, rotating the bottle to ensure contact with the entire inside surface.
6. Rinsed three times with hexane while rotating the bottle, and then air-dried.
7. Rinsed six times with Milli-Q water.
8. Soaked in 2N nitric acid for a minimum of 24-hours.
9. Rinsed six times with Milli-Q water.

Cleaning Procedures for Teflon®Hose and Other Sampling Equipment

Teflon® hose and other sampling equipment will be:

1. Teflon hose will be rinsed three times with a 2% Micro® solution or equivalent. Other sampling equipment will be washed with a 2% Micro® solution and a clean plastic brush.
2. Rinsed three times with warm tap water.
3. Rinsed three times with Milli-Q or equivalent water.
4. Rinsed three times with 2N nitric acid.
5. Soaked at least 24-hours in 2N nitric acid.
6. Rinsed three times with Milli-Q water.

5.1.2 Flow Monitoring

A flow-proportioned sample is a composite of individual sample aliquots that are collected for each set volume of water that passes by a sampling point. To obtain a valid composite sample, direct flow measurements will be made to control the sampling interval. At a Strip, both primary and secondary flow metering devices will be used. A

primary flow measuring device is a hydraulic structure inserted into a channel that monitors changes in liquid level in or near the structure. By knowing the shape and dimensions of the hydraulic structure, flow through or over the structure is related to the liquid level by a mathematical relationship. A secondary flow-metering device measures both liquid velocity and depth. Primary devices are preferable, unless hydraulic characteristics prohibit them.

A primary flow measuring discharge flume will be used at each sampling point. A bubbler will be used in conjunction with the flume. The bubbler measures the hydrostatic pressure of the liquid. The bubbler tube will be connected to the flume's stainless steel bubbler tube.

5.1.3 Rain Gauge

A rain gauge having a "tipping bucket" design that incorporates a small "bucket" which holds a known amount of rainfall will be used onsite. When the bucket is filled, it tips the water out, momentarily closes a switch, and then resets itself and starts the process again. The data logger/controller counts each switch closure to accumulate rainfall totals. The rain gauges used will tip after every 0.01 inch of rain.

5.1.4 Power

Power for the monitoring stations will be either from 110v AC (15 amp) or 12 volt batteries. If primary power is from batteries, a separate battery will be used to individually power the autosamplers, modems, and flow meters. Batteries will also be used at the AC sites as back-up. A solar panel, mounted on a pole, will be installed at each site to help keep the batteries charged.

5.1.5 Telecommunications

Cellular modem transceivers will be used to provide remote telecommunication access to the monitoring equipment. The ability to access a sampling station, monitor the status of the station in real-time, modify storm criteria, download new programs, and recover data allows for more cost effective, efficient monitoring.

A high performance base station antenna with filter will be installed; the filter will be installed from the lead-in of the antenna to prevent damage to the sampling station equipment due to nearby lightning strikes.

5.1.6 Equipment Enclosures

Steel enclosures will be used to house the samplers and associated electronic equipment. These enclosures will be bolted to the concrete pads and will be locked to secure the monitoring equipment.

5.2 Infiltration Trench Vadose Zone Monitoring

One of the monitoring elements at the IT consists of measuring dissolved metals (copper, lead, and zinc) concentrations in the vadose zone. It consists of soil particles, pore spaces, and pore liquids that are held onto the surfaces of the particles. Pore liquids in the vadose zone are at pressures below atmospheric pressure and held in tension. Percolation of water through the vadose zone occurs when forces of gravity exceed tensional forces. At times, the soil pores may become entirely filled with water resulting in downward percolation of water, similar to that water percolating through the IT. To remove pore liquids, a vacuum is used to pull them from the pores. Sampling liquid from the vadose zone requires the use of a porous sampling device and a vacuum.

5.2.1 Equipment Selection and Description

A lysimeter is a soil-pore liquid sampler that is composed of two parts: (1) a body and (2) a porous filter membrane (refer to Figure 5.1). The porous filter membrane allows pore liquids to enter the lysimeter and collect before transferring a sample to the ground surface for collection and laboratory analysis. A lysimeter can be constructed from various materials including polyvinyl chloride (PVC), polyethylene, ceramic, or Teflon®.

The selection of soil pore liquid sampling equipment requires an understanding of the physical properties and construction details of a lysimeter and the chemical and physical properties of the constituents to be monitored. The ability of the porous membrane of the lysimeter to sample potential constituents is governed by the pore size of the filter membrane and the chemical inertness of the construction materials. Materials commonly used for the porous membrane of the lysimeter are ceramic and Teflon®. The body of a lysimeter is typically constructed of PVC or Teflon®.

Ceramic membranes adsorb several metals including copper, lead, and zinc, while major cations including calcium, sodium, potassium, and magnesium and carbon dioxide gas (CO_2) are desorbed. Additionally, the small pore size of ceramic membranes (approximately 3 to 5 microns) inhibits sampling many of the large molecular organic compounds, and increases the potential for clogging of the membrane with large molecular compounds and bacteria. Lysimeters constructed of Teflon® are chemically inert and do not adsorb or desorb the constituents monitored for in this program. The pore sizes of Teflon® membranes typically range from 50 to 300 microns, which allow larger molecular compounds to enter the lysimeter and be sampled. A distinct disadvantage of the Teflon® membrane is the necessity of placing a silica flour pack around the exterior of the lysimeter to reduce pore clogging and to enhance the vacuum of the lysimeter in low-soil moisture, high-soil tension environments.

The monitoring requirements for this program include analysis of dissolved copper, lead, and zinc. Based on these constituents, Teflon® was selected as the porous filter membrane because of its larger pore sizes and chemical inertness. In addition, it is recommended that a Teflon® body and Teflon® tubing be used where pore liquids will contact the equipment. This use of Teflon® will reduce the adsorption or desorption of constituents.

Three types of lysimeters are available based on the position of the porous filter. These are the tube-type, cup-type, and casing-type lysimeters. A tube-type lysimeter was selected because the porous filter is situated above the fluid collection chamber. When applying a vacuum to the system to force the liquids to the surface, the liquids will not be forced through the porous filter. This will prevent over-concentrating the sample and losing the sample back into the formation. The collection chamber can hold approximately 400 milliliters (mL) of pore liquid before requiring extraction to the surface. An additional aspect to using an all-Teflon® body is that there is no "dead space" in the sample collection area where liquids may remain and be over-concentrated by continued sampling. A PVC lysimeter body and ceramic membrane can produce between 35 and 80 mL of "dead space" storage.

5.2.2 Lysimeter Preparation, Borehole Preparation, and Lysimeter Installation

Installation of the lysimeter will be in accordance with the manufacturer's recommendations. The following sections describe lysimeter preparation, borehole preparation, and lysimeter installation procedures.

Lysimeter Preparation

Before the lysimeter is installed, it will be vacuum tested to ensure that there is no air leakage. The procedures that will be used are described below. The manufacturer will ship the lysimeter with a latex or flexible plastic membrane around the porous membrane. Rubber bands will be placed over the membrane overlaps to maintain a seal. The lysimeter stopcocks and/or clamps will be closed. A vacuum pump will be connected to the vacuum/pressure tube and a vacuum in excess of 10 psi (508 mm of mercury [Hg]) will be applied. The vacuum reading on the gauge will be monitored and noted. The system will be left in this state for 3 hours. A drop of up to 1.5 psi (76 mm of Hg) over this time is acceptable. If a larger drop occurs, the connections will be re-tightened and the lysimeter will be re-tested.

After the lysimeter has passed this vacuum test, the lysimeter will be placed in distilled water and a vacuum of approximately 7.5 psi (380 mm of Hg) applied for about one hour. This procedure pre-wets all surfaces of the porous membrane, and removes entrained air in the porous membrane. The distilled water will be removed from the lysimeter before it is installed in the field by using the following protocol.

1. Fit a clean rigid polyethylene sample container (400 mL minimum volume) with a two-port bung to the sample collection tube, making a sealed system (refer to Figure 5.2). The tube from the lysimeter will protrude into the sample container approximately one-half inch (13 mm). The other tube to the vacuum/pressure pump will be flush with the bung.
2. Ensure that the vacuum/pressure tube and sample collection tube stopcocks are in the open position.
3. Evacuate the sample from the lysimeter by applying a vacuum of approximately 10 psi (508 mm of Hg).
4. Close the sample tube stopcock and apply a vacuum of 10 psi (508 mm of Hg) to the vacuum/pressure tube and then close the vacuum tube stopcock. The lysimeter is now ready to be installed in the field.

Borehole Preparation

The borehole for the lysimeter will be excavated after the infiltration trench is fully excavated and before any washed gravel is placed into the trench. The borehole will be excavated to provide adequate space for the lysimeter body to be surrounded by a silica flour pack. A two-inch diameter (51 mm) lysimeter will be used and requires a six-inch (150mm) or larger diameter borehole. This diameter will allow for at least 1.5 inches (38 mm) of silica flour pack to fill the annular space between the filter membrane and the walls of the borehole. The borehole will be excavated to a depth of approximately 4.80 ft (1.46 m) below the IT floor (Figure 5.3). If difficulties are encountered in maintaining an open borehole, casing will be used to temporarily hold back the soil during lysimeter installation.

Lysimeter Installation

Crystalline silica flour and distilled water will be mixed at a ratio of 150 mL of water to 450 grams of silica flour. Approximately 50 pounds of silica flour will be mixed with 2 gallons of distilled water to make enough slurry for a single lysimeter installation in a six-inch (150 mm) borehole. The slurry will be mixed by adding the silica flour slowly to the distilled water under constant stirring. The mix will be completely blended to contain no lumps.

When the slurry is completely mixed, a portion will be poured into the borehole providing a bed for the lysimeter to be placed on. This bed will be poured to an approximately thickness of 0.10 ft (30 mm) (refer to Figure 5.3). After the bed is poured, a plug will be threaded onto the lysimeter so that PVC casing can be used to lower and support the lysimeter in the center of the borehole.

The PVC casing will extend to the top of the IT and will contain the vacuum/pressure and sample tubing. No PVC glue will be used to join PVC casing sections. A minimum of at least 1.5 inch (38 mm) of silica slurry will be placed in the annular space around the

lysimeter. Slurry will also be poured into the annular space of the borehole to completely surround and cover the lysimeter body.

After the slurry has set for at least two hours, a bentonite seal will be installed in the annular space of the borehole from the top of the silica flour pack to the bottom of the infiltration trench. After the low metal concentration-type bentonite seal is installed, construction of the trench can be completed.

Upon completion of the infiltration trench construction, the lysimeter head assembly will be installed on the PVC casing and the vacuum/pressure and sample collection tubing will be connected to the appropriate ports. A locking metal cap will be installed over the lysimeter head assembly by anchoring cap to the concrete seal, as shown in Figure 5.3.

5.2.3 Vadose Zone Sample Collection

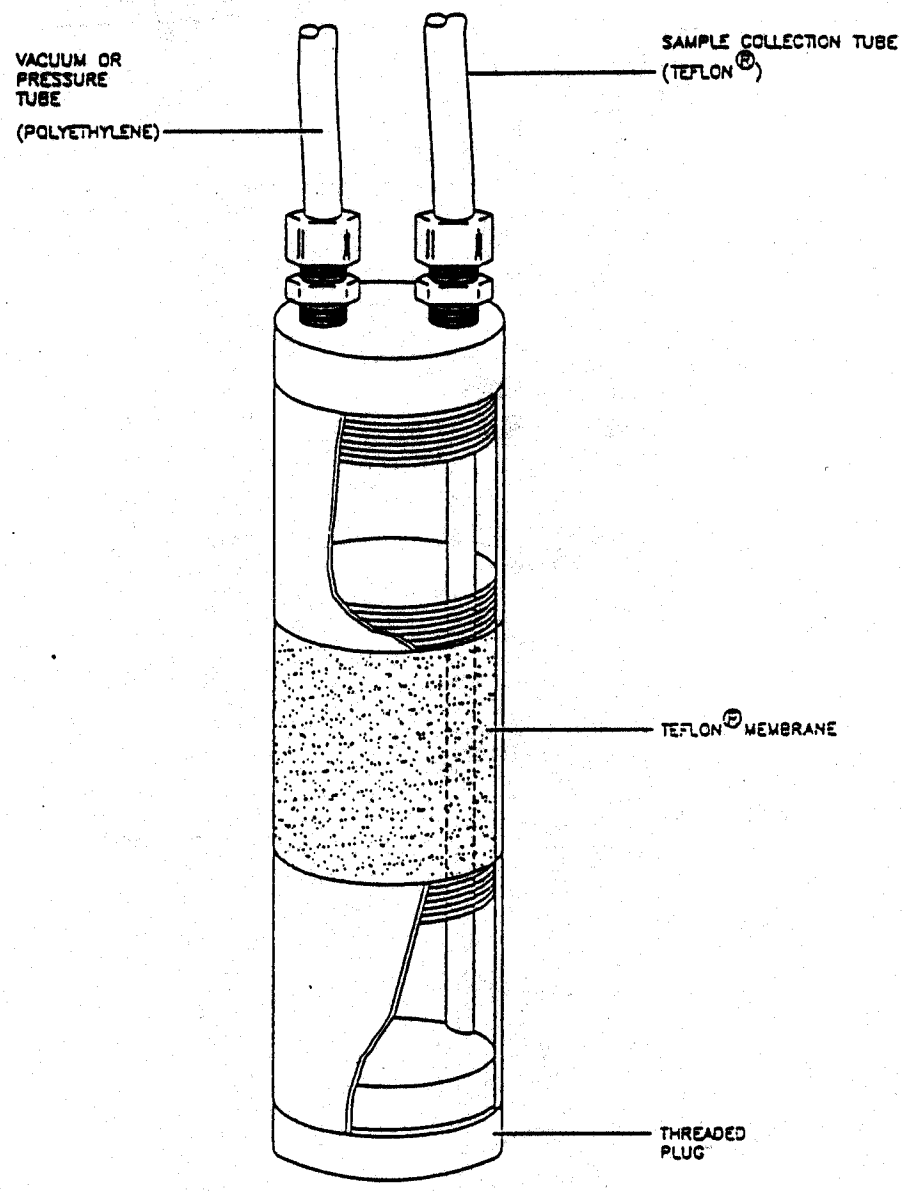
Because it is not initially known how quickly the water will pass through this soil, a performance test of the lysimeter will be conducted before the required December and January monitoring events. The performance test will take place providing the lysimeter has been installed and a storm event of at least 0.10 inch of rainfall occurs within a 24-hour period. The test will determine how long after a storm event sample collection will be attempted, and also will determine whether the lysimeter functions properly in this type of soil. During this pre-required monitoring event, sample collection will be attempted within 4 to 6 hours after the storm event and every two hours thereafter until a sample is obtained or a 24-hour period has passed. If sample collection is successful, no additional performance testing will be done, and sample collection in December and January will be attempted within the time period determined during the pre-required monitoring event. Samples from this pre-required monitoring event will only be sent to the laboratory for analysis if so directed by Caltrans. If sample collection is unsuccessful, Caltrans will be informed and a plan-of-action will be developed for future attempts to monitor pore water in the vadose zone.

Samples of pore liquid will be collected by applying a vacuum. The following protocol will be used to collect pore liquid samples using the lysimeter:

1. Place the lysimeter in the sample extraction mode by closing the sample collection stopcock.
2. Connect a 12-volt electric vacuum pump to the vacuum/pressure port. Slowly regulate the vacuum to 10 psi (508 mm of Hg) by adjusting the pressure vacuum stopcock on the lysimeter head assembly and then seal the system.
3. Once the vacuum is generated, pore liquid will be drawn from the soil pores and into the lysimeter. When the vacuum drops to 5 psi (254 mm of Hg) or less, attempt sample recovery.
4. Fit a clean, rigid, polyethylene sample container (400 mL minimum volume) with a two-port bung to the sample collection tube, making a sealed system (refer to

Figure 5.2). The tube from the lysimeter will protrude into the sample container approximately one-half inch (13 mm). The tube to the vacuum/pressure pump will be flush with the bung.

5. Ensure that the vacuum/pressure tube and sample collection tube stopcocks are in the open position.
6. Evacuate the sample from the lysimeter by applying a vacuum of approximately 10 psi (508 mm of Hg).
7. A minimum volume of 100 mL (300 mL is recommended) is required for the analysis of dissolved copper, lead, and zinc. Transfer the sample to an unpreserved polyethylene bottle provided by the laboratory. If the required volume was not obtained, repeat Steps 1 through 6.
8. When the minimum volume of sample has been obtained, properly pack and transport the sample in accordance with the procedures described in Section 5.9. Ensure that a note has been recorded on the Chain-of-Custody form requiring the laboratory to filter the sample upon receipt.
9. In accordance with the manufacturer's recommendations, lysimeter equipment decontamination is not necessary.



NOT TO SCALE

Prepared By: EDP
Checked By:

CALTRANS
DISTRICT
BMP PILOT PROGRAM

FIGURE: 5.1

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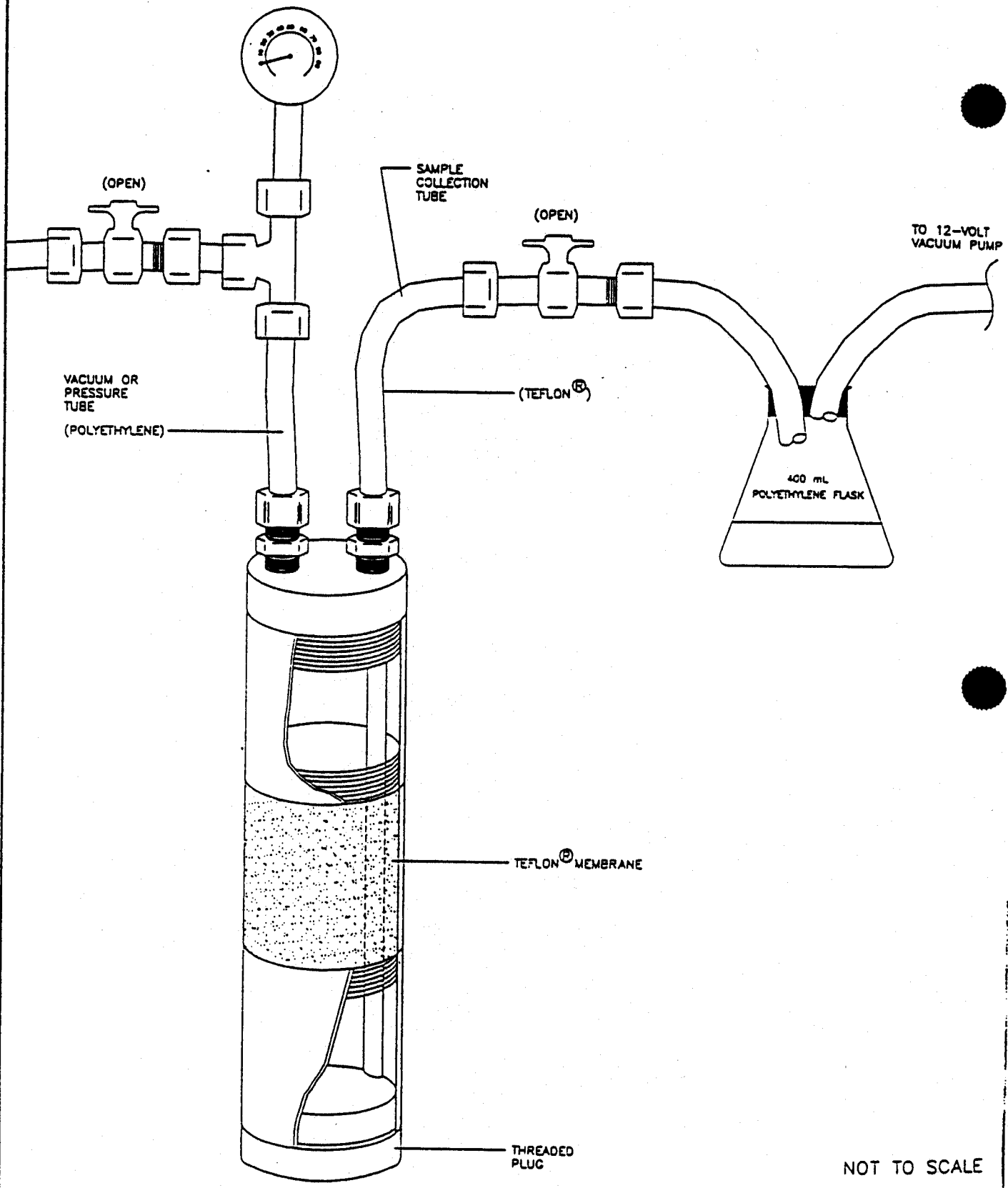
A Division of Law Engineering and Environmental Services, Inc.

LYSIMETER DETAIL

CONTRACT 43A0002C, TASK ORDER 6



NOT TO SCALE

Prepared By: EDP
Checked By:

CALTRANS
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FIGURE: 5.2

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SAMPLE COLLECTION CONFIGURATION

CONTRACT 43A0002C, TASK ORDER 6

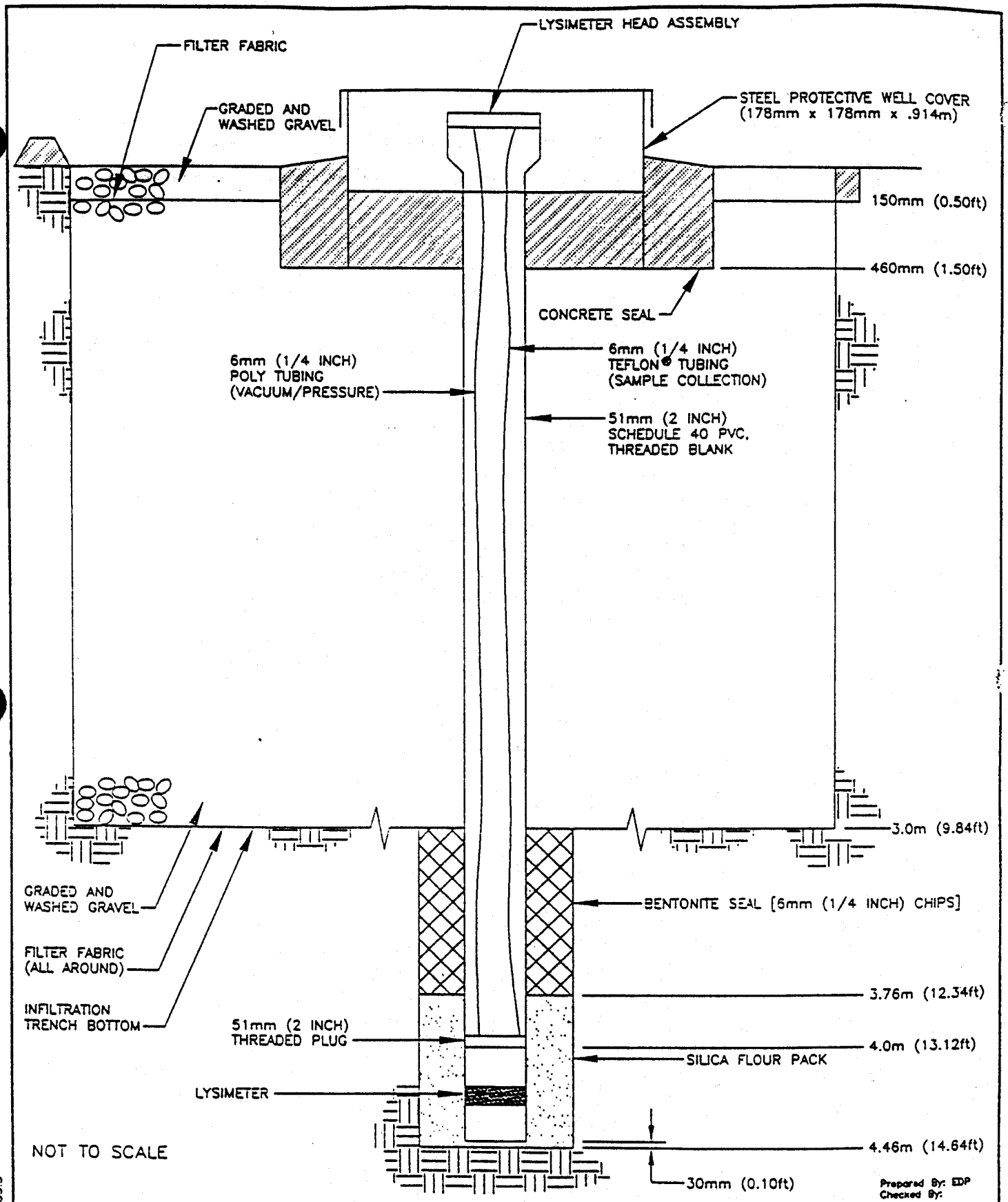

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FIGURE: 5.3

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LYSIMETER WELL
CONSTRUCTION DETAIL

CONTRACT 43A0002C, TASK ORDER 6

5.3 Water Quality Well

A groundwater monitoring well, installed in the groundwater gradient downstream of an IT, will be used for periodic measurements of groundwater quality. The well contains a casing that is perforated in the water table (saturation) zone with 0.01-inch slots. A filter pack consisting of 2/12 sand is placed around most of the perforated zone of the well. A bentonite chip annular seal is placed above the filter packs and hydrated. The space above the bentonite chips is sealed with a sodium bentonite/cement grout. Lockable well protectors and monument covers are installed above the ground surface.

Before sampling, the well will be purged of 3 case volumes using a disposable Teflon or stainless-steel bailer with a bottom emptying device. Water levels and well stabilization parameters will be monitored during the purging and sampling process. Water levels will be measured using a water level indicator. Conductivity, pH and, temperature will be measured using either a single unit that can quantify all three parameters, individual units specifically for each parameter or any combination. Turbidity quantification will be acquired using a nephelometer. All water quality instruments will be calibrated with known standards prior to use.

Water purged from the well will be placed into marked DOT 17 E drums. These drums will be stored on-site for later disposal. Proper disposal of the groundwater depends on the results of the laboratory analyses.

5.3.1 Groundwater Sampling

This section discusses the procedures for well purging and sampling at a Strip/IT facility. Baseline sampling is scheduled to occur immediately after construction of the Strip/IT. The well will be sampled two additional times during each storm season after significant rainfall events (once in December/January and once in February/March). Storm season analytical results will be compared to the baseline analytical results.

Groundwater Purging and Collection

The water level and the depth of the well will be measured using a water level indicator. These values will be used to calculate the required purge volume. Each well will be allowed to equilibrate with atmospheric pressure before the water elevation is measured.

Using a Teflon or stainless-steel bailer, a minimum of three submerged case volumes will be removed during purging of the monitoring well. During the purging process, the electrical conductivity, pH, turbidity, and temperature of the water will be measured at the beginning , in between each volume purged, and at the end of purging. These data will be recorded on the field visitation log (refer to Form I in Tab 6 of the *FGN*). Once

the well is sufficiently purged and the measured parameters are stabilized, the well will be considered ready for sampling.

Well purging will continue until the following parameters have stabilized. Stabilized conditions will be defined as follows:

1.	Electrical conductivity	± 10 percent
2.	pH	± 0.4 units
3.	Temperature	± 2 °C

Measurements will be collected during the purging process. Turbidity will be compared to historic conditions for the well as well as stabilization.

After purging, a groundwater sample will be collected using a decontaminated stainless steel or disposable Teflon bailer with a bottom-emptying device. Care will be taken when lowering and raising the bailer to minimize the turbulence of the water within the well. All sample bottles will be filled completely, then capped, labeled, and placed in a cooler with ice immediately after sample collection. After all samples have been collected, the static water level will be measured. Water level probes will be decontaminated between uses in compliance with the appropriate decontamination procedures.

All information pertaining to the groundwater sampling will be recorded in the field logbook and appropriate log sheets.

5.4 Water Level and Overflow Measurements for an IT

Water level measurements will be used to evaluate the infiltration rate of an IT. These data with influent flow will be used to estimate the quantity of runoff bypassing the trench through an overflow structure and will be used to determine if the IT is clogged and requires maintenance. The time at which overflow begins (the storage volume of the trench is filled) during a storm event will also be noted as applicable.

5.4.1 Equipment Selection and Description

A pressure transducer with internal data logger has been selected to monitor the water level in the trench (Figure 5.4). This equipment allows for unattended, log-term water level monitoring of the IT with water level measurements made at a frequency of 3 seconds or more.

5.4.2 Borehole Preparation, Well Construction, and Pressure Transducer Installation

Installation of the pressure transducer will be in accordance with the manufacturer's recommendations. The following sections describe borehole preparation and pressure transducer installation procedures.

Borehole Preparation

An 8-inch (204 mm) borehole for 4-inch (102 mm) PVC casing will be excavated after the IT is fully excavated and before any washed gravel is placed into the trench. The borehole will be excavated to a depth of approximately 4 feet (1.22 m) below the trench floor (refer to Figure 5.5).

Well Construction

Bentonite chips (¼-inch [6mm]) will be poured into the borehole providing a bed for the PVC casing. This bed will be poured to an approximately thickness of 0.10 ft (30 mm) (refer to Figure 5.5). After the bed is poured, a plug will be secured to the bottom of the threaded-blank PVC casing. The casing will be centered in the borehole and placed on the bed of bentonite chips. The threaded-blank PVC casing will extend to the bottom of the IT. Slotted screen (0.40-inch) PVC casing will be threaded to the threaded-blank PVC casing and extended to 4-feet (1.22 m) below the IT surface. A second piece of threaded-blank PVC casing will be threaded to the slotted screen PVC casing and extended to approximately 6-inches (150 mm) above the IT surface. No PVC glue will be used to join section of PVC casing. Bentonite chips will be poured in the annular space of the borehole around the PVC casing to the depth reaching the bottom surface of IT and then hydrated.

Pressure Transducer Installation

After the bentonite has hydrated for approximately one hour, construction of the trench can be completed. Upon completion of the IT construction, a locking metal cap will be installed over the PVC casing by anchoring the cap to the concrete seal, as shown in Figure 5.5.

The pressure transducer will be installed in the PVC casing using the following steps.

1. Pour water into the PVC casing so that it rises to the bottom of the IT floor.
2. Lower the pressure transducer into the PVC casing to a depth of 12.84 feet (3.94 m) below ground surface. Check to ensure the pressure transducer has been set to the proper depth using an electric water level indicator.
3. Allow the pressure transducer to remain in the water for at least one-half hour before it is calibrated and programmed.
4. Use a water level indicator to calibrate the transducer.

5. Allow at least two hours to pass and remeasure the water level and check the transducer calibration.
6. Program the data logger to begin recording background water level measurements at a frequency of every two minutes.
7. Return to the site in two days and measure the water level with an electric water level indicator. Compare this measure with that measured by the pressure transducer. If the measurement is off by more than 0.02 feet (6 mm), recalibrate the pressure transducer. If the pressure transducer is off by more than 0.1 feet (30 mm), replace the transducer and recalibrate as described above.
8. Return to the site two days later and reconfirm the operation of the pressure transducer. If the measurements are within 0.01 feet (3 mm) then the equipment is operational.
9. Recalibrate the pressure transducer as needed and download the background data.
   In the event that fine sediments are carried through the screen and accumulate in the well, the screen section may have to be developed to remove the fines adjacent to the screen.

5.4.3 Data Collection

Data is downloaded from the pressure transducer's data logger using a laptop computer or remotely through a cellular link. The laptop computer will have the manufacturer's software installed. Data will be downloaded on a monthly basis and managed by the program's database.

5.5 Maintenance and Calibration

A complete maintenance program will be performed at a Strip/IT after each large storm event during the monitoring period, or in the absence of rain, on a monthly basis. Maintenance will include checking the performance of the equipment, checking power supplies, inspecting and clearing intake structures, cleaning contaminated equipment, and performing necessary equipment calibrations. Calibrations will be conducted in accordance to specifications in the individual component manuals.

Stormwater equipment maintenance visits will be thoroughly documented. Written documentation includes the action taken at a site as well as the date performed. Accurate and thorough records of station visits will be maintained to aid in the evaluation of a Strip/IT's performance. The log illustrated in Form F in Tab 5 of the *FGN* will be used to document maintenance and calibrations. If any program parameters are changed, the log shown on Form I, J1 and/or J2 in Tab 6 in the *FGN* will be completed.

5.6 Preparation and Logistics

Success of the sampling effort requires careful preparation and planning to assure that high quality stormwater runoff samples, water level measurements, vadose zone samples, and empirical observations are obtained in association with each storm event.

5.6.1 Weather Tracking

Weather tracking will be the responsibility of the Task Order Manager and Storm Control personnel. During the wet season, the weather will be continually monitored with increased frequency as incoming storm systems are predicted. Sources of weather information to be used to track incoming storms include the following: National Weather Service, Weather Watch Service, Weather Network (WeatherNet), the Alert system from San Diego County, public broadcast information available on the Weather Channel and local news stations, and radar and satellite images downloaded from the Internet (e.g., www.weather.com).

5.6.2 Mobilization and Staffing

A staffing plan, which designates personnel and equipment for each facet of storm monitoring, will be developed as soon as a potential storm event is forecast. Crews will consist of two individuals. The staffing plan will include the following information:

- Personnel needed for each position.
    - Storm Control
    - Shift Leader
    - Crew Chiefs
    - Crew Assistants

- Shift and zone (pilot facilities manned by a single crew) designations.
- Equipment mobilization.
- Communication channels.

Storm Kit Equipment List

- Keypad/display.
- 9-pin cable from keypad to data logger.
- Full set of keys (on floatable bobber).
- Flashlights (2).
- Maps for required areas.
- Large flat screwdriver.
- Small flat screwdriver.
- Umbrella.

Storm Mobilization List

- Storm kit.
- Log books.
- pH meter.
- Paper towels.
- DI (de-ionized) water squirt bottles.
- Tape gun with clear tape.
- pH grab bottles.
- Spare sample labels.

Storm Kit Equipment List

- High quality alkaline D-cell batteries.
- Spare sample labels.
- Pencils and indelible markers.
- Desiccant (packages and jar).
- Diagonal clipper.
- Electrical tape.
- Cable ties (assorted sizes).
- Utility knife.
- Ziploc baggies (assorted sizes).
- Labeling tape.
- Polyethylene gloves.
- Rubber bands.

Storm Mobilization List

- Ice scoop.
- Sample control paperwork.
- Extra fine indelible markers.
- 20 liter bottles in 10 gallon containment buckets.
- Grab sample bottles.
- Coolers and ice.
- Grab pole.
- DI water (3-gallon jug).
- Two-way radio or cellular phone.
- Personal rain gear.
- Any necessary safety gear.

5.6.3 Communication Channels

Communication channels will be established for personnel to contact each other before and during a storm event. A telephone tree will be used to facilitate contacting field personnel and other key individuals. Phone lists with home and work numbers and other key contacts will be made available to potential crew members. Two-way radio or cellular telephone communication links to field crews are essential for efficient monitoring.

5.6.4 Biofiltration Strip Monitoring Station Preparation

Prior to a storm event, the Strip monitoring stations will be made ready to sample. This preparation includes entering the calculated “Volume-to-Sample” values, setting the autosampler and the data logger to sampling mode, pre-icing the sample bottles, and performing a general equipment inspection. The Standard Operating Procedures for Automatic Stormwater Monitoring will be consulted for specific details on each station preparation.

Determination of Volume-to-Sample

The latest weather forecast prior to each storm event will be examined to determine the proper "Volume-to-Sample" value to enter into the system. The amount of expected rainfall, how the station performed during the previous storm, and how much water is needed for analysis at the station for each storm event would be taken into consideration.

The "Volume-to-Sample" is entered as a number with units in kilo-cubic feet (kcf). To determine this number, the drainage area in acres and the runoff coefficient, which is a

number that reflects the permeability of the land in the study area. The following equation will be used to determine the volume of water expected at a Strip for a given rainfall:

A x B x C x 3.63 = volume in kcf

Where:

A = inches of rain
B = drainage area in acres
C = runoff coefficient for land area
3.63 = conversion factor: acre-inches to kilo-cubic feet

To determine how much water will pass the monitoring station between samples, divide this result by the number of samples needed to satisfy the water volume requirement for all analysis. A table will be supplied in the Field Logbook that indicates the "Volume-to-Sample" value needed to collect the correct sample amount of water for the amount of expected rainfall (refer to Exhibit 9.2, Tab 9 in the *FGN*).

After the proper "Volume-to-Sample" value is determined, it will be entered into the system before the rainfall starts. The runoff value will generally be entered from the remote computer. The value can also be entered upon arrival at the site before the system has entered storm mode. It is important that this value is accurate as possible; if the value is too high, the system will not collect enough water to be analyzed, and if the value is too low, the system may sample too fast to be monitored effectively (i.e., the percent storm capture will drop).

Prepare Sampler

The autosampler will be reset and programmed to take 78 250-ml aliquots. Also other user-entered parameters (tubing length, head height, bottle size, composite sample, sample upon one pulse, and enabled liquid detector) will be set correctly.

During each site visit, the state of the System Status Flags (switches) and Program Signature will also be recorded. These provide important information on the current sampling mode and overall integrity of the site program.

Ice Sample Bottle

The sample bottle will be iced after the decision has been made to monitor the storm and prior to initial sample collection. If this is not possible, the bottle will be iced immediately upon the first visit.

General Inspection

A brief physical inspection of the equipment will be made to make certain that there are no obvious problems such as broken conduit or a kinked hose. If possible, the intake will be cleared of debris; at sites with confined entry access, this is only possible if the safety requirements listed in Appendix II are met.

Documentation

Upon each site visit, whether during storm mode or not, records of the visit will be accurately recorded on the field form (Form I of Tab 5 in the *FGN*). Whenever possible, any data being recorded by the sampling system (for example, time or current stage) will be verified. If any program parameters are changed, a program parameter log (Forms J1 and J2 of Tab 6 in the *FGN*) will be filled out. Also once during each storm event visit, the Empirical Observation Checklist will be completed (Tab 6, Form H in the *FGN*).

General Visitation Data

During each station visit, several display locations will be recorded. The log sheets will be used as a guide to the proper display locations to record. The following data will be recorded at both the influent and effluent stations:

- Flume Stage (ft)
- Flume Q (flow in cfs)
- Station ID
- Data Logger Battery Voltage
- Flow Meter Battery Voltage
- Cellular Equipment Battery Voltage

Storm Visitation Data

Additional data will be recorded in the logbooks during storm monitoring, including:

- Volume (kcf)
  This is the volume of water that passed the station during the previous execution Interval (one minute).
- Storm Sum
  This indicates the accumulated runoff volume in kilo cubic feet (kcf) that has passed the station since the last sample.
- Percent Storm Capture
  This indicates the percent of the storm effectively sampled by the system, and it provides a quick evaluation of the quality of the monitoring.

- Volume to Sample
  This value indicates the runoff volume (in kcf) that will pass the station before the system will take the next sample.
- Sample Count
  This number indicates the number of samples taken in the current bottle. It automatically re-zeroes every time a bottle is filled.
- Total Rain (inches)
  The total rainfall in inches since the start of the storm. This is accumulated each time that the rain bucket tips.
- Max Flow (day)
  This indicates the Julian day on which the maximum flow occurred.
- Max Flow (time)
  When this number is positive, it indicates that the system was sampling during peak stage. If this number is negative, sampling did not occur during the peak stage because the bottle was full.
- Max Stage (feet)
  This indicates the height of the maximum stage during the current storm.
- Max Flow (cfs)
  This indicates the maximum flow rate during the current storm.
- Storm Volume (kcf)
  This indicates the total volume of water that has flowed past the station since the beginning of the storm.
- Storm Volume Sampled (kcf)
  This indicates the total volume of water that flowed past the station while the system has been in storm mode.

After the data have been recorded, the system will be placed in low power mode and the keyboard unplugged.

5.7 Biofiltration Strip Storm Monitoring

A priority objective of storm monitoring is to maximize the percent storm capture of the composite sample. This will be accomplished by ensuring that a composite bottle does not fill without being changed immediately. If a bottle does fill, the full sample bottle will be replaced and the system will be reset. To determine approximately when the bottle will fill and to ensure that the sampling process is not interrupted, the Storm Sum and the Volume to Sample will be evaluated. By examining how quickly the Storm Sum value is approaching the Volume to Sample value, the approximate time until the next sample is taken can be determined, as well as the approximate time until the bottle fills. The monitoring crew will be aware of the current status of each station in each of its BMP pilot facilities to determine which one will fill a bottle first so they can be on site as the bottle fills. If the station has been set properly for the amount of rainfall, changing the composite bottle will not be necessary. Volume to Sample settings will take into account

the volume of sample required to meet analytical needs. This study requires approximately 3 liters of sample to meet these needs.

The data logger pulses the autosampler to take a sample when the accumulated Storm Sum equals the Volume to Sample. The storm sum is then reset to zero and the process is repeated. This continues until the storm ends or the bottle fills. Ideally, the Volume to Sample value will be accurate for the amount of rainfall, and the bottle will not need to be changed during the storm. If, however, the rainfall is different than that predicted, a bottle may fill before the end of the storm. If this occurs, sampling will halt until the bottle is changed and the system is reset. Until the system is reset, part of the storm is not being sampled, and the percent capture will show a decrease. It is therefore imperative that the system is reset and the sample bottle is changed immediately to maintain 100% storm capture.

5.7.1 Storm Procedure

Upon arrival at a station during a storm event, the status of the composite sample bottle will be checked immediately. If it is not necessary to change the bottle at that time, the appropriate data on the log sheets will be recorded and the necessary physical measurements and observations will be taken. An approximate time that the bottle will fill will be determined, and, depending on how much time is available, the next station will be visited or the team will wait until the bottle fills.

If the sample bottle is full, the system will be reset immediately, and the bottle replaced. When the bottle has been changed, the necessary station data will be filled in on Form I, Tab 6, in the *FGN*.

5.7.2 Sample Bottle Replacement

The removal of the sample bottle from the sampler requires great care; the bottles are heavy when full and are very slippery when wet, as well as being expensive and fragile. More importantly, if the sample is lost or contaminated, the effort and expense of the storm monitoring process is wasted. Two people will be present to ensure the security of the bottle and of the sample itself. Extreme care will be taken not to kink the intake hose when handling the sampler.

The bottle number will be recorded in the logbook and the bottle will be labeled appropriately. When a new bottle has been put in place, it will be re-iced and the sampler reset to continue sampling. Full bottles will be kept iced.

5.7.3 Storm Monitoring Office

The main objective of the Storm Monitoring Office is to update field crews on the status of their stations. This will greatly reduce the amount of time a crew will spend driving

during storms. The monitoring of stations from a remote computer consists of calling each station and recording certain data for evaluation. When it is determined that a sampling system is close to filling all bottles, a field crew will be called and alerted to the status of the station. Remote interrogation of the storm stations will be logged using Form K in Tab 6 of the *FGN*.

Generally, the Storm Monitoring Office is also the storm control position. This means that critical decisions regarding the status of storm monitoring are made with input from the Storm Monitoring Office.

Therefore, this position requires awareness of the latest weather forecasts to make informed decisions on the continued monitoring of the storm.

5.7.4 Post-Sampling Procedures

After a storm event has ended, the stations need to be shut down. The station will be left ready for the next storm event in case there is insufficient time for a maintenance visit between storms. The following items will be taken care of, and will be well documented in the *FGN*.

1. The storm monitoring program will be reset to prepare for another storm event.
2. The sample bottles will be replaced and the sampler reset.
3. The station will be physically inspected to determine if damage was sustained during the storm event. The flow sensor will be inspected to determine if it is blocked by debris, or the intake is clogged. (This is only possible if all confined space safety requirements are met).
4. The data will be retrieved. This will be done via modem from either the remote monitoring computer or directly in the field using a laptop computer.
5. Battery voltages will be checked; batteries that are low will be replaced.
6. An Empirical Observation Checklist (Tab 6, Form H in the *FGN*) will be completed one time during the event.

Data Retrieval

Data will be retrieved (dumped) from the data logger after each storm event during the storm season, and approximately every month during dry weather.

Chain-of-Custody Forms

When the grab samples have been collected, the paperwork will be filled out to ensure a smooth transfer of samples to the analytical laboratory. Chain-of-Custody Forms will be filled out in detail describing the type of samples, the number of samples, and the times that the samples were collected. These forms will accompany the samples to the laboratory.

5.7.5 Evaluation

Upon termination of a storm monitoring event, evaluation of the influent and effluent stations' performance will be documented and reviewed before the samples collected are deemed valid. Evaluation of a monitoring station's performance is based on the answers to the following questions:

- Was the storm representative of the effectiveness range of the Strip/IT?
- Was capture of peak flow or runoff achieved at both sampling points?
- Did the equipment perform as designed throughout the duration of the storm event?
- Did the samplers accurately collect equal and reliable storm sample aliquots?
- Did the Strip/IT function as designed?

5.7.6 Grab Sampling

Total petroleum hydrocarbons (TPH) and bacteria (Fecal Coliform) samples are unsuitable for collection by automatic means. TPH is inappropriate because some material adheres to the surface of the tubing and the sample container. Automatic sampling for bacteria is inappropriate because the sampling equipment is not sterile after installation and exposure to the elements. Because these analytes are unsuitable for collecting using an automated approach, they will be collected as a grab sample from both the influent and effluent twice each storm monitoring year.

It is imperative that collected grab samples be transferred to a designated meeting location immediately after the sampling has been completed. Chain-of-Custody Forms for the samples will be completed and transport of the samples to the analytical laboratory will be coordinated to ensure that the samples are handled and analyzed within the proper holding times.

It is essential that the following sample handling protocols be followed when collecting grab samples to keep contamination to a minimum:

- Turn the vehicle engine OFF to minimize exposure of the sample to exhaust fumes.
- Keep the sample containers in clean coolers until sampling is actually initiated.
- Store the filled sample bottles in clean coolers at 4°C.
- Keep the bottle lid clean and free of debris while the bottle is open.

Grab samples will be collected during two storm events per monitoring season as near to the sampling point as possible. When unable to collect a sample near the intake, the sample will be collected as near the center of flow as possible or in an area of sufficient velocity to ensure good mixing. Both sampling points require a grab pole to collect the necessary grab samples. Sample bottles will be fitted snugly into the bottle holder and the bottles will be seated on the upstream side of the grab pole to reduce potential

contamination. The bottle will be filled with the mouth of the bottle faced into the current, if possible. Also, the bottle will be labeled before it is filled as it is nearly impossible to write on wet bottles, and the station I.D. will be listed on the bottle to coincide with the station sampled.

Each type of grab sample may require special treatment to ensure the quality of the sample and the safety of the sampler. The preservative in the sample bottles is usually a concentrated acid, so care will be taken that the preservative does not come into contact with the skin. Powder-free nitrile gloves will be worn when handling sample containers. Both types of grab samples are discussed below.

TPH analyses will be performed for oil, diesel and gasoline fractions and reported separately for each. Samples to be analyzed for TPH gasoline fraction will be preserved with a concentrated acid (HCl). The sample bottles will be filled to below the neck and just above the shoulder. The bottle will not be overfilled because the preservative will be washed out. If the bottle is just slightly overfilled, a small amount of sample will be poured off after the preservative has mixed with the sample. A small amount of headspace is required in the containers to allow for expansion if the sample freezes while iced during shipping. These grab samples will be collected as soon as possible after runoff is detected.

Fecal Coliform are preserved with a small sodium thiosulfate tablet. To retain the tablet while sampling, it will be removed from the container when it is dipped into the flow. The bacteria bottle will be turned over causing the tablet to fall onto the cap of the bottle; the cap will be removed and set somewhere that will prevent it from becoming contaminated (out of the rain). The sample bottle will be filled to the shoulder, the cap tipped so the tablet falls into the sample and the cap secured to the bottle. These grab samples will be collected once the entire tributary area contributes stormwater runoff (i.e., any time after 10 minutes of continuous flow past the sampling point).

Attempts will be made to maintain the 6-hour holding time for bacteria to the extent practical. However, storm field conditions and safety concerns may prove this holding time infeasible. A maximum holding time of 24 hours will be followed, in accordance with "Standard Methods for the Examination of Water and Wastewater," 18th Edition. This will require close coordination between the laboratory and the sampling team to assure that this analysis is completed within holding time.

5.8 Sample Tracking and Handling

Samples, regardless of their matrix, will be kept properly chilled and transferred to the analytical laboratory within holding times to achieve the highest quality data possible. To ensure proper tracking and handling of the samples, documentation will accompany the samples from the initial pickup to the final extractions and analysis. This

documentation includes the Chain-of-Custody Forms and Purchase Orders as required (see Form M, Tab 7 in the *FGN*). These forms or equivalent will be used to track and handle samples.

Collected samples will be labeled with the following information:

- Project name.
- Date.
- Time.
- Strip or IT name and number.
- Sampling location.
- Preservative.
- Collector's initials.
- Sample I.D. number.
- Analyte(s) to be analyzed.
- Grab or composite sample

Duplicate and QA/QC samples will be collected for media sampled, where possible. Duplicate and QA/QC samples will be prepared from the volume of the sample collected. The crews collecting the samples will be fully briefed on the procedures for collecting QA/QC samples, and will be familiar with the sample identification numbering scheme for these samples because they are to be submitted to the laboratory as blind samples. These samples will be labeled, recorded on the Chain-of-Custody Form, and transported to the analytical laboratory.

Each sample collected will receive a unique alphanumeric code (sample I.D. number) for tracking. This code will be standard for all samples and contain information as to the station, date, and sequential monitoring event number. The following is an example of this code:

SITE No.-IN-32898-001

Where:

Site No. = Site number of BMP site.
IN = Influent sampling point at the site; EF = effluent sampling point.
32898 = Julian day and year
001= First storm event monitored during this program at this location

If multiple bottles are used or needed, the last data field will indicate the bottle number and the total bottles in that sampling event (i.e., 001-1/3, 001-2/3, 001-3/3 for a three-bottle collection scheme).

A set of QA/QC samples will be provided with each type of sample. The analytical laboratory may also require additional QA/QC samples if one type of analysis is to be run in more than one batch.

Duplicate and QA/QC samples will be analyzed for the same standard analytes as the field samples. Most field QA/QC samples are submitted blind to the analytical laboratory, however, additional sample volumes provided to the laboratory for laboratory replicates or matrix spikes and matrix spike duplicates will be clearly identified. The main types of QA/QC samples that will be utilized for this study are as follows:

Duplicate Analyses - These analyses will be performed on one sample each monitoring year (i.e., 1998/1999 and 1999/2000) and will require an additional set of sample containers. Duplicate samples will be analyzed for the full list of analytes. The results will allow evaluation of sampling error introduced by both field sampling and laboratory analyses by showing the reproducibility of the sample collection and analyses. Duplicate samples will be sent "blind" to the laboratories.

Duplicate samples will be identified by adding 500 to the sequential storm event number. For example, a duplicate sample for the site identified above will be:

SITE No.-IN-32898-501

Blanks - These are for field as well as laboratory samples. Blanks help verify that the equipment and the sample containers are not contaminated, and the sampling techniques used are non-contaminating. Core soil and surface sediment collection equipment will be rinsed with reagent grade analyte free deionized water separately. The collected rinsates will be analyzed for the full list of analytes for the primary samples. Blanks will also be run on the analytical equipment. Rinsate blanks will be run on two samplers used by each consultant at one of their BMPs prior to the installation of the equipment. Each time a batch of composite bottles is cleaned, five percent of those bottles will be blanked. Each time a batch of filters is purchased five percent of those filters will be blanked.

Equipment rinsate blanks will be identified by adding 600 to the sequential storm event number. For example, an equipment rinsate blank collected from the monitoring equipment from the site identified above will be:

SITE No.-IN-32898-601

Field blanks will be identified by adding 700 to the sequential storm event number. For example, a field blank collected at the site identified above will be:

SITE No.-IN-32898-701

Matrix Spike and Matrix Duplicate Spike (MS/MSD) - The laboratory will require additional sample volumes for analyses that require matrix spikes and matrix spike duplicates to evaluate precision and accuracy of the laboratory analytical method, and to evaluate any matrix interference. MS/MSDs are analyzed for their analyte(s) and then spiked with a known amount of analyte(s). One MS/MSD sample will be run on metal samples collected during each event sampled, if enough sample volume has been collected.

MS/MSD samples will be indicated on Chain-of-Custody Forms by clearly identifying that the sample is for MS/MSD purposes.

Laboratory Replicate/Split - This QA/QC analysis will require additional sample volumes. It is a duplicate analysis performed on the same sample and evaluates the repeatability (precision) of the analytical laboratories' results. One split sample will be run from one of each consultant's BMP sampling locations during each storm event sampled and analyzed for the full list of analytes.

Laboratory replicate/split samples will be indicated on chain-of-custody forms by clearly identifying that the sample is for laboratory replicate/split sample purposes.

5.9 Laboratory Selection, Sample Container Preparation, and Analytical Methods

5.9.1 Laboratory Selection

The selected laboratories have extensive experience with environmental samples and have the ability to provide rapid response to meet critical holding time requirements for analytes requiring expeditious analysis. Laboratories are certified by the California Department of Health Services for the requested analyses. Refer to Tab 2 in the *FGN* for specific laboratory listings.

5.9.2 Holding Times, Sample Bottles, and Preparation

The laboratories will be responsible for providing appropriate sample containers and, when necessary, with preservatives for each analysis. Tables 5.1 and 5.2 provides a summary of sample volumes required for each analysis, along with the types of containers, holding times, and preservative. Because additional volumes are necessary for laboratory QA/QC, sample containers will provide at least twice the volume necessary to perform the requested analysis.

5.9.3 Project Reporting Limits

Recommended analytical methods and Reporting Limits for this project are listed in Tables 5.1 and 5.2. The Reporting Limits in this table are target Reporting Limits. In some cases, Reporting Limits may need to be adjusted due to limited sample volumes or potential matrix interference. In such cases, appropriate data qualifiers will be applied to the associated data.

5.9.4 Laboratory Data Package Deliverables

Laboratories will be required to provide a three-week turnaround on deliverables. The deliverable package will include a hard copy and electronic data files. The hard copy will include standard narratives identifying any analytical or QA/QC problems and corrective actions. The electronic data files will contain information found in the hard copy reports submitted by the laboratories. Individual data sets will be submitted as either Microsoft Excel® Workbook files or as Microsoft Access® database files. Each consultant will be responsible for laboratory coordination and data management. Data management will be consistent with the Caltrans Data Management Plan – Data Reporting Protocol and Database," DOC. I.D. CTSW-TM-98-005.

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Table 5.1
Stormwater Matrix
Analytical Parameters, Methodologies, Reporting Limits, Holding Times, Container Volumes and Types, and Preservation

Analyte	Priority Rank	Reporting Limit	Units	Analytical Technique	Method Number	Holding Time	Minimum Sample Volume	Preferred Volume and Container Type[1]	Preservation
Conventionals									
pH	1	0.1	Unit	Electrode	EPA 150.1	Immediately[2]	100 mL	1-100 mL glass/plastic	4°C
Specific Conductance	1	1.0	µmhos/cm	Electrometric	EPA 120.1	Immediately[2]	500 mL	1-500 mL glass/plastic	4°C
Hardness	5	2	mg/L	Titrimetric/ Colorimetric	EPA 130.2	6 months	100 mL	1-200 mL glass/plastic	HNO_3 to pH<2, 4°C
Total Suspended Solids	1	1	mg/L	Dried Filter Weight	EPA 160.2	7 days[3]	1 L	1-500 mL glass/plastic	4°C
Nutrients									
Nitrate-Nitrogen	2	0.01	mg/L	Colorimetric Ion Chromatography	EPA 353.3 EPA 300.0	28 days 48 hours	200 mL 200 mL	1-500 mL plastic 1-500 mL plastic	4°C and H_2SO_4 to pH<2 4°C
Total Kjeldahl Nitrogen	3	0.1	mg/L	Titrimetric/ Colorimetric	EPA 351.3	28 days	500 mL	1-1L plastic	4°C and H_2SO_4 to pH<2
Total Phosphorus	4	0.002	mg/L	Colorimetric	EPA 365.3	28 days	100 mL	1-250 mL plastic	4°C and H_2SO_4 to pH<2
Total/Dissolved Metals[4],[5]									
Copper	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Lead	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Zinc	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Organics[6]									
Total Petroleum Hydrocarbons – Diesel/Oil	Grab	250/200	µg/L	GC	EPA 8015M	14 days	1 L	2-1L amber glass	4°C
Total Petroleum Hydrocarbons - Gasoline	Grab	50	µg/L	GC	EPA 8015M	14 days	2-40 mL	3-40 mL VOA vials	4°C, HCl to pH<2
Bacteria[6]									
Fecal Coliform	Grab	2	MPN/100 mL	Multiple-tube	SM 9221E	6 hours[7]	50 mL	1-100 mL plastic	4°C

1. Analytes with the same preservative can be combined into a single container if the same laboratory is performing the analyses.
2. pH and Specific Conductance will be measured by the laboratory immediately upon receipt of the samples.
3. 7 days based upon limit for measuring TSS/no regulatory limit.
4. Total and dissolved metals samples are collected in separate containers. Only the total metals container will receive nitric acid.
5. Dissolved metals will be filtered in the laboratory prior to acidification.
6. Total Petroleum Hydrocarbon and Fecal Coliform grab samples will be collected for two storms per year.
7. Attempts will be made to maintain the 6-hour holding time for bacteria samples to the extent possible. When not possible, a maximum holding time of 24 hours will be followed in accordance with "Standard Methods for the Examination of Water and Wastewater", 18th Edition.

