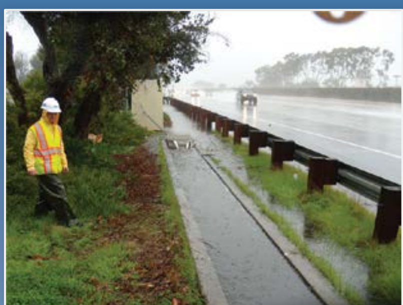

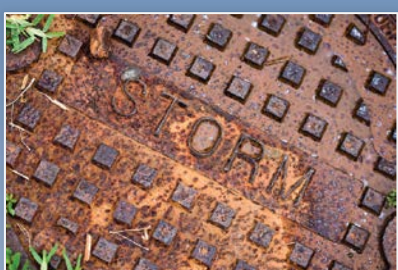

Storm Drain Insert Pilot Study

FINAL REPORT

TASK ORDER #43

DOC ID# CSD-RT-12-URS43-03

May 25, 2012

CITY OF SAN DIEGO

PREPARED BY URS CORPORATION

think BLUE
SAN DIEGO

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List of Acronyms and Abbreviations

ARS	Automatic Retractable Screen
BMPs	Best Management Practices
CPS	Connector Pipe Screen
Division	City of San Diego Transportation and Storm Water Department; Storm Water Division
DII	Drain Inlet Insert
GISB	Grate Inlet Skimmer Box
Insert	Storm Drain Inlet or Catch Basin Insert
MS4	Municipal Separate Storm Sewer System
MTS	Metropolitan Transit System
NPDES	National Pollutant Discharge Elimination System
NWS	National Weather Service
OMMP	Storm Drain Insert Pilot Study Operation, Maintenance and Monitoring Plan
QA/QC	Quality Assurance/Quality Control
QPF	Quantitative Precipitation Forecast
RFQ	Request for Qualifications
RWQCB	Regional Water Quality Control Board
SDCFCD	San Diego County Flood Control District
SDIPS	Storm Drain Insert Pilot Study
SWRCB	State Water Resources Control Board
TMDLs	Total Maximum Daily Loads
Vendor	Storm Drain Insert Pilot Study Selected Product Vendor

EXECUTIVE SUMMARY

The City of San Diego (City) manages a large Municipal Separate Storm Sewer System (MS4) that discharges stormwater and urban runoff to creek, bay, and ocean receiving waters throughout the City limits. The San Diego Regional Water Quality Control Board (RWQCB) regulates the discharge of urban runoff through the City's MS4 under the National Pollutant Discharge Elimination System (NPDES) permit program. In response to NPDES permit obligations and as a result of other program drivers, the City of San Diego Transportation and Storm Water Department; Storm Water Division (Division) has engaged in a multi-faceted urban runoff management program that includes studies to determine the most cost-effective and efficient methods to implement water quality improvements.

The Division's urban runoff management program consists of an integrated, tiered BMP implementation approach. The tiered approach allows for monitoring and assessment of each BMP tier to provide information on BMP effectiveness, potential BMP enhancements which may improve pollutant removal efficiency, cost-effectiveness and identification of successful BMPs for potential future wide-scale implementation.

The Storm Drain Insert Pilot Study (SDIPS) evaluated the performance and operation and maintenance requirements of storm drain insert BMPs at eight different locations throughout the City. To identify potential project partners for the SDIPS, the Division initiated a competitive selection process where BMP product Vendors agreed to provide and maintain the BMPs to be tested at no cost to the Division. A panel consisting of Division staff and project team members evaluated the proposals received, and ranked the products based on a variety of criteria. A total of five different products from four Vendors were selected for evaluation in the SDIPS.

Siting and installation of the pilot storm drain insert BMPs was conducted from December 2010 to April 2011. A monitoring strategy and Operation, Maintenance and Monitoring Plan (CSD-RT-11-URS36-01, OMMP) were developed for the SDIPS in June 2011, and finalized in August 2011. The monitoring program was developed to quantitatively and qualitatively assess the performance of the storm drain insert technologies during both dry and wet weather.