Table 5.2
Vadose Zone Matrix
Analytical Parameters, Methodologies, Reporting Limits, Holding Times, Container Volumes and Types, and Preservation

Analyte	Priority Rank	Reporting Limit	Units	Analytical Technique	Method Number	Holding Time	Preferred Volume and Container Type[1]	Preservation
Dissolved Metals[2]								
Copper	1	1	µg/L	ICP-MS	EPA 200.8	6 months	1 100 mL plastic	4°C and HNO_3 to pH<2 and filter
Lead	1	1	µg/L	ICP-MS	EPA 200.8	6 months	1 100 mL plastic	4°C and HNO_3 to pH<2 and filter
Zinc	1	1	µg/L	ICP-MS	EPA 200.8	6 months	1 100 mL plastic	4°C and HNO_3 to pH<2 and filter

1. Analytes with the same preservative can be combined into a single container, if the same laboratory is performing the analyses.
2. Dissolved metals will be filtered in the laboratory prior to acidification.

5.10 Sediment Sampling

As part of the maintenance program, sediment will be removed from the BMP when flows are hydraulically impeded. It is anticipated that sediment will accumulate relatively slowly over time. However, should sediment deposit in a rapid manner, an intermediate step of stockpiling may become necessary before offsite disposal. Section 5.11.1 provides procedures to be used when assessing potential sediment contamination in the event that intermediate onsite storage is necessary.

This subsection describes the sample collection procedures and analyses for assessing the quality of sediment removed from an IT for disposal. Evidence of oil and grease, antifreeze, solvents, fuel, hydrogen sulfide, and any other noxious substance will be noted. Observations will be used to determine if more than the standard list of analytes is required. The standard list (Table 5.3) is based on highway contaminants that have the potential to exceed hazardous waste criteria. After laboratory analysis, results will be compared to regulatory limits listed in California Code of Regulations (CCR) Title 22, Section 66261.24 and Department of Toxic Substances Control (DTSC) variances. Based on this evaluation, proper disposal methods will be chosen. Upon removal by licensed contractor, sediments will be transported offsite and disposed of properly by the hauling contractor. Drumming or other suitable containment will be provided if removed sediments are stored onsite.

5.10.1 Sediment Collection

Procedures in EPA Publication *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)* provide a method for determining the mean concentration of a given contaminant within a soil mass and the appropriate number of samples necessary to calculate this mean to the specified confidence interval. Initial sampling will generate a minimum number of samples/analyses as described below. Additional sample analyses may be required to meet the confidence levels given in *SW-846*, therefore archiving of samples will be necessary. Archived samples will be appropriately preserved and analyzed within the maximum holding time specified in Table 5.3. The Quality Assurance/Quality Control (Appendix III) describes the QA/QC objectives for sediment samples. The minimum number of discrete samples initially required is given below. The log shown as Form G in Tab 5 of the *FGN* will be used to document sediment collection.

- Drums: A minimum of one sample will be collected from each drum.
- Stockpiles less than 10 cubic yards: A minimum of two samples will be collected, one from each half of the stockpile. Sampling points will be selected randomly within each half.
- Stockpiles from 10-20 cubic yards: A minimum of three samples will be collected, one from each third of the stockpile. Sampling points will be selected randomly within each third.

- Stockpiles from 20-100 cubic yards: A minimum of four samples will be collected, one from each quarter of the stockpile. Sampling points will be selected randomly within each quarter.
- Stockpiles from 100-500 cubic yards: A minimum of one sample for each 25 cubic yard portion will be collected. The stockpile will be sectioned into 25 cubic yard portions to obtain a minimum of one sample for each 25 cubic yard portion. Sampling points will be selected randomly within each 25 cubic yard portion of the stockpile.

Random samples will be selected from locations on a three-dimensional grid. If the presence of materials such as boulders, debris, etc. hinder this process, the sample will be collected as close as possible to the randomly selected point without altering the essence of the random selection process. The following steps will be used to collect sediment samples:

1. Don powder-free nitrile gloves.
2. Locate the sample point in the stockpile or drum.
3. Collect the sample using a soil probe or equivalent. Ensure that the sample is collected at the correct depth and location that was randomly selected.
4. Fill one 8-ounce glass jar with a portion of the sample and close the container with the cap, using care not to aerate (volatilize) the sample. This jar will be labeled and analyzed for TPH and VOC.
5. Homogenize the other portion of the sample in a disposable bowl using a disposable spatula or spoon. Fill a second 8-ounce glass jar with this portion of the sample and close the container with the cap. This sample will be labeled and analyzed for metals.
6. Wipe the outside of each sample container with a clean paper towel.
7. Record the sampler's initials, date, and time on the pre-labeled sample bottle.
8. Place the sample containers in individual zip-top plastic bags and seal the bags.
9. Immediately pack the samples into a chilled cooler.
10. Record the required information on the Chain-of-Custody Form.
11. Document the sampling event, recording information in the designated field logbook.
12. Repeat the above steps until the minimum number of samples has been collected.

5.10.2 Sediment Analyses

Unless observations indicate additional testing, the sediment samples submitted to the laboratory will be analyzed for the list of analytes in Table 5.3 using Title 22 criteria (State of California, 1985). This table also lists the required Reporting Limits, analytical holding times, required preservation, and container sizes and types. Laboratory turn around times and data deliverables will be the same as those for the stormwater samples.

Table 5.3
Sediment Matrix (Disposal)
Analytical Parameters, Methodologies, Reporting Limits, Holding Times, Container Volumes and Types, and Preservation

Parameter	Method	Units	Detection Limit	Maximum Holding Time	Preservation	Container Size/Type(1)
Total Petroleum Hydrocarbons (TPH)	EPA 418.1	mg/kg	10	28 days	$4^{o}C$	8 oz glass jar
Volatile Organic Compounds	EPA 8260B	mg/kg	SW – 846 (5) requirements	14 days	$4^{o}C$	8 oz glass jar
California Code of Regulations (CCR), Title 22 Metals(2):	EPA 6020/7471	mg/kg	SW – 846 (5) requirements	180 days 28 days for mercury	$4^{o}C$	8 oz glass jar
California Code of Regulations (CCR), Title 22 Waste Extraction Test (WET) Metals(3):	STLC Extraction	mg/L	SW – 846 (5) requirements	180 days 28 days for mercury	4° C	NA
Toxicity Characteristic Leaching Procedure (TCLP) Metals(4):	TCLP 1311	mg/L	SW – 846 (5) requirements	180 days 28 days for mercury	4° C	NA

(1) Each sample will be collected in two 8 oz glass jars
(2) California Code of Regulation (CCR), Title 22 Metals (Sb, As, Ba, Be, Cd, Cr (total), Co, Cu, Hg, Pb, Mo, Ni, Se, Ag, Tl, V, and Zn). Initial waste characterization results may lead to a shorter list of metals for subsequent sediment disposal.
(3) Any sample for total metals that are below the Total Threshold Limit Concentration [TTLC] but exceed the ten times Soluble Threshold Limit Concentration (STLC) will be further analyzed using the WET procedure. WET extracts will be analyzed only for metals which exceed the ten times STLC criteria. Sediments associated with total metal results that exceed TTLC values are automatically considered hazardous and therefore do not need to undergo the WET procedure.
(4) If any of the WET-soluble concentrations are equal to or greater than the TCLP regulatory thresholds, analyze the waste by TCLP. “Test Methods for Evaluating Solid Waste, Physical /Chemical Methods”. SW-846, Update III.(SW-846)

5.11 Empirical Observations

5.11.1 Purpose of Empirical Observations

Performance assessments of BMP facilities cannot be fully ascertained through analytical methods. "Empirical" observations are also critical in determining the overall performance of implemented water quality management practices and in ensuring that the practices are maintained at optimum levels. Other factors such as maintenance activities, environmental variability, and physical processes, which cannot be determined analytically, can greatly influence the performance of a particular BMP. Some of these factors such as rainfall quantity and rainfall intensity can, and, will be assessed through physical measurements. Other components such as trash build-up, sediment deposition, and runoff appearance can be best assessed through careful documented observations.

5.11.2 Guidelines

Observations will be succinct but also complete. For a Strip/IT performance evaluation, the following observations will be made:

- Meteorological characteristics (present and preceding period).
- Hydrologic and hydraulic characteristics (flowing and/or standing water, channelization).
- Inlet conditions (problems affecting performance).
- Water quality appearance (visual, olfactory).
- Solids deposition (trash and debris, sediments, organics) and resuspension.
- Erosion.
- Vegetation condition.
- Outlet conditions (problems affecting performance).
- Mosquitoes and vectors.
- Structural condition of facility.
- Monitoring equipment condition.
- Infiltration medium condition (surface and observation well).

5.11.3 Checklist for Sampling and Monitoring Personnel

Form H in Tab 6 of the *FGN* provides a checklist (log form) that will be completed by sampling and monitoring personnel during every visit to the facility during wet weather or, at a minimum, once per month.

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CALTRANS
BMP RETROFIT PILOT PROGRAM

DISTRICT 11, SAN DIEGO

BMP OPERATION, MAINTENANCE, AND MONITORING PLAN

VOLUME II

APPENDIX I-E
BIOFILTRATION SWALES

September 1999

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1.1 Cross-section of a Biofiltration Swale

1.0 INTRODUCTION

The Caltrans Best Management Practice (BMP) Retrofit Pilot Program is a comprehensive water quality monitoring study to evaluate the removal of contaminants in stormwater runoff from Caltrans roads and facilities through a series of BMP pilot installations. The overall objectives of this portion of the program are to document BMP contaminant removal efficiency and technical feasibility.

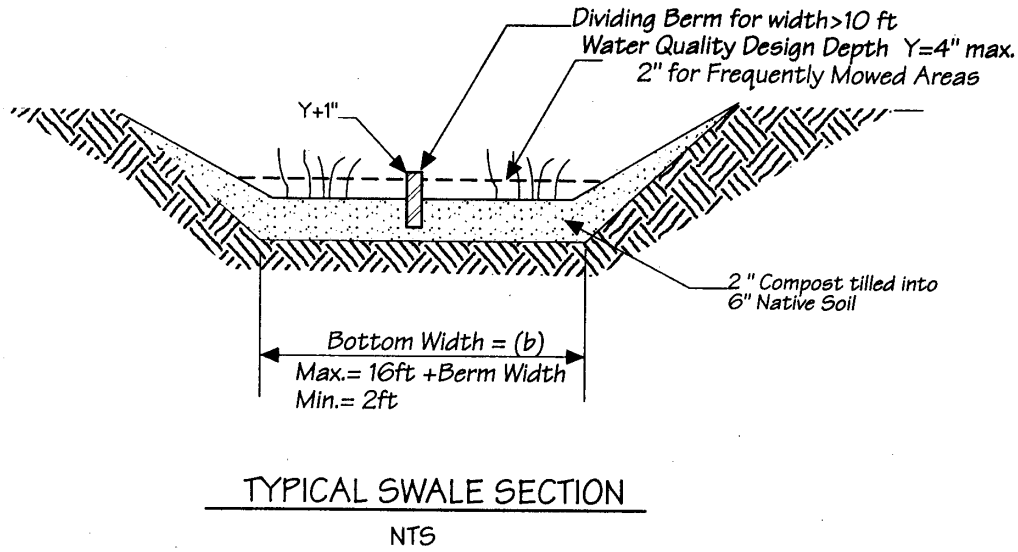
This Appendix of the Operations, Maintenance, and Monitoring Plan (OMM) applies to Biofiltration Swales (Swales). Refer to the consultant's monitoring equipment manuals and stormwater monitoring Standard Operating Procedures (SOPs) for details related to equipment installation, equipment maintenance, and storm monitoring. Maintenance, safety, documentation, and storm monitoring tasks will be carried out according to the procedures detailed in this plan. Additional measures may be necessary due to unforeseen or temporary changes to the work environment at these sites.

1.1 Retrofit BMP Description

Biofiltration Swales remove pollutants from stormwater runoff as it flows through the vegetated system by filtration, infiltration, adsorption, ion exchange, and biological removal. Swales are conveyances (typically trapezoidal channels) where the flow passes through vegetation at some specified depth.

Swales are designed to treat stormwater runoff during "water quality storm events" (defined as up to the 1-year, 24-hour peak flows). Runoff hydraulic residence times through these swales during a "water quality storm event" are typically nine minutes. No mechanism is provided to divert flows around the swales in excess of "water quality storm events".

Figure 1.1 Cross-section of a Biofiltration Swale



1.2 Evaluating BMP Performance

To effectively evaluate the performance of a Swale pilot facility, the following objectives will be met:

- Determine the quantity of runoff treated by the BMP.
- Determine the reduction (or change) in analyte concentrations between the influent and the effluent from the BMP.
- Determine and document the level of effort required to maintain the BMP at optimal effectiveness (i.e., treatment of stormwater runoff for storm events producing up to the 1-year, 24-hour peak flow).
- Determine and document the level of effort required to control vectors of human disease and nuisance insects, rodents, and vegetation at the BMP.
- Determine and document BMP performance evaluation criteria relative to the qualitative benefits of the BMP.

To effectively estimate the removal of contaminants from a Swale, the quantity and quality of runoff entering the Swale will be compared to the quantity and quality of water discharged from the Swale. These data will allow a direct estimate of the total reduction in mass loadings for a variety of contaminants.

The effectiveness of a Swale is also related to the implementation of maintenance procedures and the documentation of empirical observations. Items such as erosion and bank stability, vegetation height, trash and sediment build-up, and infiltration capability may directly affect the performance of a Swale as a stormwater treatment facility.

1.3 Deployment Criteria

Stormwater samples will be collected from the Swale for up to eight storm events over two wet seasons, weather permitting. Storms targeted for sampling will be separated by a minimum of 48 hours (72 hours preferably). The facility will be inspected per the guidelines given in Section 4.0 of the *Field Guidance Notebook* (*FGN*) which include a mandatory inspection after every storm with rainfall greater than 0.50 inches.

Based on the rainfall requirements needed to generate monitorable flows in and out of the pilots, Caltrans has developed a refined monitoring team deployment criteria. The refined deployment criteria defines when to chase storms based on season, storm forecasts, and the current count of successfully monitored storms.

The deployment season, in which monitoring teams remain "on-call" and fully staffed, will be restricted to the portion of the year when rainfall is most probable and better predictable. Summer showers are not seen as predictable events, and dry watersheds and BMPs will retain more water, which results in less effluent.

The deployment season will start on October 1. The season shall end after 3 weeks of dry weather where less than 0.2" of rainfall occurs in the San Diego area, but end no sooner than April 1 and not later than May 30th. This approach will provide a plan that adjusts to wet or dry springs.

The following criteria will decrease false starts, while allowing teams to continue to chase storms based on promising storm forecasts. The criteria will be used for pilots, regardless of drainage area size or land use.

“Forecast-Unlikely” set to less than 0.25” rain and less than 50% probability, (Decision = "No Go")

“Forecast-Marginal” set to 0.25” or greater and 50 –75% probability, (Caltrans Decision)

“Forecast-Highly Probable” set to 0.25” or greater and greater than 75% probability. (Decision = "Go")

Forecast information will be gathered as indicated in the OM&M manuals (e.g., internet sources). As always, if conditions happen to allow paired samples to be successfully taken for any storm larger than 0.1", that sampling would be considered as a successful event, which would count towards fulfilling Scoping Study requirements.

When a specific pilot is successfully monitored for the total required storms per the applicable Scoping Study, the decision to further deploy to monitor that pilot will fall to

Caltrans and no commitment to monitor beyond the terms of the Scoping Studies can be made at this time.

1.4 Data Collection and Compilation

1.4.1 Data Requirements

The following data will be collected to assess the performance and maintenance aspects of a Swale:

- Water quality and quantity data of runoff into and discharge from the Swale from flow-composite and first-flush (as soon as possible after the start of runoff) grab samples for at least eight storm events during two wet seasons, weather permitting.
- Rainfall data, recorded as a function of time, from rainfall events during the study period.
- Determination of the hydraulic residence time using dye tracing.
- Observations of water quality, weather, antecedent conditions, spills, etc.
- Documentation records of inspections and maintenance activities performed.
- Vector monitoring data.
- Records of vector control measures taken.
- Vegetation management records.

1.4.2 Data Management

Consultants will be responsible for data management. Overall management of the data will be consistent with established Caltrans procedures for stormwater monitoring projects and this manual.

The consultant's Sample Control Section will be responsible for tracking the analytical process to assure that laboratories are meeting the required turnaround times and are providing a complete deliverable package. Sample Control will also be responsible for accumulating copies of site visit logs, inspection logs, facility maintenance records, vector control sampling data, and logged rainfall and hydrographic data. Sample Control will receive the original hard and electronic copies from the laboratory, system managers, and field crews, and verify completeness and log dates of receipt. A copy of the data sets and log sheets will be filed in Sample Control's central filing system and another copy will be provided to the consultant's Database Manager. The originals will then be transferred to the Task Order Manager and filed with other project documentation to maintain complete project records.

Laboratories, system managers, and vector control crews will provide data in both hard copy and electronic formats. The forms of electronic submittals will be provided to the laboratories to ensure that the files can be imported into the project database with a minimum of editing. A relational database will be used for data. Laboratory data will be

maintained and managed using Microsoft Excel® and Microsoft Access®. Files from the influent and effluent monitoring stations will be stored in the same database system and be linked to the laboratory database. The sampling system files will include rainfall, sampling, and flow data. Site characteristics will be stored in a separate file and linked to both the chemical and sampling system files to enable useful data queries.

Data will be submitted to Caltrans in accordance with "Caltrans Statewide Data Management Plan—Data Reported Protocol and Database," a technical memorandum dated 23 April 1998 from Larry Walker Associates to Task Order Managers.

1.4.3 Data Analysis

Differences in storm characteristics, which can lead to differences in analyte loadings of monitored storm events, will be evaluated for each year of monitoring. Specific storm parameters such as total rainfall, average intensity, peak intensity, and antecedent conditions will also be measured.

Contingent on the amount and quality of actual data collected, sampling results for the influent and effluent sites will be characterized by descriptive statistics and statistical comparisons between the influent and effluent will also be performed at the Melrose and Palomar sites. However, the Palomar site will be receiving highway run-off along the swale walls that will not be sampled at the inlet. Therefore, true inlet and outlet load reduction calculations cannot be performed. Event mean concentrations (EMCs) will be measured for each water quality parameter at both locations. Annual statistics based upon assumed log-normal distributions also will be calculated for each water quality parameter. Subsequent to characterization of the stormwater runoff into and from a Swale, statistical comparisons will be performed to determine differences between the quality of the influent and the quality of the effluent at the Melrose site.

Differences in mean concentrations of analytes between storm events and locations will be considered to be statistically significant at $P \leq 0.10$. Although the acceptable level of alpha error is typically set at $P \leq 0.05$, this decision level was increased due to the relatively high coefficients of variation (CV) encountered with stormwater data.

Widely varying storm event characteristics will be considered when evaluating BMP efficiencies based on stormwater runoff data.

Empirical observations, maintenance activities, and vector control activities will be compiled and compared to water quality and quantity data. These data will be used to determine the total unit of effort and will be weighed against the water quality benefits.

1.5 Encroachment Permit and Restrictions

Visitation to a Swale requires a Caltrans Encroachment Permit. Copies of the Swale permits are located in Tab 9 of the *FGN*. These permits list access and safety requirements along with any restrictions. The respective Caltrans District Encroachment Permit Office will be contacted for further information and direction. Phone numbers can be found under Tab 2 in the *FGN* portion of the Volume II OMM Plan.

2.0 OPERATION AND MAINTENANCE

2.1 Operation and Maintenance Needs

The operational and maintenance needs of a Swale are:

- Vegetation management to maintain adequate hydraulic functioning and to limit habitat for disease-carrying animals.
- Animal and vector control.
- Periodic sediment removal to optimize performance.
- Trash, debris, grass trimmings, tree prunings, and leaf collection and removal to prevent obstruction of a Swale and monitoring equipment.
- Removal of standing water which may contribute to the development of aquatic plant communities or mosquito breeding areas.
- Removal of graffiti.
- Preventive maintenance on sampling, flow measurement, and associated BMP equipment and structures.
- Erosion and structural maintenance to prevent the loss of soil and maintain the performance of the Swale.

2.2 Inspection Frequency

The facility will be inspected and inspection visits will be completely documented (refer to Forms C and D in Tab 4):

- Once a month at a minimum.
- After every large storm (after every storm monitored or those storms with more than 0.50 inch of precipitation.)
- On a weekly basis during extended periods of wet weather.

2.3 Aesthetic and Functional Maintenance

Aesthetic maintenance is important for public acceptance of stormwater facilities. Functional maintenance is important for performance and safety reasons.

Both forms of maintenance will be combined into an overall Stormwater Management System Maintenance Program. Maintenance activities will be carried out by the consultant. Maintenance items are included in the checklist/logs found in Tab 5 of the *FGN*. Maintenance activities will conform to practices specified in this manual.

2.3.1 Aesthetic Maintenance

The following activities will be included in the aesthetic maintenance program:

- **Graffiti Removal.** Graffiti will be removed in a timely manner to improve the appearance of a Swale and to discourage additional graffiti or other acts of vandalism.
- **Grass Trimming.** Trimming of grass will be done on the Swale, around fences, at the inlet and outlet structures, and sampling structures. More specifics on vegetation management are given in Section 4.0.
- **Weed Control.** Weeds will be removed through mechanical means. Herbicide will not be used because these chemicals may impact the water quality monitoring. More specifics on vegetation management are given in Section 4.0.

2.3.2 Functional Maintenance

Functional maintenance has two components:

1. Preventive maintenance
2. Corrective maintenance

Preventive Maintenance

Preventive maintenance that will be done on a regular basis is detailed in the checklists in Tab 5 of the *FGN*. Preventive maintenance activities to be instituted at a Swale are:

- **Grass Mowing.** Vegetation seed mix within the Swale is designed to be kept short to maintain adequate hydraulic functioning and to limit the development of faunal habitats. More specifics on vegetation management are given in Section 4.0.
- **Trash and Debris.** During each inspection and maintenance visit to the site, debris and trash removal will be conducted to reduce the potential for inlet and outlet structures and other components from becoming clogged and inoperable during storm events.
- **Sediment Removal.** Sediment accumulation, as part of the operation and maintenance program at a Swale, will be monitored once a month during the dry season, after every large storm (0.50 inch), and monthly during the wet season. This information will be recorded on Form C in Tab 4 of the FGN. Specifically, if sediment reaches a level at or near plant height, or could interfere with flow or operation, the sediment will be removed. The removal of this sediment will be recorded on Form E in Tab 5. Additionally, for every storm event, empirical observations (including short circuiting, channeling, ponding, or decline from design performance) of the performance of the Swale will be recorded on Form H1 in Tab 6 of the FGN. If accumulation of debris or sediment is determined to be the cause of decline in design performance, prompt action (i.e., within ten working days) will be taken to restore the Swale to design performance standards. Actions will include

using additional fill and vegetation and/or removing accumulated sediment to correct channeling or ponding. Characterization and appropriate disposal of sediments is discussed in Section 2.6 and will comply with applicable local, county, state, or federal requirements. The swale will be regraded, if the flow gradient has changed, and then replanted with sod according to the schedule outlined in Appendix V.

- **Removal of Standing Water.** Standing water must be removed if it contributes to the development of aquatic plant communities or mosquito breeding areas.
- **Mechanical and Electronic Components.** Regularly scheduled maintenance will be performed on fences, gates, locks, and sampling and monitoring equipment in accordance with the manufacturers' recommendations. Electronic and mechanical components will be operated during each maintenance inspection to assure continued performance.
- **Fertilization and Irrigation.** The vegetation seed mix has been designed so that fertilization and irrigation is not necessary. Fertilizers and irrigation will not be used to maintain the vegetation. If the vegetation does not survive without fertilization or irrigation then Caltrans will work with the Plaintiff to discuss options for maintaining the BMPs.
- **Elimination of Mosquito Breeding Habitats.** The most effective mosquito control program is one that eliminates potential breeding habitats. Mosquito control measures are discussed more in Appendix IV of Volume II.

Corrective Maintenance

Corrective maintenance is required on an emergency or non-routine basis to correct problems and to restore the intended operation and safe function of a Swale. Corrective maintenance activities include:

- **Removal of Debris and Sediment.** Sediment, debris, and trash, which impede the hydraulic functioning of a Swale and prevent vegetative growth, will be removed and properly disposed (refer to Section 2.6). Temporary arrangements will be made for handling the sediments until a permanent arrangement is made. Vegetation will be re-established after sediment removal.
- **Structural Repairs.** Once deemed necessary, repairs to structural components of a Swale and its inlet and outlet structures will be done within 10 working days. Qualified individuals (i.e., the designers or contractors) will conduct repairs where structural damage has occurred.
- **Embankment and Slope Repairs**. Once deemed necessary, damage to the embankments and slopes of Swales will be repaired within 10 working days).
- **Elimination of Mosquito Breeding Areas.** Consult Appendix IV for controlling mosquitoes.
- **Erosion Repair.** Where a reseeding program has been ineffective, or where other factors have created erosive conditions (i.e., pedestrian traffic, concentrated flow, etc.), corrective steps will be taken to prevent loss of soil and any subsequent danger to the performance of a Swale. There are a number of corrective actions than can be

taken. These include erosion control blankets, riprap, sodding, or reduced flow through the area. Designers or contractors will be consulted to address erosion problems if the solution is not evident.

- **Fence Repair.** Repair of fences will be done within 30 days to maintain the security of the site.
- **Elimination of Animal Burrows.** Animal burrows will be filled and steps taken to remove the animals if burrowing problems continue to occur (filling and compacting). If the problem persists, vector control specialists will be consulted regarding removal steps. This consulting is necessary as the threat of rabies in some areas may necessitate the animals being destroyed rather than relocated. If the BMP performance is affected, abatement will begin immediately according to the directions in Appendix V. Otherwise, abatement will be performed annually in September.
- **General Facility Maintenance.** In addition to the above elements of corrective maintenance, general corrective maintenance will address the overall facility and its associated components. If corrective maintenance is being done to one component, other components will be inspected to see if maintenance is needed.

2.4 Maintenance Frequency

The maintenance indicator document, included as Appendix V, lists the schedule of maintenance activities to be implemented at a Swale.

2.5 Equipment, Resources, and Tools Needed

The following resources, equipment, and tools are needed by inspection personnel:

- A Locke level or other surveying equipment.
- Flashlight.
- Tape measure and other measuring device (e.g., survey rod) to determine sediment accumulation depths.
- Local erosion, sediment control, or stormwater management handbooks.
- Rain and foul weather gear.
- This Appendix and *FGN*.
- Copies of necessary inspection reports and forms.
- Encroachment permit.
- Business cards or other identification.
- Camera to document field conditions.
- Maintenance logs.
- Orange vest.
- Leather gloves.
- Hard hat.
- Safety glasses.
- Safety boots.

- Pen or pencil.

Except for the items contained onsite, the maintenance contractors will supply equipment, tools, and resources required for maintenance activities at a Swale. At a minimum, these contractors will supply the following:

- Heavy earth moving equipment (loaders, backhoes, graders, draglines, and vacuum equipment).
- Dump trucks, equipment transports, and other hauling equipment.
- Shovels, picks, rakes, wheel barrels, and other hand tools.
- Pumps.
- Mechanics tools.
- Concrete tools.
- Vegetation maintenance equipment (hand and tractor lawn mowers, gas trimmers, seed and fertilizer spreaders, pesticide and herbicide sprayers, leaf blowers, chain saws, pruning sheers, hedge trimmers, and wood chippers).
- Painting Equipment (brushes, rollers, and sprayers).
- Locke level or survey equipment, tape measures, and sediment probes.
- Safety equipment (gloves, boots, hard hats, reflective vests, safety glasses, traffic control lighting, and confined space entry equipment).

The consultants will provide for the maintenance contractors:

- This Appendix, *FGN* and approved BMP facility plans.
- Encroachment Permit.
- Logbook containing Maintenance Logs.

No items for maintenance and inspection activities will be left onsite.

2.6 Debris and Sediment Disposal

Waste generated at Swales is ultimately the responsibility of Caltrans. Consultants responsible for operating, maintaining, and monitoring the BMP will be responsible for removal and disposal of the waste material. Disposal of sediment, debris, and trash will comply with applicable local, county, state, and federal waste control programs. Table 2.1 shows a few possible disposal services for waste material.

Table 2.1
Waste Disposal Services in Southern California

Laidlaw / Rollins (OPC) 5765 Alba Street, Los Angeles, CA 92011 Ph: (213) 585-5063 Fax: (213) 589 5443 EPA: CAD050806850	Laidlaw Environmental Services 5295 S. Garvey Rd., Westmoreland, CA 92281 Ph: (619) 334-9400 Fax: (619) 344-9405 EPA: CAD000633164
TSM Recovery and Recycling 3422 W. Pico Blvd., Los Angeles, CA 90019 Ph: (213) 735-9443 EPA: CAD108040858	Pacific Resource Recovery 3150 E. Pico Blvd., Los Angeles, CA 90023 Ph: (800) 499-7145 Fax: (213) 780-9940 EPA: CAD008252405
Demenno Kerdoon Environmental Services 3650 E. 26th Street, Los Angeles, CA 90023 Ph: (213) 268-5056 Fax: (213) 268-9672 EPA: CAD080033681	U.S. Filter Recovery Services 5375 S. Boyle Ave., Vernon, CA 99058 Ph: (213) 277-1500 Fax: (213) 588-0094 EPA: CAD097030993

Prior to disposal, removed sediments will be inspected to determine the extent and type of chemical contamination. Evidence of oil and grease, antifreeze, solvents, fuel, hydrogen sulfide, and any other noxious substance will be noted. Observations will be used to determine if more than the standard analyte list is required. The standard analyte list (Table 5.2) is based on highway contaminants that have potential to exceed California Code of Regulations (CCR), Title 22 hazardous waste criteria. If any parameter concentration exceeds the maintenance indicators in Appendix V, the sediment will be removed and disposed of, appropriately. Methods used to sample sediments are discussed in Subsection 5.7. While analytical results are pending, the removed sediments will be stored in 55-gallon drums onsite in an area protected from vehicular traffic. Separate drums will be used to contain sediments suspected to be differently contaminated.

2.7 Hazardous Waste

Suspected hazardous wastes will be analyzed to determine disposal options. Hazardous wastes generated onsite will be handled and disposed of according to applicable local, state, and federal regulations. A solid or liquid waste is considered a hazardous waste if it exceeds the criteria listed in the CCR, Title 22, Article 11.

2.8 Checklists for Inspectors and Operation and Maintenance Personnel

Facility Inspection and Observational checklists or logs will be filled out during each visit to a Swale. These will be kept in a record book (field logbook) to ensure that the Swale is maintained at optimum levels throughout the monitoring period. One field logbook will contain storm monitoring data sheets and instrument calibration logs (Tab 6 of the *FGN*). A second logbook will contain Facility Inspection Checklists and

Maintenance Log Sheets. A third logbook will be kept for vector control and management logsheets (Appendix IV of Volume II).

Refer to Forms C, D, E, and F in the *FGN* for checklists related to the inspection and maintenance requirements of a Swale.

3.0 VECTOR CONTROL AND MANAGEMENT

Constructing retrofit pilot BMPs will modify the existing stormwater drainage systems. Because such retrofitting may create opportunities for disease carrying organisms to flourish, insects (such as mosquitoes and midges) or rodents may have to be controlled. Vector control and abatement will be performed in accordance with Appendix IV and by subcontracted Vector Control Districts.

4.0 VEGETATION MANAGEMENT

The three main reasons for having a vegetation management program for a Swale are:

1. Uncontrolled vegetation may affect the Swale performance.
2. Maintaining vegetation is necessary to prevent the facility from becoming a public "eyesore".
3. Maintaining vegetation is key to controlling mosquito populations and other vector and nuisance organisms.

4.1 Management for Optimal BMP Performance

Maintenance and control of vegetation is essential to the optimal operation and performance of a Swale. The Swales will be seeded with low-growing grasses, which minimizes the need for irrigation and fertilization.

The condition of the vegetation will be inspected on a monthly basis at a minimum. These inspections will insure that the Swale vegetation is kept relatively short (approximately 6 inches for Melrose and 9 inches for Palomar), that the vegetation protecting the slopes is kept healthy and continuous, and that undesirable plant species (e.g., woody vegetation) do not take root. Shorter vegetation will optimize the treatment capacity, the hydraulic residence time of runoff, and will aid in vector control. Maintaining healthy and continuous vegetation on the slopes will minimize erosion. Preventing undesirable plant species from taking root will prevent plants with large root systems from damaging the embankments. See Section 2.0 for details on vegetation maintenance.

4.2 Management for Optimal Vector Control

If vegetation such as cattails, bulrush, or willows develops within a Swale, problems may occur with vector control. Controlling vegetation and standing water is preferred to enacting vector management programs (see Appendix IV of Volume II for further details).

4.3 Maintenance Requirements

Mowing, trimming, and pruning are the preferred means for controlling vegetation at a Swale. Controlling standing water will also be essential in controlling vegetation.

When equipment is used to remove vegetation, care will be taken to prevent ruts, holes, and an uneven Swale floor. Such depressions can cause standing water that will create problems of vector control.

Additionally, the maintenance activities at a Swale will be carried out in a fashion that minimizes soil compaction.

Maintenance activities that will be conducted on landscaped vegetation include:

- Weeding.
- Pruning.
- Replacement of dead or dying plants
- Removal of woody vegetation, shrubs, dwarf plantain, pickleweed and emergent wetland vegetation, and large debris.

The vegetation seed mix has been designed so that fertilization and irrigation is not necessary. Fertilizers and irrigation will not be used to maintain the vegetation. If vegetation does not survive without fertilization and irrigation, then Caltrans will work with the Plaintiff to discuss options for maintaining the BMP. Vegetation coverage problems should be addressed if coverage drops below 90% in the Swale invert, or below 70% on the swale side slopes. The quantity of sod required will be assessed in May each year, with resodding of barren spots occurring in November. The sod will be irrigated until it becomes established.

Vegetation removed from a Swale will be promptly hauled off and disposed of properly. Cut vegetation will not be stockpiled onsite, especially in the Swale.

4.4 Checklists

During the routine vegetation inspections of the Swale, Inspection Checklists (Form C in Tab 3 of the *FGN*) will be completely filled out and signed by the inspector. These checklists incorporate necessary vegetation inspection requirements. BMP Site Maintenance Activity Checklists (Form E in Tab 5 of the *FGN*) will be filled out for maintenance activities performed.

5.0 SAMPLING AND MONITORING

This section details the monitoring equipment to be used at a Swale, sampling protocols, analytes to be tested, and quality assurance/quality control guidelines.

5.1 Equipment Installation

Runoff will be conveyed through a flume-to-swale transition structure where it will be spread evenly over the width of the Swale entrance. Influent flow will be measured and samples will be collected at the flume-to-swale transition structure. After the runoff flows through the Swale, it will pass through a second flume and then will discharge onto the ground, where the natural contours will direct the runoff to its original destination. Effluent flow will be measured and samples will be collected at the second flume.

Sampler intakes will be mounted in each conveyance upstream of the flume. Stainless steel concrete anchors will be used to secure the intakes to the invert of the conveyances.

Flow measurement points were selected at locations that minimized flow measurement errors resulting from turbulence and surcharges. Only experienced field crews will install monitoring equipment. Bubbler and intake tubing will be routed through conduit to equipment enclosures positioned on level ground near each flume. The equipment enclosures will house the data logger/controller assemblies, samplers, cellular modem equipment, flow metering electronics, and batteries.

The components of each automatic sampling system used will undergo calibration and verification during installation and also during maintenance and pre-storm visits.

5.1.1 Water Quality Samplers

The water quality samplers that will be used at a Swale will be automatic and composed of a peristaltic pump, a liquid detector, and a base to hold a sample bottle and ice. Each time a pre-determined volume of liquid passes the sampling point, the data logger/controller will signal the pump to deliver a self-calibrated sample volume. The suction hose used with the sampler will be 3/8-inch pure Teflon® tubing. Therefore, the sampler will be equipped with 3/8-inch silicon peristaltic tubing and a 3/8-inch stainless steel or Teflon® intake strainer of low-flow design. Strainers will be attached to the invert of each conveyance using stainless-steel fasteners. Samples will be collected into borosilicate glass bottles. After the storm event, the laboratory will pour portions of samples from each composite bottle into individual sample bottles, ensuring they are properly composited.

Materials used in the collection of stormwater samples will meet criteria to prevent contamination of the sample. These materials will allow for both inorganic and organic trace toxicant analyses from the same sampler and sample bottles. Only Teflon® and

borosilicate glass are suitable for both trace metal and organic analyses from the same sample bottle. Bottles will be cleaned according to USEPA-approved protocols consistent with approved methodology for analysis of stormwater samples (USEPA, 1983 and subsequent revisions). Sample hoses will be replaced and decontaminated annually, prior to the wet season. They will not be cleaned after each storm event. These bottles and hoses will be evaluated through a blanking process to verify that the sample bottles and sample hoses are decontaminated. Where possible, unused, disposable sampling equipment will be used to eliminate the need for decontamination.

Cleaning Procedures for Sample Bottles

Bottles will be:

1. Rinsed three times with warm tap water.
2. Scrubbed with a clean plastic brush.
3. Soaked in a 2% detergent (e.g., Contrad®) solution for at least 48-hours.
4. Rinsed three times with tap water.
5. Rinsed five times with Milli-Q or equivalent water, rotating the bottle to ensure contact with the entire inside surface.
6. Rinsed three times with hexane while rotating the bottle, and then air-dried.
7. Rinsed six times with Milli-Q water.
8. Soaked in 2N nitric acid for a minimum of 24-hours.
9. Rinsed six times with Milli-Q water.

Cleaning Procedures for Teflon® Hose and Other Sampling Equipment

Teflon® hose and other sampling equipment will be:

1. Teflon hose will be rinsed three times with a 2% Micro® solution or equivalent. Other sampling equipment will be washed with a 2% Micro® solution and a clean plastic brush.
2. Rinsed three times with warm tap water.
3. Rinsed three times with Milli-Q or equivalent water.
4. Rinsed three times with 2N nitric acid.
5. Soaked at least 24-hours in 2N nitric acid.
6. Rinsed three times with Milli-Q water.

5.1.2 Flow Monitoring

A flow-proportioned sample is a composite of individual sample aliquots that are collected for each set volume of water that passes by a sampling point. To obtain a valid composite sample, direct flow measurements will be made to control the sampling interval. At a Swale, both primary and secondary flow metering devices will be used. A primary flow measuring device is a hydraulic structure inserted into a channel that

monitors changes in liquid level in or near the structure. By knowing the shape and dimensions of the hydraulic structure, flow through or over the structure is related to the liquid level by a mathematical relationship. A secondary flow-metering device measures both liquid velocity and depth. Primary devices are preferable, unless hydraulic characteristics prohibit them.

A primary flow measuring discharge flume will be used at each sampling point. A bubbler will be used in conjunction with the flume. The bubbler measures the hydrostatic pressure of the liquid. The bubbler tube will be connected to the flume's stainless steel bubbler tube.

5.1.3 Rain Gauge

A rain gauge having a "tipping bucket" design that incorporates a small "bucket" which holds a known amount of rainfall will be used onsite. When the bucket is filled, it tips the water out, momentarily closes a switch, and then resets itself and starts the process again. The data logger/controller counts each switch closure to accumulate rainfall totals. The rain gauges used will tip after every 0.01 inch of rain.

5.1.4 Power

The source of primary power for the sampling systems will be 12-volt deep-cycle marine batteries. A separate battery will be used to power the autosamplers, modems, and flow meters. Solar panels will be used to maintain the charge on the batteries.

5.1.5 Telecommunications

Cellular modem transceivers will be used to provide remote telecommunication access to the monitoring equipment. The ability to access a sampling station, monitor the status of the station in real-time, modify storm criteria, download new programs, and recover data allows for more cost effective, efficient monitoring.

A high performance base station antenna with filter will be installed; the filter will be installed from the lead-in of the antenna to prevent damage to the sampling station equipment due to nearby lightning strikes.

5.1.6 Equipment Enclosures

Steel enclosures will be used to house the samplers and associated electronic equipment. These enclosures will be bolted to the concrete pads and will be locked to secure the monitoring equipment.

5.2 Maintenance and Calibration

A complete maintenance program will be performed at a Swale after each large storm event during the monitoring period, or in the absence of rain, on a monthly basis. Maintenance will include checking the performance of the equipment, checking power supplies, inspecting and clearing intake structures, cleaning contaminated equipment, and performing necessary equipment calibrations. Calibrations will be conducted in accordance to specifications in the individual component manuals.

Stormwater equipment maintenance visits will be thoroughly documented. Written documentation includes the action taken at a site as well as the date performed. Accurate and thorough records of station visits will be maintained to aid in the evaluation of a swale's performance. The log illustrated in Form F in Tab 5 of the *FGN* will be used to document maintenance and calibrations. If any program parameters are changed, the log shown on Form I, J1 and/or J2 in Tab 6 in the *FGN* will be completed.

5.3 Preparation and Logistics

Success of the sampling effort requires careful preparation and planning to assure that high quality samples are obtained in association with each storm event.

5.3.1 Weather Tracking

Weather tracking will be the responsibility of the Task Order Manager and Storm Control personnel. During the wet season, the weather will be continually monitored with increased frequency as incoming storm systems are predicted. Sources of weather information to be used to track incoming storms include the following: National Weather Service, Weather Watch Service, Weather Network (WeatherNet), the Alert system from San Diego County, public broadcast information available on the Weather Channel and local news stations, and radar and satellite images downloaded from the Internet (e.g., www.weather.com).

5.3.2 Mobilization and Staffing

A staffing plan, which designates personnel and equipment for each facet of storm monitoring, will be developed as soon as a potential storm event is forecast. Crews will consist of two individuals. The staffing plan will include the following information:

- Personnel needed for each position.
  - Storm Control.
  - Shift Leader.
  - Crew Chiefs.
  - Crew Assistants.
- Shift and zone (pilot facilities manned by a single crew) designations.

- Equipment mobilization.
- Communication channels.

Equipment needed for stormwater sampling includes the sampling equipment, sampling containers, safety equipment, personal rain gear, Storm Kits, and vehicles equipped with some type of mobile communication, and highway safety equipment (see lists). The necessary equipment will be loaded into the appropriate vehicles early in the storm preparation sequence.

Storm Kit Equipment List

- Keypad/display.
- 9-pin cable from keypad to data logger.
- Full set of keys (on floatable bobber).
- Flashlights (2).
- Maps for required areas.
- Large flat screwdriver.
- Small flat screwdriver.
- Umbrella.
- High quality alkaline D-cell batteries.
- Spare sample labels.
- Pencils and indelible markers.
- Desiccant (packages and jar).
- Diagonal clipper.
- Electrical tape.
- Cable ties (assorted sizes).
- Utility knife.
- Ziploc baggies (assorted sizes).
- Labeling tape.
- Polyethylene gloves.
- Rubber bands.

Storm Mobilization List

- Storm kit.
- Log books.
- pH meter.
- Paper towels.
- DI (de-ionized) water squirt bottles.
- Tape gun with clear tape.
- pH grab bottles.
- Spare sample labels.
- Ice scoop.
- Sample control paperwork.
- Extra fine indelible markers.
- 20 liter bottles in 10 gallon containment buckets.
- Grab sample bottles.
- Coolers and ice.
- Grab pole.
- DI water (3-gallon jug).
- Two-way radio or cellular phone.
- Personal rain gear.
- Any necessary safety gear.

Communication Channels

Communication channels will be established for personnel to contact each other before and during a storm event. A telephone tree will be used to facilitate contacting field personnel and other key individuals. Phone lists with home and work numbers and other key contacts will be made available to potential crew members. Two-way radio or cellular telephone communication links to field crews are essential for efficient stormwater monitoring.

5.3.3 Monitoring Station Preparation

Prior to a storm event, the Swale monitoring stations will be made ready to sample. This preparation includes entering the calculated "Volume-to-Sample" values, setting the autosampler and the data logger to sampling mode, pre-icing the sample bottle, and performing a general equipment inspection.

Determination of Volume-to-Sample

The latest weather forecast prior to each storm event will be examined to determine the proper "Volume-to-Sample" value to enter into the system. The amount of expected rainfall, how the station performed during the previous storm, and how much water is needed for analysis at the station for each storm event would be taken into consideration. The "Volume-to-Sample" is entered as a number with units in kilo-cubic feet (kcf). To determine this number, the drainage area in acres and the runoff coefficient, which is a number that reflects the permeability of the land in the study area. The following equation will be used to determine the volume of water expected at a Swale for a given rainfall:

A x B x C x 3.63 = volume in kcf

Where:

A = inches of rain
B = drainage area in acres
C = runoff coefficient for land area
3.63 = conversion factor: acre-inches to kilo-cubic feet

To determine how much water will pass the monitoring station between samples, divide this result by the number of samples needed to satisfy the water volume requirement for analysis. Exhibit 9.2 in Tab 9 of the *FGN* indicates the "Volume-to-Sample" value needed to collect the correct sample amount of water for the amount of expected rainfall.

After the proper "Volume-to-Sample" value is determined, it will be entered into the system before the rainfall starts. The runoff value will generally be entered from the remote computer. The value can also be entered upon arrival at the site before the system has entered storm mode. It is important that this value is accurate as possible; if the value is too high, the system will not collect enough water to be analyzed, and if the value is too low, the system may sample too fast to be monitored effectively (i.e., the percent storm capture will drop).

Prepare Sampler

The autosampler will be reset and programmed to take 78 250-ml aliquots. Also other user-entered parameters (tubing length, head height, bottle size, composite sample, sample upon one pulse, and enabled liquid detector) will be set correctly.

During each site visit, the state of the System Status Flags (switches) and Program Signature will also be recorded. These provide important information on the current sampling mode and overall integrity of the site program.

Ice Sample Bottles

The sample bottle will be iced after the decision has been made to monitor the storm and prior to initial sample collection. If this is not possible, the bottle will be iced immediately upon the first visit.

General Inspection

A brief physical inspection of the equipment will be made to make certain that there are no obvious problems such as broken conduit or a kinked hose. If possible, the intake will be cleared of debris; at sites with confined entry access, this is only possible if the safety requirements listed in Appendix II are met.

Documentation

Upon each site visit, whether during storm mode or not, records of the visit will be accurately recorded on the field form (Form I of Tab 5 in the *FGN*). Whenever possible, any data being recorded by the sampling system (for example, time or current stage) will be verified. If any program parameters are changed, a program parameter log (Forms J1 and J2 of Tab 6 in the *FGN*) will be filled out. Also once during each storm event visit, the Empirical Observation Checklist will be completed (Tab 6, Form H in the *FGN*).

General Visitation Data

During each station visit, several display locations will be recorded. The log sheets will be used as a guide to the proper display locations to record. The following data will be recorded at both the influent and effluent stations:

- Flume Stage (ft).
- Flume Q (flow in cfs).
- Station ID.

- Data logger Battery Voltage.
- Flow Meter Battery Voltage.
- Cellular Equipment Battery Voltage.

Storm Visitation Data

Additional data will be recorded in the logbooks during storm monitoring. The log sheet will be used to determine the necessary information. The following data are uniform for each station:

- Volume (kcf)
  This is the volume of water that passed the station during the previous execution interval (one minute).
- Storm Sum
  This indicates the accumulated runoff volume in kilo-cubic feet (kcf) that has passed the station since the last sample.
- Percent Storm Capture
  This indicates the percent of the storm effectively sampled by the system, and it provides a quick evaluation of the quality of the monitoring.
- Volume-to-Sample
  This value indicates the runoff volume (in kcf) that will pass the station before the system will take the next sample.
- Sample Count
  This number indicates the number of samples taken in the current bottle. It automatically re-zeroes every time a bottle is filled.
- Total Rain (inches)
  The total rainfall in inches since the start of the storm. This is accumulated each time that the rain bucket tips.
- Max Flow (day)
  This indicates the Julian day on which the maximum flow occurred.
- Max Flow (time)
  When this number is positive, it indicates that the system was sampling during peak stage. If this number is negative, sampling did not occur during the peak stage because the bottle was full.
- Max Stage (feet)
  This indicates the height of the maximum stage during the current storm.
- Max Flow (cfs)
  This indicates the maximum flow rate during the current storm.
- Storm Volume (kcf)
  This indicates the total volume of water that has flowed past the station since the beginning of the storm.

- Storm Volume Sampled (kcf)
  This indicates the total volume of water that flowed past the station while the system has been in storm mode.

After data have been recorded, the system will be placed in low power mode and the keyboard unplugged.

5.4 Storm Monitoring

A priority objective of storm monitoring is to maximize the percent storm capture of the composite sample. This will be accomplished by changing out the full sample bottle with an empty one. If bottle does fill, the full sample bottle will be replaced and the system will be reset. To determine approximately when the bottle will fill and to ensure that the sampling process is not interrupted the Storm Sum and the "Volume-to-Sample" will be evaluated. By examining how quickly the Storm Sum value is approaching the "Volume-to-Sample" value, the approximate time until the next sample is taken can be determined, as well as the approximate time until the bottle fills. The monitoring crew will be aware of the current status of each station in each of its BMP pilot facilities to determine which station will fill its bottle first so they can be onsite to change out the filled bottle. If the station has been set for the amount of rainfall that actually occurs, changing the sample bottle will not be necessary. "Volume-to-Sample" settings will take into account the volume of sample required to meet analytical needs. This study requires approximately 3 liters of sample to meet these needs.

The data logger pulses the autosampler to take a sample when the accumulated Storm Sum equals the "Volume-to-Sample." The storm sum is then reset to zero and the process is repeated. This continues until the storm ends or the bottle fills. Ideally, the "Volume-to-Sample" value will be accurate for the amount of anticipated rainfall, and the bottle will not need to be changed during the storm. If the rainfall is different than that predicted, the bottle may fill before the end of the storm. If this occurs, sampling will halt until the bottle is changed and the system is reset. While the system is reset, part of the storm is not being sampled, and the percent capture will show a decrease. It is therefore imperative that the system is reset and the sample bottle is changed immediately to maintain 100% storm capture.

5.4.1 Storm Procedure

Upon arrival at a station during a storm event, the status of the composite sample bottle will be checked immediately. If it is not necessary to change the bottle at that time, the appropriate data on the log sheets will be recorded and the necessary physical measurements and observations will be taken. An approximate time that the bottle will fill will be determined, and, depending on how much time is available, the next station will be visited or the team will wait until the bottle fills.

If the sample bottle is full, the system will be reset immediately, and the bottle replaced. When the bottle has been changed, the necessary station data will be filled in on Form I, Tab 6, in the *FGN*.

5.4.2 Sample Bottle Replacement

The removal of the sample bottle from the sampler requires great care; the bottles are heavy when full and are very slippery when wet, as well as being expensive and fragile. Two people will be present to ensure the security of the bottles and of the sample itself. Extreme care will be taken not to kink the intake hose when handling the sampler.

The bottle number will be recorded in the logbook and the bottle will be labeled appropriately. When a new bottle has been put in place, it will be re-iced and the sampler reset to continue sampling. Full bottles will be kept iced until composited.

5.4.3 Storm Monitoring Office

The main objective of the Storm Monitoring Office is to update field crews on the status of their stations. This will greatly reduce the amount of time a crew will spend driving during storms. The monitoring of stations from a remote computer consists of calling each station and recording certain data for evaluation. When it is determined that a sampling system is close to filling a bottle, a field crew will be called and alerted to the status of the station. Remote interrogation of the storm stations will be logged using Form K in Tab 6 of the *FGN*.

Generally, the Storm Monitoring Office is also the storm control position. This means that critical decisions regarding the status of storm monitoring are made with input from the Storm Monitoring Office.

Therefore, this position requires awareness of the latest weather forecasts to make informed decisions on the continued monitoring of the storm.

5.4.4 Post-Sampling Procedures

After a storm event has ended, the stations need to be shut down. The station will be left ready for the next storm event in case there is insufficient time for a maintenance visit between storms. The following items will be taken care of, and will be well documented in the field logbook.

1. The storm monitoring program will be reset to prepare for another storm event.
2. The sample bottle will be replaced and the sampler reset.

3. The station will be physically inspected to determine if damage was sustained during the storm event. The flow sensor will be inspected to determine if it is blocked by debris, or the intake is clogged. (This is only possible if confined space safety requirements are met).
4. The data will be retrieved. This will be done via modem from either the remote monitoring computer or directly in the field using a laptop computer.
5. Battery voltages will be checked; batteries that are low will be replaced.
6. An Empirical Observation Checklist (Form H1 in Tab 6 of the *FGN*) will be completed one time during the event.

Data Retrieval

Data will be retrieved (dumped) from the data logger after each storm event during the storm season, and approximately every month during dry weather.

Chain-of-Custody Forms

When the grab samples have been collected, the paperwork will be filled out to ensure a smooth transfer of samples to the analytical laboratory. Chain-of-Custody Forms will be filled out in detail describing the type of samples, the number of samples, and the times that the samples were collected. These forms will accompany the samples to the laboratory.

5.4.5 Evaluation

Upon termination of a storm monitoring event, evaluation of the influent and effluent stations' performance will be documented and reviewed before the samples collected are deemed valid. Evaluation of a monitoring station's performance is based on the answers to the following questions:

- Was the storm representative of the effectiveness range of the Swale?
- Was capture of peak flow or runoff achieved at both sampling points?
- Did the equipment perform as designed throughout the duration of the storm event?
- Did the samplers accurately collect equal and reliable storm sample aliquots?
- Did the Swale function as designed?

5.4.6 Grab Sampling

Total petroleum hydrocarbons (TPH) and bacteria (Fecal Coliform) samples are unsuitable for collection by automatic means. TPH is inappropriate because some material adheres to the surface of the tubing and the sample container. Automatic sampling for bacteria is inappropriate because the sampling equipment is not sterile after installation and exposure to the elements. Because these analytes are unsuitable for

collecting using an automated approach, they will be collected as a grab sample from both the influent and effluent twice each storm monitoring year.

It is imperative that collected grab samples be transferred to a designated meeting location immediately after the sampling has been completed. Chain-of-Custody Forms for the samples will be completed and transport of the samples to the analytical laboratory will be coordinated to ensure that samples are handled and analyzed within the proper holding times.

It is essential that the following sample handling protocols be followed when collecting grab samples to keep contamination to a minimum:

- Turn the vehicle engine OFF to minimize exposure of the sample to exhaust fumes.
- Keep sample containers in clean coolers until sampling is actually initiated.
- Store filled sample bottles in clean coolers at 4°C.
- Keep the bottle lid clean and free of debris while the bottle is open.

Grab samples will be collected during two storm events per monitoring season as near to the sampling point as possible. When unable to collect a sample near the intake, the sample will be collected as near the center of flow as possible or in an area of sufficient velocity to ensure good mixing. Both sampling points require a grab pole to collect the necessary grab samples. Sample bottles will be fitted snugly into the bottle holder and the bottles will be seated on the upstream side of the grab pole to reduce potential contamination. The bottle will be filled with the mouth of the bottle faced into the current, if possible. Also, the bottle will be labeled before it is filled as it is nearly impossible to write on wet bottles, and the station I.D. will be listed on the bottle to coincide with the station sampled.

Each type of grab sample may require special treatment to ensure the quality of the sample and the safety of the sampler. The preservative in the sample bottles is usually a concentrated acid, so care will be taken that the preservative does not come into contact with the skin. Powder-free nitrile gloves will be worn when handling sample containers. Both types of grab samples are discussed below.

TPH analyses will be performed for oil, diesel and gasoline fractions and reported separately for each. Samples to be analyzed for TPH gasoline fraction will be preserved with a concentrated acid (HCl). The sample bottles will be filled to below the neck and just above the shoulder. The bottle will not be overfilled because the preservative will be washed out. If the bottle is just slightly overfilled, a small amount of sample will be poured off after the preservative has mixed with the sample. A small amount of headspace is required in the containers to allow for expansion if the sample freezes while iced during shipping. These grab samples will be collected as soon as possible after runoff is detected.

Fecal Coliform are preserved with a small sodium thiosulfate tablet. To retain the tablet while sampling, it will be removed from the container when it is dipped into the flow. The bacteria bottle will be turned over causing the tablet to fall onto the cap of the bottle; the cap will be removed and set somewhere that will prevent it from becoming contaminated (out of the rain). The sample bottle will be filled to the shoulder, the cap tipped so the tablet falls into the sample and the cap secured to the bottle. These grab samples will be collected once the entire tributary area contributes stormwater runoff (i.e., any time after 10 minutes of continuous flow past the sampling point).

Attempts will be made to maintain the 6-hour holding time for bacteria to the extent practical. However, storm field conditions or safety concerns may prove this holding time infeasible. A maximum holding time of 24 hours will be followed, in accordance with "Standard Methods for the Examination of Water and Wastewater," 18th Edition.

5.5 Sample Tracking and Handling

Water samples will be kept properly chilled and transferred to the analytical laboratory within holding times to achieve the highest quality data possible. To ensure proper tracking and handling of the samples, documentation will accompany the samples from the initial pickup to the final extractions and analysis. This documentation includes the Chain-of-Custody Forms (see Form M in Tab 7 of the *FGN* for an example form). These forms or equivalent will be used to track and handle samples.

Samples collected, including the composite containers, will be labeled with the following information:

- Project name.
- Date.
- Time.
- Swale name and number.
- Matrix
- Influent or effluent sampling location.
- Preservative.
- Collector's initials.
- Sample I.D. number.
- Analyte(s) to be analyzed.
- Grab or composite sample.

The analytical suite for each station depends upon the total volume of water collected for the storm event. When insufficient volumes have been collected, Storm Control will need to approve the analysis of the stormwater. A Priority Analysis Sheet will be used in conjunction with a Sample Bottle Evaluation to determine the analytical suite for each station, based on the volume of water collected at that station, the Volume-to-Sample,

and the percent storm capture. When the storm has been evaluated and samples from each station accounted for, a duplicate station and a QA/QC station will be selected by Sample Control based on stormwater volumes available. Duplicate and QA/QC samples will be prepared from the combined volume of the sample collected (i.e., from each of the sample bottles) at the selected duplicate and QA/QC station.
Duplicate and QA/QC sample bottles will be labeled, recorded on the Chain-of-Custody Form, and transported to the analytical laboratory.

Grab samples will be transported to the appropriate laboratory as soon as the grab sampling is completed, whereas the sample bottles for composite samples are transferred at the end of the storm event. Samples will be properly logged on the Chain-of-Custody Form and kept chilled in coolers. There will also be a field duplicate, a field blank, and extra water collected for QA/QC samples. These QA/QC grab samples will be collected at one of each consultant's BMPs during each storm event monitored. The sampling stations will be selected by Storm Control for collecting the duplicate grab samples. The crews monitoring the stations will be fully briefed on the procedures for collecting QA/QC samples, and will be familiar with the sample identification numbering scheme for these samples because they are to be submitted to the laboratory as blind samples. These samples will be labeled, recorded on the Chain-of-Custody Form, and transported to the analytical laboratory.

Each sample collected will receive a unique alphanumeric code (sample I.D. number) for tracking. This code will be standard for samples and contain information as to the station, date, and sequential monitoring event number. The following is an example of this code:

SITE No.-IN-32898-001

Where:

Site No. = Site number of BMP site.
IN = Influent sampling point at the site; EF = effluent sampling point.
32898 = Julian day and year
001= First storm event monitored during this program at this location

If multiple bottles are used or needed, the last data field will indicate the bottle number and the total bottles in that sampling event (i.e., 001-1/3, 001-2/3, 001-3/3 for a three-bottle collection scheme).

A set of QA/QC samples will be provided with each type of sample analyzed for each storm event. The analytical laboratory may also require additional QA/QC samples if one type of analysis is to be run in more than one batch.

Blank samples, duplicate samples, MS/MSDs, and replicate/splits need not be from the same station. However, per storm event (or batch run), these QA/QC samples will be analyzed for the standard analytes as field samples. Most field QA/QC samples are

submitted blind to the analytical laboratory, however, additional sample volumes provided to the laboratory for laboratory replicates or matrix spikes and matrix spike duplicates will be clearly identified. The main types of QA/QC samples that will be utilized for this study are as follows:

Duplicate Analyses - These analyses will be performed for both grab samples and composite samples and will require an additional set of sample containers to be sub-sampled. The results will allow evaluation of sampling error introduced by both field sampling and laboratory analyses by showing the reproducibility of the sample collection and analyses. Duplicate samples will be sent "blind" to the laboratories. One duplicate sample will be collected from one of each consultant's sampling locations during each storm event sampled and analyzed for the full list of analytes.

Duplicate samples will be identified by adding 500 to the sequential storm event number. For example, a duplicate sample for the site identified above will be:

SITE No.-IN-32898-501

Blanks - These are for field as well as laboratory samples. Blanks help verify that the equipment and the sample containers are not contaminated, and the sampling techniques used are non-contaminating. Sample bottles, Teflon® tubing, and filters will be rinsed with reagent grade analyte free deionized water separately. The collected rinsates will be analyzed for the full list of analytes for the composited samples. Blanks will also be run on the analytical equipment. Rinsate blanks will be run on two samplers used by each consultant at one of their BMPs prior to the installation of the equipment. Each time a batch of composite bottles is cleaned, five percent of those bottles will be blanked. Each time a batch of filters is purchased five percent of those filters will be blanked.

Equipment rinsate blanks will be identified by adding 600 to the sequential storm event number. For example, an equipment rinsate blank collected from the monitoring equipment from the site identified above will be:

SITE No.-IN-32898-601

Field blanks will be identified by adding 700 to the sequential storm event number. For example, a field blank collected at the site identified above will be:

SITE No.-IN-32898-701

Matrix Spike and Matrix Duplicate Spike (MS/MSD) - The laboratory will require additional sample volumes for analyses that require matrix spikes and matrix spike duplicates to evaluate precision and accuracy of the laboratory analytical method, and to evaluate any matrix interference. MS/MSDs are analyzed for their analyte(s) and then spiked with a known amount of analyte(s). One MS/MSD sample will be run on metal

and TPH samples from one of each consultant's sampling locations during each storm event sampled.

MS/MSD samples will be indicated on Chain-of-Custody Forms by clearly identifying that the sample is for MS/MSD purposes.

Laboratory Replicate/Split - This QA/QC analysis will require additional sample volumes. It is a duplicate analysis performed on the same sample and evaluates the repeatability (precision) of the analytical laboratories' results. One split sample will be run from one of each consultant's BMP sampling locations during each storm event sampled and analyzed for the full list of analytes.

Laboratory Replicate/Split samples will be indicated on Chain-of-Custody Forms by clearly identifying that the sample is for Laboratory Replicate/Split sample purposes.

5.6 Laboratory Selection, Sample Container Preparation, and Analytical Methods

5.6.1 Laboratory Selection

The selected laboratories have extensive experience with environmental samples and have the ability to provide rapid response to meet critical holding time requirements for analytes requiring expeditious analysis. Laboratories are certified by the California Department of Health Services for the requested analyses. Refer to Tab 2 in the *FGN* for specific laboratory listings.

5.6.2 Holding Times, Sample Bottles, and Preparation

The laboratories will be responsible for providing appropriate sample containers and, when necessary, with preservatives for each analysis. Table 5.1 provides a summary of sample volumes required for each analysis, along with the types of containers, holding times, and preservative. Because additional volumes are necessary for laboratory QA/QC, sample containers will provide at least twice the volume necessary to perform the requested analysis. The volume of the stormwater composite from each site is often the critical factor in determining the volume of sample that can be provided to the laboratory. The Project Task Order Manager and/or Storm Control personnel, in conjunction with the laboratories, will determine the allocation of sample volume for different analyses if sample volumes are not adequate to provide needed volume for each analysis. Table 5.1 lists the analyses along with a Priority Ranking. Also listed on Table 5.1 are the analytical methods and reporting limits.

5.6.3 Project Reporting Limits

Recommended analytical methods and reporting limits for this project are listed in Table 5.1. The reporting limits in this table are target reporting limits. In some cases, reporting limits may need to be adjusted due to limited sample volumes or potential matrix interference. In such cases, appropriate data qualifiers will be applied to the associated data.

5.6.4 Laboratory Data Package Deliverables

Laboratories will be required to provide a three-week turnaround on deliverables. The deliverable package will include a hard copy and electronic data files. The hard copy will include standard narratives identifying any analytical or QA/QC problems and corrective actions. The electronic data files will contain information found in the hard copy reports submitted by the laboratories. Individual data sets will be submitted as either Microsoft Excel® Workbook files or as Microsoft Access® database files. Each consultant will be responsible for laboratory coordination and data management. Data management will be consistent with the "Caltrans Duty Management Plan – Data Reporting Protocol and Database", Doc. J. D. CTSW-TM-98-005.

5.7 Sediment Sampling

As part of the maintenance program, sediment will be removed from the BMP when flows are hydraulically impeded. It is anticipated that sediment will accumulate relatively slowly over time. However, should sediment deposit in a rapid manner, an intermediate step of stockpiling may become necessary before offsite disposal. Section 5.7.1 provides procedures to be used when assessing potential sediment contamination in the event intermediate onsite storage is necessary.

This section describes the sample collection procedures and analyses for assessing the quality of sediment removed from a Swale for disposal. Evidence of oil and grease, antifreeze, solvents, fuel, hydrogen sulfide, and any other noxious substance will be noted. Observations will be used to determine if more than the standard list of analytes is required. Observations will be documented on a checklist form (Form G in the *FGN*). The standard list (Table 5.2) is based on highway contaminants that have the potential to exceed hazardous waste criteria. After laboratory analysis, results will be compared to regulatory limits listed in California Code of Regulations (CCR) Title 22, Section 66261.24 and Department of Toxic Substances Control (DTSC) variances. Based on this evaluation, proper disposal methods will be chosen.

Table 5.1
Stormwater Matrix
Analytical Parameters, Methodologies, Reporting Limits, Holding Times, Container Volumes and Types, and Preservation

Analyte	Priority Rank	Reporting Limit	Units	Analytical Technique	Method Number	Holding Time	Minimum Sample Volume	Preferred Volume and Container Type[1]	Preservation
Conventionals									
pH	1	0.1	Unit	Electrode	EPA 150.1	Immediately[2]	100 mL	1-100 mL glass/plastic	4°C
Specific Conductance	1	1.0	µmhos/cm	Electrometric	EPA 120.1	Immediately[2]	500 mL	1-500 mL glass/plastic	4°C
Hardness	5	2	mg/L	Titrimetric/ Colorimetric	EPA 130.2	6 months	100 mL	1-200 mL glass/plastic	HNO_3 to pH<2, 4°C
Total Suspended Solids	1	1	mg/L	Dried Filter Weight	EPA 160.2	7 days[3]	1 L	1-500 mL glass/plastic	4°C
Nutrients									
Nitrate-Nitrogen	2	0.01	mg/L	Colorimetric Ion Chromatography	EPA 353.3 EPA 300.0	28 days 48 hours	200 mL 200 mL	1-500 mL plastic 1-500 mL plastic	4°C and H_2SO_4 to pH<2 4°C
Total Kjeldahl Nitrogen	3	0.1	mg/L	Titrimetric/ Colorimetric	EPA 351.3	28 days	500 mL	1-1L plastic	4°C and H_2SO_4 to pH<2
Total Phosphorus	4	0.002	mg/L	Colorimetric	EPA 365.3	28 days	100 mL	1-250 mL plastic	4°C and H_2SO_4 to pH<2
Total/Dissolved Metals[4],[5]									
Copper	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Lead	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Zinc	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Organics[6]									
Total Petroleum Hydrocarbons – Diesel/ Oil	Grab	250/200	µg/L	GC	EPA 8015M	14 days	1 L	2-1L amber glass	4°C
Total Petroleum Hydrocarbons - Gasoline	Grab	50	µg/L	GC	EPA 8015M	14 days	2-40 mL	3-40 mL VOA vials	4°C, HCl to pH<2
Bacteria[6]									
Fecal Coliform	Grab	2	MPN/100 mL	Multiple-tube	SM 9221E	6 hours[7]	50 mL	1-100 mL plastic	4°C

1. Analytes with the same preservative can be combined into a single container if the same laboratory is performing the analyses.
2. pH and Specific Conductance will be measured by the laboratory immediately upon receipt of the samples.
3. 7 days based upon limit for measuring TSS/no regulatory limit.
4. Total and dissolved metals samples are collected in separate containers. Only the total metals container will receive nitric acid.
5. Dissolved metals will be filtered in the laboratory prior to acidification.
6. Total Petroleum Hydrocarbon and Fecal Coliform grab samples will be collected for two storms per year.
7. Attempts will be made to maintain the 6-hour holding time for bacteria samples to the extent possible. When not possible, a maximum holding time of 24 hours will be followed in accordance with "Standard Methods for the Examination of Water and Wastewater", 18th Edition.

5.7.1 Sediment Collection

Procedures in EPA Publication *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)* provide a method for determining the mean concentration of a given contaminant within a soil mass and the appropriate number of samples necessary to calculate this mean to the specified confidence interval. Initial sampling will generate a minimum number of samples/analyses as described below. Additional sample analyses may be required to meet the confidence levels given in *SW-846*, therefore archiving of samples will be necessary. Archived samples will be appropriately preserved and analyzed within the maximum holding time specified in Table 5.2. None of the samples will be allowed to be composited. The Quality Assurance/Quality Control (Appendix III) describes the QA/QC objectives for sediment samples. The minimum number of discrete samples initially required is given below:

- Drums: A minimum of one sample will be collected from each drum.
- Stockpiles less than 10 cubic yards: A minimum of two samples will be collected, one from each half of the stockpile. Sampling points will be selected randomly within each half.
- Stockpiles from 10-20 cubic yards: A minimum of three samples will be collected, one from each third of the stockpile. Sampling points will be selected randomly within each third.
- Stockpiles from 20-100 cubic yards: A minimum of four samples will be collected, one from each quarter of the stockpile. Sampling points will be selected randomly within each quarter.
- Stockpiles from 100-500 cubic yards: A minimum of one sample for each 25 cubic yard portion will be collected. The stockpile will be sectioned into 25 cubic yard portions to obtain a minimum of one sample for each 25 cubic yard portion. Sampling points will be selected randomly within each 25 cubic yard portion of the stockpile.

Random samples will be selected from locations on a three-dimensional grid. If the presence of materials such as boulders, debris, etc. hinder this process, the sample will be collected as close as possible to the randomly selected point without altering the essence of the random selection process. The following steps will be used to collect sediment samples:

1. Don personal protective equipment.
2. Locate the sample point in the stockpile or drum.
3. Collect the sample using a soil probe or equivalent. Ensure that the sample is collected at the correct depth and location that was randomly selected.
4. Fill one 8-ounce glass jar with a portion of the sample and close the container with the cap, using care not to aerate (volatilize) the sample. This jar will be labeled and analyzed for volatile TPH and VOC.
5. Homogenize the other portion of the sample in a disposable bowl using a disposable spatula or spoon. Fill a second 8-ounce glass jar with this portion of the sample and close the container with the cap. This sample will be labeled and analyzed for metals.
6. Wipe the outside of each sample container with a clean paper towel.
7. Record the sampler's initials, date, and time on the pre-labeled sample bottle.
8. Place the sample containers in individual zip-top plastic bags and seal the bags.

9. Immediately pack the samples into a chilled cooler.
10. Record the required information on the Chain-of-Custody Form.
11. Document the sampling event, recording information in the designated field logbook.
12. Repeat the above steps until the minimum number of samples has been collected.

5.7.2 Sediment Analyses

Unless observations indicate additional testing, sediment samples submitted to the laboratory will be analyzed for the list of analytes in Table 5.2 using Title 22 criteria (State of California, 1985). This table also lists the required reporting limits, analytical holding times, required preservation, and container sizes and types. Laboratory turn around times and data deliverables will be same as those for the stormwater samples.

5.8 Empirical Observations

5.8.1 Purpose of Empirical Observations

Performance assessments of BMP facilities cannot be fully ascertained through analytical methods. "Empirical" observations are also critical in determining the overall performance of implemented water quality management practices and in ensuring that the practices are maintained at optimum levels. Other factors such as maintenance activities, environmental variability, and physical processes, which cannot be determined analytically, can greatly influence the performance of a particular BMP. Some of these factors such as rainfall quantity, rainfall intensity, and hydraulic residence times can, and, will be assessed through physical measurements. Other components such as trash build-up, sediment deposition, and runoff appearance are best assessed through careful documented observations.

Table 5.2
Sediment Matrix (Disposal)
Analytical Parameters, Methodologies, Reporting Limits, Holding Times, Container Volumes and Types, and Preservation

Parameter	Method	Units	Reporting Limit	Maximum Holding Time	Preservation	Container Size/Type(1)
Total Petroleum Hydrocarbons (TPH)	EPA 418.1	mg/kg	10	28 days	4^oC	8 oz glass jar
Volatile Organic Compounds	EPA 8260B	mg/kg	SW – 846 (5) requirements	14 days	4^oC	8 oz glass jar
California Code of Regulations (CCR), Title 22 Metals(2):	EPA 6020/7471	mg/kg	SW – 846 (5) requirements	180 days 28 days for mercury	4^oC	8 oz glass jar
California Code of Regulations (CCR), Title 22 Waste Extraction Test (WET) Metals(3):	STLC Extraction	mg/L	SW – 846 (5) requirements	180 days 28 days for mercury	4° C	NA
Toxicity Characteristic Leaching Procedure (TCLP) Metals(4):	TCLP 1311	mg/L	SW – 846 (5) requirements	180 days 28 days for mercury	4° C	NA

(1) Each sample will be collected in two 8 oz glass jars

(2) California Code of Regulation (CCR), Title 22 Metals (Sb, As, Ba, Be, Cd, Cr (total), Co, Cu, Hg, Pb, Mo, Ni, Se, Ag, Tl, V, and Zn). Initial waste characterization results may lead to a shorter list of metals for subsequent sediment disposal.

(3) Any sample for total metals that are below the Total Threshold Limit Concentration [TTLC] but exceed the ten times Soluble Threshold Limit Concentration (STLC) will be further analyzed using the WET procedure. WET extracts will be analyzed only for metals which exceed the ten times STLC criteria. Sediments associated with total metal results that exceed TTLC values are automatically considered hazardous and therefore do not need to undergo the WET procedure.

(4) If any of the WET-soluble concentrations are equal to or greater than the TCLP regulatory thresholds, analyze the waste by TCLP. “Test Methods for Evaluating Solid Waste, Physical /Chemical Methods”. SW-846, Update III.(SW-846)

5.8.2 Guidelines

Observations will be succinct but complete. For a Swale performance evaluation, the following observations will be taken at the influent location, within the Swale, and at the effluent location:

- Meteorological characteristics (present and preceding period).
- Hydrologic and hydraulic characteristics (flowing and/or standing water, channelization).
- Inlet conditions (problems affecting performance).
- Water quality appearance (visual, olfactory) to make a rough assessment of changes in water quality.
- Solids deposition (trash and debris, sediments, organics) and resuspension.
- Erosion.
- Vegetation condition.
- Outlet conditions (problems affecting performance).
- Mosquitoes and other vectors.
- Structural condition of facility.
- Monitoring equipment condition.
- Hydraulic residence time measurements (Swales only).

5.8.3 Checklist for Sampling and Monitoring Personnel

Form H1 in Tab 6 of the *FGN* provides a checklist (log form) that will be completed by sampling and monitoring personnel during every visit to the facility or, at a minimum, once per month.

5.9 Hydraulic Residence Time Evaluation

Removal of pollutants from stormwater is dependent on a variety of design factors including the hydraulic residence time. The hydraulic residence time is the amount of time it takes a slug of stormwater to flow through a Swale, and will be evaluated at each Swale during one storm event during each monitoring season. To determine the hydraulic residence time, a residence time distribution analysis will be carried out by injecting dye into stormwater runoff entering the Swale and monitoring the concentration (absorbance) of the dye in the runoff at the downstream end of the Swale. These results will be plotted to produce a flow-through curve, which will be used to evaluate performance indices (e.g., time to reach peak concentration and time to reach the centroid of the curve). The following procedure will be used to determine the hydraulic residence time of each Swale.

1. Mobilize a team for a storm event where the amount of rain predicted is greater than or equal to 0.10 inch. This event should **not** be an event during which stormwater monitoring (i.e., sampling) will be conducted.
2. Measure the Swale vegetation height and record it on Form H2 in Tab 6 of the *FGN*.
3. Remove any obstructions from the Swale and its inlet and outlet structures.

4. Initiate the flow monitoring equipment and ensure that it is properly calibrated. Program the bubbler to measure flow after each 1-minute interval (lowest possible setting). Set the flow monitoring equipment so that flow volume is totaled. After calibration and programming, begin data logging flow rates.
5. Pour 10 mL of yellow/green dye liquid (*Formulabs* or equivalent) into the inlet flume.
6. Once the dyed water reaches the beginning of the vegetation, start a stopwatch and begin timing the travel of the dyed water.
7. Record observation of the dyed water as it travels through the Swale.
8. Collect a sample at the downstream end of the Swale and use a colorimeter, or equivalent, to measure the absorbance in the sample.
9. Record the absorbance measurement, the time when the sample was collected, and the flow volume when the sample was collected on Form H2 in Tab 6 of the *FGN*.
10. Repeat Steps 8 and 9 every 2 minutes for a period of 1 hour or until the absorbance decreases to less than or equal to 10 percent of the peak absorbance measured, whichever occurs first.

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CALTRANS
BMP RETROFIT PILOT PROGRAM

DISTRICT 11, SAN DIEGO

BMP OPERATION, MAINTENANCE, AND MONITORING PLAN

VOLUME II

APPENDIX I-F
STORMFILTER ä
(PERLITE / ZEOLITE)

September 1999

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2.1 Waste Disposal Services in Southern California

5.1 Storm Water Matrix Analytical Parameters, Methodologies, Reporting Limits, Holding Times, Container Volumes and Types, and Preservation
5.2 Sediment Matrix Analytical Parameters, Methodologies, Reporting limits, Holding Times, Container Volumes and Types, and Preservation

FIGURES

1.1 StormFilter™ Plan View and Section View
1.2 Filter Cartridge Section View

1.0 INTRODUCTION

The Caltrans Best Management Practice (BMP) Retrofit Pilot Program is a comprehensive water quality monitoring study to evaluate the removal of contaminants in stormwater runoff from Caltrans roads and facilities through a series of BMP pilot installations. The overall objectives of this portion of the program are to document BMP contaminant removal efficiency and technical feasibility.

This Appendix of the Operations, Maintenance, and Monitoring Plan (OMM) applies to StormFilters™ (MF). Refer to the consultant's monitoring equipment manuals and stormwater monitoring Standard Operating Procedures (SOPs) for details related to equipment installation, equipment maintenance, and storm monitoring. Maintenance, safety, documentation, and storm monitoring tasks will be carried out according to the procedures detailed in this plan. Additional measures may be necessary due to unforeseen or temporary changes to the work environment at these sites.

1.1 Retrofit BMP Description

A StormFilter™ is a media filter that uses various filtration media. This type of filter removes pollutants through filtration, ion exchange, adsorption, and microbial degradation. MFs are usually multi-chambered with each chamber containing a series of filter cartridges. Storm runoff percolates horizontally through each filter cartridge. The filter cartridges consist of a hood, outer screen, air relief valve, media, and a porous center tube. The following is a description of the cartridge "priming system" : treated stormwater collects in the center tube until the water depth reaches 19-inches and activates a float/ball valve mechanism. Displacement of the float/ball valve forces entrapped air within the hood through the relief valve. This causes a siphon, which increases the flow potential through the filter media. Filtered water collects in a manifold to exit the BMP. Overflow and bypass capabilities are other common components of a MF. Upstream settling devices are recommended where a large sedimentation potential exists.

The MF BMP was designed to treat runoff up to a 1-year, 24-hour storm event or less storm events. Some runoff from larger storms will bypass the facility. The larger the storm the more runoff is bypassed. Optimal treatment will occur for longer, less intense storms. Important considerations in the design, operation, maintenance, and management of media filters can be found in a guidance manual prepared for the U.S. EPA (Watershed Management Institute, Inc., 1997).

The MF is a confined system located underground. Thus, many concerns, such as controlling vectors, vegetation, and nuisance organisms associated with other BMP types, are minimized.

Figure 1.1
StormFilter ä Plan View and Section View

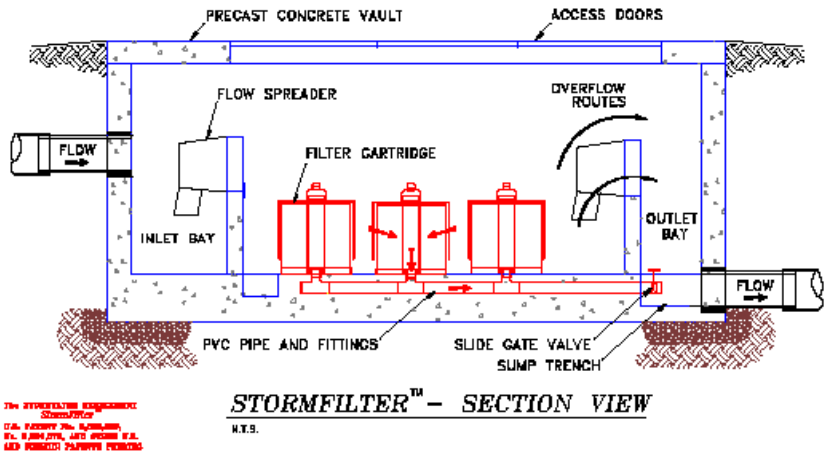
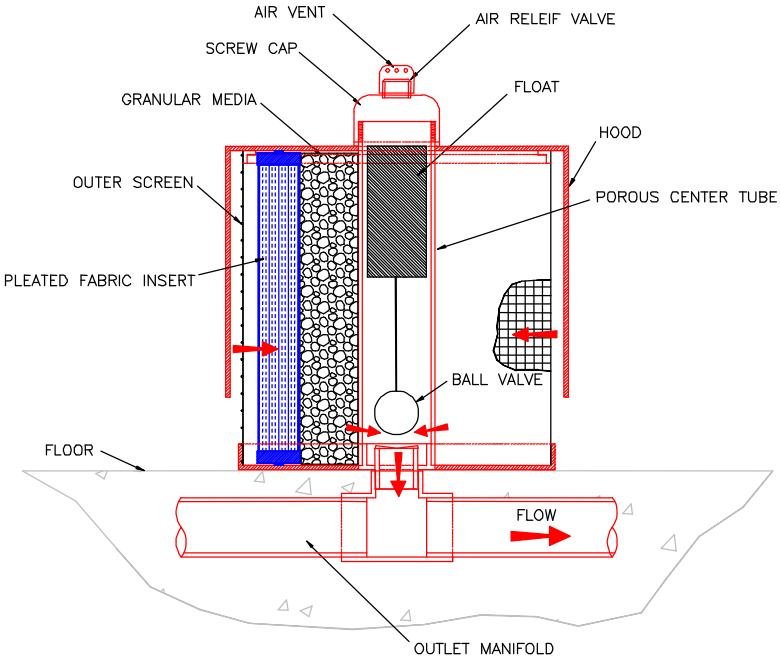


Figure 1.2
Filter Cartridge Section View



1.2 Evaluating BMP Performance

To effectively evaluate the performance of a MF pilot facility, the following objectives will be met:

- Determine the quantity of runoff treated by the MF.
- Determine the reduction (or change) in analyte concentrations between the influent to and the effluent from the MF.
- Determine and document the level of effort required to maintain the MF at optimal effectiveness.
- Determine and document the level of effort required to control vectors of human. disease and nuisance insects, and rodents at the BMP.
- Determine and document BMP performance evaluation criteria .
- Determine and document BMP performance evaluation criteria relative to the qualitative benefits.

To effectively estimate the removal of contaminants from a MF, the quantity and quality of runoff entering the MF will be compared to the quantity and quality of water discharged from the MF. These data will allow a direct estimate of the total reduction in mass loadings for a variety of contaminants.

The effectiveness of a MF is also related to the implementation of strict maintenance procedures and the documentation of empirical observations. Items such as maintenance of storage volumes, discharge rates, sediment and trash build-up, and clogging may directly effect the performance of a MF.

A MF retains water for varying periods of time, and it contains a damp and dark environment. As such, the potential to produce vectors of human disease and nuisance insects and rodents exists.

1.3 Deployment Criteria

Stormwater samples will be collected from the MF for up to eight storm events over a two wet seasons, weather permitting. Storms targeted for sampling will be separated by a minimum of 48 hours (72 hours preferably). This facility will be inspected per the guidelines given in Section 4.0 of the *Field Guidance Notebook* (*FGN*), which include a mandatory inspection after every storm greater than 0.50 inch.

Based on the rainfall requirements needed to generate monitorable flows in and out of the pilots, Caltrans has developed a refined monitoring team deployment criteria. The refined deployment criteria defines when to chase storms based on season, storm forecasts, and the current count of successfully monitored storms.

The deployment season, in which monitoring teams remain "on-call" and fully staffed, will be restricted to the portion of the year when rainfall is most probable and better predictable. Summer showers are not seen as predictable events, and dry watersheds and BMPs will retain more water which results in less effluent.

The deployment season will start on October 1. The season shall end after 3 weeks of dry weather where less than 0.2" of rainfall occurs in the San Diego area, but end no sooner than April 1 and not later than May 30th. This approach will provide a plan that adjusts to wet or dry springs.

The following criteria will decrease false starts, while allowing teams to continue to chase storms based on promising storm forecasts. The criteria will be used for pilots, regardless of drainage area size or land use.

“Forecast-Unlikely” set to less than 0.25” rain and less than 50% probability, (Decision = "No Go")

“Forecast-Marginal” set to 0.25” or greater and 50 –75% probability, (Caltrans Decision)

“Forecast-Highly Probable” set to 0.25” or greater and greater than 75% probability. (Decision = "Go")

Forecast information will be gathered as indicated in the OMM manuals (e.g., internet sources). As always, if conditions happen to allow paired samples to be successfully taken for any storm larger than 0.1", that sampling would be considered as a successful event, which would count towards fulfilling Scoping Study requirements.

When a specific pilot is successfully monitored for the total required storms per the applicable Scoping Study, the decision to further deploy to monitor that pilot will fall to Caltrans and no commitment to monitor beyond the terms of the Scoping Studies can be made at this time.

1.4 Data Collection and Compilation

1.4.1 Data Requirements

The following data will be collected to assess the performance and maintenance aspects of a MF:

- Water quality and quantity data of runoff into and discharge from the media filter from flow-composite samples and grab (as soon as possible after the start of runoff) samples for at least 8 storm events during two wet seasons, weather permitting.
- Rainfall data recorded as a function of time, from rainfall events during the study period.
- Observations of water quality, weather, antecedent conditions, spills, etc.
- Documentation records of inspections and maintenance activities performed.
- Vector monitoring and management data.

- Records of vector control measures taken.

1.4.2 Data Management

The consultant will be responsible for data management. Overall management of the data will be consistent with established Caltrans procedures for stormwater monitoring projects and this manual.

The Sample Control Section of Consultant will be responsible for tracking the analytical process to assure that laboratories are meeting the required turnaround times and are providing a complete deliverable package. Sample Control will also be responsible for accumulating copies of site visit logs, inspection logs, facility maintenance records, vector control sampling data, and logged rainfall and hydrographic data. Sample Control will receive the original hard and electronic copies from the laboratory, system managers, and field crews, and verify completeness and log dates of receipt. A copy of the data sets and log sheets will be filed in Sample Control's central filing system and another copy will be provided to the Database Manager. The originals will then be transferred to the Task Order Manager and filed with other project documentation to maintain complete project records.

Laboratories, system managers, and vector control crews will be requested to provide data in both hard copy and electronic formats. The forms of electronic submittals will be provided to the laboratories to ensure that the files can be imported into the project database with a minimum of editing. A relational database will be used for data. Laboratory data will be maintained and managed using Microsoft Excel® and Microsoft Access®. Files from the influent and effluent monitoring stations will be stored in the same database system and be linked to the laboratory database. The sampling system files will include rainfall, sampling, and flow data. Site characteristics will be stored in a separate file and linked to both the chemical and sampling system files to enable useful data queries.

Data will be submitted to Caltrans based on "Caltrans Statewide Data Management Plan—Data Reported Protocol and Database," a technical memorandum dated 23 April 1998 from Larry Walker Associates to task order managers.

1.4.3 Data Analysis

Differences in storm characteristics, which can lead to differences in analyte loadings of monitored storm events, will be evaluated for each year of monitoring. Specific storm parameters such as total rainfall, average intensity, peak intensity, and antecedent conditions will be measured to determine if these parameters correlate with analyte concentrations and loads in stormwater discharges.

Contingent on the amount and quality of actual data collected, sampling results for the influent and effluent sites will be characterized by descriptive statistics. Statistical comparisons between the influent and effluent will also be performed. Event Mean Concentrations (EMCs) will be

measured for each water quality parameter at both sampling points. Annual statistics based upon assumed log-normal distributions also will be calculated for each water quality parameter. Subsequent to characterization of the stormwater runoff into and from a MF, statistical comparisons will be performed to determine differences between the quality of the influent and the quality of the effluent.

Differences in mean concentrations of analytes between storm events and locations will be considered to be statistically significant at $P \leq 0.10$. Although the acceptable level of alpha error is typically set at $P \leq 0.05$, this decision level was increased due to the relatively high coefficients of variation (CV) encountered with stormwater data.

Care will be taken to guard against false positive or negatives, so that widely varying storm event characteristics will not result in misinterpretation of the stormwater runoff data.

Widely varying storm event characteristics will be considered when evaluating BMP efficiencies based on stormwater runoff data. Empirical observations, maintenance activities, and vector control activities will be compiled and compared to water quality and quantity data.

1.5 Encroachment Permit and Restrictions

Visitation to a MF requires a Caltrans Encroachment Permit. Copies of the MF permits are located in Tab 9 of the *FGN*. These permits list access and safety requirements along with any restrictions. The respective Caltrans District Encroachment Permit Office will be contacted for further information and direction (phone numbers can be found under Tab 2 in the *FGN* portion of the Volume II OMM Plan).

2.0 OPERATION AND MAINTENANCE

2.1 Operation and Maintenance Needs

As suggested in the manufacturer's operation and maintenance guidelines (See Section 6.0) the operation and maintenance needs of a media filter facility are:

- Removal of trash and debris from flow control and other structures within the facility.
- Removal of excessive sediment deposits which threaten to clog the facility.
- Removal of standing water that becomes a vector control problem.
- Replacement of cartridges annually or when they become clogged.
- Flushing drainage system piping.
- Removal of graffiti and debris.
- Painting.
- Preventative maintenance on equipment.

The Stormwater Management StormFilter™ Product Manual has been made available to Field Crews and has been used to complete this OMM. Section 2.4 of the Stormwater Management Storm Filter™ Product Manual will be followed when performing minor and major maintenance.

2.2 Inspection Frequency

The facility will be inspected and inspection visits will be completely documented (refer to Section 2.8):

- Once a month at a minimum.
- After every large storm (after every storm monitored or those with more than 0.5 inches of precipitation).
- On a weekly basis during extended periods of wet weather.

2.3 Aesthetic and Functional Maintenance

Functional maintenance is important for performance and safety reasons while aesthetic maintenance is important for public acceptance of stormwater facilities.

Both forms of maintenance will be combined into an overall Stormwater Management System Maintenance Program. Maintenance activities will be carried out by the consultant or a subcontractor of consultant. Maintenance items are included in the checklist/log forms found in Tab 4 and 5. Maintenance activities will conform to Caltrans practices.

2.3.1 Aesthetic Maintenance

The following activities will be included in the aesthetic maintenance program:

- **Graffiti Removal.** Graffiti will be removed in a timely manner to improve the appearance of the filter and it's related monitoring equipment, and to discourage additional graffiti or other acts of vandalism.
- **Grass Trimming.** Trimming of grass will be done around fences and sampling structures.

2.3.2 Functional Maintenance

Functional maintenance has two components:

(1) Preventive maintenance.
(2) Corrective maintenance.

Preventive Maintenance

Preventive maintenance that will be done on a regular basis is detailed in the checklists contained in Section 2.8. Preventive maintenance activities to be performed on the media filter are:

- **Trash and Debris.** A regularly scheduled program of debris and trash removal will be conducted.
- **Sediment Removal**. Sediments will be removed from the pre-sedimentation chamber when it reaches a maximum depth of 12 inches. Disposal of sediments is discussed in Section 2.6 and will comply with local, county, state, or federal requirements.
- **Standing Water.** When standing water remains 72 after last rainfall notify Vector Control.

Corrective Maintenance

Corrective maintenance is required on an emergency or non-routine basis to correct problems and to restore the intended operation and safe function of the media filter. Corrective maintenance activities include the following:

- **Removal of Debris and Sediment.** Visibly contaminated sediment, debris, and trash, which clog the facility or possibly contribute to elevated pollutant levels in the effluent, will be removed immediately and properly disposed of. Temporary arrangements will be made for handling the sediments until a permanent arrangement is made.
- **Structural Repairs.** Repairs to any structural component of the media filter will be made promptly (e.g., within 10 working days). Designers and contractors will conduct repairs where structural damage has occurred.
- **Cartridge Replacement.** Procedures outlined in the StormFilter manual will be followed when cartridges need to be replaced because of sediment loading. The results will be reported followed by a maintenance decision.
- **Flushing drainage system piping.** The drainage piping will be flushed to ensure adequate flow through the system.
- **General Facility Maintenance.** In addition to the above elements of corrective maintenance,

general corrective maintenance will address the overall facility and its associated components. If corrective maintenance is being done to one component, other components will be inspected to see if maintenance is needed.

2.4 Maintenance Frequency

The maintenance indicator, included in Volume II as Appendix V, lists the schedule of maintenance activities to be implemented at a media filter.

2.5 Equipment, Resources, and Tools Needed

The following resources and equipment are needed by inspection personnel:

- A Locke level or other surveying equipment.
- Industrial strength flashlight.
- Crowbar.
- Tape measure and other measuring device (e.g., survey rod) to determine surface sediment accumulation depths.
- Local erosion, sediment control, or stormwater management handbooks.
- Trash removal equipment.
- Sediment manipulation/removal equipment (e.g., shovels, rakes, 5-gallon buckets).
- Rain and foul weather gear and other personal protective equipment (PPE).
- This Appendix and *FGN*.
- The Stormwater Management™ Product Manual
- Copies of necessary inspection reports and forms.
- Encroachment permit.
- Business cards or other identification.
- Camera to document field conditions.
- Orange vest and hardhat.
- Maintenance logs.
- Leather gloves.
- Safety glasses.
- Safety boots.
- Pen or pencil.

Except for the items contained on site, the maintenance contractors will supply equipment, tools, and resources required for maintenance activities at the media filter. At a minimum, these contractors will supply the following:

- Shovels, picks, rakes, wheel barrows, and other hand tools.
- Mechanics Tools.
- Concrete Tools.
- Painting Equipment (brushes, rollers, and sprayers).

- tape measures and sediment probes.
- Safety equipment (gloves, boots, hard hats, reflective vests, safety glasses, traffic control lighting, and confined space entry equipment).
- Pumps.
- Camera with film.

The consultants will supply to the maintenance contractors:

- This Appendix, FGN, and approved BMP facility plans.
- The Stormwater Management™ Product Manual
- Encroachment Permit.
- Logbook containing maintenance and safety logs.

2.6 Debris and Sediment Disposal

Hazardous waste generated at the media filter is ultimately the responsibility of Caltrans. Consultants responsible for operating, maintaining, and monitoring the filter will be responsible for removal, testing, and disposal of the waste material. Disposal of sediment, debris, and trash will comply with local, county, state, and federal waste control programs. Table 2.1 shows a few of the possible disposal services for waste material.

Table 2.1
Waste Disposal Services in Southern California

Laidlaw / Rollins (OPC) 5765 Alba Street Los Angeles, CA 92011 Ph: (213) 585-5063 Fax: (213) 589 5443 EPA: CAD050806850	Laidlaw Environmental Services 5295 S. Garvey Rd. Westmoreland, CA 92281 Ph: (619) 334-9400 Fax: (619) 344-9405 EPA: CAD000633164
TSM Recovery and Recycling 3422 W. Pico Blvd. Los Angeles, CA 90019 Ph: (213) 735-9443 EPA: CAD108040858	Pacific Resource Recovery 3150 E. Pico Blvd. Los Angeles, CA 90023 Ph: (800) 499-7145 Fax: (213) 780-9940 EPA: CAD008252405
Demenno Kerdoon Environmental Services 3650 E. 26th Street Los Angeles, CA 90023 Ph: (213) 268-5056 Fax: (213) 268-9672 EPA: CAD080033681	U.S. Filter Recovery Services 5375 S. Boyle Ave. Vernon, CA 99058 Ph: (213) 277-1500 Fax: (213) 588-0094 EPA: CAD097030993

Prior to disposal, removed sediments will be inspected to determine the extent and type of chemical contamination. Evidence of oil and grease, antifreeze, solvents, fuel, hydrogen sulfide, and any other noxious substance will be noted. Observations will be used to determine if more than the standard analyte list is required. The standard analyte list (Table 5.2) is based on highway contaminants that have potential to exceed California Code of Regulations (CCR), Title 22 hazardous waste criteria (State of California, 1985). Methods used to sample sediments are

discussed in Subsection 5.7. While analytical results are pending, the removed sediments will be stored in 55-gallon drums onsite. Separate drums will be used to contain sediments suspected to be differently contaminated.

2.7 Hazardous Materials

Suspected hazardous wastes will be analyzed to determine disposal options. Hazardous materials generated on site will be handled and disposed of according to local, state, and federal regulations. A solid or liquid waste is considered a hazardous material if it exceeds the criteria listed in the California Code of Regulations, Title 22, Article 11 (State of California, 1985).

2.8 Checklist for Inspectors and Operation and Maintenance Personnel

Facility Inspection and Observational checklists or logs will be filled out during each visit to a MF. These will be kept in a field logbook to ensure that the MF is maintained at optimum levels throughout the monitoring period. One field logbook will contain storm monitoring data sheets and instrument calibration logs (Tab 6 of the *FGN*). A second logbook will contain Facility Inspection Checklists and Maintenance Log Sheets. A third logbook will be kept for vector control and management logsheets (Appendix IV of Volume II).

Refer to Forms C through F in Tabs 4 and 5 of the FGN related to the operational and maintenance requirements of the media filter.

3.0 VECTOR CONTROL AND MANAGEMENT

Constructing retrofit pilot BMPs will modify the existing stormwater drainage systems. Because such retrofitting may create opportunities for disease carrying organisms to flourish, insects (such as mosquitoes and midges) or rodents may have to be controlled. Vector control and abatement will be performed in accordance with Appendix IV and by subcontracted Vector Control Districts.

4.0 VEGETATION MANAGEMENT

Vegetation management will be comprised of grass trimming around monitoring equipment at the media filter facility because the facility is underground and the surrounding area is paved which precludes landscaping activities.

5.0 SAMPLING AND MONITORING

This section details the monitoring equipment to be used at each MF, sampling protocols, analytes to be tested, and quality assurance/quality control guidelines.

5.1 Equipment Installation

The inflow and outflow conveyances for a MF will be equipped with a flow measuring device (either a flume or an area/velocity meter or both) and a sample intake. Flumes were or will be cast into the conveyances during the construction phase. The flumes will incorporate some sort of depth measuring sensor. Flow sensors will be installed using manufacturer supplied hardware and in accordance to the manufacturers specifications. Sampler intakes will be mounted in each conveyance upstream of flumes or downstream of velocity/depth sensors. Stainless steel fasteners will be used to secure the intakes to the invert of the conveyances.

The following design specifications were considered during the engineering of the sampling points at each MF. The location at which flow will be measured will be at least 10 pipe diameters downstream and five pipe diameters upstream (or ten and five times the maximum anticipated head height) of any outfall, obstruction, inlet, or change in direction of the conveyance. The slope of the conveyance leading to the flow measuring point will be 2% or less. These two requirements were considered to insure that the flow is fully developed and is subcritical at the point where flow is measured.

Sensor wires and intake tubing will be routed through conduit from the manholes to equipment enclosures positioned on level ground near each manhole. The equipment enclosures will house the data logger/controller assemblies, samplers, cellular modem equipment, flow metering electronics, and batteries. A rain gauge will be mounted on a pole located adjacent to the inlet equipment enclosure. This pole will also support a cellular phone antenna and solar panel.

Components of each automatic sampling system used will undergo calibration and verification during installation and during maintenance and pre-storm visits.

5.1.1 Water Quality Samplers

The water quality samplers to be used at a MF will be automatic and composed of a peristaltic pump, a liquid detector, and a base to hold a sample bottle and ice. Each time a pre-determined volume of liquid passes the sampling point, the data logger/controller will signal the pump to deliver a self-calibrated sample volume. The suction hose used with the sampler will be 3/8-inch pure Teflon® tubing. Therefore, the sampler will be equipped with 3/8-inch silicon peristaltic tubing and a 3/8-inch stainless steel or Teflon® intake strainer of low-flow design. Strainers will be attached to the invert of each conveyance using stainless-steel fasteners. Samples will be collected into 20 liter borosilicate glass bottles.

Materials used in the collection of stormwater samples will meet strict criteria to prevent any form of contamination of the sample. These materials will allow for both inorganic and organic trace toxicant analyses from the same sampler and composite bottle. Only Teflon® and the highest grade of borosilicate glass are suitable for both trace metal and organic analyses from the same composite sample bottle. Bottles will be cleaned according to procedure described below. Sample hoses will be replaced and decontaminated annually, prior to the wet season. They will not be cleaned after each storm event. These bottles and hoses will be evaluated through an extensive blanking process to verify that the composite bottles and sample hoses are contamination-free and appropriately cleaned for both of inorganic and organic analyses. Where possible, unused, disposable sampling equipment will be used to eliminate the need for decontamination.

Cleaning Procedures for Composite Bottles

Bottles will be:

1. Rinsed three times with warm tap water.
2. Scrubbed with a clean plastic brush.
3. Soaked in a 2% detergent (e.g., Contrad®) solution for at least 48-hours.
4. Rinsed three times with tap water.
5. Rinsed five times with Milli-Q or equivalent water, rotating the bottle to ensure contact with the entire inside surface.
6. Rinsed three times with hexane while rotating the bottle, and then air-dried.
7. Rinsed six times with Milli-Q water.
8. Soaked in 2N nitric acid for a minimum of 24-hours.
9. Rinsed six times with Milli-Q water.

Cleaning Procedures for Teflon® Hose and Other Sampling Equipment

Teflon® hose and other sampling equipment will be:

1. Teflon hose will be rinsed three times with a 2% Micro® solution or equivalent. Other sampling equipment will be washed with a 2% Micro® solution and a clean plastic brush.
2. Rinsed three times with warm tap water.
3. Rinsed three times with Milli-Q or equivalent water.
4. Rinsed three times with 2N nitric acid.
5. Soaked at least 24-hours in 2N nitric acid.
6. Rinsed three times with Milli-Q water.

5.1.2 Flow Monitoring

A flow-proportioned sample is a composite of individual sample aliquots that are collected for each set volume of water that passes by a sampling point. To obtain a valid composite sample, direct flow measurements will be made to control the sampling interval. At a MF, both primary and secondary flow metering devices will be used. A primary flow measuring device is a

hydraulic structure inserted into a channel that changes the level of liquid in or near the structure. By knowing the shape and dimensions of the hydraulic structure, flow through or over the structure is related to the liquid level by a mathematical relationship. A secondary flow metering device measures both liquid velocity and depth. Primary devices are preferable, unless hydraulic characteristics prohibit them.

A primary flow measuring flume will be used at the sampling points. A look-down level meter will be used in conjunction with the flumes. This meter contains an ultrasonic transducer that bounces sound waves off the surface of the water. This transducer will be suspended in a location that is clear of obstructions, at a known distance above the invert of the conveyance, and approximately 0.3 meters above the maximum expected water height. The sensor will be mounted far enough away from the sidewalls and rungs of ladders in the manhole to prevent reflections of sound energy from them to be misinterpreted as energy reflected off the surface of the water.

Because back-watering may occur at the sampling points, an area-velocity (AV) flow meter will be installed at the sampling points in conjunction with the flumes. These meters will have single-point, internally-mounted, low profile depth and velocity sensors. A pressure transducer that senses gauge pressure will be used to measure depth. The pressure transducer will be vented to atmospheric pressure. The pressure transducer can be separate or integral to the velocity sensor. The velocity sensor will operate using the Doppler principal for measurement. Because the AV meters will miss important low flow conditions, the flumes will be used to measure lower flows. Flows greater than about 0.3 to 0.5 cfs will be measured with an AV meter. Velocity and stage or instantaneous flow data will be transmitted to the data logger/controller upon query commands found in the data logger software. The data logger/controller will switch between flow metering devices according to programmed logic.

5.1.3 Rain Gauge

A rain gauge having a “tipping bucket” design that incorporates a small “bucket” which holds a known amount of rainfall will be used onsite. When the bucket is filled, it tips the water out, momentarily closes a switch, and then resets itself and starts the process again. The data logger/controller counts each switch closure to accumulate rainfall totals. The rain gauges used will tip after every 0.01 inch of rain.

5.1.4 Power

The source of primary power for the sampling systems will be 12-volt deep-cycle marine batteries. A separate battery will be used to power the autosamplers, modems, and flow meters. Solar panels will be used to maintain the charge on the batteries.

5.1.5 Telecommunications

Cellular modem transceivers will be used to provide remote telecommunication access to the monitoring equipment. The ability to access a sampling station, monitor the status of the station in real-time, modify storm criteria, download new programs, and recover data allows for more cost effective, efficient monitoring.

A high performance base station antenna with filter will be installed; the filter will be installed from the lead-in of the antenna to prevent damage to the sampling station equipment due to nearby lightning strikes.

5.1.6 Equipment Enclosures

Walk-in fiberglass enclosures will be used to house the samplers and associated electronic equipment. These enclosures are to be bolted to the concrete pads and are to be locked to secure the monitoring equipment.

5.2 Maintenance and Calibration

A complete maintenance program will be performed at a MF after each storm event during the monitoring period, or in the absence of rain, on a monthly basis. Maintenance will include checking the performance of the equipment, checking power supplies, inspecting and clearing intake structures, cleaning contaminated equipment, and performing necessary equipment calibrations. Calibrations will be conducted in accordance to specifications in the individual component manuals.

Stormwater equipment maintenance visits will be thoroughly documented. Written documentation includes the action taken at a site as well as the date performed. Accurate and thorough records of station visits will be maintained to aid in the evaluation of a MF's performance. The log illustrated in Form F in Tab 5 of the *FGN* will be used to document maintenance and calibrations. If any program parameters are changed, the log shown on Form I, J1 and/or J2 in Tab 6 in the *FGN* will be completed.

5.3 Preparation and Logistics

Success of the sampling effort requires careful preparation and planning to assure that high quality samples are obtained in association with each storm event.

5.3.1 Weather Tracking

Weather tracking will be the responsibility of the Task Order Manager and Storm Control personnel. During the wet weather season, the weather will be continually monitored with increased frequency as incoming systems are predicted. Sources of weather information to be

used to track incoming storms include the following: National Weather Service, Weather Watch Service, Weather Network (WeatherNet), the Alert system from San Diego County, public broadcast information available on the Weather Channel and local news stations, and radar and satellite images downloaded from the Internet (e.g., www.weather.com).

5.3.2 Mobilization and Staffing

A staffing plan, which designates personnel and equipment for each facet of the storm monitoring, will be developed as soon as a potential event is forecast. Crews will consist of two individuals. The staffing plan will include the following information:

- Personnel needed for each position.
    - Storm Control
    - Shift Leader
    - Crew Chiefs
    - Crew Assistants
- Shift and zone (pilot facilities manned by a single crew) designations.
- Equipment mobilization.
- Communication channels.

Equipment needed for stormwater sampling includes the sampling equipment, sampling containers, safety equipment, personal rain gear, Storm Kits, and vehicles equipped with some type of mobile communication, and highway safety equipment (see lists). The necessary equipment will be loaded into the appropriate vehicles early in the storm preparation sequence.

Storm Kit Equipment List

- Keypad/display.
- 9-pin cable from keypad to data logger.
- Full set of keys (on floatable bobber).
- Flashlights (2).
- Maps for required areas.
- Large flat screwdriver.
- Small flat screwdriver.
- Umbrella.
- High quality alkaline D-cell batteries.
- Spare sample labels.
- Pencils and indelible markers.
- Desiccant (packages and jar).
- Diagonal clipper.
- Electrical tape.
- Cable ties (assorted sizes).

Storm Mobilization List

- Storm kit.
- Log books.
- pH meter.
- Paper towels.
- DI (de-ionized) water squirt bottles.
- Tape gun with clear tape.
- pH grab bottles.
- Spare sample labels.
- Ice scoop.
- Sample control paperwork.
- Extra fine indelible markers.
- 20 liter bottles in 10 gallon containment buckets.
- Grab sample bottles.
- Coolers and ice.
- Grab pole.

Storm Kit Equipment List

- Utility knife.
- Ziploc baggies (assorted sizes).
- Labeling tape.
- Polyethylene gloves.
- Rubber bands.

Storm Mobilization List

- DI water (3-gallon jug).
- Two-way radio or cellular phone.
- Personal rain gear.
- Any necessary safety gear.

Communication Channels

Communication Channels will be established for personnel to contact each other before and during a storm event. Phone lists with home and work numbers and other key contacts will be made available to potential crew members. Two-way radio or cellular telephone communication links to field crews are essential for efficient stormwater monitoring.

5.3.3 Monitoring Station Preparation

Prior to a storm event, the MF monitoring station will be made ready to sample. This preparation includes entering the correct "Volume to Sample" values, setting the autosampler and the data logger to sampling mode, pre-icing the composite sample bottle, and performing a general equipment inspection. The Standard Operating Procedures for Automatic Stormwater Monitoring (see the *FGN*) will be consulted for specific details on station preparation.

Determination of Volume to Sample

The latest weather forecast prior to each storm event will be examined to determine the proper "Volume to Sample" value to enter into the system. The amount of expected rainfall, how the station performed during the previous storm and how much water is needed for analysis at the station for each storm event will be taken into consideration.

The "Volume to Sample" is entered as a number with units in kilo-cubic feet (kcf). To determine this number, the drainage area in acres and the runoff coefficient, which is a number that reflects the permeability of the land in the study area, is listed below. Use the following equation to determine the volume of water expected at a MF for a given rainfall:

$$\mathbf{A \times B \times C \times 3.63 = volume\ in\ kcf}$$

Where:

A = inches of rain
B = drainage area in acres
C = runoff coefficient for land area
3.63 = conversion factor: acre-inches to kilo-cubic feet

To determine how much water will pass the station between samples, divide this result by the number of samples needed to satisfy the water volume requirement for analysis. A table will be supplied in the field logbook (see *FGN*) that indicates the Volume to Sample value needed to collect the correct sample amount of water for the amount of expected rainfall.

After the proper Volume to Sample value is determined, it will be entered into the system before the rainfall starts. The runoff value will generally be entered from the remote computer. The value can also be entered upon arrival at the site before the system has entered storm mode. It is important that this value is accurate as possible; if the value is too high, the system will not collect enough water to be analyzed, and if the value is too low, the system may sample too fast to be monitored effectively (i.e., the percent storm capture will drop).

Prepare Sampler

The autosampler will be reset and programmed to take 78 250-ml aliquots. Also other user-entered parameters (tubing length, head height, bottle size, composite sample, sample upon one pulse, and enabled liquid detector) will be set correctly.

During each site visit, the state of the System Status Flags (switches) and Program Signature will also be recorded. These provide important information on the current sampling mode and overall integrity of the site program.

Ice Sample Bottle

The sample bottle will be iced after the decision has been made to monitor the storm and prior to initial sample collection. If this is not possible, the bottle will be iced immediately upon the first visit.

General Inspection

A brief physical inspection of the equipment will be made to make certain that there are no obvious problems such as broken conduit or a kinked hose. If possible, the intake will be cleared of debris; at sites with confined entry access, this is only possible if the safety requirements listed in Appendix II are met.

Documentation

Upon each site visit, whether during storm mode or not, records of the visit will be accurately recorded on the field form (Form I of Tab 5 in the *FGN*). Whenever possible, any data being recorded by the sampling system (for example, time or current stage) will be verified. If any program parameters are changed, a program parameter log (Forms J1 and J2 of Tab 6 in the *FGN*) will be filled out. Also once during each storm event visit, the Empirical Observation Checklist will be completed (Tab 6, Form H in the *FGN*).

General Visitation Data

During each station visit, several display locations will be recorded. The log sheets will be used as a guide to the proper display locations to record. The following data will be recorded at both the influent and effluent stations:

- Flume Stage (ft).
- AV Meter Stage (ft).
- Velocity (f/s).
- Flume Q (flow in cfs).
- AV Meter Q (flow in cfs).
- Station ID.
- Data logger Battery Voltage.
- Flow Meter Battery Voltage.
- Cellular Equipment Battery Voltage.