Monitoring was conducted from September 2011 through December 1, 2011. Dry weather monitoring included five dry weather inspections (two pre-maintenance inspections, two post-storm inspections, and one additional dry weather inspection at the end of the monitoring period) and two maintenance observations. The Vendors performed maintenance according to their routine procedures, and the project team conducted empirical observations to document the maintenance procedures and level of maintenance effort.

Wet weather monitoring included storm event performance monitoring for a single storm event. In addition, reconnaissance-level field visits were conducted at the sites during a storm event that occurred early in the monitoring period (October 2011). Field conditions observed during the storm event reconnaissance were used to inform the monitoring approach and refine the storm event data collection procedures and field forms. Data collection efforts also included a desktop analysis/estimation of the drainage area for each site.

Data collected from the monitoring program was used to evaluate BMP performance during storm events, assess the level of effort required to maintain the BMPs, analyze pollutant loads of gross solids retained by the BMPs, and determine BMP maintenance frequency requirements.

The Storm Event Performance Monitoring results show that many of the insert BMPs evaluated for this study demonstrated appreciable levels of flow bypass during the monitored storm event. Five out of the eight products evaluated bypassed below the Water Quality Flowrate (calculated based on estimated drainage areas) at some point during the monitored period. Six out of the eight BMPs exhibited significant bypass (i.e., flow bypass greater than 50 percent of the total flow entering the curb inlet) for more than 40 percent of the monitoring period.

Re-suspension of accumulated gross solids was observed during the storm event at all sites, although appeared to be minimal at two sites. Post-storm inspections conducted after the monitored storm event confirmed evidence of gross solids bypass and/or re-suspension and deposition of gross solids in the catch basins at all sites. Clogging of insert filter material/fabric/screens was difficult to observe during the storm, however observations from post-storm inspections showed that clogging of filter material/fabric/screens was prevalent, and was likely a contributing factor for bypass.

Observation and documentation of Vendor maintenance procedures for the different insert BMP products was performed to determine the level of effort required to maintain the BMPs. The total time required to perform maintenance ranged from 15 to 30 minutes per site.

Gross solids weight, volume, and percent composition by volume of gross solids retained by the insert BMPs were collected as part of the maintenance observations. Measurements and observations of gross solids were reflective only of the amount of gross solids retained by the insert BMPs at the time of data collection, and were not reflective of the total pollutant loading of gross solids to the storm drain system. Gross solids data from the eight pilot sites appeared to be highly variable, most likely due to the differences in pollutant loading of the site drainage areas.

To ascertain some measure of the potential loading of gross solids to the storm drain system, the volume of runoff that bypassed the BMPs was estimated for the eight sites. For all sites, the bypass volume represents the estimated volume of runoff that bypassed the inserts/baskets, as a percentage of the total volume of runoff entering the curb inlet. Seven out of eight total sites exhibited estimated insert bypass volumes near or greater than 50 percent.

The final key component of the SDIPS was an evaluation of the maintenance frequency required to maintain the BMPs at optimal levels. A determination of the required maintenance frequency was based on both quantitative assessment of the amount of gross solids present, and qualitative assessments of other conditions that may have the potential to impact BMP hydraulic function. Based on the evaluation conducted by the project team, the frequency of maintenance required was determined to be more than one time during the project period (i.e., quarterly) for all eight BMPs.

Although the SDIPS was limited in duration, the study results provide valuable information regarding the specific performance and operation and maintenance requirements of the selected BMPs under the given study conditions. This information can be used to assist the Division when considering potential future implementation of various BMPs as part of their integrated, tiered BMP implementation approach.