Storm Visitation Data

Additional data will be recorded in the logbooks during storm monitoring. The log sheet will be used to determine the necessary information. The following data are uniform between both stations:

- Volume (kcf)
  This is the volume of water that passed the station during the previous execution Interval (one minute).
- Storm Sum
  This indicates the accumulated runoff volume in kilo cubic feet (kcf) that has passed the station since the last sample.
- Percent Storm Capture
  This indicates the percent of the storm effectively sampled by the system, and it provides a quick evaluation of the quality of the monitoring.
- Volume to Sample
  This value indicates the runoff volume (in kcf) that will pass the station before the system will take the next sample.
- Sample Count
  This number indicates the number of samples taken in the current bottle. It automatically re-zeroes every time a bottle is filled.
- Total Rain (inches)
  The total rainfall in inches since the start of the storm. This is accumulated each time that the rain bucket tips.
- Max Flow (day)
  This indicates the Julian day on which the maximum flow occurred.

- Max Flow (time)
  When this number is positive, it indicates that the system was sampling during peak stage. If this number is negative, sampling did not occur during the peak stage because the bottle was full.
- Max Stage (feet)
  This indicates the height of the maximum stage during the current storm.
- Max Flow (cfs)
  This indicates the maximum flow rate during the current storm.
- Storm Volume (kcf)
  This indicates the total volume of water that has flowed past the station since the beginning of the storm.
- Storm Volume Sampled (kcf)
  This indicates the total volume of water that flowed past the station while the system has been in storm mode.

After the data have been recorded, the system will be placed in low power mode and the keyboard unplugged.

5.4 Storm Monitoring

A priority objective of storm monitoring is to maximize the percent storm capture of the composite sample. This will be accomplished by ensuring that a composite bottle does not fill without being changed immediately. If a bottle does fill, the full sample bottle will be replaced and the system will be reset. To determine approximately when the bottle will fill and to ensure that the sampling process is not interrupted, the Storm Sum and the Volume to Sample will be evaluated. By examining how quickly the Storm Sum value is approaching the Volume to Sample value, the approximate time until the next sample is taken can be determined, as well as the approximate time until the bottle fills. The monitoring crew will be aware of the current status of each station in each of its BMP pilot facilities to determine which one will fill a bottle first so they can be on site as the bottle fills. If the station has been set properly for the amount of rainfall, changing the composite bottle will not be necessary. Volume to Sample settings will take into account the volume of sample required to meet analytical needs. This study requires approximately 3 liters of sample to meet these needs.

The data logger pulses the autosampler to take a sample when the accumulated Storm Sum equals the Volume to Sample. The storm sum is then reset to zero and the process is repeated. This continues until the storm ends or the bottle fills. Ideally, the Volume to Sample value will be accurate for the amount of rainfall, and the bottle will not need to be changed during the storm. If, however, the rainfall is different than that predicted, a bottle may fill before the end of the storm. If this occurs, sampling will halt until the bottle is changed and the system is reset. Until the system is reset, part of the storm is not being sampled, and the percent capture will show a decrease. It is therefore imperative that the system is reset and the sample bottle is changed immediately to maintain 100% storm capture.

5.4.1 Storm Procedure

Upon arrival at a station during a storm event, the status of the composite sample bottle will be checked immediately. If it is not necessary to change the bottle at that time, the appropriate data on the log sheets will be recorded and the necessary physical measurements and observations will be taken. An approximate time that the bottle will fill will be determined, and, depending on how much time is available, the next station will be visited or the team will wait until the bottle fills.

If the sample bottle is full, the system will be reset immediately, and the bottle replaced. When the bottle has been changed, the necessary station data will be filled in on Form I, Tab 6, in the *FGN*.

5.4.2 Sample Bottle Replacement

The removal of the sample bottle from the sampler requires great care; the bottles are heavy when full and are very slippery when wet, as well as being expensive and fragile. More importantly, if the sample is lost or contaminated, the effort and expense of the storm monitoring process is wasted. Two people will be present to ensure the security of the bottle and of the sample itself. Extremely care will be taken not to kink the intake hose when handling the sampler.

The bottle number will be recorded in the logbook and the bottle will be labeled appropriately. When a new bottle has been put in place, it will be re-iced and the sampler reset to continue sampling. Full bottles will be kept iced until subsampled.

5.4.3 Storm Monitoring Office

The main objective of the Storm Monitoring Office is to update field crews on the status of their stations. This will greatly reduce the amount of time a crew will spend driving during storms. The monitoring of stations from a remote computer consists of calling each station and recording certain data for evaluation. When it is determined that a sampling system is close to filling a bottle, a field crew will be called and alerted to the status of the station. Remote interrogation of the storm stations will be logged using Form K Tab 6 in the *FGN*.

Generally, the Storm Monitoring Office is also the storm control position. This means that critical decisions regarding the status of storm monitoring are made with input from the Storm Monitoring Office.

Therefore, this position requires awareness of the latest weather forecasts to make informed decisions on the continued monitoring of the storm.

5.4.4 Post Sampling Procedures

Declaring the end of a storm event may be difficult at a MF as the filters may hold water for longer than 48 hours and effluent flow may continue out of the filters. Thus, storm events can overlap. If storm events begin to overlap, two criteria will be used to either continue sampling or end sampling. If the effluent has 75% storm capture or more and 8 or more sample aliquots, monitoring will stop and the stations will be shut down. If the effluent has less than 75% storm capture or less than 8 sample aliquots, the influent and effluent sampling will continue monitoring the event until the event stops raining.

After a storm event has ended, the stations need to be shut down. The station will be left ready for the next storm event in case there is insufficient time for a maintenance visit between storms. The following items will be taken care of, and everything will be well documented in the field logbook.

1. The storm monitoring program will be reset to prepare for another storm event.
2. The sample bottle will be replaced and the sampler reset.
3. The station will be physically inspected to determine if any damage was sustained during the storm event. The flow sensors will be inspected to determine if it is blocked by debris, or the intake is clogged (This is only possible if confined space requirements are met).
4. The data will be retrieved. This will be done via modem from the remote monitoring computer.
5. Battery voltages will be checked; batteries that are low will be replaced.
6. An Empirical Observation Checklist for each sampling point and MF will be completed (see Form H, Tab 6, *FGN*) one time during the event.

Data Retrieval

Data will be retrieved (dumped) from the data logger after each storm event during the storm season, and, during dry weather, approximately every month.

Chain of Custody Forms

When the grab samples have been collected, the paperwork will be filled out to ensure a smooth transfer of samples to the analytical laboratory. Chains-of-Custody forms will be filled out in detail describing the type of sample, the quantity of samples, and the time that the samples were collected. These forms will accompany the samples to the laboratory.

5.4.5 Evaluation

Upon termination of a storm event monitoring, evaluation of the influent and effluent stations' performance will be documented and reviewed before the samples collected are deemed valid. Evaluation of a monitoring station's performance is based on the answers to the following questions:

- Was the storm representative of the effectiveness range of the MF?
- Was capture of peak flow or runoff achieved at both sampling points?
- Did the equipment perform as designed throughout the duration of the storm event?
- Did the samplers accurately collect equal and reliable storm sample aliquots?
- Did the MF work as designed?

5.4.6 Grab Sampling

Total petroleum hydrocarbons (TPH) and bacteriological (fecal coliform) grab samples are unsuitable for collection by automatic means, and will be collected for two storms each monitoring year. TPH is inappropriate because some material adheres to the surface of the tubing and the composite sample container. Automatic bacteria sampling is inappropriate because the sampling equipment is not sterile after installation and exposure to the elements. Because these analytes are unsuitable for collecting using an automated approach, they will be collected as a first-flush grab sample from both the influent and effluent during each monitored event.

It is imperative that collected grab samples are transferred to a designated meeting place immediately after the sampling has been completed; sample control will then complete a chain-of-custody for the samples and coordinate a pick-up time with the analytical laboratory to ensure that samples are handled and analyzed within the proper holding times.

It is essential that the following sample handling protocols be followed when collecting grab samples to keep contamination to a minimum:

- Turn the vehicle engine OFF to minimize exposure of the sample to exhaust fumes.
- Keep sample containers in clean coolers until sampling is actually initiated.
- Store filled sample bottles in clean coolers at 4°C.
- Keep the bottle lid clean and free of debris while the bottle is open.

Grab samples will be collected as near to the sampling point as possible. When unable to collect a sample near the intake, one will be collected as near the center of flow as possible or in an area of sufficient velocity to ensure good mixing. Both sampling points require a grab pole to collect the necessary grab samples. Containers will be fitted snugly into the bottle holder and the bottles will be seated on the upstream side of the grab pole to reduce potential contamination. The bottle will be filled with the mouth of the bottle faced into the current, if possible. Also, the bottle will be labeled before it is filled as it is nearly impossible to write on wet bottles, the station will be listed on the bottle to coincide with the station sampled. The samples will be collected as close to the onset of discharge as possible.

Each type of grab sample may require special treatment to ensure the quality of the sample and the safety of the sampler. The preservative in the sample bottles is usually a concentrated acid,

so care will be taken that the preservative does not come into contact with the skin. Gloves will be worn when handling sample containers. Both types of grab samples are discussed below.

TPH analyses will be performed for diesel, gasoline, and oil fractions and reported separately for each. Samples to be analyzed for TPH gasoline fraction will be preserved with a concentrated acid (HCl), while TPH diesel and oil containers are unpreserved. The sample bottles will be filled to below the neck and just above the shoulder. The bottle will not be overfilled because the preservative will be washed out. If the bottle is just slightly overfilled, a small amount of sample will be poured off after the preservative has mixed with the sample. A small amount of headspace is required in the containers to allow for expansion if the sample freezes while iced during shipping. These grab samples will be collected as soon as possible after runoff is detected.

Fecal Coliform are preserved with a small amount sodium thiosulfate tablet to remove any chlorine that might be present. To retain the tablet while sampling, it will be removed from the container when it is dipped into the flow. The bacteria bottle will be turned over causing the sodium thiosulfate tablet to fall onto the cap of the bottle; the cap will be removed and set somewhere that will prevent it from becoming contaminated (out of the rain). The sample bottle will be filled to the shoulder, the cap tipped so the sodium thiosulfate tablet falls into the sample and the cap secured to the bottle. These samples will be collected as soon as possible after the start of runoff. Storm Control will direct the field crew on when to collect these grabs.

Attempts will be made to maintain the 6-hour holding time for bacteria to the extent practical. However, storm field conditions and safety concerns may prove this holding time infeasible. A maximum holding time of 24 hours will be followed, in accordance with "Standard Methods for the Examination of Water and Wastewater," 18th Edition.

5.5 Sample Tracking and Handling

Samples, regardless of their matrix, will be kept properly chilled and transferred to the analytical laboratory within holding times to achieve the highest quality data possible. To ensure proper tracking and handling of the samples, documentation will accompany the samples from the initial pickup to the final extractions and analysis. This documentation includes: Chain-of-Custody forms as required (see Form M, Tab 7, *FGN* for example forms). These forms or equivalent will be used to track and handle samples.

Collected samples will be labeled with the following information:

- Date.
- Time.
- Project name.
- MF name and number.
- Influent or effluent sampling location.
- Preservative.
- Matrix.

- Collector's initials.
- Sample I.D. number.
- Analyte(s) to be analyzed.
- Grab or composite sample.

The analytical suite for each station depends upon the total volume of water collected for the storm event. A Priority Analysis Sheet will be used in conjunction with a Sample Bottle Evaluation to determine the analytical suite for each station, based on the volume of water collected at that station, the volume to sample, and the percent storm capture. When the storm has been evaluated and samples from each station accounted for, a duplicate station and a QA/QC station will be selected based on stormwater volumes available. Duplicate and QA/QC samples will be prepared from the combined volume of the sample collected at the selected duplicate and QA/QC station.

Duplicate and QA/QC sample bottles will be labeled, recorded on the Chain-of-Custody form, and transported to the analytical laboratory.

Grab samples will be transported to the appropriate laboratory as soon as the grab sampling is completed, whereas the sample bottles for the composite samples are transferred at the end of the storm event. Samples will be properly logged on the Chain-of-Custody form and kept chilled in coolers. There will also be a field duplicate and extra water collected for QA/QC samples. These QA/QC grab samples will be collected at one of each consultant's BMPs during each storm event monitored. The sampling stations will be selected by Storm Control for collecting the duplicate grab samples. The crews monitoring the stations will be fully briefed on the procedures for collecting QA/QC samples, and will be familiar with the sample identification numbering scheme for these samples because they are to be submitted to the laboratory as blind samples. These samples will be labeled, recorded on the Chain-of-Custody form, and transported to the analytical laboratory.

Each sample collected will receive a unique alphanumeric code (sample I.D. number) for tracking. This code will be standard for samples and contain information as to the station, date, and sequential monitoring event number. The following is an example of this code:

SITE No.-IN-32898-001

Where:

Site No. = Site number of BMP site.
IN = Influent sampling point at the site; EF = effluent sampling point.
32898 = Julian day and year
001= First storm event monitored during this program at this location

If multiple bottles are used or needed, the last data field will indicate the bottle number and the total bottles in that sampling event (i.e., 001-1/3, 001-2/3, 001-3/3 for a three-bottle collection scheme).

A set of QA/QC samples will be provided with each type of sample analyzed for each storm event. The analytical laboratory may also require additional QA/QC samples if one type of analysis is to be run in more than one batch.

Blank samples, duplicate samples, MS/MSDs, and replicate/splits need not be from the same station. However, per storm event (or batch run), these QA/QC samples will be analyzed for the standard analytes as field samples. Most field QA/QC samples are submitted blind to the analytical laboratory, however, additional sample volumes provided to the laboratory for laboratory replicates or matrix spikes and matrix spike duplicates will be clearly identified. The main types of QA/QC samples that will be utilized for this study are as follows:

Duplicate Analyses - These analyses will be performed for both grab samples and composite samples and will require an additional set of sample containers to be sub-sampled. The results will allow evaluation of sampling error introduced by both field sampling and laboratory analyses by showing the reproducibility of the sample collection and analyses. Duplicate samples will be sent "blind" to the laboratories. One duplicate sample will be collected from one of each consultant's sampling locations during each storm event sampled and analyzed for the full list of analytes.

Duplicate samples will be identified by adding 500 to the sequential storm event number. For example, a duplicate sample for the site identified above will be:

SITE No.-IN-32898-501

Blanks - These are for field as well as laboratory samples. Blanks help verify that the equipment and the sample containers are not contaminated, and the sampling techniques used are non-contaminating. Sample bottles, Teflon® tubing, and filters will be rinsed with reagent grade analyte free deionized water separately. The collected rinsates will be analyzed for the full list of analytes for the composited samples. Blanks will also be run on the analytical equipment. Rinsate blanks will be run on two samplers used by each consultant at one of their BMPs prior to the installation of the equipment. Each time a batch of composite bottles is cleaned, five percent of those bottles will be blanked.

Equipment rinsate blanks will be identified by adding 600 to the sequential storm event number. For example, an equipment rinsate blank collected from the monitoring equipment from the site identified above will be:

SITE No.-IN-32898-601

Field blanks will be identified by adding 700 to the sequential storm event number. For example, a field blank collected at the site identified above will be:

SITE No.-IN-32898-701

Matrix Spike and Matrix Duplicate Spike (MS/MSD) - The laboratory will require additional sample volumes for analyses that require matrix spikes and matrix spike duplicates to evaluate precision and accuracy of the laboratory analytical method, and to evaluate any matrix interference. MS/MSDs are analyzed for their analyte(s) and then spiked with a known amount of analyte(s). One MS/MSD sample will be run on metal and TPH samples from one of each consultant's sampling locations during each storm event sampled.

MS/MSD samples will be indicated on Chain-of-Custody Forms by clearly identifying that the sample is for MS/MSD purposes.

Laboratory Replicate/Split - This QA/QC analysis will require additional sample volumes. It is a duplicate analysis performed on the same sample and evaluates the repeatability (precision) of the analytical laboratories' results. One split sample will be run from one of each consultant's BMP sampling locations during each storm event sampled and analyzed for the full list of analytes.

Laboratory Replicate/Split samples will be indicated on Chain-of-Custody Forms by clearly identifying that the sample is for Laboratory Replicate/Split sample purposes.

5.6 Laboratory Selection, Sample Container Preparation, and Analytical Methods

5.6.1 Laboratory Selection

The selected laboratories have extensive experience with environmental samples and have the ability to provide rapid response to meet critical holding time requirements for analytes requiring expeditious analysis. Laboratories will be certified by the California Department of Health Services for the requested analyses. Refer to Tab 2 in the *FGN* for specific laboratory listings

5.6.2 Holding Times, Sample Bottles, and Preparation

The laboratories will be responsible for providing appropriate sample containers and, when necessary, with preservatives for each analysis. Table 5.1 provides a summary of sample volumes required for each analysis, along with the types of containers, holding times , and preservative. Because additional volumes are necessary for laboratory QA/QC, sample containers will provide at least twice the volume necessary to perform the requested analysis. The volume of the storm water composite from each site is often the critical factor in

determining the volume of sample that can be provided to the laboratory. The Project Task Order Manager and/or Storm Control personnel, in conjunction with the laboratories, will determine the allocation of sample volume for different analyses if sample volumes are not adequate to provide additional volume for each analysis. Table 5.1 lists the analyses along with a priority ranking. Also listed on Table 5.1 are the analytical methods and reporting limits.

5.6.3 Project Reporting limits

Recommended analytical methods and reporting limits for this project are listed in Table 5.1. The reporting limits in this table are target reporting limits. In some cases, reporting limits may need to be adjusted due to limited sample volumes or potential matrix interference. In such cases, appropriate data qualifiers will be applied to the associated data.

5.6.4 Laboratory Data Package Deliverables

Laboratories will be required to provide a three-week turnaround on deliverables. The deliverable package will include a hard copy and electronic data files. The hard copy will include standard narratives identifying any analytical or QA/QC problems and corrective actions. The electronic data files will contain information found in the hard copy reports submitted by the laboratories. Individual data sets will be submitted as either Microsoft Excel workbook files or as Microsoft Access database files. Each consultant will be responsible for laboratory coordination and data management

5.7 Sediment Sampling and Testing for Disposal Purposes

As part of the maintenance program, sediment will be removed from the BMP when flows are hydraulically impeded. It is anticipated that sediment will accumulate relatively slowly over time. However, should sediment deposit in a rapid manner, an intermediate step of stockpiling may become necessary before offsite disposal. Section 5.7.1 provides procedures to be used when assessing potential sediment contamination in the event that intermediate onsite storage is necessary.

This subsection describes the sample collection procedures and analyses for assessing the quality of surface sediment removed from an MF for disposal. Evidence of oil and grease, antifreeze, solvents, fuel, hydrogen sulfide, and any other noxious substance will be noted. Observations will be used to determine if more than the standard list of analytes is required. Observations will be documented on a checklist form (Form G in Tab 5 in the *FGN*) The standard list (*Table 5.2*) is based on highway contaminants that have the potential to exceed hazardous waste criteria. After laboratory analysis, results will be compared to regulatory limits listed in California Code of Regulations (CCR) Title 22, Section 66261.24 and Department of Toxic Substances Control (DTSC) variances. Based on this evaluation, proper disposal methods will be chosen.

Table 5.1
Stormwater Matrix
Analytical Parameters, Methodologies, Reporting Limits, Holding Times, Container Volumes and Types, and Preservation

Analyte	Priority Rank	Reporting Limit	Units	Analytical Technique	Method Number	Holding Time	Minimum Sample Volume	Preferred Volume and Container Type[1]	Preservation
Conventionals									
pH	1	0.1	Unit	Electrode	EPA 150.1	Immediately[2]	100 mL	1-100 mL glass/plastic	4°C
Specific Conductance	1	1.0	µmhos/cm	Electrometric	EPA 120.1	Immediately[2]	500 mL	1-500 mL glass/plastic	4°C
Hardness	5	2	mg/L	Titrimetric/ Colorimetric	EPA 130.2	6 months	100 mL	1-200 mL glass/plastic	HNO_3 to pH<2, 4°C
Total Suspended Solids	1	1	mg/L	Dried Filter Weight	EPA 160.2	7 days[3]	1 L	1-500 mL glass/plastic	4°C
Nutrients									
Nitrate-Nitrogen	2	0.01	mg/L	Colorimetric Ion Chromatography	EPA 353.3 EPA 300.0	28 days 48 hours	200 mL 200 mL	1-500 mL plastic 1-500 mL plastic	4°C and H_2SO_4 to pH<2 4°C
Total Kjeldahl Nitrogen	3	0.1	mg/L	Titrimetric/ Colorimetric	EPA 351.3	28 days	500 mL	1-1L plastic	4°C and H_2SO_4 to pH<2
Total Phosphorus	4	0.002	mg/L	Colorimetric	EPA 365.3	28 days	100 mL	1-250 mL plastic	4°C and H_2SO_4 to pH<2
Total/Dissolved Metals[4],[5]									
Copper	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Lead	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Zinc	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Organics[6]									
Total Petroleum Hydrocarbons – Diesel/Oil	Grab	250/200	µg/L	GC	EPA 8015M	14 days	1 L	2-1L amber glass	4°C
Total Petroleum Hydrocarbons - Gasoline	Grab	50	µg/L	GC	EPA 8015M	14 days	2-40 mL	3-40 mL VOA vials	4°C, HCl to pH<2
Bacteria[6]									
Fecal Coliform	Grab	2	MPN/100 mL	Multiple-tube	SM 9221E	6 hours[7]	50 mL	1-100 mL plastic	4°C

1. Analytes with the same preservative can be combined into a single container if the same laboratory is performing the analyses.
2. pH and Specific Conductance will be measured by the laboratory immediately upon receipt of the samples.
3. 7 days based upon limit for measuring TSS/no regulatory limit.
4. Total and dissolved metals samples are collected in separate containers. Only the total metals container will receive nitric acid.
5. Dissolved metals will be filtered in the laboratory prior to acidification.
6. Total Petroleum Hydrocarbon and Fecal Coliform grab samples will be collected for two storms per year.
7. Attempts will be made to maintain the 6-hour holding time for bacteria samples to the extent possible. When not possible, a maximum holding time of 24 hours will be followed in accordance with "Standard Methods for the Examination of Water and Wastewater", 18th Edition.

5.7.1 Sediment Collection

Procedures in EPA Publication *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)* provide a method for determining the mean concentration of a given contaminant within a soil mass and the appropriate number of samples necessary to calculate this mean to the specified confidence interval. Initial sampling will generate a minimum number of samples/analyses as described below. Additional sample analyses may be required to meet the confidence levels given in *SW-846*, therefore archiving of samples will be necessary. Archived samples will be appropriately preserved and analyzed within the maximum holding time specified in *Table 5.2*. None of the samples will be allowed to be composited. The Quality Assurance/Quality Control (Appendix III) describes the QA/QC objectives for surface sediment samples. The minimum number of discrete samples initially required is given below:

- Drums: A minimum of one sample will be collected from each drum.
- Stockpiles less than 10 cubic yards: A minimum of two samples will be collected, one from each half of the stockpile. Sampling points will be selected randomly within each half.
- Stockpiles from 10-20 cubic yards: A minimum of three samples will be collected, one from each third of the stockpile. Sampling points will be selected randomly within each third.
- Stockpiles from 20-100 cubic yards: A minimum of four samples will be collected, one from each quarter of the stockpile. Sampling points will be selected randomly within each quarter.
- Stockpiles from 100-500 cubic yards: A minimum of one sample for each 25 cubic yard portion will be collected. The stockpile will be sectioned into 25 cubic yard portions to obtain a minimum of one sample for each 25 cubic yard portion. Sampling points will be selected randomly within each 25 cubic yard portion of the stockpile.

Random samples will be selected from locations on a three-dimensional grid. If the presence of materials such as boulders, debris, etc. hinder this process, the sample will be collected as close as possible to the randomly selected point without altering the essence of the random selection process. The following steps will be used to collect surface sediment samples:

1. Don powder-free nitrile gloves.
2. Locate the sample point in the stockpile or drum.
3. Collect the sample using a soil probe or equivalent. Ensure that the sample is collected at the correct depth and location that was randomly selected.

4. Fill one 8-ounce glass jar with a portion of the sample and close the container with the cap, using care not to aerate (volatilize) the sample. This jar will be labeled and analyzed for TRPH and VOC.
5. Homogenize the other portion of the sample in a disposable bowl using a disposable spatula or spoon. Fill a second 8-ounce glass jar with this portion of the sample and close the container with the cap. This sample will be labeled and analyzed for metals.
6. Wipe the outside of each sample container with a clean paper towel.
7. Record the sampler's initials, date, and time on the pre-labeled sample bottle.
8. Place the sample containers in individual zip-top plastic bags and seal the bags.
9. Immediately pack the samples into a chilled cooler.
10. Record the required information on the Chain-of-Custody Form.
11. Document the sampling event, recording information in the designated field logbook.
12. Repeat the above steps until the minimum number of samples has been collected.

5.7.2 Sediment Analyses

Unless observations indicate additional testing, surface sediment samples submitted to the laboratory will be analyzed for analytes listed in *Table 5.2* using (CCR) Title 22 criteria (State of California, 1985). This table also lists the required reporting limits, analytical holding times, required preservation, and container sizes and types. Laboratory turn around times and data deliverables will be same as those for the stormwater samples.

5.8 Empirical Observations

5.8.1 Purpose of Empirical Observations

Performance assessments of BMP facilities cannot be fully ascertained through analytical methods. "Empirical" observations are also critical in determining the overall performance of implemented water quality management practices and in ensuring that the practices are maintained at optimum levels. Other factors such as maintenance activities, environmental variability, and physical processes, which cannot be determined analytically, can greatly influence the performance of a particular BMP. Some of these factors such as rainfall quantity, rainfall intensity, and chamber retention times can, and, will be assessed through physical measurements. Other components such as trash build-up, sediment deposition, and runoff appearance can best be assessed through careful documented observations.

Table 5.2
Sediment Matrix (Disposal)
Analytical Parameters, Methodologies, Reporting limits, Holding Times, Container Volumes and Types, and Preservation

Parameter	Method	Units	Detection Limit	Maximum Holding Time	Preservation	Container Size/Type(1)
Total Recoverable Petroleum Hydrocarbons (TRPH)	EPA 418.1	mg/kg	10	28 days	4^oC	8 oz glass jar
Volatile Organic Compounds	EPA 8260B	mg/kg	SW – 846 (5) requirements	14 days	4^oC	8 oz glass jar
California Code of Regulations (CCR), Title 22 Metals(2):	EPA 6020/7471	mg/kg	SW – 846 (5) requirements	180 days 28 days for mercury	4^oC	8 oz glass jar
California Code of Regulations (CCR), Title 22 Waste Extraction Test (WET) Metals(3):	STLC Extraction	mg/L	SW – 846 (5) requirements	180 days 28 days for mercury	4° C	NA
Toxicity Characteristic Leaching Procedure (TCLP) Metals(4):	TCLP 1311	mg/L	SW – 846 (5) requirements	180 days 28 days for mercury	4° C	NA

(1) Each sample will be collected in two 8 oz glass jars
(2) California Code of Regulation (CCR), Title 22 Metals (Sb, As, Ba, Be, Cd, Cr (total), Co, Cu, Hg, Pb, Mo, Ni, Se, Ag, Tl, V, and Zn). Initial waste characterization results may lead to a shorter list of metals for subsequent sediment disposal.
(3) Any sample for total metals that are below the Total Threshold Limit Concentration [TTLC] but exceed the ten times Soluble Threshold Limit Concentration (STLC) will be further analyzed using the WET procedure. WET extracts will be analyzed only for metals which exceed the ten times STLC criteria. Sediments associated with total metal results that exceed TTLC values are automatically considered hazardous and therefore do not need to undergo the WET procedure.
(4) If any of the WET-soluble concentrations are equal to or greater than the TCLP regulatory thresholds, analyze the waste by TCLP. "Test Methods for Evaluating Solid Waste, Physical /Chemical Methods". SW-846, Update III.(SW-846)

5.8.2 Guidelines

Observations will be succinct but also complete. For a MF performance evaluation, the following observations will be taken at the influent location, chambers, and effluent location:

- Meteorological characteristics (present and preceding period).
- Hydrologic and hydraulic characteristics (flowing and/or standing water).
- Inlet conditions (problems affecting performance).
- Water quality appearance (visual, olfactory) to make a rough assessment of changes in water quality.
- Solids deposition (trash and debris, sediments, organics) and resuspension.
- Treatment medium condition.
- Outlet conditions (problems affecting performance).
- Mosquitoes and other vectors.
- Structural condition of facility.
- Monitoring equipment condition.

5.8.3 Checklist for Sampling and Monitoring Personnel

Form H Tab 6 in the *FGN* provides a checklist (log form) that will be completely filled out by sampling and monitoring personnel during every visit to the facility or, at a minimum, once per month.

6.0 REFERENCES

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Larry Walker and Associates. 1997. Guidance Manual: Stormwater Monitoring Protocols. Prepared for California Department of Transportation, Sacramento, CA. August 15, 1997.

Robert Bein, William Frost and Associates. 1997. Scoping Study, Retrofit Pilot Program, Caltrans District 11. Calif. Dept. Trans., Sacramento, CA.

State of California 1985. California Code of Federal Regulation, Title 22, Article 11. Criteria for the identification of hazardous and extremely hazardous wastes. Register 85, No. 3.1-12-85, Para. 66693-66796, pp. 1800.75-1800.86.

Stormwater Management 1999. StormFilter Product Manual.

USEPA, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Final Update III, June 1997.

Watershed Management Institute. 1997. Operation, Maintenance, and Management of Stormwater Management Systems. Watershed Management Institute, Ingleside, MD.

7.0 MANUFACTURER'S LITERATURE

OPERATION AND MAINTENANCE GUIDELINES

StormFilter

Note: This guideline should be used as a part of the site stormwater management plan.

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SECTION 1

1.1 DESCRIPTION

StormFilter is a passive, flow-through stormwater filtration system. It consists of vaults that house rechargeable cartridges filled with a variety of filter media. The filter systems are installed in-line with storm drains. The StormFilter works by passing stormwater through media-filled cartridges, which trap particulates and adsorb materials such as dissolved metals and hydrocarbons. After being filtered through the media, the treated stormwater flows into a collection pipe or discharges into an open channel drainage way. StormFilter is offered in three different configurations: cast-in-place, precast and linear. The precast and linear models utilize pre-manufactured vaults. The cast-in-place units are customized for larger flows and may be either covered or uncovered underground units.

1.2 OPERATION

1.2.1 Purpose

The StormFilter is a passive stormwater filtration system designed to improve the quality of stormwater runoff from the urban environment before it enters receiving waterways. It is intended to function as a BMP (Best Management Practice) to meet local, state, and federal requirements, which have been, developed to comply with the Clean Water Act.

Through independent third party studies, it has been demonstrated that the StormFilter is highly effective for treatment of first flush flows and flow-paced flows during the latter part of a storm. In general, StormFilter's efficiency is highest when pollutant concentrations are highest. The primary target pollutants for removal are: sediments (TSS), soluble metals, soluble phosphorus, nitrates, and oil and grease.

1.2.2 Sizing

The StormFilter is sized to treat the peak flow of a water quality design storm as it passes through the filter. The peak flow is determined by calculations based on the contributing watershed hydrology and using a design storm magnitude. The design storm is usually based on the regulatory requirements set by the local stormwater management agency. The particular size of a StormFilter is determined by the number of filter cartridges (see Figure 4) required to treat the peak stormwater flow. Each cartridge is designed to treat a peak flow of 15 gpm. For example: a peak design stormwater flow rate of 150 gpm would require that 10 cartridges be used in the treatment vault.

Because of the highly porous nature of the granular filter media, the flow through a newly installed cartridge is restricted to 15 gpm, using a restrictor disc, to ensure adequate pollutant-media contact time.

1.2.3 Basic Function

The StormFilter is designed to siphon stormwater runoff through a filter cartridge containing media. The variety of media available can be designed to act as a mechanical filter to remove sediments, as an ion exchanger to remove dissolved heavy metals, and as an adsorber to remove oils and greases.

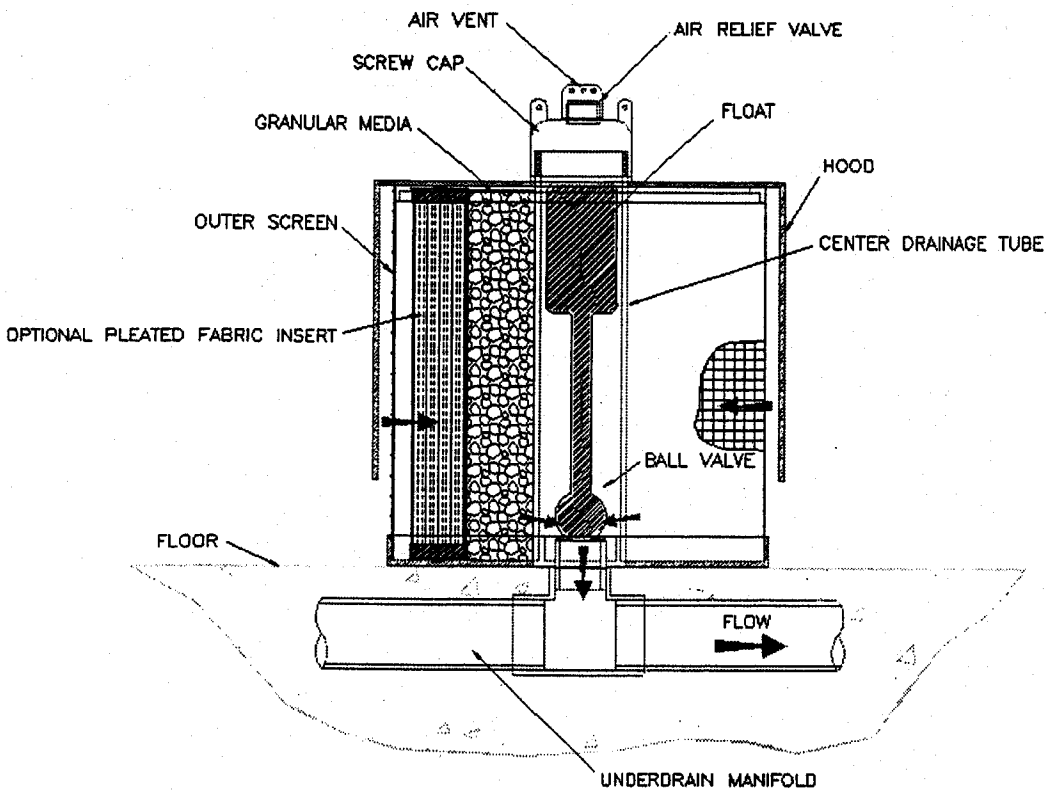

Figure 4. Filter Cartridge

1.2.4 Priming System Function

The treated stormwater collects in the center tube of the cartridge, which is equipped with a self-priming siphon system. Figure 4 illustrates this system. The key component of the system is the roto-molded float. The float consists of a ball located at the base leading up to a larger portion, which provides increased buoyancy. Initially the ball rests in a seat effectively closing off the port to the drainage manifold.

As a result, the filter fills the center drainage tube until the water level has risen high enough to purge the air from the filter cartridges and displaces the float. At a water depth of 22 inches the float pulls loose the ball and allows the filtered water to drain out through the manifold. This effectively "primes" a siphon within the drainage tube and greatly increases the potential across the filter. The priming system increases StormFilter's ability to be loaded with sediment. A related feature is the cartridge "hood". This hood maintains the siphon effect by preventing air from being drawn into the cartridge until the external water level drops below the bottom of the hood.

Cartridges are connected to the manifold with a plastic connector. Since some media used is potentially buoyant, a threaded connector affixed to the manifold with compression bolts is necessary to ensure the cartridge isn't lifted out of place. For the heavier leaf media, a slip connector is used.

StormFilter is also equipped with flow spreaders that trap floating debris and surface films, even during overflow conditions. Depending on individual site characteristics, some systems are equipped with high and/or low flow bypasses. High flow bypasses are installed when the calculated peak storm event generates a flow that overcomes the overflow capacity of the system. This is especially important for precast systems. Low flow bypasses are sometimes installed to bypass continuous

inflows caused by ground water seepage, which usually do not require treatment. All StormFilter units are designed with an overflow. The overflow operates when the inflow rate is greater than the infiltration capacity of the filter media.

1.2.4 Maintenance Overview

The primary purpose of the StormFilter is to filter out and prevent pollutants from entering our waterways. Like any effective filtration system, periodically these pollutants must be removed to restore the StormFilter to its full efficiency and effectiveness. Maintenance requirements and frequency are dependent on the pollutant load characteristics of each site. To assist the owner with maintenance issues, Stormwater Management Inc. provides detailed Operation & Maintenance Guidelines with each unit.

Maintenance services can be provided completely, or in part, by Stormwater Management Inc. Available services include tracking of installed systems, advising the system's owner of maintenance needs, and notification of the regulatory agency once the system has been maintained.

Maintenance is usually performed late in the dry season to rejuvenate the filter media and prepare the system for the next rainy season. Maintenance activities can also be required in the event of a chemical spill or excessive sediment loading due to site erosion or extreme storms. It is good practice to inspect the system after severe storm events.

END OF SECTION 1

SECTION 2

RECOMMENDED MAINTENANCE AND EXPECTED PERFORMANCE

2.1 TYPES OF MAINTENANCE

Presently, procedures have been developed for two levels of maintenance: Inspection/minor maintenance and major maintenance. Inspection/minor maintenance activities are combined since the minor maintenance does not require special equipment and typically little or no materials are in need of disposal. Inspection/minor maintenance typically involves opening the flow restricting valves (to pre-set levels) and cleanup of vegetation and debris. Major maintenance typically includes cartridge recharging. Major maintenance may involve disposal of materials that require consideration of regulatory guidelines. Depending on the particular unit configuration and equipment used, major maintenance may require an understanding of OSHA rules. Table 1 summarizes the primary activities associated with StormFilter maintenance.

Table 1: StormFilter

Facility Component Requiring Maintenance	Maintenance Activity	When Maintenance Activity Is Required	Expected Facility Performance After Maintaining
StormFilter Cartridges and Containment Structure	Trash and Debris Removal	Floatable objects or other trash is present in the filter. Remove to avoid hindrance of filtration and eliminate unsightly debris and trash.	Permanent removal from storm system.
	Cartridge Replacement and Sediment Removal	1. Media has been contaminated by high levels of pollutants, such as after a spill.	1. New media is able to effectively treat stormwater.
Drainage System Piping	Flushing With Water	Drainage system is obstructed by debris or sediment.	Outflow is not restricted.

2.2 MAINTENANCE ACTIVITIES

2.2.1 Maintenance Activity Timing

Two scheduled inspections/maintenance activities should take place during the year. During the minor maintenance activities (routine inspection, debris removal), the type of major maintenance required is determined and, if required for disposal, samples of the sediments and media are obtained. The next scheduled date is to perform major maintenance activities (replacement of the filter cartridges and associated sediment removal). In addition to the scheduled activities, it is important to check the condition of the filter after major storms to check for damage caused by high flows and to check for high sediment accumulation which may be caused by localized erosion in the drainage area. It may be necessary to adjust maintenance activity scheduling depending on the actual operating conditions encountered by the system.

In general, minor maintenance activities will occur late in the rainy season, and major maintenance will occur in late summer to early fall, when flows into the system are not likely to be present.

The months indicated in Table 2 show the best recommended times of year for maintenance activities to occur in the Pacific Northwest.

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Table 2: WORK CALENDAR FOR TYPICAL WET/DRY SEASON

WET			WET			DRY			WET		
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
			X	X	X	XX	XX	XX			

X = Schedule minor maintenance inspection and media sampling during one of these months.
XX= Schedule major maintenance during one of these months.

2.2.2 Maintenance Activity Frequency

The primary factor controlling timing of maintenance for the StormFilter is sedimentation. A properly functioning system will remove solids from water by trapping these particulates within the porous structure of the media. The flow through the system will naturally decrease as more and more solids are trapped. Eventually the flow through a system will be low enough to require replacement of the cartridges. Sediment should be removed from upstream trapping devices on an as needed basis to prevent material from being re-suspended and discharged to the system.

Site conditions greatly influence maintenance requirements. StormFilter units located in areas with erosion or active construction should be inspected and maintained more often than those in fully stabilized areas. The maintenance frequency may be adjusted as additional monitoring information becomes available during the inspection program. Areas that develop known problems should be inspected more frequently than areas that demonstrate no problems, particularly, after large storms. Ultimately, inspection and maintenance activities should be scheduled based on the historic records and characteristics of an individual filter. It is recommended that the maintenance agency develop a database to properly manage StormFilter maintenance programs.

Prior to the development of the maintenance database, maintenance frequencies shown in Table 3 should be followed. Frequencies should be updated as required. The recommended initial frequency for inspection/minor maintenance is two times per year for the precast unit. StormFilter units should be inspected after all major storms. Sediment removal on an annual basis is recommended until further knowledge is gained about a particular system.

Table 3: FREQUENCY OF MAINTENANCE ACTIVITY

	INSPECTION/MINOR MAINTENANCE (TIMES/YEAR)	MAJOR MAINTENANCE (TIMES/YEAR)
StormFilter	1 (and after major storms)	1 (except in case of a spill)

2.3 MAINTENANCE CREW REQUIREMENTS

Table 4 lists the anticipated crew requirements for maintenance operations. Removal of water and sediments during major maintenance activities can be accomplished using either a pump and water truck or a vacuum truck. All applicable safety (OSHA) and disposal regulations should be followed. A general description of the maintenance activities follows.

Table 4: ANTICIPATED CREW REQUIREMENTS

	Inspection/Minor Maintenance	Major Maintenance: Sediment Removal	Major Maintenance: Cartridge Replacement
Laborer			
Utility Worker	1	1	1
Senior Sewer Operator			
Vacuum/Water Truck Operator		1	1
Hauling Truck Operator			1
Total	**1***	**2***	**3***
Special Requirements	Knowledge of Proper StormFilter Function	Knowledge of Disposal Requirements	Knowledge of Cartridge Removal and Installation Procedures

* May require OSHA trained person if vault entry occurs.

2.4 MAINTENANCE METHODS

2.4.1 Minor Maintenance/Inspection (Once A Year)

Minor maintenance typically will involve the steps below, however if it appears that a spill of some type has occurred, the local hazard control agency and Stormwater Management Inc. should be notified immediately. **In the case of a spill, the worker should abort maintenance activities until the proper guidance has been obtained.**

Steps for Minor Maintenance

1. Maintenance to be performed by a utility worker familiar with StormFilter units.
2. If applicable, set up safety equipment up to protect pedestrians from fall hazards presented by open doors. Also set up appropriate safety equipment for work near roadways.
3. Inspect the external condition of the unit and take notes concerning defects/problems.
4. Open the doors to the vault and allow the system to air out for 5-10 minutes.
5. Without entering the vault, inspect the inside of the unit, including components.
6. Take notes about the external and internal condition.

7. Give particular attention to recording the level of sediment build-up on the floor of the vault in the forebay, and on top of the internal components. If flow is occurring, note the level of water and estimate the flow rate per drainage pipe. Record all observations.

8. Remove large loose debris and trash using a pole with a grapple or net on the end.

9. Close and fasten the door, and remove safety equipment.

10. Finally, make notes about the local drainage area relative to ongoing construction, erosion problems, or high loadings of other materials to the system.

2.4.2 Major Maintenance Inspection (Once A Year)

The primary goal of the major maintenance inspection is to assess the condition of the cartridges relative to the level of sediment loading. It may be desirable to conduct this inspection during a storm to observe the relative flow through the filter cartridges. If the submerged cartridges are severely plugged, large amounts of sediments should be present and very little flow will be discharging from the drainage pipes. It is likely that the cartridges need to be replaced. Major maintenance inspection will typically involve the steps below. However, if it appears that a spill of some type has occurred, the local hazard control agency and Stormwater Management Inc. should be notified immediately. **In the case of a spill, the worker should abort maintenance activities until the proper guidance has been obtained.**

Steps For Pre-Major Maintenance Inspection

1. Maintenance to be performed by a utility worker familiar with StormFilter units.

2. If applicable, set up safety equipment to protect pedestrians from fall hazards presented by open doors. Also, set up appropriate safety equipment for work near roadways.

3. Inspect the external condition of the unit and take notes concerning defects/problems.

4. Open the doors to the vault and allow the vault to air out for 5-10 minutes.

5. Without entering the vault, give the inside of the unit, including components, a general condition inspection.

6. Take notes about the external and internal condition.

7. Give particular attention to recording the level of sediment build-up on the floor of the vault, in the forebay, and on top of the internal components.

8. Remove large loose debris and trash using a pole with a grapple or net on the end.

9. If the visit is during a storm, make the flow observations discussed above.

10. Close and fasten the door, and remove safety equipment.

11. Make notes about the local drainage area relative to ongoing construction, erosion problems, or high loading of other materials to the system.

12. Review the condition reports from the previous minor and major maintenance visits and schedule for cartridge replacement if needed.

2.4.3 Major Maintenance/Cartridge Replacement

Major maintenance/filter cartridge replacement typically involves the steps below. However, if it appears that a spill of some type has occurred, the local hazard control agency and Stormwater Management Inc. should be notified immediately. **In the case of a spill, the worker should abort maintenance activities until the proper guidance has been obtained.** Depending on the configuration of the particular system, a worker may be required to enter the vault to perform some tasks. If vault entry is required, OSHA rules for general confined space entry must be followed. Filter cartridge replacement should occur during dry weather and it may be necessary to plug the filter inlet pipe if base flows exist. Standing water present in the vault should be regarded as polluted and contained during this operation by temporarily capping the manifold connectors.

<u>Steps For Cartridge Replacement Maintenance</u>

1. Depending on the particular unit, one or two utility workers and a hauling truck operator will deliver the replacement cartridges to the site. Information concerning how to obtain the replacement cartridges is available from Stormwater Management Inc.

2. If applicable, set up safety equipment to protect pedestrians from fall hazards presented by open doors. Also, set up appropriate safety equipment for work near roadways.

3. Inspect the external condition of the unit and take notes concerning defects/problems.

4. Open the doors to the vault and allow the system to air out for 5-10 minutes.

5. Without entering the vault, give the inside of the unit, including components, a general condition inspection.

6. Make notes about the external and internal condition.

7. Give particular attention to recording the level of sediment build-up on the floor of the vault, in the forebay, and on top of the internal components.

8. Remove large loose debris and trash using a pole with a grapple or net on the end.

9. Using a boom, crane, or other device (dolly and ramp), off load the replacement cartridges (150 lbs. each) and set aside.

10. Using an appropriate sling, (cartridges must be supported from the base) attach the cable from the boom, crane, or tripod to the cartridge being removed. The threads that the cap attaches to are not a safe lifting point. For more information contact Stormwater Management Inc. This activity may require that workers enter the vault to remove the cartridges from the drainage system and place them under the vault opening for lifting. Note that cartridges containing media other than the leaf media require unscrewing from their threaded connectors. Take care not to damage the manifold connectors. This connector should remain installed in the manifold and capped if necessary. (See figure 4).

11. Remove the cartridge (250 lbs. each) from the vault. Care must be used to avoid damaging the cartridges during removal and installation. The cost of repairing components damaged during maintenance will be the responsibility of the owner unless maintenance activities are being performed by Stormwater Management and damage is not related to discharges to the system.

12. Set the used cartridge aside or load onto the hauling truck.

13. Continue steps 10 through 12 until all cartridges have been removed.

14. Remove deposited sediment from the floor of the vault and, if large amounts are present, from the forebay. This can usually be accomplished by shoveling the sediment into containers which, once full, are lifted mechanically from the vault and placed onto the hauling truck. In some cases of extreme sediment loading, especially if the sediment is saturated, a vactor truck may be required.

15. Once the sediments are removed, it is necessary to assess the condition of the vault, particularly the manifold and the connectors. These are short sections of 2-inch schedule 40 PVC, or threaded schedule 80 PVC that should protrude above the floor of the vault. If required, apply a light coating of FDA approved silicon grease to the outside of the exposed portion of the connectors. This ensures a watertight connection between the cartridge and the drainage pipe. Replace any damaged connectors.

16. Using the boom, crane, or tripod, lower and install the new cartridges. Once again, take care not to damage connections.

17. Close and fasten the door, and remove safety equipment

18. Make notes about the local drainage area relative to ongoing construction, erosion problems, or high loadings of other materials to the system.

19. Finally, dispose of the residual materials in accordance with applicable regulations. Make arrangements to return the used cartridges to Stormwater Management Inc.

2.4.4 Related Maintenance Activities (Performed on an as-needed basis)

StormFilter units are often just one of many components in a more comprehensive stormwater drainage and treatment system. The entire system may include catch basins, detention vaults, sedimentation vaults and manholes, detention/retention ponds, swales, artificial wetlands, and other miscellaneous components. In order for maintenance of the StormFilter to be successful, it is imperative that all other components be properly maintained. The maintenance/repair of upstream facilities should be carried out prior to StormFilter maintenance activities. In addition to considering upstream facilities, it is also important to correct any problems identified in the drainage area. Drainage area concerns may include: erosion problems, heavy oil & grease loading, and discharges of inappropriate materials.

2.5 TYPICAL EQUIPMENT REQUIRED FOR MAINTENANCE ACTIVITIES

Typical equipment required for conducting maintenance is shown in Table 5. Some of the materials listed are suggestions rather than requirements. It should be noted that there is more than one way to accomplish some tasks. Owners with available labor and equipment resources may desire to use alternative methods. However, it is advisable that guidance from Stormwater Management Inc. be obtained prior to using alternative techniques.

Table 5: MAINTENANCE EQUIPMENT REQUIREMENTS

Maintenance Equipment Required		
Minor Maintenance	Pre-Major Maintenance Inspection	Major Maintenance Cartridge Replacement
Safety Equipment*: first aid, cones, barricades, flagging, flares, tape, vests, hard hats.	Safety Equipment*: first aid, cones, barricades, flagging, flares, tape, vests, hard hats.	Safety Equipment*: first aid, cones, barricades, flagging, flares, tape, vests, hard hats.
Work Clothes: rubber boots, coveralls, and gloves.	Work Clothes: rubber boots, coveralls, and gloves.	Work Clothes: rubber boots, coveralls, and gloves.
Door Bolt, Wrench, Pentasocket And Miscellaneous Tools.	Door Bolt, Wrench, Pentasocket And Miscellaneous Tools.	Door Bolt, Wrench, Pentasocket And Miscellaneous Tools.
Tape Measure	Tape Measure	Tape Measure
Flashlight	Flashlight	Flashlight
Grapple or Net Pole	Grapple or Net Pole	Grapple or Net Pole
Record Keeping Forms	Record Keeping Forms	Record Keeping Forms
Trash/Debris Container	Trash/Debris Container	Vacuum Truck
		Replacement Cartridges
		Cartridge Hauling Truck
		Crane, Tripod and Hoist, or Other Lifting Device (300 lb. or greater capacity)
		Shovels
		Extra 2 Inch PVC Caps
		Trash/Debris Container
		Vault Inlet Pipe Plug
		Dolly
		PVC Pipe Cutter
		Ladder
		Cartridge Installation And Removal Sling

***Confined space equipment may be required for vault entry. This equipment must be used by personnel with the appropriate OSHA training. This equipment typically includes: atmospheric testing devices, atmospheric purging and ventilating devices, and entry, exit, and rescue assisting devices.**

2.6 MATERIAL DISPOSAL

The accumulated sediment found in stormwater treatment and conveyance systems must be handled and disposed of in a manner that will not allow the material to affect surface or ground water. It is possible for sediments to contain measurable concentrations of heavy metals and organic chemicals (such as pesticides and petroleum products). Areas with the greatest potential for high pollutant loading include industrial areas and heavily traveled roads. Sediments and water must be disposed of in accordance with all applicable waste disposal regulations. It is not appropriate to discharge these materials back to the stormwater drainage system. Part of arranging for maintenance to occur should include coordination of disposal of solids (landfill coordination) and liquids (municipal vacuum truck decant facility, local wastewater treatment plant, on-site treatment and discharge). Owners should contact the local public works department and inquire about how the department disposes of their street waste residuals. Disposal methods or reuse of the media contained in the cartridges will be determined by Stormwater Management Inc. If the material has been contaminated with any unusual substance, the cost of special handling and disposal will be the responsibility of the owner.

Sample ***StormFilter™*** Minor Maintenance and Inspection Data Sheet

Date: _____ **Location:** _____

System Size: _____ **TYPE: Cast-In-Place Precast Linear**
Personnel:_____

System Observations

Media Months in Service: _____

Oil and Grease in Forebay:_____

Sediment Depth in Forebay:_____

Sediment Depth on Vault Floor: _____

Structural Damage:_____

_____

Estimated Flow from Drainage Pipes (if available): _____

Cartridges Submerged (Yes_____ No_____) How Deep: _____

StormFilter Minor Maintenance Activities (check off if done and give description)

Remove Trash and Debris:_____

Minor Structural Repairs:_____

Drainage Area Report

Excessive Oil and Grease Loading (Yes_____ No_____) Source: _____

Sediment Accumulation on Pavement (Yes_____ No_____) Source:_____

Erosion of Landscaped Areas (Yes_____ No_____) Source: _____

Items Needing Further Work: _____

_____

_____

Comments: _____

_____

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Sample ***StormFilter™*** Major Maintenance Inspection Data Sheet

It may be desirable to conduct this inspection during a storm to observe the relative flow through the filter cartridges. If the submerged cartridges are severely plugged, large amounts of sediments should be present, very little flow will be discharging from the drainage pipes, and it is likely that the cartridges need to be replaced during major maintenance.

Date: _____ **Location:** _____

System size: _____ **TYPE: Cast-In-Place Precast Linear**
Personnel: _____

System Observations

Media Months in Service: _____

Oil and Grease in Forebay: _____

Sediment Depth in Forebay: _____

Sediment Depth on Vault Floor: _____

Structural Damage: _____

Estimated Flow from Drainage Pipes (if available): _____

Cartridges Submerged? (Yes_____ No_____) How Deep? _____

Drainage Area Report

Excessive Oil and Grease Loading (Yes_____ No_____) Source: _____

Sediment Accumulation on Pavement (Yes_____ No_____) Source: _____

Erosion of Landscaped Areas (Yes_____ No_____) Source: _____

Comments: _____

_____

_____

_____

Review the condition reports from the previous minor and major maintenance visits.

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Sample ***StormFilter™*** Major Maintenance/Cartridge Replacement Data Sheet

Date:_____ **Location:** _____

System size: _____ **TYPE: Cast-In-Place Precast Linear**
Personnel: _____

List Safety Procedures and Equipment Used:_____

_____

_____

System Observations

Media Months in Service: _____

Oil and Grease in Forebay:_____

Sediment Depth in Forebay:_____

Sediment Depth on Vault Floor: _____

Structural Damage:_____

Drainage Area Report

Excessive Oil and Grease Loading (Yes_____ No_____) Source: _____

Sediment Accumulation on Pavement (Yes_____ No_____) Source:_____

Erosion of Landscaped Areas (Yes_____ No_____) Source: _____

StormFilter Cartridge Replacement Maintenance Activities (check off if done and give description)

Remove Trash and Debris (Yes_____ No_____) Details:_____

Replace Cartridges (Yes _____ No_____) Details:_____

Sediment Removed (Yes_____ No_____) Details: _____

Quantity of Sediment Removed (estimate?): _____

Minor Structural Repairs (Yes_____ No_____) Details:_____

Residuals (debris, sediment) Disposal Methods: _____

Notes/Problems: _____

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CALTRANS
BMP RETROFIT PILOT PROGRAM

DISTRICT 11, SAN DIEGO

BMP OPERATION, MAINTENANCE, AND MONITORING PLAN

VOLUME II

APPENDIX I-G
WET BASINS

September 1999

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FIGURES

1.1 Overview of a Wet Basin

1.0 INTRODUCTION

The Caltrans Best Management Practice (BMP) Retrofit Pilot Program is a comprehensive water quality monitoring study to evaluate the removal of contaminants in stormwater runoff from Caltrans roads and facilities through a series of BMP pilot installations. The overall objectives of this portion of the program are to document BMP contaminant removal efficiency and technical feasibility.

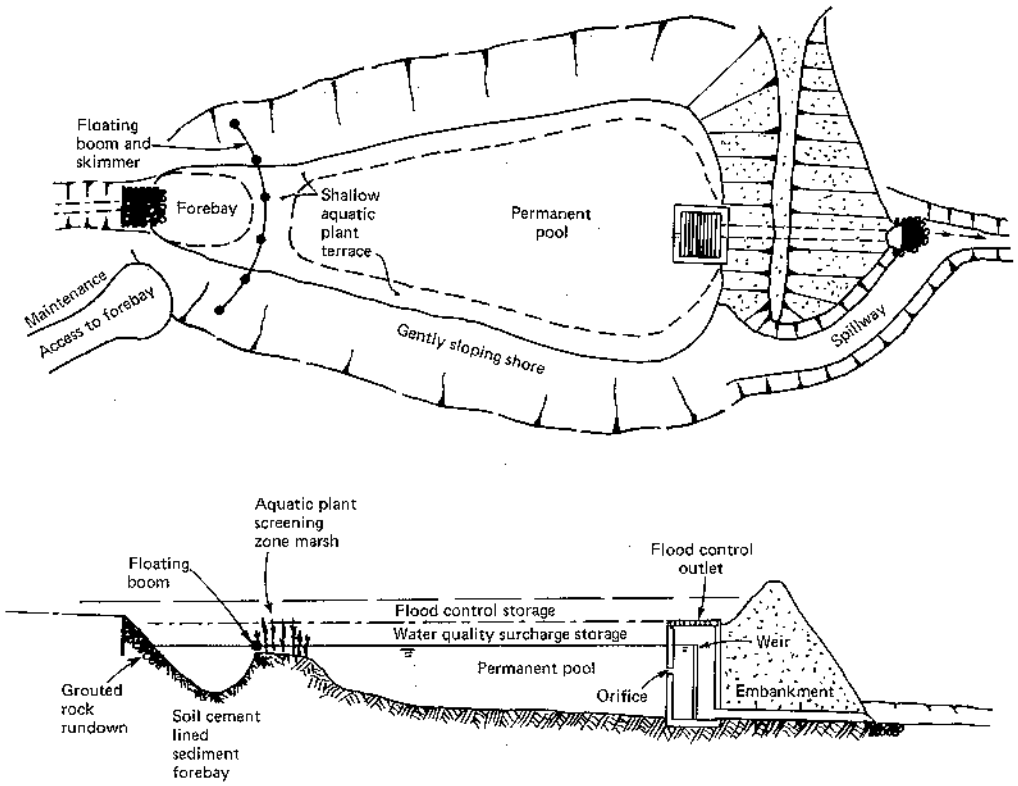
This Appendix of the Operations, Maintenance, and Monitoring Plan (OMM) applies to Wet Basins. Refer to the consultant's monitoring equipment manuals and stormwater monitoring Standard Operating Procedures (SOPs) for details related to equipment installation, equipment maintenance, and storm monitoring. Maintenance, safety, documentation, and storm monitoring tasks will be carried out according to the procedures detailed in this plan. Additional measures may be necessary due to unforeseen or temporary changes to the work environment at these sites.

1.1 Retrofit BMP Description

Wet Basins are similar to Extended Detention Basins in that they are depressions or enclosed areas used to detain stormwater so that soluble and small particulate constituents are removed through settling processes and biological uptake. However, unlike Extended Detention Basins, Wet Basins do not become dry between storm events and maintain a permanent storage of water. Wet Basins are most effective in treating runoff during quiescent periods between storms due to this permanent pool of water.

Runoff fills the Wet Basin until the water surface elevation is at the overflow weir of the outlet structured connected to a discharge conveyance. The 1-year average storm discharges through this water quality orifice located in the outlet structure. The invert of the orifice is set at the permanent pool water surface elevation. Discharge from greater than 1-year storm events will spill over the weir. Discharge significantly greater than 1-year storm events will discharge through a rock-lined spillway/ The designed draw down time of the runoff volume stored below at the overflow weir and the permanent pool water surface elevation is 24 hours and should not exceed 25 hours. The Wet Basin has been designed to optimally treat total runoff from storm events that are equal to or less than 1-year average storms.

Figure 1.1 Overview of a Wet Basin



Urbonas and Stahre, 1993

1.2 Evaluating BMP Performance

To effectively evaluate the performance of a Wet Basin pilot facility, the following objectives will be met:

- Determine the quantity of runoff treated by the BMP.
- Determine the reduction (or change) in analyte concentrations between the influent and the effluent from the BMP.
- Determine and document the level of effort required to maintain the BMP at optimal effectiveness (i.e., treatment of stormwater runoff for storm events producing up to the 1-year, 24-hour peak flow).
- Determine and document the level of effort required to control vectors of human disease and nuisance insects, rodents, and vegetation at the BMP.

To effectively estimate the removal of contaminants from a Wet Basin, the quantity and quality of runoff entering the Wet Basin will be compared to the quantity and quality of water discharged from the Wet Basin. In addition, monthly time-weighted composite samples will be taken at the Wet Basin to establish baseline levels of constituents present in the permanent pool. Using these results, data will allow a direct estimate of the total reduction in mass loadings for a variety of contaminants.

The effectiveness of a Wet Basin is also related to the implementation of maintenance procedures and the documentation of empirical observations. Items such as erosion and bank stability, vegetation height and type (i.e. aquatic or terrestrial vegetation), trash and sediment build-up, and draw down capability may directly affect the performance of a Wet Basin as a stormwater treatment facility.

1.3 Deployment Criteria

Stormwater samples will be collected from the Wet Basin for up to eight storm events over a two wet seasons, weather permitting. Storms targeted for sampling will be separated by a minimum of 48 hours (72 hours preferably). This facility will be inspected per the guidelines given in Section 4.0 of the *Field Guidance Notebook* (*FGN*), which include a mandatory inspection after every storm greater than 0.50 inch.

Based on the rainfall requirements needed to generate monitorable flows in and out of the pilots, Caltrans has developed a refined monitoring team deployment criteria. The refined deployment criteria defines when to chase storms based on season, storm forecasts, and the current count of successfully monitored storms.

The deployment season, in which monitoring teams remain "on-call" and fully staffed, will be restricted to the portion of the year when rainfall is most probable and better predictable. Summer showers are not seen as predictable events, and dry watersheds and BMPs will retain more water which results in less effluent.

The deployment season will start on October 1. The season shall end after 3 weeks of dry weather where less than 0.2" of rainfall occurs in the San Diego area, but end no sooner than April 1 and not later than May 30th. This approach will provide a plan that adjusts to wet or dry springs.

The following criteria will decrease false starts, while allowing teams to continue to chase storms based on promising storm forecasts. The criteria will be used for pilots, regardless of drainage area size or land use.

“Forecast-Unlikely” set to less than 0.25” rain and less than 50% probability, (Decision = "No Go")

“Forecast-Marginal” set to 0.25” or greater and 50 –75% probability, (Caltrans Decision)

"Forecast-Highly Probable" set to 0.25" or greater and greater than 75% probability. (Decision = "Go")

Forecast information will be gathered as indicated in the OMM manuals (e.g., internet sources). As always, if conditions happen to allow paired samples to be successfully taken for any storm larger than 0.1", that sampling would be considered as a successful event, which would count towards fulfilling Scoping Study requirements.

When a specific pilot is successfully monitored for the total required storms per the applicable Scoping Study, the decision to further deploy to monitor that pilot will fall to Caltrans and no commitment to monitor beyond the terms of the Scoping Studies can be made at this time.

1.4 Data Collection and Compilation

1.4.1 Data Requirements

The following data will be collected to assess the performance and maintenance aspects of a Wet Basin:

- Water quality and quantity data of runoff into and discharge from the Wet Basin from flow-composite samples and first-flush (as soon as possible after the start of runoff) grab samples for at least eight storm events during two wet seasons, weather permitting.
- Monthly 48-hour time-weighted composite samples from September through May each monitoring year.
- Annual sediment sampling of the bottom of the wet basin at the end of each monitoring year.
- Rainfall data, recorded as a function of time, from rainfall events during the study period.
- Observations of water quality, weather, antecedent conditions, spills, etc.
- Documentation records of inspections and maintenance activities performed.
- Vector monitoring data.
- Records of vector control measures taken.
- Vegetation management records.

1.4.2 Data Management

Consultants will be responsible for data management. Overall management of the data will be consistent with established Caltrans procedures for stormwater monitoring projects and this manual.

The consultant's Sample Control Section will be responsible for tracking the analytical process to assure that laboratories are meeting the required turnaround times and are providing a complete deliverable package. Sample Control will also be responsible for accumulating copies of site visit logs, inspection logs, facility maintenance records, vector control sampling data, and logged rainfall and hydrographic data. Sample Control will receive the original hard and

electronic copies from the laboratory, system managers, and field crews, and verify completeness and log dates of receipt. A copy of the data sets and log sheets will be filed in Sample Control's central filing system and another copy will be provided to the consultant's Database Manager. The originals will then be transferred to the Task Order Manager and filed with other project documentation to maintain complete project records.

Laboratories, system managers, and vector control crews will provide data in both hard copy and electronic formats. The forms of electronic submittals will be provided to the laboratories to ensure that the files can be imported into the project database with a minimum of editing. A relational database will be used for data. Laboratory data will be maintained and managed using Microsoft Excel® and Microsoft Access®. Files from the influent and effluent monitoring stations will be stored in the same database system and linked to the laboratory database. The sampling system files will include rainfall, sampling, and flow data. Site characteristics will be stored in a separate file and linked to both the chemical and sampling system files to enable useful data queries.

Data will be submitted to Caltrans in accordance with "Caltrans Statewide Data Management Plan—Data Reported Protocol and Database," a technical memorandum dated 23 April 1998 from Larry Walker Associates to Task Order Managers.

1.4.3 Data Analysis

Differences in storm characteristics, which can lead to differences in analyte loadings of monitored storm events, will be evaluated for each year of monitoring. Specific storm parameters such as total rainfall, average intensity, peak intensity, and antecedent conditions will also be measured.

Contingent on the amount and quality of actual data collected, sampling results for the influent and effluent sites will be characterized by descriptive statistics and statistical comparisons between the influent and effluent. Event mean concentrations (EMCs) will be measured for each water quality parameter at both locations. Annual statistics based upon assumed log-normal distributions also will be calculated for each water quality parameter. Subsequent to characterization of the stormwater runoff into and from a Wet Basin, statistical comparisons will be performed to determine differences between the quality of the influent and the quality of the effluent.

Differences in mean concentrations of analytes between storm events and locations will be considered to be statistically significant at $P \leq 0.10$. Although the acceptable level of alpha error is typically set at $P \leq 0.05$, this decision level was increased due to the relatively high coefficients of variation (CV) encountered with stormwater data.

Widely varying storm event characteristics will be considered when evaluating BMP efficiencies based on stormwater runoff data.

Empirical observations, maintenance activities, and vector control activities will be compiled and compared to water quality and quantity data. These data will be used to determine the total unit of effort and will be weighed against the water quality benefits.

1.5 Encroachment Permit and Restrictions

Visitation to a Wet Basin requires a Caltrans Encroachment Permit. Copies of the Wet Basin permits are located in Tab 9 of the *FGN*. These permits list access and safety requirements along with any restrictions. The respective Caltrans District Encroachment Permit Office will be contacted for further information and direction. Phone numbers can be found under Tab 2 in the *FGN* portion of the Volume II OMM Plan.

2.0 OPERATION AND MAINTENANCE

2.1 Operation and Maintenance Needs

The operational and maintenance needs of a Wet Basin are:

- Vegetation management to maintain both adequate hydraulic functioning and biological uptake, and to the extent possible limit habitat for disease-carrying animals.
- Animal and vector control.
- Periodic sediment removal to optimize performance.
- Trash, debris, grass trimmings, tree prunings, and leaf collection and removal to prevent obstruction of the Wet Basin and monitoring equipment.
- Removal of graffiti.
- Preventive maintenance on monitoring and associated BMP equipment and structures.
- Erosion and structural maintenance to prevent the loss of soil and maintain the performance of the Wet Basin.

2.2 Inspection Frequency

The facility will be inspected and inspection visits will be completely documented (refer to Section 2.8):

- Once a month at a minimum.
- After every large storm (after every storm monitored or those storms with more than 0.50 inch of precipitation.)
- On a weekly basis during extended periods of wet weather.

2.3 Aesthetic and Functional Maintenance

Aesthetic maintenance is important for public acceptance of stormwater facilities. Functional maintenance is important for performance and safety reasons.

Both forms of maintenance will be combined into an overall Stormwater Management System Maintenance Program. Maintenance activities will be carried out by the consultant. Maintenance items are included in the checklist/logs found in Tab 5 of the *FGN*. Maintenance activities will conform to practices specified in this manual.

2.3.1 Aesthetic Maintenance

The following activities will be included in the aesthetic maintenance program:

- **Graffiti Removal.** Graffiti will be removed in a timely manner to improve the appearance of a Wet Basin and to discourage additional graffiti or other acts of vandalism.

- **Grass Trimming.** Trimming of grass will be done to the vegetated area around the Wet Basin, at the inlet and outlet structures, and sampling structures. More specifics on vegetation management are given in Section 4.0.
- **Weed Control.** Weeds will be removed through mechanical means. Herbicide will not be used because these chemicals may impact the water quality monitoring. More specifics on vegetation management are given in Section 4.0.

2.3.2 Functional Maintenance

Functional maintenance has two components:

1. Preventive maintenance
2. Corrective maintenance

Preventive Maintenance

Preventive maintenance that will be done on a regular basis as detailed in the checklists in Tab 5 of the *FGN*. Preventive maintenance activities to be instituted at a Wet Basin are:

- **Wetland Vegetation.** Annual assessments of the wetland vegetation will be made with visual observations and estimates. Wetland plant density must be maintained at the "as constructed density" and there must by at least 30% of open water space in the permanent pool. If wetland plant density is less than the "as constructed" density, these plants will be replanted on November 1 of each year. If less than 30% of open water space remains in the permanent pool, plant material will be removed from the permanent pool. A wetland scientist will be consulted to ensure a stable balance of plant life is sustained.
- **Trash and Debris.** During each inspection and maintenance visit to the site, debris and trash removal will be conducted to reduce the potential for inlet and outlet structures and other components from becoming clogged and inoperable during storm events.
- **Sediment Removal.** Sediment accumulation, as part of the operation and maintenance program at a Wet Basin, will be monitored once a month during the dry season, after every large storm (0.50 inch), and weekly during extended periods of wet weather. This information will be recorded on Form C in Tab 4 of the FGN. Specifically, if sediment is more than 2 inches in the forebay or 4 inches in the main pond, the sediment will be removed within 30 working days. The removal of this sediment will be recorded on Form G in Tab 5. Additionally, for every storm event, empirical observations (including short circuiting or decline from design performance) of the performance of the Wet Basin will be recorded on Form H in Tab 6 of the FGN. If accumulation of debris or sediment is determined to be the cause of decline of design performance, prompt action (i.e., within 30 working days) will be taken to restore the Wet Basin to design performance standards. Disposal of sediments is discussed in Section 2.6 and will comply with applicable local, county, state, or federal requirements.

- **Mechanical and Electronic Components.** Regularly scheduled maintenance will be performed on fences, gates, locks, and sampling and monitoring equipment in accordance with the manufacturers' recommendations. Electronic and mechanical components will be operated during each maintenance inspection to assure continued performance.
- **Fertilization.** The vegetation seed mix has been designed so that fertilization is not necessary. Fertilizers will not be used to maintain the vegetation. If the vegetation does not survive without fertilization then Caltrans will work with the Plaintiff to discuss options for maintaining the BMPs.
- **Elimination of Vectors.** The most effective vector control program is one that eliminates potential breeding habitats. As Wet Basins will always contain standing water, elimination of these breeding habitats is not feasible. Therefore, a biological control agent, *Gambusia affinis* (mosquitofish), will be used to control breeding populations in the Wet Basin. Mosquito control measures are discussed more in Appendix IV of Volume II.

Corrective Maintenance

Corrective maintenance is required on an emergency or non-routine basis to correct problems and to restore the intended operation and safe function of a Wet Basin. Corrective maintenance activities include:

- **Draw Down Time.** When the designed 24-hour draw down time is greater than 25-hours or water is flowing over the spillway, the canal gate at the outlet structure will be opened to discharge water until it reaches the permanent pool elevation. The canal gate at the permanent pool inflow structure will be closed.
- **Removal of Debris and Sediment.** Sediment, debris, and trash, which impede the hydraulic functioning of a Wet Basin and prevent vegetative growth, will be removed and properly disposed (refer to Section 2.6). Temporary arrangements will be made for handling the sediments until a permanent arrangement is made. Vegetation will be re-established after sediment removal.
- **Structural Repairs.** Once deemed necessary, repairs to structural components of a Wet Basin and its inlet and outlet structures will be done promptly (e.g., within 10 working days). Qualified individuals (i.e., the designers or contractors) will conduct repairs where structural damage has occurred.
- **Embankment and Slope Repairs**. Once deemed necessary, damage to the embankments and slopes of Wet Basins will be repaired promptly (e.g., within 10 working days).
- **Erosion Repair.** Where a reseeding program has been ineffective, or where other factors have created erosive conditions (i.e., pedestrian traffic, concentrated flow, etc.), corrective steps will be taken to prevent loss of soil and any subsequent danger to the performance of a Wet Basin. There are a number of corrective actions that can be taken. These include erosion control blankets, riprap, sodding, or reduced flow through the area. Designers or contractors will be consulted to address erosion problems if the solution is not evident.
- **Fence Repair.** Repair of fences will be done promptly (e.g., within 10 working days) to maintain the security of the site.

- **Elimination of Animal Burrows.** Animal burrows will be filled and steps taken to remove the animals if burrowing problems continue to occur (filling and compacting). If the problem persists, vector control specialists will be consulted regarding removal steps. This consulting is necessary as the threat of rabies in some areas may necessitate the animals being destroyed rather than relocated. If the BMP performance is affected, abatement will begin immediately according to the directions in Appendix V. Otherwise, abatement will be performed annually in September.

2.4 Maintenance Frequency

The maintenance indicator document, included as Appendix V, lists the schedule of maintenance activities to be implemented at a Wet Basin.

2.5 Equipment, Resources, and Tools Needed

The following resources, equipment, and tools are needed by inspection personnel:

- A Locke level or other surveying equipment.
- Flashlight.
- Tape measure and other measuring device (e.g., survey rod) to determine sediment accumulation depths.
- Local erosion, sediment control, or stormwater management handbooks.
- Rain and foul weather gear.
- This Appendix and *FGN*.
- Copies of necessary inspection reports and forms.
- Encroachment permit.
- Business cards or other identification.
- Camera to document field conditions.
- Maintenance logs.
- Orange vest.
- Leather gloves.
- Hard hat.
- Safety glasses.
- Safety boots.
- Pen or pencil.

Except for the items contained onsite, the maintenance contractors will supply equipment, tools, and resources required for maintenance activities at a Wet Basin. At a minimum, these contractors will supply the following:

- Heavy earth moving equipment (loaders, backhoes, graders, draglines, and vacuum equipment).
- Dump trucks, equipment transports, and other hauling equipment.
- Shovels, picks, rakes, wheel barrels, and other hand tools.

- Pumps.
- Mechanics tools.
- Concrete tools.
- Vegetation maintenance equipment (hand and tractor lawn mowers, gas trimmers, seed and fertilizer spreaders, pesticide and herbicide sprayers, leaf blowers, chain saws, pruning sheers, hedge trimmers, and wood chippers).
- Painting Equipment (brushes, rollers, and sprayers).
- Locke level or survey equipment, tape measures, and sediment probes.
- Safety equipment (gloves, boots, hard hats, reflective vests, safety glasses, traffic control lighting, and confined space entry equipment).

The consultants will provide for the maintenance contractors:

- This Appendix, *FGN* and approved BMP facility plans.
- Encroachment Permit.
- Logbook containing Maintenance Logs.

No items for maintenance and inspection activities will be left onsite.

2.6 Debris and Sediment Disposal

Waste generated at a Wet Basin is ultimately the responsibility of Caltrans because they are the owner/generator. Consultants responsible for operating, maintaining, and monitoring the BMP will be responsible for removal, testing, and disposal of the waste material. Disposal of sediment, debris, and trash will comply with applicable local, county, state, and federal waste control programs. Table 2.1 shows a few possible disposal services for waste material.

Table 2.1
Waste Disposal Services in Southern California

Laidlaw / Rollins (OPC) 5765 Alba Street, Los Angeles, CA 92011 Ph: (213) 585-5063 Fax: (213) 589 5443 EPA: CAD050806850	Laidlaw Environmental Services 5295 S. Garvey Rd., Westmoreland, CA 92281 Ph: (619) 334-9400 Fax: (619) 344-9405 EPA: CAD000633164
TSM Recovery and Recycling 3422 W. Pico Blvd., Los Angeles, CA 90019 Ph: (213) 735-9443 EPA: CAD108040858	Pacific Resource Recovery 3150 E. Pico Blvd., Los Angeles, CA 90023 Ph: (800) 499-7145 Fax: (213) 780-9940 EPA: CAD008252405
Demenno Kerdoon Environmental Services 3650 E. 26th Street, Los Angeles, CA 90023 Ph: (213) 268-5056 Fax: (213) 268-9672 EPA: CAD080033681	U.S. Filter Recovery Services 5375 S. Boyle Ave., Vernon, CA 99058 Ph: (213) 277-1500 Fax: (213) 588-0094 EPA: CAD097030993

Prior to disposal, removed sediments will be inspected to determine the extent and type of chemical contamination. Evidence of oil and grease, antifreeze, solvents, fuel, hydrogen sulfide, and any other noxious substance will be noted. Observations will be used to determine if more than the standard analyte list is required. The standard analyte list (Table 5.2) is based on highway contaminants that have potential to exceed California Code of Regulations (CCR), Title 22 hazardous waste criteria. Methods used to sample sediments are discussed in Subsection 5.7. While analytical results are pending, the removed sediments will be stored in 55-gallon drums onsite in an area protected from vehicular traffic. Separate drums will be used to contain sediments suspected to be differently contaminated.

2.7 Hazardous Waste

Suspected hazardous wastes will be analyzed to determine disposal options. Hazardous wastes generated onsite will be handled and disposed of according to applicable local, state, and federal regulations. A solid or liquid waste is considered a hazardous waste if it exceeds the criteria listed in the CCR, Title 22, Article 11.

2.8 Checklists for Inspectors and Operation and Maintenance Personnel

Facility Inspection and Observational checklists or logs will be filled out during each visit to a Wet Basin. These will be kept in a record book (field logbook) to ensure that the Wet Basin is maintained at optimum levels throughout the monitoring period. One field logbook will contain storm monitoring data sheets and instrument calibration logs (Tab 6 of the *FGN*). A second logbook will contain Facility Inspection Checklists and Maintenance Log Sheets. A third logbook will be kept for vector control and management logsheets (Appendix IV of Volume II).

Refer to Forms C through F (in Tabs 4 and 5 of the *FGN*) for checklists related to the inspection and maintenance requirements of a Wet Basin.

3.0 VECTOR CONTROL AND MANAGEMENT

Constructing retrofit pilot BMPs will modify the existing stormwater drainage systems. Because such retrofitting may create opportunities for disease carrying organisms to flourish, insects (such as mosquitoes and midges) or rodents may have to be controlled. Vector control and abatement will be performed in accordance with Appendix IV and by subcontracted Vector Control Districts.

4.0 VEGETATION MANAGEMENT

The three main reasons for having a vegetation management program for a Wet Basin are:

1. Uncontrolled vegetation may affect the Wet Basin performance.
2. Maintaining vegetation is necessary to prevent the facility from becoming a public "eyesore".
3. Maintaining vegetation is key to controlling mosquito populations and other vector and nuisance organisms.

4.1 Management for Optimal BMP Performance

Maintenance and control of vegetation is essential to the optimal operation and performance of a Wet Basin. The Wet Basin will be planted with a series of terrestrial vegetation including black willow, salt grass, Mexican elderberry, and wetland vegetation including bulrush and broadleaf cattail.

The condition of the vegetation will be inspected on a monthly basis at a minimum. These inspections will insure that the Wet Basin wetland vegetation coverage is maintained at the "as constructed" density, that the vegetation protecting the slopes is kept healthy and continuous, and that undesirable plant species (e.g., woody vegetation) do not take root. The wetland vegetation will optimize the treatment capacity and will aid in vector control. Maintaining healthy and continuous vegetation on the slopes will minimize erosion. Preventing undesirable plant species from taking root will prevent plants with large root systems from damaging the embankments. See Section 2.0 for details on vegetation maintenance.

4.2 Management for Optimal Vector Control

If wetland vegetation such as watercress, cattails, bulrush, or willows begins to envelope the Wet Basin, problems may occur with vector control. Controlling vegetation is preferred to enacting vector management programs (see Appendix IV of Volume II for further details).

If vegetation control is needed, cut vegetation must not be left in the Wet Basin. If this material is flooded, by-products of decomposition will be attractive to egg-laying female mosquitoes and will provide food resources for mosquito larvae. Mulching of cut vegetation into the Wet Basin is also not a viable alternative.

4.3 Maintenance Requirements

Mowing, trimming, pruning and thinning are the preferred means for controlling vegetation around and in a Wet Basin.

Maintenance activities that will be conducted on landscaped vegetation include:

- Weeding.
- Pruning.
- Thinning (consult wetland scientist).
- Replacement of dead or dying plants.

The vegetation seed mix has been designed so that fertilization is not necessary. Fertilizers will not be used to maintain the vegetation. If vegetation does not survive without fertilization, then Caltrans will work with the Plaintiff to discuss options for maintaining the BMP.

Vegetation removed from a Wet Basin will be promptly hauled off and disposed of properly. Cut vegetation will not be stockpiled onsite, especially in the Wet Basin.

4.4 Checklists

During the routine vegetation inspections of the Wet Basin, Inspection Checklists (Form C in Tab 4 of the *FGN*) will be completely filled out and signed by the inspector. These checklists incorporate necessary vegetation inspection requirements. BMP Site Maintenance Activity Checklists (Form E in Tab 5 of the *FGN*) will be filled out for maintenance activities performed.

5.0 SAMPLING AND MONITORING

This section details the monitoring equipment to be used at a Wet Basin, sampling protocols, analytes to be tested, and quality assurance/quality control guidelines.

5.1 Equipment Installation

Runoff flows into a Wet Basin, raises the elevation of the permanent water pool, and then discharges into an outlet riser below a spillway. The Wet Basin and its conveyance will handle flows that are generated from less than 25-year storm events. Some discharge from greater than 25-year storm events may spill over the spillway. When discharge into overflow weir occurs, it will be monitored with a 1 ft. H-flume.

The influent sampling point will be located upstream of the inlet into the basin and will be accessed through a manhole. The effluent sampling point will be located in a 6 inch pipe connected to the outlet riser (see *FGN* site maps and sampling descriptions). Confined space procedures will be followed when accessing the sampling points (see Appendix II, Health and Safety Plan).

The inflow and outflow conveyances for the Wet Basin will be equipped with a flow measuring devices and sample intakes. The outlet H-flume will incorporate a bubbler for depth measurement. Flumes will be cast into the conveyances during the construction phase. Flow sensors will be installed using manufacturer supplied hardware and in accordance to the manufacturers specifications. Sampler intakes will be mounted in each conveyance upstream of flumes or downstream of velocity/depth sensors. Stainless steel fasteners will be used to secure the intakes to the invert of the conveyances.

Sampler intakes will be mounted in each conveyance at least 0.6 m upstream of the flume or 1.2 m downstream of the velocity/depth sensors. Stainless-steel concrete anchors will be used to secure the intakes to the invert of the conveyances.

Sensor wires and intake tubing will be routed through conduit from the manholes to the equipment enclosures positioned on level ground near each manhole. The equipment enclosures will house the data logger/controller assemblies, samplers, cellular modem equipment, flow metering electronics, and batteries. A rain gauge will be mounted on a pole located adjacent to the inlet equipment enclosure. This pole will also support a cellular phone antenna and solar panel.

Components of each automatic sampling system used will undergo calibration and verification during installation and during maintenance and pre-storm visits.

There are several design specifications that were considered in designing the sampling points. The location at which flow will be measured will be at least 10 pipe diameters downstream and five pipe diameters upstream (or ten and five times the maximum anticipated head height) of any

outfall, obstruction, inlet, or change in direction of the conveyance. The slope of the conveyance leading to the flow measuring point is 2% or less. These two requirements are to insure that the flow is fully developed and is subcritical at the point where flow is measured. Only experienced field crews will install monitoring equipment.

5.1.1 Water Quality Samplers

The water quality samplers that will be used at a Wet Basin will be automatic and composed of a peristaltic pump, a liquid detector, and a base to hold a sample bottle and ice. Each time a pre-determined volume of liquid passes the sampling point, the data logger/controller will signal the pump to deliver a self-calibrated sample volume. The suction hose used with the sampler will be 3/8-inch pure Teflon® tubing. Therefore, the sampler will be equipped with 3/8-inch silicon peristaltic tubing and a 3/8-inch stainless steel or Teflon® intake strainer of low-flow design. Strainers will be attached to the invert of each conveyance using stainless-steel fasteners. Samples will be collected into 20L borosilicate glass bottles. After the storm event, the laboratory will pour portions of samples from each composite bottle into individual sample bottles, ensuring they are properly composited.

Materials used in the collection of stormwater samples will meet criteria to prevent contamination of the sample. These materials will allow for both inorganic and organic trace toxicant analyses from the same sampler and sample bottles. Only Teflon® and borosilicate glass are suitable for both trace metal and organic analyses from the same sample bottle. Bottles will be cleaned according to USEPA-approved protocols consistent with approved methodology for analysis of stormwater samples (USEPA, 1983 and subsequent revisions). Sample hoses will be replaced and decontaminated annually, prior to the wet season. They will not be cleaned after each storm event. These bottles and hoses will be evaluated through a blanking process to verify that the sample bottles and sample hoses are decontaminated. Where possible, unused, disposable sampling equipment will be used to eliminate the need for decontamination.

Cleaning Procedures for Sample Bottles

Bottles will be:

1. Rinsed three times with warm tap water.
2. Scrubbed with a clean plastic brush.
3. Soaked in a 2% detergent (e.g., Contrad®) solution for at least 48-hours.
4. Rinsed three times with tap water.
5. Rinsed five times with Milli-Q or equivalent water, rotating the bottle to ensure contact with the entire inside surface.
6. Rinsed three times with hexane while rotating the bottle, and then air-dried.
7. Rinsed six times with Milli-Q water.
8. Soaked in 2N nitric acid for a minimum of 24-hours.
9. Rinsed six times with Milli-Q water.

Cleaning Procedures for Teflon®Hose and Other Sampling Equipment

Teflon® hose and other sampling equipment will be:

1. Teflon hose will be rinsed three times with a 2% Micro® solution or equivalent. Other sampling equipment will be washed with a 2% Micro® solution and a clean plastic brush.
2. Rinsed three times with warm tap water.
3. Rinsed three times with Milli-Q or equivalent water.
4. Rinsed three times with 2N nitric acid.
5. Soaked at least 24-hours in 2N nitric acid.
6. Rinsed three times with Milli-Q water.

5.1.2 Flow Monitoring

A flow-proportioned sample is a composite of individual sample aliquots that are collected for each set volume of water that passes by a sampling point. To obtain a valid composite sample, direct flow measurements will be made to control the sampling interval. At a Wet Basin, both primary and secondary flow metering devices will be used. A primary flow measuring device is a hydraulic structure inserted into a channel that monitors changes in liquid level in or near the structure. By knowing the shape and dimensions of the hydraulic structure, flow through or over the structure is related to the liquid level by a mathematical relationship. A secondary flow metering device measures both liquid depth and/or velocity. Primary devices are preferable, unless hydraulic characteristics prohibit them.

A primary flow measuring discharge flume, a 300-mm H-flume, will be used at the effluent sampling point when water passes through the weir of the outlet structure. A bubbler depth meter will be used in conjunction with the discharge flume. The bubbler measures the hydrostatic pressure of the liquid. The bubbler tube will be connected to the flume's stainless steel bubbler tube. In addition, a an area-velocity (AV) flow meter (or equivalent) will be installed to the 8-inch connector pipe to the outlet riser. Therefore, both inputs to the outlet riser, flow from the pipe and the weir, will be measured. The AV meter will have single-point, internally-mounted, low profile depth and velocity sensors. A pressure transducer that senses gauge pressure will be used to measure depth. The pressure transducer will be vented to atmospheric pressure. The pressure transducer can be separate or integral to the velocity sensor. The velocity sensor will operate using the Doppler principal for measurement. The depth and velocity sensors will be secured to the invert of the conveyance using a mounting ring supplied by the manufacturer.

Because the influent sampling point will most likely be submerged during storms, an area-velocity (AV) flow meter (or equivalent) will also be installed. Once again, the depth and velocity sensors will be secured to the invert of the conveyance using a mounting ring supplied by the manufacturer.

5.1.3 Rain Gauge

A rain gauge having a "tipping bucket" design that incorporates a small "bucket" which holds a known amount of rainfall will be used onsite. When the bucket is filled, it tips the water out, momentarily closes a switch, and then resets itself and starts the process again. The data logger/controller counts each switch closure to accumulate rainfall totals. The rain gauges used will tip after every 0.01 inch of rain.

5.1.4 Power

The source of primary power for the sampling system will be 12-volt deep-cycle marine batteries. A separate battery will be used to power the autosamplers, modems, and flow meters. Solar panels will be used to maintain the charge on the batteries.

5.1.5 Telecommunications

Cellular modem transceivers will be used to provide remote telecommunication access to the monitoring equipment. The ability to access a sampling station, monitor the status of the station in real-time, modify storm criteria, download new programs, and recover data allows for more cost effective, efficient monitoring.

A high performance base station antenna with a filter will be installed; the filter will be installed from the lead-in of the antenna to prevent damage to the sampling station equipment due to nearby lightning strikes.

5.1.6 Equipment Enclosures

Steel enclosures will be used to house the samplers and associated electronic equipment. These enclosures will be bolted to the concrete pads and will be locked to secure the monitoring equipment.

5.2 Maintenance and Calibration

A complete maintenance program will be performed at a Wet Basin after each large storm event during the monitoring period, or in the absence of rain, on a monthly basis. Maintenance will include checking the performance of the equipment, checking power supplies, inspecting and clearing intake structures, cleaning contaminated equipment, and performing necessary equipment calibrations. Calibrations will be conducted in accordance to specifications in the individual component manuals.

Stormwater equipment maintenance visits will be thoroughly documented. Written documentation includes the action taken at a site as well as the date performed. Accurate and thorough records of station visits will be maintained to aid in the evaluation of a Wet Basin's performance. The log illustrated in Form F in Tab 5 of the *FGN* will be used to document

maintenance and calibrations. If any program parameters are changed, the log shown on Form I, J1 and/or J2 in Tab 6 in the *FGN* will be completed.

5.3 Monthly Baseline Sampling

In order to assess the pollutant removal efficiency of a Wet Basin, it is necessary to understand the pollutant loads present in the permanent pool. Therefore, water quality samples will be taken from a 6-inch PVC pipe that ties into the inlet. This 6-inch PVC pipe uses a flow diversion structure to route water from a nearby 84-inch RCP. The water in the 6-inch PVC pipe is used to maintain the permanent pool at the Wet Basin. From September to May, during each monitoring year, monthly time-weighted composite samples will be taken over a 48-hour period. Samples will be analyzed for the analytes listed in Table 5.1.

5.4 Preparation and Logistics

Success of the sampling effort requires careful preparation and planning to assure that high quality samples are obtained in association with each storm event.

5.4.1 Weather Tracking

Weather tracking will be the responsibility of the Task Order Manager and Storm Control personnel. During the wet season, the weather will be continually monitored with increased frequency as incoming storm systems are predicted. Sources of weather information to be used to track incoming storms include the following: National Weather Service, Weather Watch Service, Weather Network (WeatherNet), the Alert system from San Diego County, public broadcast information available on the Weather Channel and local news stations, and radar and satellite images downloaded from the Internet (e.g., www.weather.com).

5.4.2 Mobilization and Staffing

A staffing plan, which designates personnel and equipment for each facet of storm monitoring, will be developed as soon as a potential storm event is forecast. Crews will consist of two individuals. The staffing plan will include the following information:

- Personnel needed for each position.
  - Storm Control.
  - Shift Leader.
  - Crew Chiefs.
  - Crew Assistants.
- Shift and zone (pilot facilities manned by a single crew) designations.
- Equipment mobilization.
- Communication channels.

Equipment needed for stormwater sampling includes sampling equipment, sampling containers, safety equipment, personal rain gear, Storm Kits, and vehicles equipped with some type of mobile communication, and highway safety equipment (see lists). The equipment will be loaded into the appropriate vehicles early in the storm preparation sequence.

Storm Kit Equipment List

- Keypad/display.
- 9-pin cable from keypad to data logger.
- Full set of keys (on floatable bobber).
- Flashlights (2).
- Maps for required areas.
- Large flat screwdriver.
- Small flat screwdriver.
- Umbrella.
- High quality alkaline D-cell batteries.
- Spare sample labels.
- Pencils and indelible markers.
- Desiccant (packages and jar).
- Diagonal clipper.
- Electrical tape.
- Cable ties (assorted sizes).
- Utility knife.
- Ziploc baggies (assorted sizes).
- Labeling tape.
- Polyethylene gloves.
- Rubber bands.

Storm Mobilization List

- Storm kit.
- Log books.
- pH meter.
- Paper towels.
- DI (de-ionized) water squirt bottles.
- Tape gun with clear tape.
- pH grab bottles.
- Spare sample labels.
- Ice scoop.
- Sample control paperwork.
- Extra fine indelible markers.
- 20 liter bottles in 10 gallon containment buckets.
- Grab sample bottles.
- Coolers and ice.
- Grab pole.
- DI water (3-gallon jug).
- Two-way radio or cellular phone.
- Personal rain gear.
- Any necessary safety gear.

Communication Channels

Communication channels will be established for personnel to contact each other before and during a storm event. A telephone tree will be used to facilitate contacting field personnel and other key individuals. Phone lists with home and work numbers and other key contacts will be made available to potential crew members. Two-way radio or cellular telephone communication links to field crews are essential for efficient stormwater monitoring.

5.4.3 Monitoring Station Preparation

Prior to a storm event, the Wet Basin monitoring stations will be made ready to sample. This preparation includes entering the calculated “Volume-to-Sample” values, setting the autosampler and the data logger to sampling mode, pre-icing the sample bottle, and performing a general equipment inspection.

Determination of Volume-to-Sample

The latest weather forecast prior to each storm event will be examined to determine the proper "Volume-to-Sample" value to enter into the system. The amount of expected rainfall, how the station performed during the previous storm, and how much water is needed for analysis at the station for each storm event would be taken into consideration.

The "Volume-to-Sample" is entered as a number with units in kilo-cubic feet (kcf). To determine this number, the drainage area in acres and the runoff coefficient, which is a number that reflects the permeability of the land in the study area. The following equation will be used to determine the volume of water expected at a Wet Basin for a given rainfall:

A x B x C x 3.63 = volume in kcf

Where:

A = inches of rain
B = drainage area in acres
C = runoff coefficient for land area
3.63 = conversion factor: acre-inches to kilo-cubic feet

To determine how much water will pass the monitoring station between samples, divide this result by the number of samples needed to satisfy the water volume requirement for analysis. A table will be supplied in the *FGN* that indicates the “Volume-to-Sample” value needed to collect the correct sample amount of water for the amount of expected rainfall.

After the proper “Volume-to-Sample” value is determined, it will be entered into the system before the rainfall starts. The runoff value will generally be entered from the remote computer. The value can also be entered upon arrival at the site before the system has entered storm mode. It is important that this value is accurate as possible; if the value is too high, the system will not collect enough water to be analyzed, and if the value is too low, the system may sample too fast to be monitored effectively (i.e., the percent storm capture will drop).

Prepare Sampler

The autosampler will be reset and programmed to take 78 250-ml aliquots. Also other user-entered parameters (tubing length, head height, bottle size, composite sample, sample upon one pulse, and enabled liquid detector) will be set correctly.

During each site visit, the state of the System Status Flags (switches) and Program Signature will also be recorded. These provide important information on the current sampling mode and overall integrity of the site program.

Ice Sample Bottles

The sample bottle will be iced after the decision has been made to monitor the storm and prior to initial sample collection. If this is not possible, the bottle will be iced immediately upon the first visit.

General Inspection

A brief physical inspection of the equipment will be made to make certain that there are no obvious problems such as broken conduit or a kinked hose. If possible, the intake will be cleared of debris; at sites with confined entry access, this is only possible if the safety requirements listed in Appendix II are met.

Documentation

Upon each site visit, whether during storm mode or not, records of the visit will be accurately recorded on the field form (Form I of Tab 5 in the *FGN*). Whenever possible, any data being recorded by the sampling system (for example, time or current stage) will be verified. If any program parameters are changed, a program parameter log (Forms J1 and J2 of Tab 6 in the *FGN*) will be filled out. Also once during each storm event visit, the Empirical Observation Checklist will be completed (Tab 6, Form H in the *FGN*).

General Visitation Data

During each station visit, several display locations will be recorded. The log sheets will be used as a guide to the proper display locations to record. The following data will be recorded at both the influent and effluent stations:

- Flume Stage (ft).
- AV Meter Stage (ft).
- Velocity (f/s).
- Flume Q (flow in cfs).
- AV Meter Q (flow in cfs).
- Station ID.
- Data logger Battery Voltage.
- Flow Meter Battery Voltage.
- Cellular Equipment Battery Voltage.

Storm Visitation Data

Additional data will be recorded in the logbooks during storm monitoring. The log sheet will be used to determine the necessary information. The following data are uniform for each station:

- Volume (kcf)
  This is the volume of water that passed the station during the previous execution interval (one minute).
- Storm Sum
  This indicates the accumulated runoff volume in kilo-cubic feet (kcf) that has passed the station since the last sample.
- Percent Storm Capture
  This indicates the percent of the storm effectively sampled by the system, and it provides a quick evaluation of the quality of the monitoring.
- Volume-to-Sample
  This value indicates the runoff volume (in kcf) that will pass the station before the system will take the next sample.
- Sample Count
  This number indicates the number of samples taken in the current bottle. It automatically re-zeroes every time a bottle is filled.
- Total Rain (inches)
  The total rainfall in inches since the start of the storm. This is accumulated each time that the rain bucket tips.
- Max Flow (day)
  This indicates the Julian day on which the maximum flow occurred.
- Max Flow (time)
  When this number is positive, it indicates that the system was sampling during peak stage. If this number is negative, sampling did not occur during the peak stage because the bottles were full.
- Max Stage (feet)
  This indicates the height of the maximum stage during the current storm.
- Max Flow (cfs)
  This indicates the maximum flow rate during the current storm.
- Storm Volume (kcf)
  This indicates the total volume of water that has flowed past the station since the beginning of the storm.
- Storm Volume Sampled (kcf)
  This indicates the total volume of water that flowed past the station while the system has been in storm mode.

After data have been recorded, the system will be placed in low power mode and the keyboard unplugged.

5.5 Storm Monitoring

A priority objective of storm monitoring is to maximize the percent storm capture of the composite sample. This will be accomplished by changing out full sample bottles with empty ones. If the bottles do fill, the full sample bottles will be replaced and the system will be reset. To determine approximately when the bottles will fill and to ensure that the sampling process is not interrupted, the Storm Sum and the "Volume-to-Sample" will be evaluated. By examining how quickly the Storm Sum value is approaching the "Volume-to-Sample" value, the approximate time until the next sample is taken can be determined, as well as the approximate time until the bottles fill. The monitoring crew will be aware of the current status of each station in each of its BMP pilot facilities to determine which station will fill the bottle first so they can be onsite to change out filled bottles. If the station has been set for the amount of rainfall that actually occurs, changing the sample bottles will not be necessary. "Volume-to-Sample" settings will take into account the volume of sample required to meet analytical needs. This study requires approximately 3 liters of sample to meet these needs.

The data logger pulses the autosampler to take a sample when the accumulated Storm Sum equals the "Volume-to-Sample". The storm sum is then reset to zero and the process is repeated. This continues until the storm ends or the bottles fill. Ideally, the "Volume-to-Sample" value will be accurate for the amount of anticipated rainfall, and the bottles will not need to be changed during the storm. If the rainfall is different than that predicted, the bottles may fill before the end of the storm. If this occurs, sampling will halt until the bottles are changed and the system is reset. While the system is not reset, part of the storm is not being sampled, and the percent capture will show a decrease. It is therefore imperative that the system is reset and the sample bottles are changed immediately to maintain 100% storm capture.

5.5.1 Storm Procedure

Upon arrival at a station during a storm event, the status of the composite sample bottle will be checked immediately. If it is not necessary to change the bottle at that time, the appropriate data on the log sheets will be recorded and the necessary physical measurements and observations will be taken. An approximate time that the bottle will fill will be determined, and, depending on how much time is available, the next station will be visited or the team will wait until the bottle fills.

If the sample bottle is full, the system will be reset immediately, and the bottle replaced. When the bottle has been changed, the necessary station data will be filled in on Form I, Tab 6, in the *FGN*.

5.5.2 Sample Bottle Replacement

The removal of the sample bottles from the sampler requires great care; the bottles are heavy when full and are very slippery when wet, as well as being expensive and fragile. Two people

will be present to ensure the security of the bottles and of the sample itself. Extreme care will be taken not to kink the intake hose when handling the sampler.

The bottle numbers will be recorded in the logbook and each bottle will be labeled appropriately. When new bottles have been put in place, they will be re-iced and the sampler reset to continue sampling. Full bottles will be kept iced until composited.

5.5.3 Storm Monitoring Office

The main objective of the Storm Monitoring Office is to update field crews on the status of their stations. This will greatly reduce the amount of time a crew will spend driving during storms. The monitoring of stations from a remote computer consists of calling each station and recording certain data for evaluation. When it is determined that a sampling system is close to filling the bottle, a field crew will be called and alerted to the status of the station. Remote interrogation of the storm stations will be logged using Form K in Tab 6 in the *FGN*.

Generally, the Storm Monitoring Office is also the storm control position. This means that critical decisions regarding the status of storm monitoring are made with input from the Storm Monitoring Office.

Therefore, this position requires awareness of the latest weather forecasts to make informed decisions on the continued monitoring of the storm.

5.5.4 Post-Sampling Procedures

Declaring the end of a storm event may be difficult at a Wet Basin as the basin may hold water for longer than 48 hours and effluent flow may continue out of the basin, thus storm events can overlap. If storm events begin to overlap, two criteria will be used to either continue sampling or end sampling. If the effluent has 75% storm capture or more and 8 or more sample aliquots, monitoring will stop and the stations will be shut down. If the effluent has less than 75% storm capture or less than 8 sample aliquots, the influent and effluent sampling will continue monitoring the event until the event stops raining.

After a storm event has ended, the stations need to be shut down. The station will be left ready for the next storm event in case there is insufficient time for a maintenance visit between storms. The following items will be taken care of, and will be well documented in the *FGN*.

1. The storm monitoring program will be reset to prepare for another storm event.
2. The sample bottles will be replaced and the sampler reset.
3. The station will be physically inspected to determine if damage was sustained during the storm event. The flow sensor will be inspected to determine if it is blocked by debris, or the intake is clogged. (This is only possible if confined space safety requirements are met).
4. The data will be retrieved. This will be done via modem from either the remote monitoring computer or directly in the field using a laptop computer.
5. Battery voltages will be checked; batteries that are low will be replaced.

6. An Empirical Observation Checklist (Tab 5, Form H1 in the *FGN*) will be completed one time during the event.

Data Retrieval

Data will be retrieved (dumped) from the data logger after each storm event during the storm season, and approximately every month during dry weather.

Chain-of-Custody Forms

When the grab samples have been collected, the paperwork will be filled out to ensure a smooth transfer of samples to the analytical laboratory. Chain-of-Custody Forms will be filled out in detail describing the type of samples, the number of samples, and the times that the samples were collected. These forms will accompany the samples to the laboratory.

5.5.5 Evaluation

Upon termination of a storm monitoring event, evaluation of the influent and effluent stations' performance will be documented and reviewed before the samples collected are deemed valid. Evaluation of a monitoring station's performance is based on the answers to the following questions:

- Was the storm representative of the effectiveness range of the Wet Basin?
- Was capture of peak flow or runoff achieved at both sampling points?
- Did the equipment perform as designed throughout the duration of the storm event?
- Did the samplers accurately collect equal and reliable storm sample aliquots?
- Did the Wet Basin function as designed?

5.5.6 Grab Sampling

Total petroleum hydrocarbons (TPH) and bacteria (Fecal Coliform) samples are unsuitable for collection by automatic means. TPH is inappropriate because some material adheres to the surface of the tubing and the sample container. Automatic sampling for bacteria is inappropriate because the sampling equipment is not sterile after installation and exposure to the elements. Because these analytes are unsuitable for collecting using an automated approach, they will be collected as a grab sample from both the influent and effluent twice each storm monitoring year.

It is imperative that collected grab samples be transferred to a designated meeting location immediately after the sampling has been completed. Chain-of-Custody Forms for the samples will be completed and transport of the samples to the analytical laboratory will be coordinated to ensure that samples are handled and analyzed within the proper holding times.

It is essential that the following sample handling protocols be followed when collecting grab samples to keep contamination to a minimum:

- Turn the vehicle engine OFF to minimize exposure of the sample to exhaust fumes.
- Keep sample containers in clean coolers until sampling is actually initiated.
- Store filled sample bottles in clean coolers at 4°C.
- Keep the bottle lid clean and free of debris while the bottle is open.

Grab samples will be collected during two storm events per monitoring season as near to the sampling point as possible. When unable to collect a sample near the intake, the sample will be collected as near the center of flow as possible or in an area of sufficient velocity to ensure good mixing. Both sampling points require a grab pole to collect the necessary grab samples. Sample bottles will be fitted snugly into the bottle holder and the bottles will be seated on the upstream side of the grab pole to reduce potential contamination. The bottle will be filled with the mouth of the bottle faced into the current, if possible. Also, the bottle will be labeled before it is filled as it is nearly impossible to write on wet bottles, and the station I.D. will be listed on the bottle to coincide with the station sampled.

Each type of grab sample may require special treatment to ensure the quality of the sample and the safety of the sampler. The preservative in the sample bottles is usually a concentrated acid, so care will be taken that the preservative does not come into contact with the skin. Powder-free nitrile gloves will be worn when handling sample containers. Both types of grab samples are discussed below.

TPH analyses will be performed for diesel, gasoline, and oil fractions and reported separately for each. Samples to be analyzed for TPH gasoline fraction will be preserved with a concentrated acid (HCl), while TPH diesel and oil containers are unpreserved. The sample bottles will be filled to below the neck and just above the shoulder. The bottle will not be overfilled because the preservative will be washed out. If the bottle is just slightly overfilled, a small amount of sample will be poured off after the preservative has mixed with the sample. A small amount of headspace is required in the containers to allow for expansion if the sample freezes while iced during shipping. These grab samples will be collected as soon as possible after runoff is detected.

Fecal Coliform are preserved with a small sodium thiosulfate tablet. To retain the tablet while sampling, it will be removed from the container when it is dipped into the flow. The bacteria bottle will be turned over causing the tablet to fall onto the cap of the bottle; the cap will be removed and set somewhere that will prevent it from becoming contaminated (out of the rain). The sample bottle will be filled to the shoulder, the cap tipped so the tablet falls into the sample and the cap secured to the bottle. These grab samples will be collected once the entire tributary area contributes stormwater runoff (i.e., any time after 10 minutes of continuous flow past the sampling point).

Attempts will be made to maintain the 6-hour holding time for bacteria to the extent practical. However, storm field conditions and safety concerns may prove this holding time infeasible. A maximum holding time of 24 hours will be followed, in accordance with

"Standard Methods for the Examination of Water and Wastewater," 18th Edition. This will require close coordination between the laboratory and the sampling team to assure that this analysis is completed within holding time.

5.6 Sample Tracking and Handling

Water samples will be kept properly chilled and transferred to the analytical laboratory within holding times to achieve the highest quality data possible. To ensure proper tracking and handling of the samples, documentation will accompany the samples from the initial pickup to the final extractions and analysis. This documentation includes the Chain-of-Custody Forms (see Form M in Tab 7 in the *FGN* for an example form). These forms or equivalent will be used to track and handle samples.

Collected samples will be labeled with the following information:

- Project name.
- Date.
- Time.
- Wet Basin name and number.
- Matrix
- Influent or effluent sampling location.
- Preservative.
- Collector's initials.
- Sample I.D. number.
- Analyte(s) to be analyzed.
- Grab or composite sample.

The analytical suite for each station depends upon the total volume of water collected for the storm event. When insufficient volumes have been collected, Storm Control will need to approve the analysis of the stormwater. A Priority Analysis Sheet will be used in conjunction with a Sample Bottle Evaluation to determine the analytical suite for each station, based on the volume of water collected at that station, the Volume-to-Sample, and the percent storm capture. When the storm has been evaluated and samples from each station accounted for, a duplicate station and a QA/QC station will be selected by Sample Control based on stormwater volumes available. Duplicate and QA/QC samples will be prepared from the combined volume of the sample collected (i.e., from each of the sample bottles) at the selected duplicate and QA/QC station.

Duplicate and QA/QC sample bottles will be labeled, recorded on the Chain-of-Custody Form, and transported to the analytical laboratory.

Grab samples will be transported to the appropriate laboratory as soon as the grab sampling is completed, whereas the sample bottles for composite samples are transferred at the end of the storm event. Samples will be properly logged on the Chain-of-Custody Form and kept chilled in

coolers. There will also be a field duplicate, a field blank, and extra water collected for QA/QC samples. These QA/QC grab samples will be collected at one of each consultant's BMPs during each storm event monitored. The sampling stations will be selected by Storm Control for collecting the duplicate grab samples. The crews monitoring the stations will be fully briefed on the procedures for collecting QA/QC samples, and will be familiar with the sample identification numbering scheme for these samples because they are to be submitted to the laboratory as blind samples. These samples will be labeled, recorded on the Chain-of-Custody Form, and transported to the analytical laboratory.

Each sample collected will receive a unique alphanumeric code (sample I.D. number) for tracking. This code will be standard for the samples and contain information as to the station, date, and sequential monitoring event number. The following is an example of this code:

SITE No.-IN-32898-001

Where:

Site No. = Site number of BMP site.
IN = Influent sampling point at the site; EF = effluent sampling point.
32898 = Julian day and year
001= First storm event monitored during this program at this location

If multiple bottles are used or needed, the last data field will indicate the bottle number and the total bottles in that sampling event (i.e., 001-1/3, 001-2/3, 001-3/3 for a three-bottle collection scheme).

A set of QA/QC samples will be provided with each type of sample analyzed for each storm event. The analytical laboratory may also require additional QA/QC samples if one type of analysis is to be run in more than one batch.

Blank samples, duplicate samples, MS/MSDs, and replicate/splits need not be from the same station. However, per storm event (or batch run), these QA/QC samples will be analyzed for the standard analytes as field samples. Most field QA/QC samples are submitted blind to the analytical laboratory, however, additional sample volumes provided to the laboratory for laboratory replicates or matrix spikes and matrix spike duplicates will be clearly identified. The main types of QA/QC samples that will be utilized for this study are as follows:

Duplicate Analyses - These analyses will be performed for both grab samples and composite samples and will require an additional set of sample containers to be sub-sampled. The results will allow evaluation of sampling error introduced by both field sampling and laboratory analyses by showing the reproducibility of the sample collection and analyses. Duplicate samples will be sent "blind" to the laboratories. One duplicate sample will be collected from one of each consultant's sampling locations during each storm event sampled and analyzed for the full list of analytes.

Duplicate samples will be identified by adding 500 to the sequential storm event number. For example, a duplicate sample for the site identified above will be:

SITE No.-IN-32898-501

Blanks - These are for field as well as laboratory samples. Blanks help verify that the equipment and the sample containers are not contaminated, and the sampling techniques used are non-contaminating. Sample bottles, Teflon® tubing, and filters will be rinsed with reagent grade analyte free deionized water separately. The collected rinsates will be analyzed for the full list of analytes for the composited samples. Blanks will also be run on the analytical equipment. Rinsate blanks will be run on two samplers used by each consultant at one of their BMPs prior to the installation of the equipment. Each time a batch of composite bottles is cleaned, five percent of those bottles will be blanked.

Equipment rinsate blanks will be identified by adding 600 to the sequential storm event number. For example, an equipment rinsate blank collected from the monitoring equipment from the site identified above will be:

SITE No.-IN-32898-601

Field blanks will be identified by adding 700 to the sequential storm event number. For example, a field blank collected at the site identified above will be:

SITE No.-IN-32898-701

Matrix Spike and Matrix Duplicate Spike (MS/MSD) - The laboratory will require additional sample volumes for analyses that require matrix spikes and matrix spike duplicates to evaluate precision and accuracy of the laboratory analytical method, and to evaluate any matrix interference. MS/MSDs are analyzed for their analyte(s) and then spiked with a known amount of analyte(s). One MS/MSD sample will be run on metal and TPH samples from one of each consultant's sampling locations during each storm event sampled.

MS/MSD samples will be indicated on Chain-of-Custody Forms by clearly identifying that the sample is for MS/MSD purposes.

Laboratory Replicate/Split - This QA/QC analysis will require additional sample volumes. It is a duplicate analysis performed on the same sample and evaluates the repeatability (precision) of the analytical laboratories' results. One split sample will be run from one of each consultant's BMP sampling locations during each storm event sampled and analyzed for the full list of analytes.