SECTION 1 INTRODUCTION

The City of San Diego Transportation and Storm Water Department; Storm Water Division (Division) manages a Municipal Separate Storm Sewer System (MS4) that includes structures such as storm drain pipes, inlets, channels, curbs, gutters, and other ancillary structures. While the main purpose of the MS4 is to protect both citizens and property from flooding, many studies have determined that pollutants found in urban runoff may be transported to receiving waters through the MS4. These pollutants can include gross solids (trash and debris), bacteria, oil and grease, sediment, metals, nutrients and pesticides.

In 1990, the State of California began regulating storm water runoff under the Federal Clean Water Act. The State Water Resources Control Board (SWRCB) and San Diego Regional Water Quality Control Board (RWQCB) have implemented regulations, programs, and permit requirements that direct municipalities to address urban runoff pollution within their jurisdictions to comply with the Clean Water Act, such as Total Maximum Daily Loads (TMDLs), Water Quality Control Plans (i.e., Basin Plans), and MS4 permits.

In an effort to comply with the Clean Water Act, the Division is implementing a multi-faceted Best Management Practices (BMPs) strategy. In order to cost-effectively implement this strategy City-wide, the Division is taking an integrated tiered and phased BMP implementation approach.

The three-tiered approach includes both non-structural source control and pollution prevention BMPs, as well as structural BMPs. Tier I of this approach is focused on non-structural BMPs that aim to address water quality problems through implementation of pollution prevention and source control projects. Tier II, of which this project is a part, are structural and non-structural BMPs that target the reduction of the volume of runoff and/or a portion of the pollutant load through runoff diversion/capture and infiltration and evaporation. Tier III are structural treatment control BMPs that reduce runoff volume and treat storm water to reduce pollutant discharges to the maximum extent practicable.

The Division's integrated BMP implementation approach allows for monitoring and assessment of each BMP tier to provide information on BMP effectiveness, potential BMP enhancements which may improve pollutant removal efficiency, cost-effectiveness and ultimately identifies successful BMPs for potential future wide-scale implementation.

The Storm Drain Insert Pilot Study (SDIPS) retrofitted existing MS4 storm drain inlets and/or catch basins with inserts identified as BMPs within the City right of way at eight different locations. The performance and operation and maintenance requirements of the insert BMPs were evaluated.

The purpose of the SDIPS project report (Report) is to summarize the results of the SDIPS. This Report contains a description of the data collection efforts, a summary of collected field data, and an evaluation of the project findings as they relate to BMP maintenance level-of-effort, insert product performance during storm events, gross solids pollutant load analysis, and maintenance frequency requirements of the pilot BMP inserts.

1.1 PROJECT BACKGROUND

To identify potential project partners for the SDIPS, the Division initiated a Request for Qualifications (RFQ) to storm drain inlet or catch basin insert (inserts or insert BMPs) product vendors (Vendors) in June 2010. The RFQ invited Vendors to participate in a competitive selection process, where Vendors agreed to provide and maintain the BMPs to be tested, at no cost to the Division. A panel consisting of Division staff and the Division's consultant project team (project team) evaluated the proposals received, and ranked the products based on a variety of criteria outlined in the RFQ, including:

- Pollutant removal capability;
- Capacity;
- Impact to existing infrastructure;
- Potential for flooding impacts;
- Operation and Maintenance requirements;
- Warranty;
- References of performance at other locations;
- Other criteria.

The insert BMPs ranked the highest by the Division's Vendor Selection Panel were selected for study, and successful Vendors awarded in September 2010. A total of five different products from four Vendors were selected for evaluation in the SDIPS.

Potential project sites for the SDIPS were identified by the Division in the RFQ, to provide assistance to the Vendors during the proposal process. After the conclusion of the Vendor selection process in September 2010, site visits were conducted to evaluate the suitability of the proposed locations for the pilot study. Site visits to select the final SDIPS study locations were performed in December 2010 to February 2011. Based on the findings of the site evaluations, several of the site locations originally identified in the RFQ were replaced with alternative sites. During this time period, site visits were also conducted with the Vendors, to field-verify the compatibility of the BMP products with the storm drain configuration at the specific sites.