Laboratory Replicate/Split samples will be indicated on Chain-of-Custody Forms by clearly identifying that the sample is for Laboratory Replicate/Split sample purposes.

5.7 Laboratory Selection, Sample Container Preparation, and Analytical Methods

5.7.1 Laboratory Selection

The selected laboratories have extensive experience with environmental samples and have the ability to provide rapid response to meet critical holding time requirements for analytes requiring expeditious analysis. Laboratories are certified by the California Department of Health Services for the requested analyses. Refer to Tab 2 in the *FGN* for specific laboratory listings.

5.7.2 Holding Times, Sample Bottles, and Preparation

The laboratories will be responsible for providing appropriate sample containers and, when necessary, with preservatives for each analysis. Table 5.1 provides a summary of sample volumes required for each analysis, along with the types of containers, holding times, and preservative. Because additional volumes are necessary for laboratory QA/QC, sample containers will provide at least twice the volume necessary to perform the requested analysis. The volume of the stormwater composite from each site is often the critical factor in determining the volume of sample that can be provided to the laboratory. The Project Task Order Manager and/or Storm Control personnel, in conjunction with the laboratories, will determine the allocation of sample volume for different analyses if sample volumes are not adequate to provide needed volume for each analysis. Table 5.1 lists the analyses along with a Priority Ranking. Also listed on Table 5.1 are the analytical methods and reporting limits.

5.7.3 Project Reporting Limits

Recommended analytical methods and reporting limits for this project are listed in Table 5.1. The reporting limits in this table are target reporting limits. In some cases, reporting limits may need to be adjusted due to limited sample volumes or potential matrix interference. In such cases, appropriate data qualifiers will be applied to the associated data.

5.7.4 Laboratory Data Package Deliverables

Laboratories will be required to provide a three-week turnaround on deliverables. The deliverable package will include a hard copy and electronic data files. The hard copy will include standard narratives identifying any analytical or QA/QC problems and corrective actions. The electronic data files will contain information found in the hard copy reports submitted by the laboratories. Individual data sets will be submitted as either Microsoft Excel® Workbook files or as Microsoft Access® database files. Each consultant will be responsible for laboratory coordination and data management. Data management will be consistent with the "Caltrans Duty Management Plan – Data Reporting Protocol and Database", Doc. J. D. CTSW-TM-98-005.

Table 5.1
Stormwater Matrix
Analytical Parameters, Methodologies, Reporting Limits, Holding Times, Container Volumes and Types, and Preservation

Analyte	Priority Rank	Reporting Limit	Units	Analytical Technique	Method Number	Holding Time	Minimum Sample Volume	Preferred Volume and Container Type[1]	Preservation
Conventionals									
pH	1	0.1	Unit	Electrode	EPA 150.1	Immediately[2]	100 mL	1-100 mL glass/plastic	4°C
Specific Conductance	1	1.0	µmhos/cm	Electrometric	EPA 120.1	Immediately[2]	500 mL	1-500 mL glass/plastic	4°C
Hardness	5	2	mg/L	Titrimetric/ Colorimetric	EPA 130.2	6 months	100 mL	1-200 mL glass/plastic	HNO_3 to pH<2, 4°C
Total Suspended Solids	1	1	mg/L	Dried Filter Weight	EPA 160.2	7 days[3]	1 L	1-500 mL glass/plastic	4°C
Nutrients									
Nitrate-Nitrogen	2	0.01	mg/L	Colorimetric Ion Chromatography	EPA 353.3 EPA 300.0	28 days 48 hours	200 mL 200 mL	1-500 mL plastic 1-500 mL plastic	4°C and H_2SO_4 to pH<2 4°C
Total Kjeldahl Nitrogen	3	0.1	mg/L	Titrimetric/ Colorimetric	EPA 351.3	28 days	500 mL	1-1L plastic	4°C and H_2SO_4 to pH<2
Total Phosphorus	4	0.002	mg/L	Colorimetric	EPA 365.3	28 days	100 mL	1-250 mL plastic	4°C and H_2SO_4 to pH<2
Total/Dissolved Metals[4],[5]									
Copper	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Lead	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Zinc	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Organics[6]									
Total Petroleum Hydrocarbons – Diesel/ Oil	Grab	250/200	µg/L	GC	EPA 8015M	14 days	1 L	2-1L amber glass	4°C
Total Petroleum Hydrocarbons - Gasoline	Grab	50	µg/L	GC	EPA 8015M	14 days	2-40 mL	3-40 mL VOA vials	4°C, HCl to pH<2
Bacteria[6]									
Fecal Coliform	Grab	2	MPN/100 mL	Multiple-tube	SM 9221E	6 hours[7]	50 mL	1-100 mL plastic	4°C

1. Analytes with the same preservative can be combined into a single container if the same laboratory is performing the analyses.
2. pH and Specific Conductance will be measured by the laboratory immediately upon receipt of the samples.
3. 7 days based upon limit for measuring TSS/no regulatory limit.
4. Total and dissolved metals samples are collected in separate containers. Only the total metals container will receive nitric acid.
5. Dissolved metals will be filtered in the laboratory prior to acidification.
6. Total Petroleum Hydrocarbon and Fecal Coliform grab samples will be collected for two storms per year.
7. Attempts will be made to maintain the 6-hour holding time for bacteria samples to the extent possible. When not possible, a maximum holding time of 24 hours will be followed in accordance with "Standard Methods for the Examination of Water and Wastewater", 18th Edition.

5.8 Sediment Sampling

As part of the maintenance program, sediment will be removed from the BMP when flows are hydraulically impeded. It is anticipated that sediment will accumulate relatively slowly over time. However, should sediment deposit in a rapid manner, an intermediate step of stockpiling may become necessary before offsite disposal. Section 5.7.1 provides procedures to be used when assessing potential sediment contamination in the event intermediate onsite storage is necessary.

This section describes the sample collection procedures and analyses for assessing the quality of sediment removed from a Wet Basin for disposal. Evidence of oil and grease, antifreeze, solvents, fuel, hydrogen sulfide, and any other noxious substance will be noted. Observations will be used to determine if more than the standard list of analytes is required. Observations will be documented on a checklist form (Form G in the *FGN*). The standard list (Table 5.2) is based on highway contaminants that have the potential to exceed hazardous waste criteria. After laboratory analysis, results will be compared to regulatory limits listed in California Code of Regulations (CCR) Title 22, Section 66261.24 and Department of Toxic Substances Control (DTSC) variances. Based on this evaluation, proper disposal methods will be chosen.

5.8.1 Sediment Collection

Procedures in EPA Publication *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)* provide a method for determining the mean concentration of a given contaminant within a soil mass and the appropriate number of samples necessary to calculate this mean to the specified confidence interval. Initial sampling will generate a minimum number of samples/analyses as described below. Additional sample analyses may be required to meet the confidence levels given in *SW-846*, therefore archiving of samples will be necessary. Archived samples will be appropriately preserved and analyzed within the maximum holding time specified in Table 5.2. None of the samples will be allowed to be composited. The Quality Assurance/Quality Control (Appendix III) describes the QA/QC objectives for sediment samples. The minimum number of discrete samples initially required is given below:

- Drums: A minimum of one sample will be collected from each drum.
- Stockpiles less than 10 cubic yards: A minimum of two samples will be collected, one from each half of the stockpile. Sampling points will be selected randomly within each half.
- Stockpiles from 10-20 cubic yards: A minimum of three samples will be collected, one from each third of the stockpile. Sampling points will be selected randomly within each third.
- Stockpiles from 20-100 cubic yards: A minimum of four samples will be collected, one from each quarter of the stockpile. Sampling points will be selected randomly within each quarter.
- Stockpiles from 100-500 cubic yards: A minimum of one sample for each 25 cubic yard portion will be collected. The stockpile will be sectioned into 25 cubic yard portions to obtain a minimum of one sample for each 25 cubic yard portion. Sampling points will be selected randomly within each 25 cubic yard portion of the stockpile.

Random samples will be selected from locations on a three-dimensional grid. If the presence of materials such as boulders, debris, etc. hinder this process, the sample will be collected as close as possible to the randomly selected point without altering the essence of the random selection process. The following steps will be used to collect sediment samples:

1. Don personal protective equipment.
2. Locate the sample point in the stockpile or drum.
3. Collect the sample using a soil probe or equivalent. Ensure that the sample is collected at the correct depth and location that was randomly selected.
4. Fill one 8-ounce glass jar with a portion of the sample and close the container with the cap, using care not to aerate (volatilize) the sample. This jar will be labeled and analyzed for volatile TPH and VOC.
5. Homogenize the other portion of the sample in a disposable bowl using a disposable spatula or spoon. Fill a second 8-ounce glass jar with this portion of the sample and close the container with the cap. This sample will be labeled and analyzed for metals.
6. Wipe the outside of each sample container with a clean paper towel.
7. Record the sampler's initials, date, and time on the pre-labeled sample bottle.
8. Place the sample containers in individual zip-top plastic bags and seal the bags.
9. Immediately pack the samples into a chilled cooler.
10. Record the required information on the Chain-of-Custody Form.
11. Document the sampling event, recording information in the designated field logbook.
12. Repeat the above steps until the minimum number of samples has been collected.

5.8.2 Sediment Analyses

Unless observations indicate additional testing, sediment samples submitted to the laboratory will be analyzed for the list of analytes in Table 5.2 using Title 22 criteria (State of California, 1985). This table also lists the required reporting limits, analytical holding times, required preservation, and container sizes and types. Laboratory turn around times and data deliverables will be same as those for the stormwater samples.

5.9 Empirical Observations

5.9.1 Purpose of Empirical Observations

Performance assessments of BMP facilities cannot be fully ascertained through analytical methods. "Empirical" observations are also critical in determining the overall performance of implemented water quality management practices and in ensuring that the practices are maintained at optimum levels. Other factors such as maintenance activities, environmental variability, and physical processes, which cannot be determined analytically, can greatly influence the performance of a particular BMP. Some of these factors such as rainfall quantity, rainfall intensity, and hydraulic residence times can, and, will be assessed through physical measurements. Other components such as trash build-up, sediment deposition, and runoff appearance are be best assessed through careful documented observations.

Table 5.2
Sediment Matrix (Disposal)
Analytical Parameters, Methodologies, Reporting Limits, Holding Times, Container Volumes and Types, and Preservation

Parameter	Method	Units	Reporting Limit	Maximum Holding Time	Preservation	Container Size/Type(1)
Total Petroleum Hydrocarbons (TPH)	EPA 418.1	mg/kg	10	28 days	4^oC	8 oz glass jar
Volatile Organic Compounds	EPA 8260B	mg/kg	SW – 846 (5) requirements	14 days	4^oC	8 oz glass jar
California Code of Regulations (CCR), Title 22 Metals(2):	EPA 6020/7471	mg/kg	SW – 846 (5) requirements	180 days 28 days for mercury	4^oC	8 oz glass jar
California Code of Regulations (CCR), Title 22 Waste Extraction Test (WET) Metals(3):	STLC Extraction	mg/L	SW – 846 (5) requirements	180 days 28 days for mercury	4° C	NA
Toxicity Characteristic Leaching Procedure (TCLP) Metals(4):	TCLP 1311	mg/L	SW – 846 (5) requirements	180 days 28 days for mercury	4° C	NA

(1) Each sample will be collected in two 8 oz glass jars

(2) California Code of Regulation (CCR), Title 22 Metals (Sb, As, Ba, Be, Cd, Cr (total), Co, Cu, Hg, Pb, Mo, Ni, Se, Ag, Tl, V, and Zn). Initial waste characterization results may lead to a shorter list of metals for subsequent sediment disposal.

(3) Any sample for total metals that are below the Total Threshold Limit Concentration [TTLC] but exceed the ten times Soluble Threshold Limit Concentration (STLC) will be further analyzed using the WET procedure. WET extracts will be analyzed only for metals which exceed the ten times STLC criteria. Sediments associated with total metal results that exceed TTLC values are automatically considered hazardous and therefore do not need to undergo the WET procedure.

(4) If any of the WET-soluble concentrations are equal to or greater than the TCLP regulatory thresholds, analyze the waste by TCLP. “Test Methods for Evaluating Solid Waste, Physical /Chemical Methods”. SW-846, Update III.(SW-846)

5.9.2 Guidelines

Observations will be succinct but complete. For a Wet Basin performance evaluation, the following observations will be taken at the influent location, within the Wet Basin, and at the effluent location:

- Meteorological characteristics (present and preceding period)
- Hydrologic and hydraulic characteristics (flowing and/or standing water, channelization)
- Water level
- Inlet conditions (problems affecting performance)
- Description of amount and location of sediment accumulation in basin
- Water quality appearance (visual, olfactory) to make a rough assessment of changes in water quality.
- Solids deposition (trash and debris, sediments, organics) and resuspension
- Erosion
- Vegetation condition
- Outlet conditions (problems affecting performance)
- Mosquitoes and other vectors
- Structural condition of facility
- Monitoring equipment condition
- Approximate draw down time
- Predominant type of litter found in basin
- Condition/clogging of outlet structure
- Degree and type of vegetation establishment in the basin
- Evidence of vandalism of equipment or basin structures

5.9.3 Checklist for Sampling and Monitoring Personnel

Refer to Form H, Tab 6, *FGN* for a checklist (log form) that will be completed by sampling and monitoring personnel during each storm event visit to the facility.

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CALTRANS
BMP RETROFIT PILOT PROGRAM

DISTRICT 11, SAN DIEGO

BMP OPERATION, MAINTENANCE, AND MONITORING PLAN

VOLUME II

APPENDIX II

HEALTH AND SAFETY PLAN

September 1999

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1.0 REVIEW HEALTH AND SAFETY PLAN

All field personnel working on the Retrofit Pilot Program must become familiar with the HSP and site specific safety concerns. The project Health and Safety Officer will be responsible for assuring that all members of the field team are familiar with the requirements of the Health and Safety Plan (HSP) and have received appropriate training for their specific roles. A copy of the project HSP can be found in Volume I of the Retrofit Pilot Program OM&M Plan. General Caltrans safety guidelines can be found in Chapter 8: Protection of Workers (Division of Maintenance, revised June, 1993). The Project Health and Safety Officer will be responsible for enforcing Site Specific Health and Safety protocols. Site-specific Health and Safety protocols include Emergency Response/Contingency Plans. The project Health and Safety Officer and individual employees have authority to suspend work, if necessary, due to health and safety concerns.

1.1 Field Activities

Field activities associated with the Retrofit Pilot Program are similar to other BMP evaluation programs. Activities will include:

- Equipment installation and maintenance
  Installation and maintenance may include confined space entry, working with power tools in wet or damp environments, and the operation of heavy equipment.
- Travel
  Travel to and from the monitoring sites will occur for both routine maintenance activities and storm event monitoring. Although travel during the storm events will be minimized by use of automated equipment, some access is typically necessary during storm events and often at night in order to document observations, replace composite sample containers, and repair any equipment malfunctions.
- Establishment of work zones and traffic control
  Efforts will be made to locate equipment in safe work zones, far from high-traffic, high-use areas.
- Removal and replacement of sample containers
  Composite sample containers will need to be removed and replaced immediately after each storm event and, perhaps, during storm events.

1.2 Traffic Safety

Traffic safety is critical when working at roadside sites. Consideration was used when choosing sites to locate them in relatively safe work zones, far from high-traffic, high-use zones. The following rules and guidelines were developed to maximize the safety of field personnel, Caltrans employees, and the traveling public:

- *Prior to beginning any work on or adjacent to a major roadway, the local highway patrol traffic control department shall be notified. Local highway patrol contact numbers can be found in the Field Guidance Notebook portions of Vol. II of the OM&M Plan.*
- *Whenever possible, plan the timing of the work for non-peak traffic congestion periods.*
- All affiliated personnel must wear an orange safety vest.
- Use enough cones and barricades to sufficiently divert traffic safely around the work area.
- Any open manhole must be barricaded.
- Remember that visibility is the key to minimizing the dangers of working in traffic.
- Upon completion of the work, the area must be cleaned up of all materials and left in a clean and orderly state.

1.3 Hazardous Material Spills

Operations, maintenance, and monitoring activities at field sites can potentially bring personnel in contact with a hazardous material spill. If a hazardous material spill occurs, do the following:

1. Notify Public Safety or the local fire department immediately. See the Field Guidance Notebooks for local department phone numbers. Report the location of the spill, the source if known, and the nature of the material. Hazardous spills will also be reported to the Department of Transportation's National Response Center (NRC) at 800-424-8802.
2. Evacuate to a safe area. No employee shall knowingly approach a spill or leak of hazardous materials except under the specific direction of the person in charge.
3. Do not attempt to clean up a spill or leak of a known or suspected hazardous material.
4. Attempt to contain the spill or leak only if the material is known, proper safety equipment is worn, and the person in charge has deemed it safe to do so.

1.4 General Safety

In addition to traffic hazards, field crews may face a variety of potential dangers while maintaining the facilities, installing equipment and performing environmental monitoring. Some these dangers include:

- Slippery conditions
- Lightning
- Fast moving water

- Unstable earth
- Poor visibility, especially at night
- Lifting heavy objects
- Muggers and other criminals
- Power tools and heavy equipment
- High places
- Sharp edges - broken glass
- Overhead dangers
- Dogs and other biological hazards

Always be aware of these dangers and all other hazards. Here are some tips that will help increase your safety and the safety of others while working in the field:

- Stay away from the edges of a fast moving body of water. These edges are usually slippery and unstable during rainy conditions.
- If sampling is required at the edge of a fast moving body of water, use a lifeline and a personal flotation device. Have on hand a grabbing device when possible.
- Never work alone at night and avoid working alone during the day.
- Avoid leaving tools and equipment lying around where someone can trip over them.
- Maximize lighting at night.
- Keep a phone or other means of communication nearby.
- Do not use your back to lift heavy objects. Get help.
- Never use drugs or alcohol while working.
- Always wear a hard hat.
- Do not use power tools and heavy equipment unless trained in the proper use and care of the specific power tools.
- Always wear eye protection when hammering or working with power tools.
- Wear rain gear
- Never leave open holes unattended.
- Do not sample during lightning
- Clean up the work area before leaving.

1.5 Confined Space Entry

A priority commitment of Caltrans is to the safety and wellbeing of all staff. The installation and monitoring of sampling systems or the collection of discrete samples may involve varying degrees of safety risk and require confined space entry.

Advanced planning will ensure that entry into confined spaces is performed quickly and safely without taking undue risks. Planning will include determination and gathering of all safety equipment and personnel needed to complete a job. Plan work around the safest time of the day and when weather conditions are optimal. Planning will minimize the time spent working on a street and in a manhole or other confined space.

Refer to Volume I of the OM&M Plan for a complete description of the project Confined Space Entry (CSE) Program. The objective of this CSE program is to minimize the risks to which employees are exposed while conducting work in and around confined spaces. In order to meet this objective, employees are to be trained in the proper CSE rules and know all of the following:

- The definitions and hazards of a confined space.
- The types and classifications of confined spaces.
- Confined space entry procedures.
- The use and maintenance of CSE protective equipment.
- Logging the Certificate to Enter a Confined Space (Entry Permit).
- Confined space emergency procedures.

OSHA requires that all employees required to enter a confined space be instructed in the nature of the hazards involved, the necessary precautions to be taken, and the use of protective and emergency equipment required for the job.

2.0 SITE-SPECIFIC HEALTH AND SAFETY PLAN

This section provides information on unique hazards and necessary precautions at the types of sites that will monitored during this study. Appropriate emergency response numbers and routes to the nearest medical emergency facilities can be found in the Field Guidance Notebooks. All field personnel will be responsible to adhere to the requirements of this plan for installation, maintenance, and storm monitoring. If additional measures are necessary due to unforeseen or temporary changes to the work environment, the on-site team leader will make the final judgement for any safety procedure changes.

2.1 Site Specific Safety Concerns

2.1.1 Errant Vehicles

There is a moderate exposure hazard from errant vehicles while accessing some of the pilot facilities. While stopped on the shoulder of the highway, personnel will keep well back from the highway lanes and face the approaching traffic. A lookout person is required if two or more workers are engaged in exposed activity within 30 feet of the travel lane. See the Field Guidance Notebooks for site descriptions and access requirements for the individual facilities.

2.1.2 Chemical Hazards

Chemical hazards may collect within pipes and/or the basins. Chemicals can be corrosive and will burn exposed flesh, and/or they can cause severe illness if they are allowed to be absorbed through the skin or ingested. Exercise caution when dealing with a suspected a liquid hazard. Use a pH meter or pH test paper to test for corrosivity, but always assume that a hazardous chemical is present and wear personal protective clothing. Chemical hazards other than those discussed above could be hazardous chemicals that have precipitated or accumulated on the sides of pipe or have been deposited in the confined space. Table 2.1 lists potential chemicals that may be on site along with each chemical's PEL, IDHL, odor thresholds, and routes of entry. All personnel will use proper personnel protective equipment guard against chemical hazards.

Table 2.1
Toxic Gasses

Name	Source/Use	IDLH Ceiling (ppm)	STEL (ppm)	TWA 8-Hr PEL (ppm)	Odor Threshold
Ammonia	Sewer Gas	50	35/15	25	low
Acetone	Solvent	3,000	1,000/15	750	100
Benzene	Industrial Solvent	50	25/10	10	4.6
Carbon Dioxide	Comb./Sludge	-	-	5,000	
Carbon Monoxide	Comb. Exhaust	400	300/15	50	
Carbontetrachloride	Industrial Solvent	200	25/5	5	21.4-200
Chlorine		3	4/60	1	
Gasoline	Fuel		500/15	300	0.005-10
Hydrogen Sulfide	Sewer/Sludge Coal Gas/Petrol.	50	20/10	10	Impairs smell
Isopropyl Alcohol	Solvent	20,000	500/15	400	50
Nitrogen Oxides		60	5/15	3	
Ozone	Electric Arcing	1	0.3/10	0.1	0.015
Sulfur Dioxide	Industrial Waste	200	50/30	2	
Toluene	Solvent	500	200/10	100	0.17-40
Xylene	Solvent	10,000	300/15	100	0.5-2,000

2.1.3 Physical Hazards

Always be alert and use adequate protection to safeguard against the physical hazards associated with working at these sites. The most common hazard encountered is falling or tripping. The following are some other common hazards:

- Falling Objects
- Sharp Objects
- "Flash" Flooding
- High Water
- Electrical Shock
- Grinding
- Chipping
- Moving vehicles and Heavy Equipment Operation
- Mechanical Energy
- Engulfment (collapse of a confined space)

2.1.4 Biological Hazards

Be aware that spiders, mosquitoes, snakes, rodents, and other biota which like small, dark, moist areas may be encountered. These animals are common in confined spaces. Beware of poison ivy, poison oak, and other plants that cause allergic reactions. Also, use protection against bacteria and other microbiota that could be present in the water and sediment. Be aware that mosquitoes are a common vector for human diseases.

2.1.5 Heat Stress

Heat stress is a major hazard, especially for workers wearing protective clothing. The same protective materials that shield the body from chemical exposure also limit the dissipation of body heat and moisture. In its early stages, heat stress can cause rashes, cramps, discomfort, and drowsiness, resulting in impaired functional ability that threatens the safety of both the individual and coworkers. Continued heat stress can lead to heat stroke and death. Avoiding overprotection, careful training and frequent monitoring of personnel who wear protective clothing, judicious scheduling of work and rest periods, and frequent replacement of fluids can protect against this hazard.

2.1.6 Cold Exposure

Although the pilot facilities are in warm southern California, storms can bring unusual cold weather to the area. Cold injury (frostbite and hypothermia) and impaired ability to work are dangers at low temperatures and wet conditions. To guard against this hazard, wear appropriate clothing, have warm shelter readily available, carefully schedule work and rest periods, and monitor workers' physical conditions.

2.2 Confined Space Safety

At many of the pilot facilities, confined space entry will be required. Because these spaces may have insufficient ventilation to remove the potential accumulation of toxic or flammable air and /or oxygen deficient air, has limited access or egress for the removal of a suddenly disabled person, and is not designed for continuous employee occupancy, a permit (Figure 2.1) must be maintained during each entry.

Figure 2.1
Confined Space Entry Permit

Site Name: Date:
Authorized Duration:

Street Address:
Site Safety Officer:
Authorized Entrant:
Authorized Attendants:
Description of Confined Space:

Intended Operations:

Description of Hazards:

Measures Taken to Isolate Space and Manage Hazards:
Purging Performed (circle one): Yes No Ventilation Performed (circle one): Yes No

Acceptable Entry Conditions:

OXY%	CO ppm	H_2S ppm	%EXPLS
>19.5-<23.5	<50	<10	<10

Communication Procedures:

Special Equipment Required:

Gas Meter Model & Serial #:_____ Calibration Date:
Neotronics Exotox calibrated within past 6 months (circle one): Yes No
Gastech calibrated today (circle one): Yes No

Additional Permits Required:

Rescue and Emergency Services and Phone Numbers:
Gas Meter Readings Prior to Entry (see back side of form to record gas readings during entry):

TIME	OXY%	CO ppm	H_2S ppm	%EXPLS	INITIALS
___ TOP	___		____	_____	_____
___ MID	___		____	_____	_____
___ BOT	___		____	_____	_____

Site Acceptable for Entry? (y/n)_____ Date:

Authorization Signature:

Comments/Requirements:

Permit-required confined spaces have the following classifications based on the level of hazardous conditions.

2.2.1 Class A Confined Space

This type of confined space contains atmospheres or conditions that are, or are approaching extreme danger. Characteristics of a Class A confined space are as follows:

- Oxygen is less than 16% or greater than 25%.
- Flammability is 20% or greater of a gases Lower explosive Limit (LEL).
- Toxicity readings indicate a concentration of H_2S or CO greater than the level that a person could tolerate for 30 minutes without symptoms or health effects [concentrations greater than Immediately Dangerous to Life and Health (IDLH); 50 ppm for H_2S, and 400 ppm for CO].

Entry into a Class A confined space **is prohibited** except in cases of extreme emergency such as rescue efforts. In the event of such an emergency entry, a minimum of two rescuers equipped with full safety and NIOSH-approved life support equipment are required. Communication shall be established and maintained between the person entering the space and attendant personnel outside the space. If explosive gases or vapors are present, all equipment with potential ignition sources are prohibited. Under no circumstances is a rescue to be attempted without calling for emergency assistance first (call 911) and no rescue entry shall be made until such time as the emergency response team is on site.

2.2.2 Class B Confined Space

This is a confined space that contains dangerous atmospheres or conditions that could become IDLH but are not immediately life threatening. Characteristics of a Class B confined space are as follows:

- Oxygen is greater then 16.0 % but less then 19.5%, or it is greater then 21.5% and less then 25.0%.
- Flammability ranges between 10% and 19% of a gases' LEL.
- Toxicity readings (CO or H_2S) at or above Permissible Exposure Limits or Threshold Limit Values (PEL/TLV), but less then IDLH (CO≥50 ppm, H_2S≥10 ppm).

A Supplied Air System with a Bail Out Bottle is required for entry into a Class B confined space. Additionally, a site-specific safety plan must be drafted for all entries into a Class B confined space. If an area become classified as "B" during the course of work, the space will be evacuated immediately and the project manager/safety officer will be notified.

Rescue operations will be handled as if the confined space was rated as Class A.

2.2.3 Class C Confined Space

This type of confined space contains atmospheres or conditions that are potentially hazardous but not life threatening. Characteristics of a Class C confined space are as follows:

- Oxygen ranges between 19.5% and 21.4%.
- Flammability is less then 10% of a gases' LEL.
- Concentrations of toxic gases are below their PEL/TLV (CO≤50 ppm, H_2S≤10 ppm).

Class C confined spaces may be entered if necessary but will be avoided if at all possible. Entry must be authorized by the Corporate Safety Director and by the designated site safety officer. Use caution when entering a Class C confined space.

2.2.4 Class D Confined Space

A Class D Confined Space contains no flammable or toxic gases, has an oxygen level between 19.5% and 21.4%, and indicates little potential for generation of hazardous conditions. This is the only type of confined space that can be "routinely" entered. The Corporate Safety Director and/or the designated site safety officer must authorize entry. A "D" classification can only be assigned with assurance after extensive testing. A Class D confined space still requires an entry permit.

2.2.5 Confined Space Entry Procedures

The hazards associated with a confined space can be minimized by carefully following safe job site practices. Each member of a job crew will be aware of the hazards discussed above.

Thorough planning for each task can minimize the amount of time required in a potentially hazardous site. Each job crewmember will fully understand the specific tasks they are responsible for completing.

The following rules and procedures must be followed for confined space entries during this study:

1. The site supervisor must sign a confined space Entry Permit form. Crewmembers shall fill out all pertinent data on this form prior to, during, and at the conclusion of entry into a confined space. This form is illustrated in Figure 2.1.
2. All personnel working in a confined space or acting as an attendant-rescuer must be certified in confined space entry, first aid/CPR, rescue, respiratory protection and chemical hygiene. All personnel must complete an initial confined space training course and annual confined space training refresher course. At a minimum these courses must contain the following material:

- Confined space definitions
- Confined space hazards
- Classifications of confined space
- Entry procedures
- Use and maintenance of confined space equipment
- Completing a confined space entry permit
- Donning of emergency equipment
- Emergency and rescue procedures

3. Each entrant in a confined space requires a separate attendant-rescuer at all times. This attendant-rescuer must be in a safe location and be in continuous communication with the entrant. He/she must also be able to evaluate traffic hazards as well as obtain assistance quickly when needed. The attendant-rescuer must prevent bystanders from interfering with the confined space operation, prevent smoking or other ignition sources within ten feet of the space opening, monitor the atmosphere within the space if a meter with a probe or intake hose is being used, or prompt the entrant for gas detection measurements at least every 15 minutes.
4. There must be enough personnel and rescue gear on the job site for one equipped attendant-rescuer to be available for each entrant in the confined space. This means there must be at least two people on any confined space entry site at all times, one in and one safely out. There must be at least three people on a confined space entry site if a single person outside the space cannot devote his/her entire time as an attendant-rescuer. A third person attendant is recommended for all confined space entry performed for KLI. Although desirable, the third person attendant is not required to be trained as an observer rescuer as his primary function is to assist the attendant-rescuer with topside safety. All potential attendant-rescuers shall be certified to wear SCBA and they must remain out of the confined space unless a rescue is necessary.
5. Telephone or other means of communicating with Professional Emergency Services must be designated prior to entry. Be sure highway post mile location is available to direct emergency personnel when called. Log this information on the Entry Permit.
6. A person trained in the use and care of a gas detection meter shall conduct atmospheric monitoring tests.
7. No source of ignition shall be permitted in the vicinity of the confined space access until the atmosphere inside has been thoroughly tested.
8. Initial atmospheric testing shall be made through a hole in the manhole cover. If this is not possible, crack open the cover wide enough to insert the probe or intake hose.
9. Tests shall be conducted for percent oxygen and flammables, and for the concentration of H_2S. It is advisable to also test for the concentration of CO. If the initial tests indicate that the atmosphere is safe, open the manhole cover and profile the air at all the levels within the confined space. Many gases and vapors are heavier

then air. Be sure to place the manhole cover in a safe location to prevent slips, trips, or falls. Additionally, measurements for pH need to be taken if any liquids are present in the confined space.

10. Provide pedestrian, vehicle, or other barriers as necessary to protect entrants from external hazards.
11. The confined space entrant and attendant-rescuer are required to be fully trained in the operation of all rescue equipment. Rescue equipment must be deployed in a location near the point of entry. All other persons on site, including the attendant if present, will be familiar with the operations of the equipment and the procedures for a rescue (see Confined Space Entry - Safety and Rescue Equipment, and Emergency and Rescue Procedures).
12. All personnel entering a confined space must wear a hard hat. The person entering the confined space must be equipped with the personal protective equipment described in Section 2.3.1. The designated attendant-rescuer will check the condition and fit of that equipment on the entrant just prior to entry.
13. The person entering the hole must wear a harness and lifeline attached to a confined space entry retrieval winch on a davit or tripod. At no time shall the harness and/or lifeline be detached while personnel are downhole.
14. Ventilate the enclosed space prior to and during the entry using approved blowers, exhausters, or fans. Blowers with long outlet hoses are recommended. Forced ventilation of the workspace can greatly improve the quality of the air in an enclosed space. Some gases and vapors may not be detected with a gas meter.
15. The blower outlet hose will be placed as low and close to the work as practical to ensure the best possible supply of air to the entrant. If the blower hose interferes with the entrant, try to force air down a side drain or shaft leading into the confined space.
16. The blower inlets will be set up-wind of the access to avoid recirculating contaminants. Exhaust from vehicles, generators, and welding equipment will settle in low-lying areas, so blower placement must be above and away from these areas.
17. Entry can be made only if the site safety officer approves the confined space as a Class C or D and the procedures described above are carried out in full. Additionally, Class C spaces require the approval of the Corporate Safety Director. Special procedures are required for entry into a Class B confined space. Entering into a Class A confined space is prohibited.
18. Communication with the entrant(s) inside the confined space must be maintained continuously by the attendant-rescuer. At high noise areas, hand signals are to be agreed upon prior to entry. Two-way radio communication may not serve as the only means of communication between the entrant and the attendant-rescuer.
19. All permanent mechanical devices present in the certified space shall be “locked out” and “tagged out” to prevent inadvertent movement.

20. Continuous monitoring of the atmosphere at all levels shall be conducted whenever an entrant is within the confined space. Gas readings must be logged on the Entry Permit by the attendant-rescuer at least every 15 minutes.
21. Any items that have accumulated in the confined space that may be hazardous or contain a hazardous substance must be removed prior to starting the work.
22. All combustible material (rags, wood, other debris) must be removed from the confined space prior to hot work (any power tool operation or welding).
23. Any AC power cords in the confined space must be protected with a ground fault interrupter. Only AC power cords with a three-prong plug are to be used in conjunction with a ground fault interrupter.
24. A supply of clean water of at least several gallons must be located at the job site for removing contaminants from people, tools, and protective equipment and for potential eye wash situations.
25. Crew task assignments shall be rotated throughout the day to reduce exposure to possible contaminants. Only personnel fully qualified to serve as an entrant and attendant-rescuer may fulfill their particular task assignment.
26. Safety is the primary concern of all personnel on site. No supervisor shall knowingly allow crews to bypass safety procedures. No crews shall knowingly allow supervisors to bypass safety procedures.
27. All accidents, no matter how minor, must be reported immediately.

2.3 Worker Safety

Only personnel trained in the use of the proper safety equipment will be allowed to complete the required tasks. All personnel will follow the program Safety Manual (Vol. 1 OM&M Manual) and the Caltrans "Manual of Traffic Control" procedures while working at this site.

2.3.1 Personal Protective Equipment

Personal Protective Equipment recommended includes hard hats, safety vests, work boots, Gloves, and sturdy clothing. This equipment will not only help protect you from numerous potential hazards but will also allow others to identify you as belonging to the work site. Additionally, Nitrile, latex, or other plastic-based Personal Protective Equipment will be used by any personnel who is likely to come in contact with stormwater runoff as the contents of the water are unknown and potentially dangerous.

2.3.2 Special Circumstances

Extreme caution will be used when maintenance of the rain gauge is required. This task will be performed with proper equipment and by qualified individuals due to the danger of potential falls.

2.4 Traffic Safety

A rotating amber light is required when accessing many of the pilot facilities (see individual Field Guidance Manuals for details). A shoulder closure will be considered for work near the shoulder that is expected to last more than 30 minutes. Traffic control requirements described in the encroachment permit for the individual facilities shall be followed. A copy of the encroachment permits Can be found in Appendix G.

2.5 Vector Management Safety

Training and Safety requirements for vector control personnel should closely parallel that required for Vector Control Technician Certification by the California Department of Health Services. Vertebrate Vector Control Decisions often require knowledge beyond that of a pesticide applicator. Skills required for sound vertebrate vector management programs include:

- Knowledge of the biological and ecological parameters of the target vector species.
- Broad knowledge of pesticide use, safety, and emergency procedures.
- Depth of field experience sufficient to make complex vector control decisions appropriate to the situation.

In order to survey and to implement control measures against mosquitoes and midges personnel must meet the following minimum requirements:

- Pass sections A and B of State Certification by the California Department of Health Services. These sections generally address (i)mixing, loading and applying insecticides and (ii) the biology and identification of mosquitoes. Valid State of California certification/licensing is required for anyone applying pest control chemicals and agents.
- Have familiarity with, or complete a training program on, mosquito and midge identification, biology and sampling, particularly as these subjects relate to the BMP designs under consideration.

Possess a valid California driver's license and individual must be insurable.

2.6 Sampling Safety

The following precautions will be taken while sampling at pilot facilities:

- Life vests will be worn when working near the basin at high water levels.
- Use plenty of light during the evening hours and use reflective orange vests if working near the highway.
- Always wear protective gloves.

- Boots and foul weather gear will be worn during rainy weather.
- Never enter a confined space during rainy weather to collect samples.
- Refrain from eating or smoking while sampling.
- Use proper lifting techniques and get assistance when moving coolers and large sample composite containers.

2.7 Emergency Procedures

2.7.1 Confined Space Emergencies

Emergency procedures must be carefully planned prior to site activities at each individual facility, especially when conducting confined space entry. Fatalities and serious injuries are a common outcome of attempted rescues. **More than 60 percent of the fatalities in confined spaces each year involve would-be rescuers of initial victims.**

In all cases it is preferable to take what may seem like extreme measures to avoid needing to send additional personnel into a hazardous work environment where a co-worker has lost consciousness. Obviously, the best way to do this is to perform a rescue only in such a way that they can be pulled to safety quickly at any time. No one expects an accident, and frequent successful days of work can make extensive safety procedures seem unnecessary especially for small tasks. It is the responsibility of all persons on a job site to point out any inadequate safety precaution.

The first step for an emergency rescue is to immediately request assistance from emergency services (see individual Field Guidance Manuals for emergency contacts). The most fire department personnel are trained in confined space rescue procedures. Once emergency services are on the way, an attempt will be made to rescue an unconscious victim without additional exposure to the hazard if the victim passed out from a toxic atmosphere. Do not attempt to move a victim with serious injuries.

If the victim can not be pulled out from outside the hazard area or confined space, then entry of a rescuer may be considered. A rescue attempt can only be made by persons trained to do so. If the victim is in a confined space, the rescuer must be equipped with full protective gear (SCBA, Harness, lifeline, and personal protective equipment) and be backed up by a standby rescuer also in full protective gear. In most cases, a second standby rescuer would not be available on site until emergency services personnel arrive.

All personnel functioning as an attendant-rescuer shall be trained and have practice in the following:

- Donning and using an SCBA.
- Proper entering of a space.

- Assisting in the rescue of an entrant while wearing an SCBA.
- Retrieving a person in a space with a hoisting device.
- First Aid and CPR.

2.7.2 Medical Emergencies

Even with full safety awareness and compliance by field crews, medical emergencies can and do occur. To handle minor injuries, crews will have a basic first aid kit on-site at all times.

See individual Field Guidance Manuals for site-specific emergency contacts and nearest hospital information.

2.7.3 Other Emergencies

In the event of fire, flooding, structural collapse, or hazardous spills, immediately notify emergency services and evacuate the area.

Earthquakes can rapidly endanger personnel in the basin and entrant(s) in a confined space. Storm drains may become flooded and/or contaminated in a large quake. Immediately evacuate any unstable area or a confined space and remain in a safe location until the risk of aftershocks has subsided. Reentry into a confined space may not be attempted after a large earthquake, until it has been deemed safe by proper authorities.

All accidents or unusual events that endanger workers must be documented and reported to the Corporate Safety Director and proper authorities in a prompt manner.

2.8 Hazardous Spills

Hazardous substances may be used for various purposes at and around the site. When working with hazardous substances, leaks and spills are always a concern. With the close proximity of the site to the roadway, the probability also exists of potential hazardous spills originating from traveling vehicles.

A spill may present a number of hazards. The specific hazards depend on the substance or substances involved. Among the possibilities are:

- Fire
- Explosion
- Contamination of individuals who come in contact with the spilled substance
- Hazardous substances entering the water supply

Spill response procedures are designed to minimize the risk of any of these things occurring as a result of a spill or, at the very least, reducing the degree of hazard. The primary concern of spill contamination is to stop or retard the spill before it becomes serious.

Field crews working with potentially hazardous materials will be trained in the use of proper personal protective equipment, the safe usage or handling of the substances, and contingency plans for spills and leaks. In the event of a hazardous material spill, follow the procedures listed under Section 1.3. The hazards posed by a spill of a particular substance are detailed on the Material Safety Data Sheet (MSDS) for that substance.

In the event of a hazardous material spill originating from an external source such as an accident on the roadway, follow the procedures listed under Section 1.3.

2.9 Tailgate Safety Training

Tailgate safety training sessions will be conducted regularly by a designated Safety Officer. These meetings will be held on-site prior to work operations. All new personnel working on site will be required to attend a tailgate meeting prior to work operations. The purpose of the safety-training meeting is to ensure that field crewmembers understand and will abide by all safety and potential emergency response measures that may be necessary for the well being of the field team. The following items will be discussed at each safety meeting:

- Traffic safety
- Safe entering and exiting of the freeway.
- Use of personal protective clothing and equipment.
- Confined space entry and associated emergency response procedures.
- Potential chemical and physical hazards and how to deal with them.
- Nearest hospital information
- Emergency response procedures.
- Any other site-specific safety issues.

All field crewmembers must sign the tailgate safety training meeting form in acknowledgment of understanding all issues discussed. A sample tailgate meeting form is shown in Figure 2.2.

Figure 2.2

Caltrans Retrofit Pilot Program
Tailgate Safety Meeting Form

Date: _____ Time: _____ Project Number: _____
Site Name: _____
Site Location: _____

Safety Topics Presented

Traffic Safety and Control:

Protective Clothing/Equipment:

Chemical Hazards:
Physical Hazards:
Confined Space Entry Procedures:
Emergency Response Procedures:
Other Site-Specific Issues:

Nearest Hospital:
Phone #:
Ambulance Phone #:
Hospital Address and Route:

ATTENDEES

Name Printed Signature

Meeting conducted by: _____ Name Printed _____ Signature

Project Safety Officer: _____
Project Manager: _____

CALTRANS
BMP RETROFIT PILOT PROGRAM

DISTRICT 11, SAN DIEGO

BMP OPERATION, MAINTENANCE, AND MONITORING PLAN

VOLUME II

APPENDIX III
QUALITY ASSURANCE / QUALITY CONTROL PLAN

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1.0 INTRODUCTION

The Caltrans BMP Retrofit Pilot Program serves to measure the effectiveness of several Best Management Practices (BMP) pilot installations throughout Los Angeles and San Diego counties. The overall objectives of this portion of the program are to document BMP contaminant removal efficiency, and technical feasibility of retrofitting Caltrans facilities with storm water quality controls.

This Quality Assurance and Quality Control (QA/QC) Plan is an integrated component of the overall Operations, Maintenance, and Monitoring (OMM) Plan. The procedures stated herein are to be followed for all sampling and analysis under the scope of this program. Analytical data will be qualified using the protocols listed in the *National Functional Guidelines for Organic Data Review (EPA/540/R/090)* and the *Guidance on the Documentation and Evaluation of Trace Metals Data Collected for Clean Water Act Compliance Monitoring (EPA/821/B/95/002).*

Refer to Volume I of the Operations, Maintenance, and Monitoring Plan for the Caltrans BMP Retrofit Pilot Program for program-specific requirements and procedures. Refer to the BMP Appendices (A through I for District 7 locations; A through F for District 11 locations) for BMP-specific details related to field equipment installation, equipment maintenance, storm water monitoring, vector monitoring, and sample labeling protocols. Other site-specific guidance on inspecting BMPs are provided in the "Caltrans BMP Stormwater Monitoring Field Guidance Notebook," which is an integral component of this Volume II OMM Plan.

The sections that follow address QA/QC activities associated with both the field sampling and laboratory analyses for this BMP retrofit program. Field QA/QC samples are collected and used to evaluate potential contamination and sampling error introduced into a sample prior to its submittal to the analytical laboratory. Laboratory QA/QC activities provide information needed to assess potential laboratory contamination, analytical precision and accuracy, and representativeness. See paragraph 5.10 of Volume I of the OMM Plan for evaluation of QA/QC data.

2.0 SAMPLE TRACKING AND HANDLING

Water samples will be kept properly chilled and transferred to the analytical laboratory within holding times to achieve the highest quality data possible. To ensure proper tracking and handling of the samples, documentation will accompany the samples from the initial pickup to the final extractions and analysis. The Chain-of-Custody Forms (see Figure 2.1) provide the minimum information needed to track and handle the samples.

It is imperative for data quality assurance that analytical laboratory results provide facsimile confirmation of all analytical tests to be conducted, their respective reporting limits, analytical methods, and costs before proceeding with analyses.

Figure 2.1
Chain-of-Custody Form

Laboratory:	Lab # Date Rec'd	**From:**
Project: **P.O.#:**	**Project #:** **Required Completion Date:**	

Sample ID #	Site ID #	Lab ID #	Matrix/Analysis	Containers	Pres.	Sample Date/Time		Condition Upon Receipt

Data Reports **WILL** include the following: Sample/Site ID, Analytical Method, Reporting Limit, Date of Extraction if applicable, Date of Analysis, Analytical Results and Signature of QA Reviewer.

Special Instructions/Comments:

Relinquished By: Date/Time	Transporter	Received By: Date/Time
Relinquished By: Date/Time	Transporter	Received By: Date/Time
Relinquished By: Date/Time	Transporter	Received By: Date/Time

3.0 ANALYTICAL LABORATORY REQUIREMENTS

3.0 ANALYTICAL LABORATORY REQUIREMENTS

3.1 Laboratory Selection

Selected laboratories have extensive experience with environmental samples and have ability to provide rapid response to meet critical holding time requirements for analytes requiring expeditious analysis. *Laboratories shall be certified by the California Department of Health Services* for the requested analyses.

3.2 Reporting Limits, Analytical Methods, Holding Times, Sample Bottle Requirements

The laboratories will be responsible for providing appropriate sample containers with preservatives, when necessary, for each analysis. Table 3.1 provides a summary of sample volumes required for each analysis, along with the types of containers, holding times, and preservative. Because additional volumes are necessary for laboratory QA/QC, sample containers will provide at least twice the volume necessary to perform the requested analysis. The volume of the storm water composite from each site is often the critical factor in determining the volume of sample that can be provided to the laboratory. Table 3.1 lists the suggested priority rankings for each analysis should the sample volume be inadequate for running all analyses. Required analytical methods and reporting limits are also listed.

Holding times for grab samples are defined as starting at the time the samples are taken. Holding times for composite samples are considered to start at the time that the last aliquot was sampled.

Fecal coliform bacteria samples are taken as grab samples. The bacteria samples have critical holding time requirements. Every effort will made to assure that the analyses are started within the 6-hour holding time. This will require close coordination between the laboratory and the sampling team to attempt to meet this within holding time. If the 6-hour holding time cannot be met, the samples will be analyzed within the 24-hour holding time allowed by "Standard Methods" (Greenberg, *et al.* 1992) for conditions where meeting the 6-hour holding time is not possible.

In addition to storm water sample analyses, sediments accumulating in BMP components will require removal and eventual testing to determine the suitable disposal alternative. Sediment samples submitted to the laboratory will be analyzed for the list of analytes in Table 3.2 using Title 22 criteria (State of California, 1985). This table also lists the required reporting limits, analytical holding times, required preservation, and container sizes and types. Laboratory turn around times and data deliverables will be same as those for the storm water samples.

The reporting limits presented in Tables 3.1 and 3.2 are target reporting limits. In some cases, reporting limits may need to be adjusted due to limited sample volumes or potential matrix interference. In such cases, appropriate data qualifiers will be applied to the associated data.

3.3 Laboratory Data Package Deliverables

Laboratories will be required to provide a 3-week turnaround on all deliverables. The deliverable package will include a hard copy and electronic data files. The hard copy will include standard narratives identifying any analytical or QA/QC problems and corrective actions. The electronic data files will contain all information found in the hard copy reports submitted by the laboratories. Individual data sets will be submitted as either Microsoft Excel workbook files or as Microsoft Access database files. The electronic data submittal format should conform to the established Caltrans Stormwater Monitoring Database format established in 1998 (Andy Bale, CTSW-TM-98-005, dated April 23, 1998.

Table 3.1
Water Matrices
Analytical Parameters, Methodologies, Reporting Limits, Holding Times, Container Volumes and Types, and Preservation

Analyte	Priority Rank	Reporting Limit	Units	Analytical Technique	Method Number	Holding Time	Minimum Sample Volume	Preferred Volume and Container Type[1]	Preservation
Conventionals									
pH	1	0.1	Unit	Electrode	EPA 150.1	Immediately[2]	100 mL	1-100 mL glass/plastic	4°C
Specific Conductance	1	1.0	µmhos/cm	Electrometric	EPA 120.1	Immediately[2]	500 mL	1-500 mL glass/plastic	4°C
Hardness	5	2	mg/L	Titrimetric/ Colorimetric	EPA 130.2	6 months	100 mL	1-200 mL glass/plastic	HNO_3 to pH<2, 4°C
Total Suspended Solids	1	1	mg/L	Dried Filter Weight	EPA 160.2	7 days[3]	1 L	2-L glass/plastic	4°C
Nutrients									
Nitrate-Nitrogen	2	0.01	mg/L	Colorimetric Ion Chromatography	EPA 353.3 EPA 300.0	28 days 48 hours	200 mL 200 mL	1-500 mL plastic 1-500 mL plastic	4°C and H_2SO_4 to pH<2 4°C
Total Kjeldahl Nitrogen	3	0.1	mg/L	Titrimetric/ Colorimetric	EPA 351.3	28 days	500 mL	1-1L plastic	4°C and H_2SO_4 to pH<2
Total Phosphorus	4	0.002	mg/L	Colorimetric	EPA 365.3	28 days	100 mL	1-250 mL plastic	4°C and H_2SO_4 to pH<2
Total/Dissolved Metals[4],[5]									
Copper	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Lead	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Zinc	1	1	µg/L	ICP-MS	EPA 200.8	6 months	2 @ 500 mL	2-1L plastic	4°C and HNO_3 to pH<2 and filter
Organics									
Total Petroleum Hydrocarbons - Diesel /Oil	Grab	250/200	µg/L	GC	EPA 8015M	14 days	1 L	2-1L amber glass	4°C
Total Petroleum Hydrocarbons - Gasoline	Grab	50	µg/L	GC	EPA 8015M	14 days	2-40 mL	3-40 mL VOA vials	4°C, HCl to pH<2
Oil and Grease	Grab	5	mg/L	IR/Gravimetric	EPA 413.2/1664HEM	28 days	1 L	2-1L amber glass	4°C and H_2SO_4 to pH<2
Bacteria									
Fecal Coliform	Grab	2	MPN/100 mL	Multiple-tube	SM 9221E	6 hours[6]	100mL	2-100 mL plastic	4°C

1. Analytes with the same preservative can be combined into a single container if the same laboratory is performing the analyses.
2. pH and Specific Conductance will be measured by the laboratory immediately upon receipt of the samples.
3. 7 days based upon limit for measuring TSS/no regulatory limit.
4. Total and dissolved metals samples are collected in separate containers. Only the total metals container will receive nitric acid.
5. Dissolved metals will be filtered in the laboratory prior to acidification.
6. Attempts will be made to maintain the 6-hour holding time for bacteria samples to the extent possible. When not possible, a maximum holding time of 24 hours will be followed in accordance with "Standard Methods for the Examination of Water and Wastewater", 18th Edition.

Table 3.2
Sediment and Soil Matrices
Analytical Parameters, Methodologies, Reporting Limits, Holding Times, Container Volumes and Types, and Preservation

Parameter	Method	Units	Reporting Limit	Maximum Holding Time	Preservation	Container Size/Type(1)
Total Petroleum Hydrocarbons (TPH)	EPA 418.1	mg/kg	10	28 days	4^oC	8 oz glass jar
Volatile Organic Compounds	EPA 8260B	mg/kg	SW – 846 (5) requirements	14 days	4^oC	8 oz glass jar
California Code of Regulations (CCR), Title 22 Metals(2)	EPA 6020/7000	mg/kg	SW – 846 (5) requirements	180 days 28 days for mercury	4^oC	8 oz glass jar
California Code of Regulations (CCR), Title 22 Waste Extraction Test (WET) Metals(3	STLC Extraction	mg/L	SW – 846 (5) requirements	180 days 28 days for mercury	4° C	NA
Toxicity Characteristic Leaching Procedure (TCLP) Metals(4)	TCLP 1311	mg/L	SW – 846 (5) requirements	180 days 28 days for mercury	4° C	NA

(1) Each sample will be collected in two 8 oz glass jars

(2) *California Code of Regulation (CCR), Title 22 Metals (Sb, As, Ba, Be, Cd, Cr (total), Co, Cu, Hg, Pb, Mo, Ni, Se, Ag, Tl, V, and Zn). Initial waste characterization results may lead to a shorter list of metals for subsequent sediment disposal.*

(3) Any sample for total metals that are below the Total Threshold Limit Concentration [TTLC] but exceed the ten times Soluble Threshold Limit Concentration (STLC) will be further analyzed using the WET procedure. WET extracts will be analyzed only for metals which exceed the ten times STLC criteria. Sediments associated with total metal results that exceed TTLC values are automatically considered hazardous and therefore do not need to undergo the WET procedure.

(4) If any of the WET-soluble concentrations are equal to or greater than the TCLP regulatory thresholds, analyze the waste by TCLP.

(5) "Test Methods for Evaluating Solid Waste, Physical /Chemical Methods". SW-846, Update III.(SW-846)

4.0 FIELD QUALITY ASSURANCE/QUALITY CONTROL

A set of QA/QC samples will be provided with each type of sample analyzed for each storm event. The analytical laboratory may also be required to perform additional QA/QC samples if one type of analysis is to be run in more than one batch or require more than a day to complete. The main types of QA/QC samples that will be utilized for this study are as follows:

Blanks - Blanks help verify that the equipment and the sample containers are not contaminated, and the sampling techniques used are non-contaminating. Sample bottles, Teflon® tubing, and filters will be rinsed with reagent grade, analyte-free deionized water separately. The collected rinsates will be analyzed for the full list of constituents to be analyzed in the composite samples. Blanks will also be run on the analytical equipment. Rinsate blanks will be run on two samplers used by each consultant for one of their BMPs prior to the installation of the equipment. Each time a batch of composite bottles is cleaned, five percent of those bottles will be blanked. Each time a batch of filters is purchased five percent of those filters will be blanked from each lot number. Whenever possible, filter purchases should come from a single lot.

Field Duplicate Analyses - These analyses will be performed on grab samples and will require an additional set of sample containers. These analyses will be used as an indication of the overall precision. Duplicates will be sent "blind" to the laboratories. One duplicate will be collected from one of each consultant's sampling locations during each storm event sampled and analyzed for the full list of analytes associated with grab samples.

Sub-Sampling Duplicate Analyses – These analyses will be performed on composite samples and will require an additional container to be sub-sampled. It is expected that the sub-sampling duplicate results will have a greater variance than the field duplicate analyses given the difficulties associated with reproducing a composite sample. Sub-sampling duplicates will be sent "blind" to the laboratories. One sub-sampling duplicate will be collected from one of each consultant's sampling locations during each storm event sampled and analyzed for the full list of analytes associated with composite samples.

Matrix Spike and Matrix Duplicate Spike (MS/MSD) - The laboratory will require additional sample volumes for analyses where matrix spikes and matrix spike duplicates are to used to evaluate precision and accuracy of the laboratory analytical method, and to evaluate any matrix interference. MS/MSDs are analyzed for their analytes and then spiked with a known amount of the analyte(s). One set of MS/MSD samples will be run for metals and TPH samples by each laboratory for each storm event sampled.

Laboratory Replicate/Split - This QA/QC analysis will require additional sample volumes. It is a duplicate analysis performed on the same sample and evaluates the repeatability (precision) of the analytical laboratories' results. One split sample will be analyzed for the full list of analytes by each laboratory during each storm event sampled.

The blank samples, duplicate samples, MS/MSDs, and replicate/splits need not all be from the same station. However, per storm event (or batch run), all these QA/QC

samples will be analyzed for the same constituents analyzed in the field samples. Most field QA/QC samples are submitted blind to the analytical laboratory, however, additional sample volumes provided to the laboratory for laboratory replicates or matrix spikes and matrix spike duplicates will be clearly identified.

4.1 Composite Samples

The analytical suite for each station depends upon the total volume of water collected for the storm event. When insufficient volumes have been collected, Storm Control (critical decision making personnel) will need to approve the analysis of the stormwater. A Priority Analysis Sheet is used in conjunction with a Composite Sample Bottle Evaluation to determine the analytical suite for each station, based on the volume of water collected at that station, the volume to sample and the percent storm capture. When the storm has been evaluated and all bottle volumes recorded, a duplicate station and a QA/QC station will be selected by Sample Control based on stormwater volumes available and sub-sampling can begin.

All subsamples will be placed in a designated location for transfer to the analytical laboratory. The subsampled bottles will be labeled and accompanied by all appropriate sample handling and tracking paperwork.

4.2 Grab Samples

Grab samples will be transferred to the appropriate laboratory as soon as the grab sampling is completed, whereas composite samples are transferred at the end of the storm event. All samples will be properly logged on the Chain-of-Custody Form and kept chilled in coolers. There will also be a field duplicate, a field blank, and extra water for QA/QC samples. These QA/QC grab samples will be collected at one of each consultant's BMPs during each storm event monitored. The sampling stations will be selected by Storm Control for collecting these duplicate grab samples. The crews monitoring the stations will be fully briefed on the procedures for collecting QA/QC samples, and familiarized with the "mock" station identification for these samples because they are to be submitted as blind samples. These samples also will be transferred immediately to the analytical laboratory under proper chain-of-custody.

4.3 Flow Meter Calibration Procedures

The following procedures apply to the American Sigma 960 Flow Meter.

Bubbler-type flow meters in Caltrans District 7 are used in conjunction with primary devices (i.e., H-flumes and Palmer-Bowlus flumes). The Bubbler-type flow meter continuously forces air through tubing that is affixed in the flow stream at the proper location for head measurement. The pressure in the tubing changes in proportion to the liquid level in the flow stream. The Sigma 950/960 reads this pressure and converts it into a level reading. After measuring a level, the microprocessor in the flow meter then

converts the level reading to a flow rate based on the user defined characteristics of the primary device through which the stream flows.

Initial calibration of the bubbler is performed at the factory; re-calibration should be performed annually to assure optimum accuracy. To calibrate the bubbler, first select the Bubble Rate to 2 or 3 (or approximately 1 bubble per second). Install a three-foot length of new bubbler tubing from the flow meter to a graduated cylinder filled with at least 6 inches of water. Assure that the tubing is held securely in the cylinder and can not move during calibration.

Select CALIBRATE BUBBLER from the Bubbler Calibration menu. Carefully measure the depth of the bubbler line with a ruler. Measure from the surface of the water to the bottom of the bubbler line (ignore the bubble).

The Sigma 960 takes its measurement just after the bubble escapes, thus assuring the most consistent and accurate reading.

Enter the new depth using the numeric keypad and press the ACCEPT soft key. The current reading is shown for reference. This depth value is always entered in the unit of measure, which was selected in the SETUP menu (i.e., inches). After calibration, re-check the level adjust when re-installing the flow meter.

5.0 LABORATORY QUALITY ASSURANCE/ QUALITY CONTROL

Analytical quality assurance for this program includes the following:

- Calibration of analytical instruments.
- Use of Standard Reference Materials (SRMs).
- Complete documentation of sample tracking and analysis.

Internal laboratory quality control checks will include the use of method blanks, matrix parameter.

Table 5.1
Laboratory Quality Control Samples by Analyte

Analyte	Blanks	Duplicates	MS/MSDs	LCS	Surrogates	SRMs
Water Matrices						
pH	—	✓	—	—	—	✓
Specific Conductance	—	✓	—	—	—	✓
Hardness	✓	✓	—	—	—	✓
TSS	✓	✓	—	—	—	—
Nitrate-N	✓	✓	✓	✓	—	✓
TKN	✓	✓	✓	✓	—	✓
Total Phosphorus	✓	✓	✓	✓	—	✓
Metals	✓	✓	✓	✓	—	✓
TPH/Oil and Grease	✓	✓	✓	✓	✓*	✓
Bacteria	✓	✓	—	—	—	—
Sediment/Soil Matrices						
TPH	✓	✓	✓	✓	—	—
VOCs	✓	✓	✓	✓	✓	—
Total Metals	✓	✓	✓	✓	—	✓
WET Metals	✓	✓	✓	✓	—	—
TCLP Metals	✓	✓	✓	✓	—	—

*TPH only

Table 5.2
Water Matrix
Quality Assurance/Quality Control Objectives

Analyte	Detection Limit	Accuracy		Precision		Completeness
		Spike Recovery	SRM[1] Recovery	Matrix Spike RPDs	Laboratory Duplicate RPDs	
Conventionals						
pH	0.1 units	—	80-120%	—	±20%	95%
Specific Conductance	1.0 µmhos/cm	—	80-120%	—	±20%	95%
Hardness	2 mg/L	—	80-120%	—	±20%	95%
TSS	1 mg/L	—	80-115%	—	±20%	95%
Nutrients						
Nitrate-N	0.01 mg/L	80-120%	80-115%	±25%	±20%	95%
TKN	0.1 mg/L	80-120%	80-115%	±25%	±20%	95%
Total Phosphorus	0.002 mg/L	80-120%	80-115%	±25%	±20%	95%
Metals						
Copper	1 µg/L	75-125%	80-120%	±25%	±20%	95%
Lead	1 µg/L	75-125%	80-120%	±25%	±20%	95%
Zinc	1 µg/L	75-125%	80-120%	±25%	±20%	95%
Organics						
TPH as Diesel/Oil	250 µg/L/200 ug/L	50-150%	50-150%	±50%	±50%	95%
TPH as Gasoline	50 µg/L	50-150%	50-150%	±50%	±50%	95%
Oil and Grease	5 mg/L	50-150%	50-150%	±50%	±50%	95%
Bacteria*						
Fecal Coliform	2 MPN/100 mL	—	—	—	—	95%

1. SRM recovery values based upon values provided with each specific SRM

Table 5.3
Sediment and Soil Matrices
Quality Assurance/Quality Control Objectives

Analyte	Reporting Limit	Units	Accuracy	Precision		Completeness
			Matrix Spike Recovery	Matrix Spike RPD	Replicate RPD	
Total Petroleum Hydrocarbons (TPH)	10	mg/kg	—	<30	<35	95%
Volatile Organic Compounds (VOCs)	SW – 846 (5) requirements	mg/kg	50-150%	<30	<35	95%
California Code of Regulations (CCR), Title 22 Metals(2):	SW – 846 (5) requirements	mg/kg	75-125%	<25	<35	95%
California Code of Regulations (CCR), Title 22 Waste Extraction Test (WET) Metals(3):	SW – 846 (5) requirements	mg/L	75-125%	<25	<35	95%
Toxicity Characteristic Leaching Procedure (TCLP) Metals(4):	SW – 846 (5) requirements	mg/L	75-125%	<25	<35	95%

(1) Surrogates are used to evaluate spike recovery and precision.: Benzene recovery limits=66-142, RPD<21; Toluene recovery limits=59-139, RPD<21; Chlorobenzene recovery limits=60-133, RPD<21.

5.1 Replicates (Laboratory Split)

On a frequency of one per batch of 20 or fewer samples, the laboratory will split/replicate one sample into two portions for each analytical method and analyze each portion. Duplicate analyses results are evaluated by calculating the relative percent difference (RPD) between the two sets of results. This serves as a measure of the reproducibility (precision) of the sample results. Typically, duplicate results will fall within an accepted RPD range, depending upon the analysis (see Tables 5.2 and 5.3).

5.2 Method Blanks

On a frequency of one per batch of 20 or fewer samples, a method blank sample will be analyzed for each analytical method. A method blank is a sample of a known matrix that has been subjected to the same complete analytical procedure as the submitted samples to determine if potential contamination has been introduced into the samples during processing. Blank analysis results are evaluated by checking against reporting limits for that analyte. Results obtained should be less than the reporting limits for each analyte.

5.3 Spikes

Two different kinds of spikes will be used: matrix spikes (MS) and laboratory control (blank) spikes (LCS).

Matrix spikes involve adding a known amount of the analyte(s) of interest to one of the submitted samples being analyzed. One sample is split into three separate portions. One portion is analyzed to determine the concentration of the analyte(s) in question in an un-spiked state. The other two portions are spiked with a known concentration of the analyte(s) of interest. The recovery of the spike, after accounting for the concentration of the analyte in the original sample, is a measure of the accuracy of the analysis. By determining MSD recoveries, another measure of precision (RPD) can be calculated. Both the RPD values and spike recoveries are compared against accepted and known method-dependent limits. Results outside these limits are subject to corrective action. MS/MSD data are also useful in evaluating matrix interference.

The second spike type, the LCS, involves spiking known amounts of the analyte(s) of interest into a known, clean matrix to assess the possible matrix effects on spike recoveries. High or low recoveries of the analytes in the matrix spikes may be caused by interferences in the sample. LCSs assess these possible matrix effects because the matrix is known to be free from interferences. Matrix spikes and LCSs are analyzed at a frequency of one per batch of 20 or fewer samples. Laboratory control spikes will only be conducted on water samples, not on sediment samples.

5.4 Standard Reference Materials (SRMs)

External reference standards (also known as SRMs) are artificial standards prepared by an external agency. The concentration of analytes in the standards are certified within a given range of concentrations. These are used as an external check on laboratory accuracy. One external reference standard appropriate to the sample matrix should be analyzed at least quarterly by the laboratory. If required, the laboratory should report the results of the external reference standard. If possible one reference standard should be analyzed with each batch of samples (also called a performance evaluation sample).

5.5 Surrogates

Surrogate standards will be added to all environmental samples and QC samples tested for TPH (using GC methods) and VOCs. Surrogates are non-target compounds that are analytically similar to the analytes of interest. The surrogate compounds are spiked into the sample prior to the extraction or analysis. Surrogate recoveries will be evaluated with respect to the laboratory acceptance criteria to provide information on the extraction efficiency of every sample.

5.6 Corrective Action

Corrective action is taken when an analysis is deemed unreasonable for some reason. These reasons include exceeding RPD ranges and/or problems with spike recoveries or blanks. The corrective action varies somewhat from analysis to analysis, but typically involves the following:

- A check of procedures.
- A review of documents and calculations to identify possible errors.
- Correction of errors.
- Similar calculations to improve accuracy.
- A re-analysis of the sample extract, if available, to determine if results can be improved.
- A complete reprocessing and re-analysis of additional sample material, if available.

6.0 DATA QUALITY MANAGEMENT

The following sections discuss data management and review procedures to be conducted for data generated under the OMM Plan.

6.1 Data Validation and Usability

Stormwater data collected under this program will be appropriately verified and validated. The purpose of data verification and validation is to assure that:

- Data collected meet the Project Data Quality Objectives (DQOs)
- Data can be used as a basis for evaluation of BMP constituent removal efficiency.

If needed, the data should be able to serve as a legal record of the field and laboratory activities conducted. In order to serve these purposes, all of the following verification criteria must be met:

- Date and time of sample collection - required to uniquely identify sample and assess any holding time limitations;
- Location of samples - required to uniquely identify samples (these data will be provided in the Chain- of Custody forms ;
- Chain-of-Custody documentation - required to demonstrate integrity of samples and maintain unique identity of samples; it includes a unique sample identification number, sample collection date and time, and signature of the persons relinquishing and receiving the sample;
- Field QA/QC procedures - required to demonstrate sample integrity; it includes the collection of field blanks, and the collection of duplicate samples during each sampling activity;
- Name and location of laboratory - required for chain-of-custody documentation and to verify credentials of laboratory;
- Analytical methods - required to assess appropriateness and acceptability of analytical method used;
- Reporting limits - required to assess the lower limit of parameter identification;
- Holding times, dates of extraction, analysis and preservation - required to assess whether the samples were extracted and analyzed within the holding time required; and
- Laboratory QA/QC procedures - required to assess analytical accuracy and sample integrity. Spikes, duplicates, method blanks, and surrogates (where applicable) are to be analyzed by the laboratory at appropriate frequencies.

Data validation will include calculation of precision, accuracy and completeness, as describe below. Validated data will be used to determine whether the DQOs have been met.

6.1.1 Data Validation

Data validation will be performed in accordance with the *National Functional Guidelines for Organic and Inorganic Data Review (EPA/540/R/94/090)* and *Guidance on the Documentation and Evaluation of Trace Metals Data Collected for the Clean Water Act Compliance Monitoring (EPA/821/B/95/002).* All laboratory and field data generated under this program will be reviewed for accuracy, precision and completeness. The review will include:

- Data package completeness;
- Chain-of-custody;
- Use of specified analytical methods;
- Holding times for extraction and analysis;
- Blank results (e.g., equipment blank, bottle blanks, filter blanks, and method blanks) relative to reporting limits and sample concentrations;
- Field duplicate frequency and precision;
- Laboratory duplicates frequency and precision
- LCS frequency, compounds, and recoveries;
- Surrogate standard frequency, compounds, and recoveries;
- Matrix spike frequency, compounds, and recoveries;
- Matrix spike duplicate frequency and relative differences;
- Reporting limits and dilution factors consistency; and
- Appropriate identification of analytical problems and exceedance of data quality objective in the case narrative.

The completeness of the data will be assessed by comparing the valid acquired data to the project objectives to see that these objectives are being addressed and met.

6.1.2 Data Usability

After the data has been collected and validated in accordance with the QAPP, the data must be evaluated to determine whether the DQOs have been satisfied. The data usability process will determine:

- Whether the data meets the assumptions under which the DQOs and the data collection design were developed, and
- Whether the total error in the data is small enough for the data to support the decision within tolerable error rates.

6.2 Evaluation of Analytical Results

The analytical data will be evaluated in conjunction with empirical observations to determine constituent removal efficiency per BMP type. The evaluation of water quality data will examine influent versus effluent constituent concentrations, the associated documentation, the quality of analytical results, and any data usability issues that may prevent defensibility of results.

Prior to any interpretation, the analytical data will be evaluated with respect to QA/QC results. Specifically, the data will be examined with regard to data qualifiers assigned during the data validation process, and concentrations of contaminants, if any, detected in blanks.

Data qualifiers assigned during the data validation process will be examined to determine their effect on data quality. If data validation indicates that a particular result is unusable, the data will be rejected. If the data validation indicates that a particular numerical value is an estimated quantity, then the data may be used during the evaluation process as long as the qualification is considered during data interpretation.

Any metals or organic analytes that can be classified as common laboratory contaminants as defined by USEPA (*EPA, Risk Assessment Guidance for Superfund Volume I, Human Health Evaluation Manual, EPA/540/1-89/002, 1989*) and are detected in blanks will be evaluated regarding the sample results. If the same analytes are detected in samples associated with the blank(s) at concentrations below ten times (metals and common organic constituents) the concentrations found in the blanks, then the analyte will be considered not present. If the concentration found in a sample is above ten times the concentration found in a blank, the results will be considered a positive detection.

If an analyte is detected in a blank and associated samples, but is not a metal nor considered a common laboratory contaminant then the following evaluation will occur. If the same analytes are detected in samples associated with the blank(s) at concentrations below five times the concentrations found in the blanks, then the analyte will be considered not present. If the concentration found in a sample is above five times the concentration found in a blank, the results will be considered a positive detection.

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CALTRANS
BMP RETROFIT PILOT PROGRAM

DISTRICT 11, SAN DIEGO

BMP OPERATION, MAINTENANCE, AND MONITORING PLAN

VOLUME II

APPENDIX IV
VECTOR CONTROL PLAN

September 1999

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1.0 INTRODUCTION

Constructing retrofit pilot BMPs will modify the existing stormwater drainage systems by adding various retrofitted stormwater treatment technologies. Because such retrofitting may create opportunities for disease-carrying or nuisance organisms to flourish, organisms such as mosquitoes, midges, or rodents may have to be controlled.

Structures that create standing water present opportunities for vectors to establish themselves and potentially spread diseases. The organisms that pose the greatest threat for spreading vector-borne diseases are vectors like mosquitoes, and vertebrate hosts such as rats, ground squirrels, skunks and opossums. The program for monitoring and controlling vectors is described below. Although the vector organisms identified do not include cockroach species, they have been carefully studied and analyzed by local vector-control agencies and specialists. The result of this evaluation has concluded that cockroach vectors will not be a disease path of concern for these retrofit projects, and therefore cockroaches are not discussed further herein.

This section discusses the monitoring program for detecting any possible disease vectors or nuisance organisms. It also discusses the inspection and maintenance measures that will be taken to minimize the potential for such vector or nuisance organisms, and the treatment guidelines to be taken if such problems are detected. The first operational winter will serve as a basis for determining what vector control strategies are necessary. Following the first operational season, vector control specialists and agencies will be consulted with respect to any changes in abatement procedures.

The strategy for the management of potential vector problems requires the following:

- Minimize the opportunities for such vector or nuisance organisms to become a potential problem.
- Carve out a monitoring and maintenance program based upon defined and regular observations and inspections that will ensure that unsuitable conditions do not develop that encourage a vector or nuisance problem.
- Define threshold criteria to identify such a problem, and treatment guidelines to correct the problem.

2.0 VECTOR MONITORING

2.1 Mosquito, Midge and Black Fly Monitoring

The vector and nuisance insect monitoring program consists of two components: larval monitoring and adult monitoring. The larval monitoring will also collect pupae. Abatement decisions will be based on the abundance of immature stages, particularly larvae, in samples.

The adult monitoring is carried out using two traps: a CO_2-light trap and a gravid trap (Reiter, 1983; 1987, Service, 1993). Because the extent of attractancy to carbon dioxide differs among mosquito species, utilizing two trap types will provide a better measure of the mosquitoes present at BMP sites. The addition of a long-wave ultraviolet light source will enhance the attractiveness of traps to mosquitoes and to chironomid midges. Midges are not attracted to carbon dioxide.

Larvae monitoring is carried out by dipping or net hauls for mosquito larvae, by benthic grabs or cores for midges, and by quadrant counts for black fly larvae.

2.1.1 Mosquitoes and Midges: Adult Sampling

CO_2-Light Traps

Carbon dioxide-light traps will be run for one night each week at each BMP location. Multiple traps will be placed at BMP sites that are larger than 0.25 km in diameter. Each trap will carry a site-specific label. The air-actuated gate and the fan of each CO_2-light trap will be programmed to turn on at dusk (30 minutes before civil sunset) and to turn off after sunrise (30 minutes after civil sunrise).

In order to attract both mosquitoes and midges, the trap will be equipped with a single 4-watt ultraviolet lamp (wavelength range: 320-420 nm). Each CO_2-light trap will be stocked with 2 kg of solid carbon dioxide (dry ice). During the night, the carbon dioxide will sublimate and be released by the manifold directly above the fan and collection bag at approximately 500ml/min.

The trap is powered by 6-volt batteries. They can also be powered by D-cell alkaline batteries connected in series or by rechargeable 6-volt dry cells. Because of the ultraviolet light, the life of the power supply must exceed 10 amp hours.

If mosquitoes or midges are collected, then the catch will be labeled with a site-specific tag, placed into an insulated cooler, and returned to the laboratory. Prior to identification, the mosquitoes will be killed by freezing or by exposure to carbon dioxide in an enclosed container (e.g., a small insulated chest).

Placement of the CO_2-Light Trap

The CO_2-light trap will be placed in a sheltered position such as near a tree, vegetation, or a vertical wall. If a vertical structure is not present, then the trap can be hung from a stake. The same site will be used repeatedly to standardize sampling.

Vandalism and theft are common problems encountered during trapping studies. Some of the BMP sites are accessible to the general public. Attempts will be made to hide the traps. Interlacing a metal cable among the parts of a trap and locking it to a vertical structure may provide additional security.

In order to reduce the likelihood of distracting drivers, traps should not be placed adjacent to traffic or breakdown lanes. When possible, light traps will be hidden from traffic.

For the majority of BMP sites, one trap is adequate to census the mosquito/midge populations. If the traps are adequately maintained, trap failure is rare.

CO_2-Light Trap Set-Up

The following items will be accomplished prior to leaving for field sites:

- Charge batteries.
- Check synchronization of photosensor switches.
- Repair/replace any motor, air-actuated gate, photosensor, or any component found to be malfunctioning.
- Carry out preventative maintenance on motors including cleaning brushes, lubricating moving parts, etc.
- Obtain a sufficient quantity of dry ice for the traps. Stocking dry ice containers with precut blocks of dry ice will expedite trap placement at the BMP sites. A block of dry ice for each trap is preferable to chips of dry ice because the block sublimates more slowly and is more likely to persist throughout very warm nights. Dry ice must be transported separately from the driver and passenger(s). Dry ice should be transported in the rear of a pick-up truck fitted with a camper shell.

Gravid Traps

One gravid trap will be run for one night each week at each BMP location.

The gravid trap and CO_2-light trap will be placed in proximity since they sample different components of the adult mosquito population. Because gravid traps contain liquid, a reasonably level site will be selected. Ants may be a problem because they will enter collection chambers and eat the trapped insects. Ant-proofing may be required. Preferred methods of ant-proofing are (1) a ring of sticky substance (e.g., Tanglefoot) or (2) a ring of Teflon paint at the base of the trap.

Each week a fresh infusion of oviposition medium will be set up in large plastic trash bins. A trash bin should be perforated on the bottom and sides, and set in a second bin prior to adding the infusion constituents. The infusion is composed of 0.5 kg hay, 5 g dried brewer's yeast, 5 g lactalbumen, and 114 liters of water. Water aged for a minimum of seven days is preferred to distilled/de-ionized water or tap water. The mixture is covered for 5 days outdoors. The water temperature must be kept below 40°C. Prior to use, the infusion will be screened (screen size opening approximately 0.6 cm) to remove floating debris.

The following items will be accomplished prior to leaving for field sites:

- Charge batteries.
- Check synchronization of photosensor switches.
- Repair/replace any motor, air-actuated gate, photosensor, or any component found to be malfunctioning. Carry out preventative maintenance on motors including cleaning brushes, lubricating moving parts, etc.

The infusion for the gravid traps will be transported to the BMP sites in 20 liter covered carboys. At each BMP site, four liters of infusion will be added to the bottom of the gravid trap and then the top components of the trap will be assembled and placed onto the trap's base. The motor/fan of the gravid trap at each BMP location is programmed to activate at dusk (30 minutes before civil sunset). The motors are turned off the following morning when the trap is retrieved.

If mosquitoes are collected, then the catch will be labeled with a site-specific tag, placed into an insulated cooler, and returned to the laboratory. Prior to identification, the mosquitoes will be killed by freezing. Each trap will carry a site-specific tag/label attached to the collection bag. The following information will be recorded on the label:

- Date and time trap was deployed.
- Name of the facility.
- An unique alphanumeric identification code.
- Samplers initials.
- Preservative (i e., dry ice) if any.
- Date and time trap was deployed.

During all site visits to the EDB for the purpose of vector control inspections and sampling, a vector control checklist will be filled out (Figure 4.3).

2.1.2 Mosquitoes and Midges: Larval Sampling

Larval surveys can determine the spatial and temporal use of a habitat by a particular mosquito species. Larval surveys can also determine the composition and density of a population. These data help decide which control measures are best, and whether they are effective.

Routine larval and adult surveillance data can evaluate whether sites, other than those under consideration, are sources of adult mosquitoes or midges. For example, if control measures were carried out at a BMP site, larval surveys would indicate if the control measures were effective. If adult populations did not change or decrease, it is likely that another site was also producing the adults.

Dipping

Larval mosquitoes can be sampled by standard dipping techniques. A standard plastic dipper is used which has a solid bottom and holds approximately 400 ml of liquid. The sampling method should minimize overflow from the dipper and avoidance behavior by mosquito larvae. The technique that is used depends on: (1) the mosquito species likely to be present, (2) habitat, and (3) weather conditions. A quick dipping technique utilizes a swift and steady flick of the wrist, and works best where emergent vegetation is present and for larvae that are not always at the water surface or that exhibit rapid avoidance behaviors to physical disturbance such *Aedes* and some *Culex*. A slow dipping technique utilizes a slow pulling of the dipper through the water column, and works best for surface-dwelling larvae such as *Anopheles*.

For shallow water (water depth < the height of the dipper's cup), the dipper is held at a 45° angle, and water is allowed to flow into the dipper (Knight 1964, O'Malley 1995).

Three to five dips should be taken every 3-6 m (5-10 paces) around the perimeter of vegetated habitat. Dippers with extendable handles should extend the distance that samples can be taken without creating shadows on the surface of the water.

The following protocol will be used in dip sampling:

1) Observing all Caltrans safety requirements, park your vehicle and approach the BMP site.
2) Assess whether standing water is present.
    a) If standing water is not present, then larval sampling cannot be carried out. Proceed to step 5.
    b) If standing water is present, then proceed to step 3.
3) Determine the location, extent (approximate surface area), and depth of standing water.
4) Dips: Three to five dips should be taken every 3-6 m (5-10 paces). Transects across standing water should be separated by 3 m, with special attention being paid to any emergent vegetation where larvae are likely to be aggregated. The number of dips taken should be recorded. Dips should be concentrated using a concentrator cup (mesh opening ≤ 200 microns), rinsed into a labeled sample jar or vial, and preserved with 95% ethanol (final concentration = 50%).
5) Continue with other duties and safely leave the site.

Several factors should be considered when collecting samples of mosquito larvae.

- Approach cautiously in order to avoid disturbing mosquito larvae at the water surface.
- Mosquito larvae are typically associated with vegetation or debris on the water surface. In larger water bodies, larvae will be found in the vegetation at the periphery and not in open, deep water. If conditions are windy, larvae will be concentrated along the windward side of the habitat.
- If it is raining, postpone larval sampling until after the rain.

Larvae can be counted in the field or preserved for enumeration and identification in the laboratory. The water volume of the sample is reduced by filtering the sample through a screen (mesh opening < 200 μm). A concentrator can be constructed from a plastic measuring cup (volume = 500 ml) into which screen windows have been cut. A squirt bottle containing water can be used to rinse any material caught on the screens. The material in the concentrator cup should be rinsed into a labeled sample jar or vial and then preserved with 95% ethanol (final concentration approximately 50% ethanol).

Net Hauls

Mosquito larvae in steep-sided chambers such as catch basins are best sampled by net (Service 1993) or by strainers attached to lines (Siegel and Novak 1997). Three samples, two along the sides of the chamber and one at the center of the basin are recommended. If one side of the catch basin is shaded, then one sample should be taken along the shaded side of the basin. Three plankton or World Health Organization (WHO)-style nets may be lowered into the basin at the same time. Lowering the net(s) into the water will disturb the mosquito larvae, causing them to submerge. After waiting 3-4 minutes, raise the net slowly until the net is within approximately 15 cm (6 inches) of the water surface and then pull the net through the water surface in one rapid motion. A squirt bottle with water can be used to rinse any material caught on the net into the collection chamber at the base of the net. The material in the collection chamber should be rinsed into a labeled sample jar or vial and then preserved with 95% ethanol (final concentration approximately 50% ethanol).

Laboratory Processing of Samples

The abundance and species composition of immature stages of the mosquito life cycle will be quantified in the laboratory.

1) The liquid contents of the sample should be removed by screening the sample through a screen of similar (or smaller) mesh size than that in the concentrator cup.

   Because ethanol solutions can be an irritant to persons working over preserved samples, replacing the ethanol with water is advisable. Properly dispose of the ethanol solution.

2) The biological material retained on the screen is rinsed with water and placed into a gridded petri dish.

The grid on the petri dish should be small enough to assist counting under a dissecting microscope. A 10 cm diameter petri dish with a grid of 1 cm squares is recommended. The points equal to 25, 50 and 75% of the surface area are noted on the bottom of the dish; this will allow sub-sampling of the samples.

3) Count the number of immature stages of mosquitoes present in the sample.

Three categories should be scored: young larvae, old larvae, and pupae. Mosquito larvae should be separated into young (stages I and II) and old (stages III and IV) larvae. Young larvae and pupae can be readily assigned to genus. Old larvae can be identified to species. Identifications should be made using Bohart and Washino (1978) and current species names should be substituted where necessary.

Sampling for Midges

Soft Substrates. Midge larvae living on and within soft sediments are sampled using either an Ekman grab or a coring device. Both samplers take samples of known surface area. Midge larvae are then separated from the sediments and enumerated. Because greater replication is possible and processing time is greatly reduced, coring samplers are recommended. Even though coring samples sample a smaller surface area than does the Ekman grab sampler, threshold concentrations of 300 midge larvae per ft^2 can be readily determined using cores.

Ekman Grab Sampler. The Ekman grab consists of a metal box (typical measurements: 15.2 X 15.2 cm) equipped with spring-operated jaws. The sampler can be suspended either from a rope or from a pole. The jaws are usually triggered by sending a weight (messenger) down the line which passes through the tripping mechanism to the top of the sampler. **Caution must be exercised when using the sampler** because the doors are held under pressure when open; inadvertent triggering can cause injury if one's fingers are within the operating arc of the jaws.

To take a sample, the doors are cocked open and the sampler is lowered until it rests on the sediments. The messenger is sent down the line to close the jaws. If a pole is substituted for the line, the doors are closed by exerting downward pressure on the pole which is attached to top of the trigger plate. The sampler is retrieved and a 10-liter (2.5 gallon) plastic bucket is placed beneath the sampler as it breaks the water surface. The jaws are opened and the sediments are washed into the bucket. If the jaws did not close completely (e.g., a piece of debris did not allow the jaws to close completely), the sample should be discarded.

While the Ekman grab takes large samples, the sieving and sorting time required is much longer than for coring devices. A large sample is statistically advantageous; however, greater replication with a sampling device that samples a smaller surface area may be advantageous.

Coring Sampler: The coring sampler is essentially a tube that is forced into the sediment. The top of the tube is closed or plugged prior to removal of the tube from the substrate so that sediments are not washed out. If sediments are very soft or flocculent, the tube may require a closing device on the bottom. A coring device could be easily constructed using a length of PVC pipe and appropriate-sized rubber stopper(s).

As compared to the Ekman grab sampler, coring devices usually sample a small area. Whereas small samples are disadvantageous when studying sparsely distributed organisms, the reduction in sample processing time and increased replication are advantages of cores. If the core has a diameter of 7.62 cm (3 inches), each sample will be equal to 182 cm^2 (or 0.2 ft^2). If the threshold for treatment is set at 300 midge larvae·ft^2, then samples containing > 60 larvae are indicative that treatment is needed.

A minimum of 3 cores is recommended for catch basins and a minimum of 6 cores is recommended for small infiltration basins. Increasing the number of replicates will improve the accuracy of density estimates; the number of cores might have to be increased if the variation in counts is too large. Assuming a Poisson distribution of larvae in the sediments, the expected variation around a mean of 60 individuals is about 25-30%.

Field and Laboratory Processing

In order to reduce the volume of sediment, the sample should be screened using standard metal geological sieves. Ideally, a mesh size of 0.20 mm should be used to reduce the volume of sediments in samples. Smaller mesh sizes are impractical because of clogging and increased processing time. Whereas some small organisms/instars might pass through the screen, this mesh size represents the practical lower size limit for sampling benthic insects. If clogging of the 0.20 mm sieve is a consistent problem, larger mesh sizes (0.40 - 1 mm) should be considered. Mesh sizes ≤ 0.60 mm should retain the larval instars that might be indicative of potential nuisance midge problems. After screening, the sample can be placed into a labeled Tupperware container and then into a cooler for transport to the laboratory. If the samples are to be processed within 48 hours, then preservation may not be needed. If preservation is needed, 95% ethanol combined with a small amount of rose bengal dye is recommended. The rose bengal dye will stain the insects a bright scarlet and help to distinguish the insects from the sediments during sorting.

The midge larvae are separated from the sediments and counted by placing small amounts of the sample into a white enamel or plastic tray, and removing the larvae by hand. Dividing the pan into smaller units by marking the sides and bottom of the pan with an indelible marker will allow subsamples to be taken if needed.

Hard Substrates

Midge larvae can also be found attached to hard surfaces such as cement basins, cement water conveyance structures, etc. Such structures should be examined for the presence of larval chironomids. Larval densities can be assessed by random placement ***1 ft^2 quadrat*** and counting the number of larvae per unit area.

2.1.3 Black Fly Larvae

The immature stages of black flies are found in flowing water where the larvae form aggregations on stones, vegetation, debris, and other objects in flowing water. Pupae can be found attached to the larval substrates. Black fly larvae are generally assessed by inspections. Quantitative estimates of larvae can be obtained by use of the quadrant method on flat surfaces where the densities of larval aggregates are not extremely high.

2.2 Vertebrate Vector Monitoring

2.2.1 Vertebrates: General

The design of the BMP and degree of maintenance will determine whether vertebrate vectors become a problem. None of the sites will provide significant harborage, forage, or any other requirement for vertebrate vectors. However they may offer short term (72 hour) sources of drinking water if the BMPs function as expected and are operated according to established maintenance schedules. Monitoring should be considered only if preliminary findings indicate it is necessary. Observations for vertebrates would be carried out weekly, in conjunction with insect monitoring. Only after a vertebrate vector problem is identified at a site would actual vertebrate monitoring or control measures be implemented.

The opportunity for monitoring ground squirrels extends from March 1 to July 1. This will allow ample time to carry out a monitoring plan for ground squirrels toward the end of March and repeated at the end of April, May and June. It is estimated that the proposed vertebrate vector inspections will require between one and three hours, depending on the physical size and location of the site. Rodents can be monitored year-round and the schedule for those activities can be set after the inspections are completed.

Some vertebrates that are considered “vectors” are actually “reservoirs” or hosts, and the agents that cause human disease are transmitted by their arthropod parasites. A classic example is plague. The bacterium *Yersinia pestis* is transmitted to humans by fleas that live on rodents. In California, ground squirrels, chipmunks, and wood rats have also been implicated in the transmission of plague. Other human diseases associated with vertebrates and their parasites are murine typhus, relapsing fever, and Lyme disease. Animals can be true vectors and transmit disease through bites or other close contact. Rabies is transmitted when infected saliva contaminates enter through a break in the skin. In California, skunks, bats, and foxes are most associated with rabies. Hantavirus pulmonary syndrome is also transmitted directly when humans inhale virus in feces or urine of deer mice . Other diseases associated with vertebrate vectors in California include tularemia, Rocky Mountain spotted fever, and leptospirosis. The vertebrate vectors that may be associated with currently planned BMPs are: the following:

A. Commensal (domestic) Rodents.
   1. Family Muridae
      a. Roof rat, *Rattus rattus*
      b. Norway rat, *Rattus norvegicus*
      c. House mouse, *Mus musculus*

B. Wild rodents
   1. Family Cricetidae
      a. vole, *Microtus* spp.
      b. wood rat, *Neotoma* spp.
      c. deer mouse, *Peromyscus* spp.
   2. Family Sciuridae
      a. California ground squirrel, *Spermophilus beecheyi*

C. Other Vertebrates
   1. Family Mustelidae
      a. striped skunk, *Mephitis mephitis*
   2. Family Didelphiidae
      a. opossum, *Didelphis marsupialis*

2.2.2 Vertebrate Monitoring: Methods and Equipment

Several methods can be used to monitor vertebrate vector activity.

Observation***:***

- Visual sighting.
- Burrowing/nesting activity.
- Plant/structure damage.
- Tracks/trails.
- Fecal/urine deposits.
- Odor, skeletal/skull identification.

Trapping

Live trapping is commonly used for both surveillance and control of vertebrate vectors.

Ground squirrels can be trapped , using baits such as nuts, peanut butter, or grain, occasionally supplemented with fruit. Traps should be placed and retrieved within 24 hours. A minimum of twenty traps are usually set at one time. Skunks, opossums, rats, mice, voles, and other animals can also be trapped with appropriate baited live traps placed near known habitat and runways. Live traps and their dimensions are identified below.

A. Ground squirrels
   1. Tomahawk live trap 19”x 6”x 6” (48.3 x 15.2 x 15.2 cm)
   2. Havahart live trap 18”x 5”x 5” (45.8 x 12.7 x 12.7 cm)
   3. Tru-catch (Margo Supply-Canada)

B. Rats (Norway rats, roof rats and wood rats)
   1. Tomahawk live trap 16”x 5”x 5” (40.8 x 12.7 x 12.7 cm)
   2. Havahart live trap 18” x 5”x 5” (45.8 x 12.7 x 12.7 cm)
   3. Sherman live traps 12”x 3”x 3 3/4” (30.4 x 7.6 x 9.5 cm)

C. Mice
   1. Havahart live traps 10”x 3”x 3” (25.4 x 7.7 x 7.7 cm)
   2. Sherman live traps 9”x 3” x 3 ½” (22.9 x 7.6 x 8.9 cm)

D. Skunks/opossum
   1. Tomahawk live trap 20”x 7”x 7” (50.8 x 17.8 x 17.8 cm)
   2. Havahart live trap 30”x 7”x 7” (76.2 x 17.8 x 17.8 cm)

2.2.3 Vertebrate Vector Monitoring Strategies

Monitoring populations of small animal requires knowledge and experience. Ground squirrels are active in daylight hours. Since they are burrowing animals, activity can be determined by observing burrowing systems. Tracks and trails are less reliable but can confirm their presence in concert with other signs. Their activity is greatly reduced after late fall , during winter, and during the warmest parts of summer. Their home range is approximately 300 feet. A minimum of twenty live traps of the appropriate size should be placed at least four times during the monitoring season. The traps should be set early in the morning, checked twice during the day, and collected when full or during the same evening. Animals trapped are identified to species, weighed and measured, sexed, approximate age determined, euthanized, and data recorded. If the Regional Supervising Public Health Biologist, California Department of Health Services, Vector-borne Disease Section determines that it is necessary, blood and ectoparasite samples will be tested by the Departments laboratory for the presence of disease.

Voles

Voles prefer habitat where there are abundant seeds, roots, and other forage. They connect their burrows with one to two inch wide runways through matted grass. They are chiefly diurnal but are seldom seen. Voles are extremely fecund and their population is cyclic. They reach high population levels every three to four years, followed by a rapid decline the next breeding season. Voles are active year-round and their home range is 60 feet or less. To monitor voles, traps of the appropriate size are placed as needed in the early morning and collected the same evening, over three consecutive days, repeated quarterly. Animals trapped will be identified to species, weighed and measured, sexed, appropriate age determined, and data recorded.

Norway Rats

Norway rats are usually associated with burrows that are adjacent to structures. These burrows can be seen, but tracks, gnawing marks, and rub marks from their fur can also indicate their presence. They are nocturnal and sighting is not a reliable method of monitoring their populations. Their home range is typically 100 to 150 feet.

Roof rats

Roof rats are excellent climbers and spend much of their time above ground. They prefer a vegetarian diet and are associated with dense vegetation. Roof rats may be detected by observing gnawing on fruit, trees, and other objects in their habitat. Roof rats are nocturnal and have oily fur that will frequently stain light colored surfaces. The roof rat home range is usually greater than 100 to 150 feet. Domestic rodents will be trapped on three consecutive trapping nights, repeated quarterly at each site where monitoring is necessary. Sites will be pre-baited two consecutive nights prior to the traps being set. Traps of the appropriate size will be placed as needed after pre-baiting, in the evening and collected the next morning. On each of the three collection days, the animals caught will be identified to species, weighed and measured, sexed, approximate age determined, and the data recorded.

3.0 VECTOR CONTROL STRATEGIES

In order to reduce the production of vectors and nuisance insects and minimize the application of pesticides at BMP sites, effective habitat management is essential. Management strategies should focus on three general areas: (1) physical control, (2) biological control, and (3) chemical control.

3.1 Physical Control

3.1.1 Mosquitoes and Midges

Standing water should not persist more than 7 days in any BMP designs except for wet basins that require continuous flooding. If floodwater mosquitoes such as *Psorophora* spp. become problematic, the time period will be reduced to 3 days. Standing water that is present beyond the requirements for water quality improvement should be removed immediately. Wet basins must be designed so the depth of water can be manipulated rapidly and effectively.

Vegetation provides refuge from predation and physical disturbance (e.g., waves), and food resources for mosquitoes (Collins and Resh 1989). Vegetation management also aids in the control of mosquitoes. Each type of BMP must employ its own vegetation management strategy.

One effective way to control vegetation is to properly manage water (Cardarelli 1976,Collins and Resh 1989). Standing water that contains vegetation and/or organic debris is a typical problem. Additionally, habitat that is temporarily inundated can also produce mosquitoes. Shallow ponds with fluctuating water levels, partial draw down of deep-water systems and complete draw down of a wetland may create substrate that is the preferred oviposition sites for *Aedes* spp. and *Psorophora* spp. Where these species occur, the sides of the BMP must be almost vertical. Channels with steep sides that increase the water flow will reduce the likelihood that pools and marshy areas will develop (Service 1980). Procedures that create depressions e.g., tire tracks that collect standing water in the basin floor should be avoided.

Partial draw down is an effective strategy when mosquitoes are restricted to the periphery of a source (Collins and Resh 1989). Augmentation of water is generally more successful at controlling the growth of bulrush *Schoenoplectus(Scirpus)* and cattail (*Typha*) (based on growth requirements listed in Kadlec and Knight 1996. Augmentation of water is not effective in all situations, particularly where hydrophytes are already established. If emergent vegetation at the wetland periphery is the primary source of mosquitoes, augmentation could exacerbate problems by increasing the amount of wetted vegetation (Collins and Resh 1989). Augmentation is also impractical for stormwater control structures because the water supply is unpredictable.

Other forms of vegetation management include harvesting, controlled burning and using herbicides (Collins and Resh 1989, Kadlec and Knight 1996). Herbicides are impractical where water quality is the primary concern. Harvesting requires heavy, expensive equipment such as

tractors, bulldozers, or amphibious/aquatic mechanical weed-harvesting equipment (McComas 1993). If tractors or bulldozers are used, the BMP should be dry.

Burning creates several undesirable effects. Fire mobilizes stored nutrients and pollutants (Kadlec and Knight 1996). Drying is required for burning and may destroy the litter and sediment layers (Kadlec and Knight 1996). Burning adversely affects air quality and increases the potential for forest/brush fires. Winter rains can significantly limit the effectiveness of controlled burns. Ash and other residuals are likely to have a negative effect on water quality.

3.1.2 Vertebrates

Ground Squirrels

Any modification that discourages burrowing is helpful in controlling ground squirrels. Controlling the amount of vegetation and seeds used for food and nesting materials where possible is also recommended.

Small numbers of ground squirrels can be controlled with traps. The live traps described in the monitoring section could be used, and any animals that are caught should be handled as described in the vector monitoring section.

Rats

Norway rats are burrowers and they feed on high protein food sources such as meat scraps and garbage. They have a daily requirement for water. Regular control of weeds and removal of debris near structures will reduce the amount of food and harborage. Roof rats live in lush vegetation. They feed on many of the fruits and vegetables in their environment. Roof rats get much of their water from the foods they consume. Removal of harborage and food are the two most important steps in controlling roof rats.

Physical barriers can prevent rodents from entering structures. All openings larger than 1/4 inch should be sealed with material, e.g., galvanized hardware cloth that rats cannot gnaw through. Burrowing near structures can be prevented by laying a strip of heavy gravel at least two feet wide and six inches thick around the perimeter of foundations or concrete slabs. Ventilation openings greater than 1/4 inch in diameter should be securely covered with galvanized hardware cloth. To prevent roof rats from climbing trees, trunks can be banded with 18-inch wide bands of metal. Wires or pipes leading into trees or structures can be fitted with metal cone guards at least 20 inches in diameter.

Rats may be trapped with snap traps. Traps should be placed where rats are most likely to come in contact with them, e.g., on runways, areas adjacent to vertical surfaces, near burrow openings and other known travel routes. Effective baits are peanut butter, either alone or mixed with dry oatmeal, cooked bacon, and marshmallows. The bait must be securely attached to the trigger

mechanism. To avoid neophobic behavior, pre-baiting with unset, baited traps is recommended for the first 2-3 nights. Bait should be replaced regularly. Petroleum based lubricants should not be used to lubricate trap moving parts.

Voles

Removal of grass and seed on slopes may be the only effective physical method of controlling voles. Controlling vegetation that provides harborage and/or food is an essential part of a comprehensive control program. Algerian ivy, bougainvillea, palm trees, bamboo, natal plum bushes, and other lush vegetation can serve as both shelter and food sources for rats and other rodents. Grasses and their seeds provide forage and nesting materials for voles and other small rodents. Vegetation should be removed entirely or thinned to the extent where they are no longer attractive as either food or harborage.

3.2 Biological Controls

3.2.1 Mosquitoes

The biological control agent most commonly used to control mosquitoes is the mosquitofish, Gambusia affinis. Mosquitofish are most effective in wet basins that have a depth of 4-12 feet and limited shallow shoreline (< 30% of surface area). Their effectiveness as a mosquito control agent declines as the density of vegetation increases.

3.2.2 Vertebrates

Biological control techniques for vertebrate vectors are not well studied. Existing population of natural predators may help. These include hawks and owls, coyotes, bobcats, gopher snakes, foxes, weasels, and skunks.

3.3 Chemical Control

3.3.1 Mosquitoes

Vector control agencies prefer “biologically rational” compounds to control mosquitoes. Most programs focus on controlling mosquito larvae with compounds such as mosquito-specific bacteria in the genus *Bacillus* (Eldridge and Federici 1988) and insect growth regulators (IGRs). Adulticiding is used only as a last resort. In Southern California, three types of pesticides are currently used against mosquito larvae: mosquitocidal oils, mosquito-specific bacteria and insect growth regulators (IGRs).

Mosquitocidal Oils

Mosquitocidal oil kills mosquito larvae and pupae by suffocation. This oil is the only material available for use in California that is effective against mosquito pupae (Beehler and Mulla 1996). The oils dissipate within 48 hours after application. If this is the only pesticide used, sites where

mosquitoes are breeding must be monitored and treated every 7 - 10 days. Mosquitocidal oils are used when pupae are present, or when the condition of the water makes all other pesticides ineffective.

Mosquito-Specific Bacteria

Bacillus thuringiensis variety *sraelensis* (*Bti*) and *Bacillus sphaericus* are currently registered for use in California. *Bacillus sphaericus* is more effective in wastewater with high organic content and/or suspended sediment than *Bti*.

Both *Bti* and *B. sphaericus* do not harm humans and non-target organisms when applied according to the label. The toxins they produce degrade rapidly in aquatic environments. The application of *Bti* and *B. sphaericus* to BMPs should not compromise the water quality.

Sites should be monitored weekly during the peak mosquito season (April until October). *Bti* may provide effective control for 1 to 2 weeks (Mulla 1985). *B. sphaericus* is effective for much longer (weeks to months in small containers, but will have to be applied more frequently at BMPs).

Insect Growth Regulators

Methoprene is a synthetic hormone that inhibits the emergence of adult mosquitoes. When applied to sites where larvae are present, mosquitoes fail to develop into adults. Methoprene is available in several formulations including liquid concentrates, pellets, and briquettes, and can also be applied in combination with Bti.

Liquid formulations of methoprene are used regularly as part of an integrated control program against mosquitoes in Los Angeles County. Other formulations may also be effective at BMPs. Briquettes release methoprene over a 30-120 day period. Environmental conditions influence the persistence of methoprene, e.g., heavy rainfall, burial by sediment, and thick vegetation inhibit dispersion. Briquettes are used at rates from 0.5 per 100 square feet to 4 per 100 square feet for shallow and low-flow habitats. Application rates vary with the flow-through rates of a site. In general, 1 briquette is applied per 10 cubic feet (75 gallons) of water at flow rates greater than 40 cubic feet per month. The number of briquettes increases with the maximum water volume in the application site and each four-fold increase in flow rate. When the flow rate exceeds four volume changes per month, the treatment interval is adjusted according to the formula:

[allowable flow/actual flow] x 30 = adjusted interval (days),

where allowable flow is four volume changes of the maximum volume of the application site.

Methoprene briquettes can control mosquitoes for most of the mosquito season if the conditions at the site are right. Sites where methoprene is applied must be monitored to assess the effectiveness of the application.

3.3.2 Midges

All efforts at controlling midges are directed towards larvae. When at least 300 larvae per square foot of substrate are observed, methoprene granules should be applied at a not to exceed rate of ten pounds per acre.

3.3.3 Vertebrates

Physical controls should be used whenever possible and chemical controls should be considered as a supplemental alternative. For rats and other rodents, currently registered rodenticides such as multiple dose anticoagulants should be considered. These are typically formulated in wax blocks or pellets and are placed in approved tamper-resistant bait stations designed to allow access to the target rodent. These stations are placed in proximity to rodent habitat. Second generation anticoagulants require one feeding to produce the desired results. All bait stations and rodenticide containers must be properly labeled and they must be placed and monitored by trained staff.

4.0 THRESHOLD CRITERIA AND TREATMENT GUIDELINES

4.1 Mosquitoes and Midges

Measures to control mosquito larvae are initiated when one or more larvae or pupae are found at a BMP site.

Adult monitoring will indicate whether more larval sampling is necessary and will be compared to the baseline abundance and species for a given BMP site. If the number of adults is much greater than background levels, samples of mosquito larvae from the BMP site need to be obtained. Larval samples can be combined with adult surveillance data to evaluate whether adult mosquitoes are in fact coming from the BMP site.

Abatement measures to control mosquitoes, midges, or black flies may be necessary. Mosquito specific bacteria may be used. The duration of control will depend on environmental factors, particularly the flushing rate. Larvicides must be applied according to the label. *Bacillus sphaericus* may be effective for three or more weeks (Siegal and Novak 1997). The evolution of resistance to this product is of concern. Rotation of larvicides will reduce the likelihood that the mosquitoes will develop resistance to *B. sphaericus*.

Insect growth regulators, i.e., methoprene can be applied as briquettes or in PVC units for season-long application, providing that rainfall occurs throughout the peak mosquito season and standing water is present for extended periods. Methoprene can also be applied as a "duplex formulation" with *Bti*.

Larvicidal oil should be used only when pupae are the predominant stage of mosquito found at a site. Oil is the least expensive pesticide, but is indiscriminate since it kills by suffocation. The impact of larvicidal oils on water quality is unknown. However, since this pesticide dissipates in 48 hours, its effect is thought to be minimal.

Pesticides shall be applied only by properly certified staff of vector control districts or approved certified applicators. Whenever possible, the most specific and least toxic material shall be used.

4.2 Vertebrates

If the presence of rodents or evidence of rodent activity, such as rodent droppings, trails, or gnawing is found at a BMP, abatement and control operations shall begin.

Where diseases transmitted by rodents and their arthropod parasites are known to occur, rodents shall be routinely monitored for the presence of the agents that cause these diseases by staff from local vector control agencies, the County, or the California Department of Health Services. If these agents are detected, appropriate rodent and ectoparasite control measures shall begin. These measures shall continue until the risk of human disease is over.

In all cases, vector control agencies shall use control measures that are specific and minimize impact on the environment and its biota. Any disease surveillance activities associated with vertebrate vectors at the BMP sites should be done and the Regional Senior Public Health Biologist, California Department of Health Services, Vector-borne Disease Section informed.

5.0 DATA COLLECTION AND ANALYSIS

5.1 Data Collection

Data must be collected in a standardized manner. Monitoring programs are to be designed to ensure that the data represent conditions at each BMP site.

5.2 Data Management

A protocol for the storage, retrieval, and transfer of data must be established before monitoring activities begin. A standardized system must be used by all agencies/contractors to collect data, and the data must be administered by an agency that is readily accessible to all participants of the study.

5.3 Analysis

5.3.1 Mosquitoes and Midges

Larvae

For each species of mosquito, the median number of larvae/dip and percent positive dips will be compared among the BMP sites and designs with nonparametric statistics, i.e., repeated measures ANOVA based on ranked abundance or Kruskal-Wallis test. If treatment is needed, post-treatment dip samples used to assess application efficacy will not be included in the analysis. Post-treatment dip samples will be defined as 24 and 48 hour post-treatment samples or weekly post-treatment sample events for which no larvae were recovered from sites treated with a residual material; i.e., samples which do not contain larvae at two weeks after treatment with *Bacillus sphaericus*. The number of treatments at a particular BMP site and design will be examined statistically using ranked data.

Adults

For each type of trap, the number of mosquitoes and midges collected at each BMP location will be ranked and compared across time with a nonparametric repeated-measures ANOVA. Each species and the sum of all individuals collected on each sample date will be analyzed. If an ANOVA is statistically significant ($P < 0.05$), then a posteriori comparisons between the medians for each BMP location will be completed to determine whether particular locations have larger mosquito populations than other BMP locations. Similar analyses will be carried out for midges.

If the data fulfill the assumptions of parametric statistical analyses, measures of central tendency and variation in abundance will be calculated for each BMP location. If abundance data have a non-normal distribution, nonparametric measures of central tendency and variation will be calculated.

The similarity of data related to gravid traps will be compared among the sites by multivariate statistical analyses using ordination. The ordinations for the background monitoring period can be compared to those for the period of BMP operation to assess whether the mosquito fauna differ temporally.

5.3.2 Vertebrates

Rodents trapped in monitoring studies will be counted, identified to species, sexed, measured, and weighed. These data will be used to determine:

- Species of rodents associated with BMP sites and adjacent habitat.
- Approximate population densities.
- Reproductive trends.
- The general state of health of the local rodent population.
- How monitoring results compare with earlier trapping data, and with data from other BMP locations.
- If disease surveillance measures are necessary.

5.4 Identification

5.4.1 Mosquitoes and Midges

Midges will be identified to genus using Merritt and Cummins (1997). Type specimens will be sent to systematic experts for identification below the generic level. If, larval midges are difficult to identify, and will be referred to taxonomic experts.

Larval and adult mosquitoes will be identified using Bohart and Washino (1978). When the name of a species has changed since the publication of this key, the updated species names will be used.

5.4.2 Vertebrates

Rodents will be identified using *A Field Guide to the Mammals of North America, North of Mexico,* Burt and Grossenheider (1976). When the species name has been changed since the publication of this reference, the updated name will be used.

6.0 PROGRAM IMPLEMENTATION

As detailed above, the overall strategy for the management of potential vector problems is based upon the following:

- Minimizing the opportunities for such vector or nuisance organisms to become a potential problem.
- A monitoring and maintenance program based upon defined and regular observations and inspections that will ensure that unsuitable conditions do not develop that encourage a vector or nuisance problem.
- Definition of threshold criteria to identify such a problem, and treatment guidelines to correct the problem are outlined.

Specifically, the following field, laboratory, and control measures are to be implemented:

1) Inspections and monitoring of each Retofit Site to identify conditions that might lead to a vector problem, or to identify such a problem that has developed.
2) Comparison of inspection or monitoring results with criteria on conditions or vector organism populations that require control measures to be implemented.
3) Implementation of defined control measures as appropriate whether physical, biological, or chemical in nature.

Vector inspection, monitoring, and control activities, schedules and responsibilities are outlined in Table 4.1 for both Caltrans District 7 and 11. Associated vector management parameters are given in Table 4.2.

6.1 Mosquitoes and Midges

Monitoring of mosquitoes and midges are to be carried out at each BMP site one night each week at each BMP location from April until October, and for one night biweeky from November through March. Both CO_2-light traps and gravid traps will be used. Midge larvae will be sampled with an Ekman grab or a core.

6.1.1 Treatment Thresholds

Criteria for control response are the following:

1) Measures to control mosquito larvae are initiated when one or more larvae or pupae are found at a BMP site.

   Mosquitoes: any larvae.

2) Adult monitoring will indicate whether more larval sampling is necessary at the site by comparison of abundance and species to baseline levels.

3) Standing water should not persist more than 7 days in all BMP designs except for wet basins that require continuous flooding. This period will be reduced to 3 days if floodwater mosquitoes become a problem.

4) Vegetation should be maintained so as to minimize the habitat for mosquitoes or midges.

5) Measures to control blackflies and midges are the following:

Black flies: larvae. If larvae are seen during visual inspection of devices with flowing water, then abatement should proceed if densities exceed 10/3 ft^2.

Midges: $\geq$ 300 larvae per ft^2. Larval densities will need to be determined after laboratory processing of samples. Benthic samples should be taken if adults are observed resting on structures at the BMP site or catches in CO_2-light traps exceed baseline levels.

It should be noted that densities of $\geq$ 300 midge larvae per ft^2 do not necessarily indicate that midges will be a problem. Midges that are not nuisances can be present at densities > 300 midge larvae per ft^2 and not create problems. It is also true that nuisance midges might create a problem at a lower density. Action thresholds, if they can be accurately determined, may need to be site- or region-specific, and related to the midge species found at a particular site. Seasonal and temporal dynamics of midge populations, age of the impoundment, water quality, etc., will influence adult abundance. Action thresholds can only be determined and evaluated by in-depth studies; this type of work is outside the scope of this project. A combination of adult and larval monitoring is a reasonable first step to address potential nuisance problems from midges.

Field checklists for the required mosquito and midge monitoring tasks are given in Figures 4.1 through Figure 4. .

6.1.2 Data Collection for Mosquito and Midge Monitoring and Abatement Activities

Vector surveillance and abatement activities will be recorded for each BMP site. Site ID should conform to the standardized site identification codes of the OMM manual. On each date that a site is inspected for the presence of vectors, the following data will be recorded onto the data sheets:

- The name(s) of the person(s) inspecting the site.
- Date as month/day/year.
- Arrival time in military time (24 hour clock: i.e., 1 PM = 13:00).
- Departure time in military time (24 hour clock: i.e., 1 PM = 13:00).
- The number of potential sources for vectors which is the number of distinct bodies of standing water. For example, if a large basin has three distinct pools of standing water, then the number of sources is equal to three.