The pilot BMP inserts were installed at final project sites from February through April 2011. The installation procedures, level of effort, and other technical issues related to product installation were documented through photographs and collection of field data using standard forms (refer to Appendix B).

A monitoring strategy and Operation, Maintenance and Monitoring Plan (CSD-RT-11-URS36-01, OMMP) to implement the monitoring strategy were developed for the SDIPS in June 2011, and finalized in August 2011. The OMMP was developed to achieve the study objectives and answer the Management Questions outlined in Section 1.2.

The Division is developing a Strategic Storm Water Business Plan to serve as a roadmap for a master storm water planning program (City of San Diego, 2010). The Strategic Storm Water Business Plan is designed to streamline efforts, provide a basis for proactive maintenance, allow for informed decision-making and provide for transparency and clarity of Division activities. The Strategic Storm Water Business Plan identifies a mission statement, core values, and five goals for Division activities (Figure 1-1). The SDIPS is aligned with three of the five strategic goals of the Division. The SDIPS aims to: aid in restoring and maintaining clean beaches, streams and bays (Goal A), use best science and practices to advance storm water management (Goal B) and comply with regulatory requirements (Goal E).

Figure 1-1. Storm Water Division Mission Statement, Core Values and Goals

1.2 STUDY OBJECTIVES

The objective of the SDIPS is to evaluate the performance and operation and maintenance requirements of the pilot BMP inserts. This will be accomplished by the following tasks:

- Document the operational performance of the BMP during dry weather and storm events;
- Document the level of effort required to maintain the BMP;
- Determine the mass, volume, and general category of gross solids removed by the inserts;
- Determine and document BMP performance evaluation criteria relative to the qualitative benefits of the BMP;
- Determine the quantity of runoff treated by the BMP;
- Validate product Vendor performance specifications.

The Management Questions for the SDIPS include:

Question 1

Is the screening component of the device functional throughout a storm event of greater than 0.25 inches in rain depth (per the City of Los Angeles test protocol for trash capture pilot studies), but where flow rates do not exceed 0.2 inches per hour (i.e., MS4 permit criteria for flow-based BMP sizing)? If not, what is the primary mode of failure (premature clogging, swing gate stuck open, other)? What is the quantity of trash released by this mode of failure?

Question 2

If flows are observed overtopping (bypassing) the screening component, either because flow rate exceeds the design capacity or the screen is clogged, does captured trash become re-suspended and released into the storm drain? What is the quantity of trash released by this mode of failure?

Question 3

Is one cleaning of the BMP prior to the start of the rainy season sufficient to ensure adequate performance for the first two months of the rainy season, for conditions under the study year? If not, what is the recommended increase in frequency of cleaning?

Question 4

What maintenance equipment is required to maintain insert?

Question 5

What is the level of effort needed to maintain insert? What specific type of maintenance procedures are required?

1. Insertion of vacuum hose only
2. Manual Entry into Manhole required (Confined Space Entry)
3. Average time needed to maintain insert
4. Number of workers involved
5. Types of tools and equipment required