- Component: The number of sources should be quantified by component. It is important that sites of potential vector production be correctly assigned to either the stormwater device or to the water quality monitoring structures. Because water quality monitoring structures are not intended to be part of a operational stormwater device, potential vector production in the water quality monitoring structures should not be attributed to the BMP stormwater device.
- The number of sources positive is the number of sources that contain vectors or nuisance insects.
- The insect(s)/vector(s) present. Representative samples should be returned to laboratory for identification.
- The number of samples taken.
- The abundance of insect(s)/vector(s) per sample.
- The life cycle stages present.

If abatement is necessary, then the following information will be collected:

- Abatement procedure carried out. The type of insecticide used should be noted.
- Amount of material used.
- Unit of measure for the amount of material used. Because application rates specified on product labels are often in English (non-metric) units, non-metric units can be used here to avoid conversion errors between the two systems of measurement. Following data entry into computer files, metric conversions should be applied where needed.
- Method of application such as the equipment/method used to deliver pest control agents.
- The surface area treated with pest control agents. Because application rates specified on product labels are often in English (non-metric) units, non-metric units can be used here to avoid conversion errors between the two systems of measurement. Following data entry into computer files, metric conversions should be applied where needed.

Standard abbreviations for each category should be used. The following abbreviations are to be used. Any additional abbreviations should be described in writing as a memorandum to the agency responsible for data management. All data should be transcribed to electronic medium following the guidelines in the OMM manual.

<u>Component:</u>

BT = biofiltration strip
BW = biofiltration swale
MF = media filter
CB = catch basin. Each linked catch basin such as those at the four Pacoima sites should be assigned a unique designation.
TC = trapping catch basin
IB = infiltration basin
IT = infiltration trench
DB = extended detention basin
OW = oil-water separator
MC = multi-chamber treatment chain
WQ = water quality measurement device

Vector/Nuisance Insect:

BF = black fly
MI = midge
M = mosquito
U = unknown (collect a representative sample)

Life Cycle Stages Present:

1, **2**, **3**, **4** = larval stages of mosquitoes
L = larvae, but stage was not determined
P = pupae

Treatment:

G = Golden Bear 1111
AX = Altosid extended range briquets
AL = Altosid liquid
AB = Altosid 30-day briquets
AG = Altosid granules
AP = Altosid pellets
T = Teknar HP-D (*Bti*)
V12 = Vectobac 12AS (*Bti*)
VG = Vectobac granules (*Bti*)
CG = Vectolex CG (*B. sphaericus*)
F = *Gambusia*
N = no treatment
O = other (list material used)
S = source reduction (i.e., vegetation removal)

Unit of Measure:

LB = pounds
ML = milliliters
OZ = ounces
PT = pints
QT = quarts
GA = gallons

Equipment:

B = backtank
H = hand
T = truck unit

O = other (equipment must be listed; Equipment inventory should be updated by the company contracted to provide abatement services).

6.1.3 Notification for Abatement

If vectors/nuisance insects are present at an abundance greater than the treatment threshold in samples collected during surveillance, personnel should contact the agency responsible for abatement decisions via phone.

Site maps completed by surveillance personnel would be very useful for conveying the location of sources containing vectors to the abatement personnel. Maps with the location of standing water and standing water found to contain vectors could be transmitted by facsimile to the abatement personnel.

6.1.4 Follow-up Monitoring

Depending on treatment, follow-up samples will be need to be taken by surveillance personnel at 24-48 hours after abatement measures are carried out to determine whether abatement was effective. If abatement measures are ineffective, then either repeated application is necessary or an alternative abatement strategy needs to be considered.

24 hour post-treatment monitoring should be carried out following application of:

G = Golden Bear 1111
T = Teknar HP-D (*Bti*)
V12 = Vectobac 12AS (*Bti*)
VG = Vectobac granules (*Bti*)

48 hour post-treatment monitoring should be carried out following application of:

CG = Vectolex CG (*B. sphaericus*)

Insect growth regulators (IGRs), such as methoprene, inhibit molting into the adult stage. The efficacy of methoprene should be determined by rearing individuals in the laboratory to determine the proportion of individuals failing to emerge. A reduction in the host-seeking population collected by CO_2-light traps could also indicate that control is effective. The presence of larvae and a concomitant increase in the adult host seeking population at a BMP site is indicative that additional abatement measures are required. The following treatments require the aforementioned tests/considerations:

AX = Altosid extended range briquets
AL = Altosid liquid
AB = Altosid 30-day briquets
AG = Altosid granules
AP = Altosid pellets

6.1.5 Abatement of Midges

Two methods have been used to control nuisance midge populations in Southern California: methoprene and bacteria (*Bacillus thuringiensis* var. *israelensis* at 10 to 100 times the mosquitocidal dosage). It is unlikely that midge populations will develop in habitats that are intermittently flooded for < 72 hours. Bacteria are generally less effective against midges than are IGRs. Methoprene is recommended for use against midge populations at BMP sites.

6.1.6 Black Flies

Monitoring

Black flies, in the family Simuliidae, are biting flies that inflict a painful bite. Like mosquitoes, only the female takes blood meals. Many humans react adversely to the black fly bites. While black flies are important vectors of human disease in the New World and Old World tropics, they do not transmit any known disease to humans living in California.

The immature stages of black flies are found in flowing water where the larvae form aggregations on stones, vegetation, debris and other objects. The larvae attach to substrates using a posterior sucker and the head is pointed downstream. Pupae can be found attached to larval substrates. The life cycles of black flies include 4 to 9 larval stages, with seven larval stages being most common, and larvae range in size from approximately 0.3 to 12 mm in total length. The late instar (instars IV - VII) larvae of species found in the BMP Retrofit Study region are likely to range between about 4 and 10 mm in total length. Aggregations of darkly colored late instar larvae should be obvious during visual inspections of any structure where flowing water is present.

Abatement

Black flies should be restricted to devices that create and maintain flowing water, such as drain outlets or flumes. If black fly larvae are seen during visual inspections at the BMP site, then abatement should be carried out. After completing all inspection and surveillance activities at a site, surveillance personnel should notify the agency responsible for abatement.

Source reduction should be considered as the first method of control. Intermittent water flow (complete drying for several days with no sheet flow over surfaces) should eliminate black fly larvae. In the unlikely event that black flies become abundant at a BMP site, treatment with bacterial larvicides (i.e., Vectobac 12AS or Teknar: *Bacillus thuringiensis* var. *israelensis*) is recommended.

6.2 Vertebrates

The implementation strategy for vertebrate vectors is to first carry out inspections to determine whether conditions are such as to provide habitat for problem vertebrates, or if potentially problem vertebrates occur on site. If vertebrates are present, monitoring of their populations would be carried out by live-trapping methods. Control measures to alter the habitat, or measures for direct control of the vertebrate population would then be implemented if warrented.

6.2.1 Checklist for Inspectors and Maintenance Personnel

The inspection and maintenance checklist (see Figure 4.5) will help ensure that vector control is carried out according to California Health Code regulations and the procedures detailed in this plan. This checklist will insure that all necessary observations, measurements, and potential problems are considered, and it will serve as a means of documenting all facets of vector control management.

This checklist (see Figure 4.5) will be filled out during each visit by vector control inspectors, monitoring personnel, and abatement personnel. A site-specific logbook will be kept that contains the checklist along with the procedures documented in this plan. Maintenance, monitoring, and operations personnel will use the checklists provided.

Inspection visits will be conducted at the same frequency as maintenance and operation inspections. The following items will be observed and recorded on the vector control checklist for each inspection and maintenance visit:

- Visual sighting
- Burrowing/nesting activity
- Plant/structure damage
- Tracks/trails
- Fecal/urine deposits
- Odor (skunks)
- Skeletal/skull identification

Monitoring efforts should be considered only if the rat, ground squirrel, or vole activity is observed after the first operational winter storm season. These inspections can be done anytime thereafter for rats and voles. Inspections and monitoring (if needed) will be completed between March 1, and July 1, for ground squirrels due to their hibernation/ aestivation patterns.

Figure 4.1
Mosquito and Midge Monitoring Equipment List

Equipment Checklist:

Safety:

hard hat
reflective orange vest
white coveralls
first aid kit
flashlight
cellular phone
insulated gloves
protective eye wear
hat, sunscreen

Miscellaneous:

Tool kit: sledge hammer, screw drivers, pliers, etc.
Flagging tape
Encroachment permits
Emergency contact telephone numbers

CO_2-light traps:

For each BMP site:
rain shield (trap lid)
fan, UV-light and electronics array
collection chamber
insulated attractant chamber with attachment device included
6V, 10 amp-hr rechargeable battery
site-specific label
stake/pole

Gravid traps

For each BMP site:
basin for attractant fan and collection tube2 wooden supports for upper components of the trap
electronics circuit board
collection chamber
6V, 10 amp-hr rechargeable battery
site-specific label

In each vehicle:
three 20-liter carboys with tubing attached to spigots
2 2-liter carboys with carrying slings
large plastic funnel

Larval sampling

dipper
plankton nets
Ekman grab
concentrator cup
squirt bottle
distilled/deionized water
95% ethanol
sample vials (prelabeled with white tape)
indelible markers for labeling vials
labeling tape
spare vials
field notebook
measuring tape (100 m on reel)
boots
forceps, probes, hand screens
device for measuring water depth

Figure 4.2
Mosquito and Midge Monitoring Task Checklist

Task List:

CO_2-light traps:

Prior to leaving for field sites:

☐ 1) Charge batteries for 24 hours prior to setting traps.
Remember to connect batteries in parallel.
Use extreme care when connecting the charger to batteries: do not short the leads!

☐ 2) Check synchronization of photosensor switches.

☐ 3) Carry out preventative maintenance on the traps.

☐ 4) Repair/replace any motor, air-actuated gate, photosensor, or any component found to be malfunctioning.

☐ 5) Obtain a sufficient quantity of dry ice for the traps.

☐ 6) Carry out preventative maintenance on vehicle. Check the mileage and plan for routine maintenance during the days that traps are not set/retrieved.

At field sites:

☐ 1) Assemble the trap.

☐ 2) Connect trap to power supply.

☐ 3) Check that the site-specific tag is attached to the collection chamber.

☐ 4) Carry out preventative measures against ant infestations.

☐ 5) Retrieve trap the following morning.

☐ 6) Place collection chamber into an insulated chamber with a small amount of dry ice wrapped in paper.

At the laboratory:

☐ 1) Place collection chambers into freezer.

☐ 2) Identify mosquitoes and midges in each trap.

☐ 3) Remove and reserve any species that were not previously recorded in collections.

Gravid traps:

☐ 1) Clean out trash bin for brewing attractant.

☐ 2) Set up aged water for attractant batch of two weeks in the future (trash bin 1 of 2).

☐ 3) Add innoculum to one week old aged water for next week's attractant (trash bin 2 of 2).

☐ 4) Scrub, wash and rinse pans that comprise the base of the gravid trap.

☐ 5) Rinse carboys used to transport attractant to field sites.

Prior to leaving for field sites:

☐ 1) Charge batteries for 24 hours prior to setting traps.
Remember to connect batteries in parallel.
Use extreme care when connecting the charger to batteries: do not short the leads!

☐ 2) Check synchronization of photosensor switches.

☐ 3) Carry out preventative maintenance on the traps.

☐ 4) Repair/replace any motor, air-actuated gate, photosensor, or any component found to be malfunctioning.

☐ 5) Filter attractant and place the filtrate into carboys.

Figure 4.2
Mosquito and Midge Monitoring Task Checklist (continued)

At field sites:

- ☐ 1) Assemble the trap.
- ☐ 2) Connect trap to power supply.
- ☐ 3) Check that the site-specific tag is attached to the collection chamber.
- ☐ 4) Carry out preventative measures against ant infestations.
- ☐ 5) Retrieve trap the following morning.
- ☐ 6) Place collection chamber into an insulated chamber with a small amount of dry ice wrapped in paper.

At the laboratory:

- ☐ 1) Place collection chambers into freezer.
- ☐ 2) Identify mosquitoes and midges in each trap.
- ☐ 3) Remove and reserve any species that were not previously recorded in collections.

Larval sampling:

- ☐ 1) Assess BMP for standing water. All components of the BMP and water quality assessment program should be examined for standing water.
- ☐ 2) Determine the amount of standing water and where (i.e., in what component) the pool is located. Dependent on the BMP design, water depth and/or surface area of the pool should be determined.
- ☐ 3) Determine the date of last measurable rainfall event. These data may be available through the water quality studies.
- ☐ 4) Collect dipper or plankton net samples from standing water using the guidelines for each BMP site. Samples should be preserved in the field.
- ☐ 5) Label all samples completely. Include location, date, and number of dips/net hauls per sample. This information and any pertinent information (e.g., ambient weather conditions, vegetation cover, etc.) should be recorded in the field notes.
- ☐ 6) Process samples in the laboratory. The stage (1st and 2nd larval instars, 3rd and 4th larval instars, or pupae) should be noted. Identifications should be to the level of genus; species-level identifications should be carried out when possible.

Abatement:

- ☐ 1) If mosquito larvae are present, abatement is to be carried out following State of California regulations and federal requirements on the label of any abatement product.
- ☐ 2) Data regarding the abatement measure used, amount of material used, application methodology and any other pertinent information related to abatement efforts should be recorded.
- ☐ 3) Mosquitofish should be stocked into wet basins as soon as possible after sufficient water is present in the basin to support fish.

Figure 4.3

Vector Monitoring and Control Report
Caltrans BMP Retrofit Pilot Project

Site ID _____ Location _____ Date _____

Inspection by _____

Vertebrate Vector Inspection Comments

Rats ☐ Ground Squirrels ☐ Mice or Voles ☐ Other ☐

Location _____

Observations _____

_____

_____

Recommended Action _____

_____

Maintenance Recommendations Relative to Vectors

Vegetation ☐ Water ☐ Debris ☐ Other ☐

Figure 4.4
Inspection Checklist for Vertebrate Vectors

General Information:_____

Date:_____ **Time:**_____

Team Leader:_____ **Consultant:**_____

BMP Location:_____ **BMP Type:**_____

Vertebrate Vector Species		Signs of their Presence
Roof Rats/Norway Rats	[ ]	Live rats observed. As a rule, live rats observed in the daytime indicates a high population.
	[ ]	Carcasses of rats.
	[ ]	Fecal pellets.
	[ ]	Roof rat pellets are sausage shaped, dark in color, and approximately ½" in length. More pointed on ends.
	[ ]	Norway rat pellets are also sausage shaped, dark color, larger around, about ¾ " in length, and not as pointed on the ends.
	[ ]	Smudge marks on light colored surfaces from oily fur. This indicates continued contact with surface.
	[ ]	Gnaw marks. Striated marks left on wood, plastic, wax, fruit or other solid materials. Fabric and paper/cardboard may also be damaged.
	[ ]	Burrow openings (Norway rats). Small holes in the ground, often near foundations, slabs, or other structures, three inches or smaller in diameter.
	[ ]	Nesting evidence. Small collections of nesting materials and/or caches of food.
	[ ]	Odor. These rats have a characteristic musty odor reminiscent of urine.
Ground Squirrels	[ ]	Live ground squirrels observed. Ground squirrels can be distinguished from tree squirrels by their habit of staying at ground level, burrowing, and their tails are not as bushy in appearance as tree squirrels. Ground squirrels are diurnal (day active).
	[ ]	Carcasses. NOTE: Caution should be exercised when handling dead ground squirrels as their fleas can transmit plague to humans and other animals.

Figure 4.4 (continued)
Inspection Checklist for Vertebrate Vectors

Ground Squirrels (Cont'd)	[ ]	Burrows and open mounds. Burrow openings of ground squirrels are usually four inches or greater in diameter, and have small amounts of mounded dirt in front of the opening.
	[ ]	Sound. Ground squirrels have a loud, cheep-cheep, almost birdlike call that can be heard in the daytime when they are active.
Meadow Mice (voles)	[ ]	Live animals observed. Voles are small brown colored rodents 6" to 10 1/2" in length including relatively short tail. They are active day and night. Not to be confused with so called "field mice" that have much longer tails.
	[ ]	Carcasses.
	[ ]	Runways. On grassy slopes they create one to two inch runways through the grass. They also dig burrows with small, round openings.

Figure 4.5
Vertebrate Vector Control Related
Maintenance Activity Checklist for Affected BMP
Facilities by Type

General Information:_____

Date:_____ **Time:**_____

Team Leader:_____ **Consultant:**_____

I. BMP Type: Infiltration Basin

Location:

[ ] Peripheral vegetation should be minimized on site through regular trimming, mowing and removal of all cuttings to eliminate any possible harborage or forage opportunities for rodents.

[ ] Water should be drained or otherwise removed within the specified seventy-two hour water residency time limit to prevent a semi-permanent source of drinking water for rodents.

[ ] Floating debris should be removed as basin dries to eliminate possible rodent harborage opportunities.

II. BMP Type: Infiltration Trench

Location:

[ ] Peripheral vegetation should be minimized on site through regular trimming, mowing and removal of all cuttings to eliminate any possible harborage or forage opportunities for rodents.

[ ] Water should be drained or otherwise removed within the specified seventy-two hour water residency time limit to prevent a possible semi-permanent source of drinking water for rodents.

[ ] Floating debris should be removed as trench dries to prevent possible rodent harborage opportunities.

Figure 4.5 (continued)
Vertebrate Vector Control Related
Maintenance Activity Checklist for Affected BMP
Facilities by Type

III. BMP Type: Extended Detention Basin

Location:

[ ] Peripheral vegetation should be minimized on site through regular trimming, mowing and removal of all cuttings to prevent any possible harborage or forage opportunities for rodents.

[ ] Water should be drained or otherwise removed within the specified seventy-two hour water residency time limit to prevent a semi-permanent source of drinking water for rodents.

[ ] Floating debris should be removed as basin dries to eliminate possible rodent harborage opportunities.

IV. BMP Type: Biofiltration Swale/Strip

Location:

[ ] Peripheral vegetation should be minimized on site through regular trimming, mowing and removal of all cuttings to prevent any possible harborage or forage opportunities for rodents.

[ ] Grasses composing the biofilter should be mowed when at a maximum height of six inches. All grass clippings should be removed immediately from the site.

Table 4.1
Vector Inspection, Monitoring, and Control Activities, Schedules, and Responsibilities. Caltrans District 7 and 11

Activity	Frequency	Responsibility	
		District 7	District 11
Insects			
Larval Sampling	Weekly (or as needed)	VCD	Co. of S.D.
Adult Sampling	Weekly	UC Riverside (UCR)	UC Riverside (UCR)
Sample Analysis	Weekly	VCD/UCR	Co. of S.D./UCR
Call for Abatement	As Needed	VCD	Co. of S.D.
Insect Abatement	As Needed	VCD	Co. of S.D.
Follow up Sampling	As Needed	VCD/DHS	Co. of S.D./DHS
Consulting		Bill Walton	Bill Walton
Vertebrates			
Vertebrate Inspections	Weekly	VCD/UCR/DHS	S.D./UCR/DHS
Call for Monitoring	As Needed	DHS/VCD	DHS & Co. of S.D.
Call for Abatement	As Needed	DHS/VCD	DHS & Co. of S.D.
Vertebrate Abatement	As Needed	VCD	Co. of S.D.
Follow up Monitoring	As Needed	VCD/DHS	Co. of S.D./DHS
Consulting		Fred Beams	Fred Beams
Other Vectors			
Inspections	Weekly	VCD/UCR/DHS	S.D./UCR/DHS
Call for Monitoring/ Abatement	As Needed	VCD/DHS	DHS & Co. of S.D.
Abatement	As Needed	VCD	Co. of S.D.
Consulting		Fred Beams	Fred Beams
Data Management & Reporting			
Call for Monitoring/ Abatement	Weekly	VCD/DHS	DHS & Co. of S.D.
Abatement	As Needed	VCD	Co. of S.D.
Consulting	As Needed	Fred Beams	Fred Beams
Data Management & Reporting			
Local Data Management		VCD	Co. of S.D.
Overall Data Management		DHS	DHS
Routine Reporting		VCD	Co. of S.D.
Cost Data Collection		VCD	Co. of S.D.
Program Oversight	Continuous	DHS	DHS & Co. of S.D.

Table 4.2
Implementation Parameters

Vector Management	District 7	District 11
Criteria	Immature stages of mosquito present. Black fly exceed 10/3ft^2 area. Midge larvae exceed 300/ft^2. Vertebrate vectors present req. control. (Determined by VCD's)	Immature stages of mosquito present. Black fly exceed 10/3ft^2 area. Midge larvae exceed 300/ft^2. Vertebrate vectors present req. control. (Determined by Co. of S.D.)
Notification	VCD notify Caltrans within 24hrs.	Co. of S.D. notify in less than 24hrs Co. of S.D. and Caltrans
Abatement	VCD carryout abatement within 24 to 48hrs.	Co. of S.D. carryout after notification by Co. of S.D.
Reinspection	VCD within 48hrs.	Co. of S.D. carryout after notification by Co. of S.D.
Reports	VCDs report monthly to Caltrans and DHS. VCDs report by the 10th to Caltrans and DHS. Caltrans & DHS give comments within 30 days,	Co. of S.D. report monthly to Caltrans and DHS. Co. of S.D. report by the 10th to Caltrans and DHS. Caltrans & DHS give comments within 30 days,

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CALTRANS
BMP RETROFIT PILOT PROGRAM

DISTRICT 11, SAN DIEGO

BMP OPERATION, MAINTENANCE, AND MONITORING PLAN

VOLUME II

APPENDIX V
MAINTENANCE INDICATOR DOCUMENT

September 1999

CALTRANS BMP RETROFIT PILOT PROGRAM
BMP MAINTENANCE INDICATORS

The following specific thresholds are for specified and implied criteria which “trigger” maintenance activities for specific BMPs. The maintenance activity shown is for those times when the field measurement exceeds the maintenance indicator. These thresholds do not preclude taking other actions needed to mitigate the given thresholds or taking actions needed to mitigate unanticipated problems. These indicators are not only for the BMP pilot program, but they are also considered representative of the long-term maintenance requirements for the BMPs.

This document covers routine maintenance. There may be occasions where emergencies arise, such as accidents, toxic spills, or other incidents, where critical response is needed. On those occurrences, Caltrans crews will respond to the emergency, on a priority basis and, if necessary, the BMP will be taken out of service until the BMP can be restored. The goal for such critical situations is to have the BMP back into service within 30 days.

The time period noted, for completion of any maintenance activity, is a goal that will depend on weather, access to the BMP, personnel and equipment availability.

BIOFILTER – STRIPS and SWALES
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Uniform sheet flow over length of strip and across swale invert	Evidence of significant channeling or ponding	Visual inspection of erosion or major portions of flow discharge across strip/swale	Monthly, during target storms in the wet season	Correct channelized or ponded areas using additional fill and vegetation and/or by removing accumulated sediment. Target completion time is within 10 days.	None
Height of vegetation	Average plant height exceeds 10 inches	Visual inspection of vegetation throughout strip/swale	In October , and January and monthly during dry season	Cut plants to a average height of 6 inches and remove trimmings. Target completion within 10 days.	Palomar Airport Road Site: maximum average height is 13 inches; trim to 9 inches
Assess adequate vegetative cover	Less than 90 percent coverage in strip invert/swale or less than 70 percent on swale side slope	Visual inspection of strip/swale. Prepare a site schematic to record location and distribution of barren or browning spots to be restored. File the schematic for assessment of persistent problems.	Assess quantity needed in May each year	Re-sod barren spots during October/ November. Wet soil before and after sod is placed. Scarify area to be re-stored, to depth of 2-in.. Restore side slope coverage with hydroseed mixture. Irrigate same as saltgrass	Keep a reserve of approximately 10 percent of sodded surface area in saltgrass flats. Use mature flats to restore coverage. Order replacement material in May for delivery in September. Use original design erosion control seed mix on side slopes.

BIOFILTER – STRIPS and SWALES
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Residence time is less that design criteria	Residence time is less than design criteria	Measure mean residence times in swale using protocol in OMM plan. Calculate residence time for design storm.	Once per year during target storm	Assess the cause of the problem. As soon as weather and moisture conditions allow, take corrective action. If sediment is the cause, in September, remove and dispose of accumulated sediment. Regrade to restore flow gradient. Resod by November 1	Swales only Cerritos MS – 4 min 605/91 – 9 min 5/605 – 7 min 605/Carson – 9 min Palomar – 14 min Melrose – 15 min
Inspect for debris accumulation	Vegetative debris, debris or litter present	Visual observation	Monthly	Remove litter, vegetative debris, and debris. Target completion period within 10 days.	None
Inspect for accumulated sediment	Sediment at or near plant height, channeling of flow, inhibited flow due to change in slope	Visual observation	Monthly during wet season	Remove sediment. If flow is channeled, determine cause and take corrective action. If sediment becomes deep enough to change the flow gradient, remove sediment, conduct sediment characterization according to OMM Plan Vol II, dispose of sediment, and replant. Regrade to design specification and replant swale/strip with sod. If	None

BIOFILTER – STRIPS and SWALES
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				regrading is necessary, the process should start near May 1. Resod strip/swale in Nov. Target completion period within 10 days.	
Inspect for burrowing rodent activity	Ground squirrel holes, vole or gopher mounds	Visual observation	Monthly, for rodent activity with abatement immediately if the activity affects the performance of the BMP otherwise abate annually in September	• Where ground squirrels are active, firmly backfill the burrows to prevent seepage, erosion and leakage. • Where ground squirrels are not active, confirm that no owl activity is present (a biologist may be needed if uncertain). Firmly backfill the burrows to prevent seepage, erosion and leakage. • Where gophers are present, trap the gophers and level the mounds and firmly backfill the burrows to prevent seepage, erosion and leakage.	None

BIOFILTER – STRIPS and SWALES
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				• Where voles are present, firmly backfill the burrows to prevent seepage, erosion and leakage • If ground squirrel abatement is needed conduct a one time poisoning program. After the appropriate amount of time has passed (determined by the pesticide applicator), firmly backfill the burrows to prevent seepage, erosion and leakage.	
Inspect for possible endangered species, threatened species and species of special concern within the BMP maintenance perimeter	Evidence of ponding, emergence of wetland or woody vegetation, shrubs, dwarf plantain, or burrowing animal damage. Presence of logs, woodpiles rocks, or large debris.	Visual observation	Weekly, during the wet season	• Remove woody vegetation, shrubs, dwarf plantain, pickleweed, woody wetland vegetation[3], and large debris within strip/swale within 10 days. • Correct ponded areas using sand fill within 3 days.	Vulnerable sites are: SR-78/Melrose I-5/Palomar Airport Rd

BIOFILTER – STRIPS and SWALES
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				• If burrows are found between Mar 1 and Aug 30, a biologist needs to confirm that no birds are nesting in the burrow before sealing the hole. • At vulnerable sites, remove debris, woodpiles etc. within 10 days.	
Inspect for standing water	Water accumulation in spreader ditch or any structure	Standing water in spreader ditch or any structure	Annually, May 1	Where gravity draining is possible, drain the standing water	None
General Maintenance Inspection	Inlet structures, outlet structures, side slopes or other features damaged, significant erosion, emergence of trees, woody vegetation or weeds, fence damage, etc.	Visual observation	Monthly	Take action as needed to correct problems. Target completion period within 30 days.	Remove any trees, woody vegetation, or weeds taller than 12-inches.

DRAIN INLET INSERTS – STREAM GUARD
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Sediment removal	Sediment more than 6-inches	Visual inspection of sediment collected within insert	• Before each target storm event • Weekly during extended wet periods • Monthly during periods of dry weather	Replace insert. Target completion period within 10 days.	None
Inspect for debris/trash	Sufficient debris/trash that could interfere with proper functioning of insert	Visual observation	• Before and once during each target storm event • Weekly during extended wet periods	Remove and dispose of debris/trash. Target completion period within 1 day.	None
Oil and grease removal	Evidence of oily sheen in insert or downstream monitoring vault	Visual observation	During each target storm event and monthly during the dry season	Within 10 working days, replace oil absorbent polymer	None
Inspection for structural integrity	Improper installation, rips, tears, or other loss of structural integrity	Visual observation	Monthly	Replace insert or immediately consult with design engineer to develop course of action, effect repairs within 10 working days	None
Annual renewal of medium	End of wet season, April 30	None	Annually	Remove media and analyze for parameters shown in OMM Plans. Replace media before Oct 1	None

DRAIN INLET INSERTS – FOSSIL FILTER
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Inspect for debris/trash	Sufficient debris/trash that could interfere with proper functioning of insert	Visual observation	• Before and once during each target storm event • Weekly during extended wet periods • Monthly during the dry season	Remove and dispose of debris/trash. Target completion period within 1 day.	None
Oil and grease removal	Absorbent granules dark gray, or darker, or unit clogged with sediment.	Visual observation	• At the end of each target storm event • Weekly during extended wet periods • Monthly during the dry season	Replace Fosil Filter™ trough within 10 working days.	None
Inspection for structural integrity	Broken or otherwise damaged insert	Visual observation	Monthly	Replace insert or immediately consult with design engineer to develop a course of action, effect repairs within 10 working days	None
Annual renewal of medium	End of wet season, April 30	None	Annually	Remove media and analyze for parameters shown in OMM Plans. Replace media before Oct 1	None

EXTENDED DETENTION BASINS
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Drain time is 72 hours for design volume	Less than 48 hours or more than 72 hours for full basin	Determine drain time based on effluent flow meter activity or visual observation	Immediately after each target storm	• If time too long, open gate to discharge remaining volume, within 1 day. Per direction from design engineer, modify holes on standpipe after basin drains, within 30 days • Remove and dispose of debris/trash from outlet/outlet screen, within 10 days.	• Does not apply to District 7 Extended detention Basins • Clean rip-rap and standpipes in District 7
Basin side slope planted for erosion protection and planted invert	Average plant height greater than 18-inches	Visual observation and random measurements through out the side slope area	Monthly	Cut vegetation to an average height of 12-inches and remove trimmings. May cut to 8 inches after July 1. Target completion period within 30 days Do not cut more than four times per year,	None
Inspect for adequate vegetative cover	Less than 70 percent coverage on invert and side slopes	Visual observation	October each year	Hydroseed barren spots by Nov 1, scarify surface if needed.	
Inspect for possible vector harborage	Standing water for more than 72 hours	Visual observation	Monthly and 72 hours after target storm event	Immediately notify VCD for vector abatement assessment	None
Inspection for trash and	Debris/trash present	Visual observation	Monthly and before	Remove and dispose of	None

EXTENDED DETENTION BASINS
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
debris at inlet and outlet structures			every target storm	trash and debris Target completion period within 10 days.	
Inspection for sediment management and characterization of sediment for removal	• Sediment depth averages 18-inches or 10 percent of basin volume which ever is less • Any parameter concentration (See Table 5.2, Vol II) exceeds 50% of Title 22 TTLC. Or, if the parameter concentration falls between 10X STLC and TTLC, is less than 50% TTLC, and the WET results exceed 50 % of the STLC value.	• Measure depth at apparent maximum and minimum accumulation of sediment. Calculate average depth • Sample according to OMM plan and send samples to lab	June 1 each year	Remove and dispose of sediment. Regrade and revegetate if vegetation coverage drops below 70 percent. Revegetate with seed as required by threshold on Nov. 1	None
Inspect for burrowing rodent activity	Ground squirrel holes, vole or gopher mounds	Visual observation	Monthly, for rodent activity with abatement immediately if the activity affects the performance of the BMP otherwise abate annually in September	• Where ground squirrels are active, firmly backfill the burrows to prevent seepage, erosion and leakage.	None

EXTENDED DETENTION BASINS
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				• Where ground squirrels are not active, confirm that no owl activity is present (a biologist may be needed if uncertain). Firmly backfill the burrows to prevent seepage, erosion and leakage. • Where gophers are present, trap the gophers and level the mounds and firmly backfill the burrows to prevent seepage, erosion and leakage. • Where voles are present, firmly backfill the burrows to prevent seepage, erosion and leakage • If ground squirrel abatement is needed conduct a one time poisoning program. After the appropriate amount of time has passed (determined by the pesticide	

EXTENDED DETENTION BASINS
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				applicator), firmly backfill the burrows to prevent seepage, erosion and leakage.	
Inspect for possible endangered species, threatened species and species of special concern. within the BMP maintenance perimeter.	Evidence of ponding, emergence of wetland or woody vegetation, shrubs, dwarf plantain, or burrowing animal damage. Presence of logs, woodpiles, rocks, or large debris.	Visual observation	Weekly, during the wet season	• Remove woody vegetation, shrubs, dwarf plantain, pickleweed and woody wetland vegetation[3] in the basin within 10 days. • Remove debris, woodpiles etc. within 10 days. • Correct ponded areas using sand fill • For vulnerable sites, on Mar 1, deploy stakes with mylar strips and place scarecrow device around BMP. • If burrows are found between Mar 1 and Aug 30, a biologist needs to confirm that no birds are nesting in the burrow before sealing the hole.	Vulnerable sites are: I-5/SR56 I-5/Manchester I-15/SR-78

EXTENDED DETENTION BASINS
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Inspect for standing water	Water accumulation in any structure or other location within the basin	Standing water in any structure or other location within the basin	Annually, May 1	Where gravity draining is possible, drain the standing water	None
General Maintenance Inspection	Inlet structures, outlet structures, side slopes or other features damaged, significant erosion, emergence of trees or woody vegetation, graffiti or vandalism, fence damage, etc.	Visual observation	Monthly	Within 10 working days, take corrective action. Consult engineers if immediate solution is not evident.	None

INFILTRATION BASINS
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
72 hour infiltration of design volume	Evidence of ponding water after 72 hours	Evaluation of water level within basin using data logging bubbler or visual observation of basin for evidence of ponding water	72 hours after target storm event	Remove sediment, scarify invert and revegetate before November 1. If problem persists, immediately notify engineer. Undertake investigation for course of action to achieve acceptable infiltration rate or other acceptable solution. If unable to achieve acceptable infiltration rate or implement alternative solution then move to decommission	None
Vegetation of basin invert and side slopes	Plant height exceeds 12 inches	Visual observation and random measurements through out the side slope and invert area	Monthly	Cut vegetation to a height of 6 inches and remove cuttings. Target completion period within 30 days.	None
Inspect for possible vector harborage	Standing water for more than 72 hours	Visual observation	Monthly and 72 hours after target storm event	Immediately notify VCD for vector abatement assessment	None
Inspect for standing water	Water accumulation in any structure or other location within the basin	Standing water in any structure or other location within the basin	Annually, May 1	Where gravity draining is possible, drain the standing water	None
Inspection for trash and debris at inlet structures	Debris/trash present	Visual observation	Monthly	Remove and dispose of debris/trash. Target completion period	None

INFILTRATION BASINS
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				within 10 days.	
Inspection for sediment management	Sediment accumulation greater than 18-inches or 10 percent of basin volume which ever is less	Measure depth at apparent maximum and minimum accumulation of sediment. Calculate average depth	June 1 each year	Remove, characterize and dispose of sediment. Regrade and revegetate if vegetation coverage drops below 70 percent. Revegetate with seed as required by threshold on Nov. 1	None
Inspection and characterization for sediment removal	Any parameter concentration (See Table 5.2, Vol II) exceeds 50% of Title 22 TTLC. Or, if the parameter concentration falls between 10X STLC and TTLC, is less than 50% TTLC, and the WET results exceed 50 % of the STLC value.	Sample according to OMM plan and send samples to lab	May 1 each year	Remove and dispose of sediment regrade basin floor to ensure proper drainage. Revegetate on November 1 if coverage falls below 70%.	None
Vegetation coverage inspection	Coverage falls below 70 percent	Visual observation	During month of September	Plant during month of November	None
Inspect for burrowing rodent activity	Ground squirrel holes, vole or gopher mounds	Visual observation	Monthly, for rodent activity with abatement immediately if the activity affects the performance of the BMP otherwise abate annually in September	• Where ground squirrels are active, firmly backfill the burrows to prevent seepage, erosion and leakage. • Where ground squirrels are not	None

INFILTRATION BASINS
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				active, confirm that no owl activity is present (a biologist may be needed if uncertain). Firmly backfill the burrows to prevent seepage, erosion and leakage. • Where gophers are present, trap the gophers and level the mounds and firmly backfill the burrows to prevent seepage, erosion and leakage. • Where voles are present, firmly backfill the burrows to prevent seepage, erosion and leakage • If ground squirrel abatement is needed conduct a one time poisoning program. After the appropriate amount of time has passed (determined by the pesticide applicator), firmly backfill the burrows	

INFILTRATION BASINS
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				to prevent seepage, erosion and leakage.	
Inspect for possible endangered species, threatened species and species of special concern within the BMP maintenance perimeter.	Evidence of ponding, emergence of wetland or woody vegetation, shrubs, dwarf plantain, or burrowing animal damage. Presence of logs, woodpiles, rocks, or large debris.	Visual observation	Weekly, during the wet season	• Remove woody vegetation, shrubs, dwarf plantain, pickleweed and woody wetland vegetation[3] in the basin within 10 days. • Remove debris, woodpiles etc. within 10 days. • Correct ponded areas using sand fill. If burrows are found between Mar 1 and Aug 30, a biologist needs to confirm that no birds are nesting in the burrow before sealing the hole.	None
General Maintenance Inspection	Inlet structures, outlet structures, side slopes or other features damaged, significant erosion, emergence of trees or woody vegetation, graffiti or vandalism, fence damage, etc.	Visual observation	Monthly	Within 30 working days, take corrective action. Consult engineer if immediate solution is not evident.	None

INFILTRATION TRENCHES
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Design infiltration rate	Infiltration rate falls below 90 percent of design rate	Calculate infiltration rate with pressure transducer or measure in observation well	After each target storm	Immediately notify engineer. Undertake investigation for course of action to achieve acceptable infiltration rate. If unable to achieve acceptable infiltration then BMP operations cease.	Carlsbad MS – 1.2 in/hr Altadena MS – 1.5 in/hr
Inspect for possible vector harborage	Standing surface water for more than 72 hours	Visual observation	Monthly and 72 hours after target storm event	Immediately notify VCD for vector abatement assessment	None
Inspection for trash and debris at inlet and outlet structures	Trash/debris present	Visual observation	Monthly	Remove and dispose of trash and debris. Target completion period within 10 days.	None
Inspect for sediment accumulation	Visible sediment	Visual inspection of the stone aggregate, no sediment should be visible at the top of the	Monthly during the dry season After every storm greater than 0.5-inches	Remove top layer of trench, silt, filter fabric and stone, wash stone and reinstall fabric and	None

INFILTRATION TRENCHES
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
		trench.		stone into trench	
Inspect for burrowing rodent activity	Ground squirrel holes, vole or gopher mounds	Visual observation	Monthly, for rodent activity with abatement immediately if the activity affects the performance of the BMP otherwise abate annually in September	• Where ground squirrels are active, firmly backfill the burrows to prevent seepage, erosion and leakage. • Where ground squirrels are not active, confirm that no owl activity is present (a biologist may be needed if uncertain). Firmly backfill the burrows to prevent seepage, erosion and leakage. • Where gophers are present, trap the gophers and level the mounds and firmly backfill the burrows to prevent seepage, erosion and leakage. • Where voles are present, firmly backfill the burrows to prevent seepage, erosion and leakage	None

INFILTRATION TRENCHES
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				• If ground squirrel abatement is needed conduct a one time poisoning program. After the appropriate amount of time has passed (determined by the pesticide applicator), firmly backfill the burrows to prevent seepage, erosion and leakage.	
Inspect for standing water at end of wet season	Spreader ditch contains water following the wet season (i.e., June 1 through September 30)	Visual observation	May 1 each year	Remove spreader ditch bypass plug during first week of dry season to allow water to drain into infiltration trench. Remove bypass drain blockage monthly.	Bypass plug will be installed throughout the wet season
Inspect for accumulation of sediment and debris in biofiltration strip spreader ditch	Spreader ditch contains sediment and debris following the wet season (i.e., June 1 through September 30)	Visual observation	Annually, during the first week of the dry season	Remove collected sediment and debris from the spreader ditch.	None
General Maintenance Inspection	Inlet structures, outlet structures, filter fabric or other features damaged, emergence of trees or woody vegetation, graffiti or vandalism, fence damage, etc.	Visual observation	Monthly	Within 30 working days, take corrective action. Consult engineer if immediate solution is not evident.	None

MEDIA FILTERS – PERLITE/ZEOLITE
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Design flow rate through canisters: 15 gpm per canister	Less than 13 gpm flow rate per canister, measured collectively on a per vault basis	Evaluate peak and average flow rates drain time from inlet and outlet flow data loggers or staff gage within vaults	During one storm per month during wet season	Within 10 working days or as weather conditions permit, back flush canisters and remove sediment in the vault. If back flushing does not restore flow through rate, replace canisters.	None
Inspect for sediment accumulation in pre-treatment sedimentation chamber	Maximum 12-inches Any parameter concentration (See Vol II) exceeds 50% of Title 22 TTLC. Or, if the parameter concentration falls between 10X STLC and TTLC, is less than 50% TTLC, and the WET results exceed 50 % of the STLC value.	Measure with appropriate device Characterize sediment by sampling according to OMM plan Vol II	Measure sediment depth monthly during period of extended wet weather. Characterize sediment annually on May 1	Remove sediment within 10 days during wet season, characterize sediment and dispose of the sediment within 30 days If sediment characterization exceeds maintenance indicator, remove and dispose of sediment.	
Inspect for minor maintenance	Per manufacture's guidelines	None	Monthly	Flush underdrains and other maintenance per manufacturer's guidelines.	None.

MEDIA FILTERS – PERLITE/ZEOLITE
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Manufacturer's recommended major maintenance	Per manufacture's guidelines	Per manufacture's guidelines	Annually, May 1	Replace canisters, remove sediment and other maintenance per manufacturer's guidelines	None
Inspection for trash and debris at inlet and outlet structures and within vaults	Trash/debris present	Visual observation	Weekly during the wet season and monthly during the dry season	Remove and dispose of trash and debris. Target completion period within 1 day during wet season and 10 days during dry season.	None
Inspect for vector harborage	Standing water for more than 72 hours	Visual Observation	Monthly and 72 hours after target storm event	Immediately notify VCD for vector abatement assessment. Renew vector control briquettes every 3 months.	None
Inspect for standing water	Water accumulation in any structure or other location within the filter	Standing water in any structure or other location within the filter	Annually, May 1	Where gravity draining is possible, drain the standing water	None
General Maintenance Inspection	Inlet structures, outlet structures, vault, piping, or other features damaged and for graffiti or vandalism	Visual observation	Monthly	Within 30 working days, take corrective action. Consult engineer if immediate solution is not evident.	None

MEDIA FILTERS – SAND
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Design filter loading rate of 0.0545 gpm/sf (10.5 ft/d), or Drain time of 48 hours	Loading rate drops below 9 ft/d or Drain time exceeds 48 hours	Use staff gage in vault to measure loading rate, or Evaluate peak and average loading rates from inlet and outlet flow data loggers or.	During one storm event per month if staff gage is used. After one storm event per month during wet season	Remove sediment, trash and debris., remove top 2 inches of media and dispose of sediment. Restore media depth to 18 inches when overall media depth drops to 12 inches. Target completion period within 10 days. If problem persists, consult with engineer.	None.
Inspect for sediment accumulation in sedimentation chamber	Maximum 12-inches, or Any parameter concentration (See Vol II) exceeds 50% of Title 22 TTLC. Or, if the parameter concentration falls between 10X STLC and TTLC, is less than 50% TTLC, and the WET results exceed 50 % of the STLC value.	Measure with appropriate device Characterize sediment by sampling according to OMM plan Vol II and send samples to lab	Measure sediment depth monthly during period of extended wet weather. Characterize sediment annually on May 1	Remove sediment within 10 days during wet season, characterize sediment and dispose of the sediment within 30 days If sediment characterization exceeds maintenance indicator, remove and dispose of sediment.	

MEDIA FILTERS – SAND
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Inspect for vector harborage	Standing water for more than 72 hours	Visual observation	Monthly and 72 hours after target storm event	Immediately notify VCD for vector abatement assessment. Renew vector control briquettes every 3 months or as recommended by the VCD	None
Inspection for trash / debris at inlet and outlet structures and on media surface	Trash and debris present	Visual observation	Weekly during the wet season and monthly during the dry season	Remove and dispose of trash and debris. Target completion period within 1 day during wet season and 10 days during dry season.	None
Inspect pumps for proper functioning	Pump does not operate	Energize pump to see if water is discharged	September or after one month of inactivity during the wet season	Make assessment to determine if problem is electrical or mechanical. Take appropriate action. Replace pump if needed. Target completion time is 10 days (keep one pump in storage as back-up)	District 7 filters only
Inspect pumps for serviceability and periodic maintenance	Per manufacture's guidelines	Per manufacture's guidelines	Per manufacture's guidelines	Per manufacture's guidelines	District 7 filters only
Inspect for burrowing rodent activity	Ground squirrel holes, vole or gopher mounds	Visual observation	Monthly, for rodent activity with abatement immediately if the activity affects the performance of the BMP otherwise abate annually	• Where ground squirrels are active, firmly backfill the burrows to prevent seepage, erosion and leakage.	None

MEDIA FILTERS – SAND
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
			in September	• Where ground squirrels are not active, confirm that no owl activity is present (a biologist may be needed if uncertain). Firmly backfill the burrows to prevent seepage, erosion and leakage. • Where gophers are present, trap the gophers and level the mounds and firmly backfill the burrows to prevent seepage, erosion and leakage. • Where voles are present, firmly backfill the burrows to prevent seepage, erosion and leakage • If ground squirrel abatement is needed conduct a one time poisoning program. After the appropriate amount of time has passed (determined	

MEDIA FILTERS – SAND
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				by the pesticide applicator), firmly backfill the burrows to prevent seepage, erosion and leakage.	
Inspect for possible endangered species, threatened species and species of special concern within the BMP maintenance perimeter.	Presence of bare ground, sparse ground cover, woodpiles, rocks, logs, rocks, evidence of burrowing animal damage or evidence of ponding, emergence of wetland or woody vegetation, shrubs, dwarf plantain,	Visual observation	Weekly, during the wet season	• On March 1 place nylon/plastic mesh with mylar strips over the filter sand area to prevent bird nesting. Remove the mesh and mylar in September each year. If nesting occurs in the BMP, immediately notify the engineer. • Remove debris, woodpiles etc. within 10 days. • On Mar 1, deploy stakes with mylar strips and place scarecrow device around BMP. If burrows are found between Mar 1 and Aug 30, a biologist needs to confirm that no birds are nesting in the burrows before sealing the hole.	Vulnerable sites: I-5/La Costa PR I-5/SR-78 PR

MEDIA FILTERS – SAND
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				• Remove woody vegetation, shrubs, dwarf plantain, pickleweed and woody wetland vegetation[3] outside the wetted pond area within 10 days.	
Inspect for standing water	Water accumulation in any structure or other location within the filter	Standing water in any structure or other location within the filter	Annually, May 1	Where gravity draining is possible, drain the standing water	None
General Maintenance Inspection	Inlet structures, outlet structures, filter fabric or other features damaged, emergence of vegetation, graffiti or vandalism, fence damage, etc.	Visual observation	Monthly	Within 30 working days, take corrective action. Consult engineer if immediate solution is not evident.	None

MULTI-CHAMBER TREATMENT TRAINS
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Maximum filter drain time of 72 hrs for design and smaller storms	Drain time greater than 72 hours	Visual observation	After each target storm	If filter surface has sediment, remove and replace filter fabric blanket. Target completion period within 10 days. If problem persists, consult with engineer, the media may need to be replaced.	None
Inspection for trash/ debris at inlet and outlet structures and the MCTT	Trash/debris present	Visual observation	Weekly during the wet season and monthly during the dry season	Remove and dispose of trash and debris. Target completion period within 1 day during wet season, 10 days during dry season..	None
Inspection for sediment accumulation	Maximum of 6-inches in main settling chamber Maximum of 2-feet grit chamber, or Any parameter concentration (See Vol II) exceeds 50% of Title 22 TTLC. Or, if the parameter concentration falls between 10X STLC and TTLC, is less than 50% TTLC, and the	Measure with appropriate device Characterize sediment by sampling according to OMM plan Vol II and send samples to lab	Measure sediment depth monthly during period of extended wet weather. Characterize sediment annually on May 1	Remove sediment within 10 days during wet season, characterize sediment and dispose of the sediment within 30 days If sediment characterization exceeds maintenance indicator, remove and dispose of sediment.	None

MULTI-CHAMBER TREATMENT TRAINS
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
	WET results exceed 50 % of the STLC value.				
Inspect for possible vector harborage	Standing water for more than 72 hours	Visual observation	Monthly and 72 hours after target storm event	Immediately notify VCD for vector abatement assessment. Renew vector control briquettes every 3 months.	None
Inspect for standing water	Water accumulation in any structure or other location within the device	Standing water in any structure or other location within the device	Annually, May 1	Where gravity draining is possible, drain the standing water	None
Replace filter media every 3 years per designer's specification	Operation greater than 3 years	Not applicable	Every 3 years	Remove and replace filter media	None
Renew sorbent pillows in main settling chamber every year per designer's specification	Not applicable	Not applicable	Annually at the end of the wet season	Renew sorbent pillows	None
Inspect pumps for proper functioning	Pump does not operate	Energize pump to see if water is discharged	September or after one month of inactivity during the wet season	Make assessment to determine if problem is electrical or mechanical. Take appropriate action. Replace pump if needed. Target completion time s 10 days (keep one pump in storage as back-up)	None
Inspect pumps for serviceability and periodic maintenance	Per manufacture's guidelines	Per manufacture's guidelines	Per manufacture's guidelines	Per manufacture's guidelines	None

MULTI-CHAMBER TREATMENT TRAINS
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
General Maintenance Inspection	Inlet structures, outlet structures, filter fabric, settling tubes or other features damaged, emergence of vegetation, graffiti or vandalism, fence damage, etc.	Visual observation	Monthly	Within 30 working days, take corrective action. Consult engineer if immediate solution is not evident.	None

OIL-WATER SEPARATOR
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Inspect for sediment accumulation in the pre-separator and separator chamber	Greater than 12-inches	Measure with appropriate device	Monthly	Within 10 working days remove the accumulated material with a suction hose from a vacuum vehicle or portable pump.	None
Inspect for oil accumulation in oil chamber	Oil depth is not more than 50 percent of chamber volume	Gauge the level of oil/water with a wooden gauge stick	Monthly	Within 10 working days remove and dispose of oil and grease.	None
Inspect coalescer for debris and gummy deposits	Debris or gummy deposits present	Visual observation	Two times per year – at the beginning and end of each wet season (Sep 1 and April 15)	Wash the coalescer with a high-pressure hot water.	None
Inspect water level in tank	Less than full	Visual observation	Monthly	Fill with water within 1 day	None
Inspect for general mechanical integrity	Per manufacture's guidelines	Per manufacture's guidelines	Monthly during the wet season and before the beginning of the wet season	Operate each mechanical component to ensure proper operation. Repair as needed	None

WET BASIN
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
24 hour draw down measured between the outlet structure and invert of the WQ orifice in the outlet structure..	Drawdown greater than 25 hours or water is flowing over weir.	Evaluate drain time from inlet and outlet flow data loggers or observe 25 hours after target storm. Observation of water flowing over spillway	After each target storm event	If >25-hours: Open gate to discharge water to permanent pool elevation, clear outlet of debris. Consult engineer if needed. If water is spilling over weir open canal gate until water level is at permanent pool elevation.	None
Inspect for burrowing rodent activity	Ground squirrel holes, vole or gopher mounds	Visual observation	Monthly, for rodent activity with abatement immediately if the activity affects the performance of the BMP otherwise abate annually in September	• Where ground squirrels are active, firmly backfill the burrows to prevent seepage, erosion and leakage. • Where ground squirrels are not active, confirm that no owl activity is present (a biologist may be needed if uncertain). Firmly backfill the burrows to prevent seepage, erosion and leakage. • Where gophers are present, trap the	None

WET BASIN
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				gophers and level the mounds and firmly backfill the burrows to prevent seepage, erosion and leakage. • Where voles are present, firmly backfill the burrows to prevent seepage, erosion and leakage • If ground squirrel abatement is needed conduct a one time poisoning program. After the appropriate amount of time has passed (determined by the pesticide applicator), firmly backfill the burrows to prevent seepage, erosion and leakage.	
Inspect for possible endangered species, threatened species and species of special concern within the BMP maintenance perimeter.	Evidence of emergence of woody vegetation, shrubs, dwarf plantain, or wetland vegetation, burrowing animal damage. Presence of logs, woodpiles, rocks, or large debris.	Visual observation	Weekly, during the wet season	• Remove woody vegetation, shrubs, dwarf plantain, pickleweed and woody wetland vegetation[3] above the maintenance road area within 10 days.	None

WET BASIN
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
				• Remove debris, woodpiles etc. within 10 days. • On Mar 1, deploy stakes with mylar strips and place scarecrow device around BMP. If burrows are found between Mar 1 and Aug 30, a biologist needs to confirm that no birds are nesting in the burrows before sealing the hole. Remove floating debris and dead and floating vegetation mats within 10 days. •Maintain wetland vegetation only between August and February	
General Maintenance Inspection	Inlet structures, outlet structures, side slopes or other features damaged, significant erosion, graffiti or vandalism, fence damage, etc.	Visual observation	Monthly	Within 10 working days, take corrective action. Consult engineers is immediate solution is not evident.	None
Inspect zone of periodic inundation vegetation	•Wetland plant density in the zone of periodic	Visual observation/estimate	Annually, approx. May 1	By Nov 1 each year, restore to “as	None

WET BASIN
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
	inundation is maintained at the "as constructed" density.			constructed" plant density	
Inspect for sediment accumulation in forebay and main pond	More than 2 inches in the forebay and 4 inches in the main pond, or	Measure with appropriate device	Monthly	Remove and dispose of sediment. Target completion period within 30 days. If vegetation coverage drops below 30 percent during maintenance operation, replant vegetation on November 1 to restore to 30 percent coverage	La Costa site only
	Any parameter concentration (See Vol II) exceeds 50% of Title 22 TTLC. Or, if the parameter concentration falls between 10X STLC and TTLC, is less than 50% TTLC, and the WET results exceed 50 % of the STLC value.	Sample according to OMM plan Vol II and send samples to lab	May 1 each year	If sediment characterization exceeds maintenance indicator, remove and dispose of sediment. Regrade. Revegetate, if vegetation coverage drops below 30 percent. Replant vegetation on November 1 to restore to 30 percent coverage	

CONTINUOUS DEFLECTIVE SEPARATION (CDS) UNITS
Preventive Maintenance and Routine Inspections

DESIGN CRITERIA, ROUTINE ACTIONS	MAINTENANCE INDICATOR	FIELD MEASUREMENT	MEASUREMENT FREQUENCY	MAINTENANCE ACTIVITY	SITE SPECIFIC REQUIREMENTS
Inspect for accumulation of trash and debris	Unit 85 percent full	Visual observation	Monthly during the wet season	Empty unit when the it is 85 percent full or annually in May, effect cleaning within 30 days	
Inspect for vector harborage	Standing water for more than 72 hours	Visual observation	Monthly and 72 hours after target storm event	Immediately notify VCD for vector abatement assessment.	None
Inspect the screen for damage and to ensure that it is properly fastened.	Screen becomes clogged, damaged or loose	Visual observation	Annually between September 15 and October 1)	Brush or high pressure wash the screen	None
Inspection for structural integrity	Holes in screen, large debris, damage to housing or weir box	Visual observation	Monthly or prior to a target storm during the wet season, and annually in May	Immediately consult with engineer and manufacturer's representative to develop a course of action, effect repairs within 10 working days	None

Notes for all BMPs:

1. Design storm event is a storm that is a one year 24 hour recurrence frequency.
2. A target storm event is a storm with a predicted greater than 0.25 inches of rainfall or 0.1 inches for drain inlet inserts. Storm events should be separated by at least 72 hours of dry weather from the previous storm event.
3. Woody wetland vegetation consists of: willows *(Salix spp)*, mule fat *(baccharis salicifolia)*, cottonwood *(populus fremontii)*, western sycamore *(plantanus racemosa)* and emergent large stature monocots including the genera *Cyperus, Juncus, Scirpus, and Typha)*

This Maintenance Indicator Document has been developed using site-specific information gathered by specialists trained in the identification of threatened and endangered species and their habitat. Information contained in this document includes guidance for inspection for possible threatened and endangered species harborage. Further, some of the maintenance recommendations are based on the requirements of specific plant species used in this Pilot Program. The recommendations provided in this document must be reassessed with respect to species and plant materials if the guidance contained herein is to be used for a separate project in another area.