1.3 GENERAL SCOPE OF MONITORING ACTIVITIES

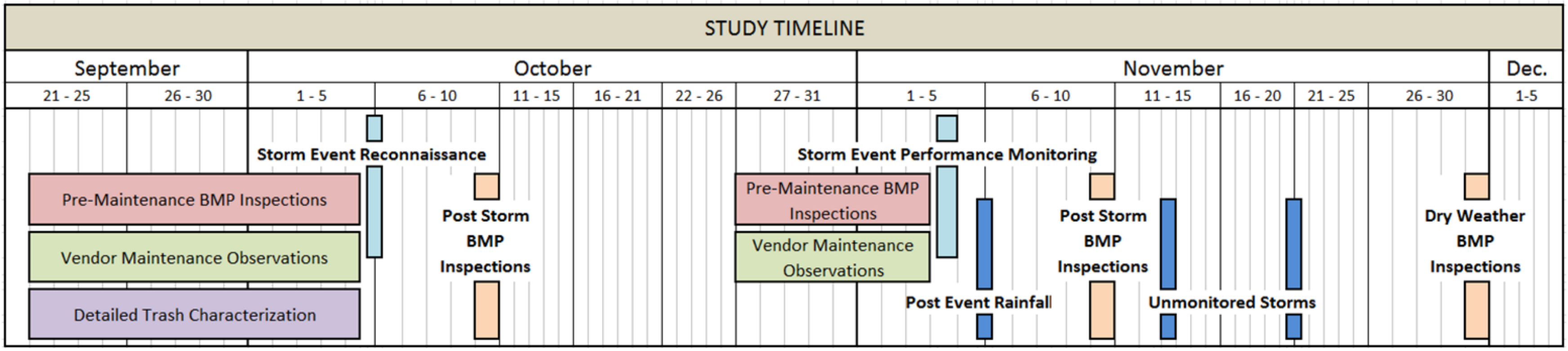
The overall SDIPS monitoring approach developed and outlined in the OMMP includes a phased implementation strategy with both dry and wet weather components. The initial phase (Phase I) of the strategy is comprised of an operational assessment of the selected storm drain insert technologies at eight sites. Data collected during Phase I would be used to quantitatively and qualitatively assess the performance of the storm drain insert technologies during both dry and wet weather. Under the phased monitoring strategy, these data would be used to determine the feasibility and direct the specific monitoring techniques for Phase II stormwater quality monitoring, which may include collection of representative water quality samples to determine product pollutant removal effectiveness in wet weather, if implemented.

Prior to the initiation of Phase I, it was determined that only Phase I monitoring would be conducted for the SDIPS. Monitoring was conducted from September 2011 through December 1, 2011. Phase I dry weather monitoring included five dry weather inspections (two pre-maintenance inspections, two post-storm inspections, and one additional dry weather inspection at the end of the monitoring period), and two maintenance observations (one conducted at the end of the dry season, and one conducted in the middle of the wet season, both before impending storm events). At least one inspection of the ARS was conducted within one to three days prior to street sweeping. The first maintenance observation included a detailed trash characterization. The specific maintenance procedures for each insert product were determined by the Vendor. The Vendors performed the required maintenance activities, and the project team conducted empirical observations to document the maintenance procedures and verify the level of maintenance effort.

Phase I wet weather monitoring included continuous weather monitoring, and storm event performance monitoring for a single storm event. In addition, reconnaissance-level field visits were conducted at the sites during a storm event that occurred early in the monitoring period (October 5, 2011). Field conditions observed during the storm event reconnaissance were used to inform the monitoring approach and refine the storm event data collection procedures and field forms. Phase I data collection efforts also included a desktop analysis/estimation of the drainage area for each site.

Figure 1-2 shows the timeframe and monitoring activities performed for the SDIPS.

Figure 1-2. Storm Drain Insert Pilot Study Timeline (2011)



1.4 PROJECT ORGANIZATION AND RESPONSIBILITIES

The project team for the SDIPS consists of staff representing the Division, URS Corporation (URS) and the insert BMP product Vendors. The Division Project Manager for this project was James Hook. The URS Task Order Manager was Bryn Evans.

The Division Project Manager was responsible for initial coordination with the Vendors regarding scheduling of vendor maintenance activities. Maintenance procedures conducted by the Vendor were carefully coordinated so that maintenance activities could be observed and thoroughly documented. In addition, the Division Project Manager was responsible for coordination with Division Operations and Maintenance (O&M) staff, so they could be informed of any SDIPS maintenance and monitoring activities that may impact routine Division O&M procedures and schedules.

The Vendors were responsible for performing maintenance activities associated with the study. URS conducted monitoring, inspections, and documentation of Vendor maintenance procedures. The Task Order Manager was responsible for informing the Division Project Manager of all pending monitoring events, including potential storm events to be monitored. The Division Project Manager was responsible for providing final approval for mobilization of field crews for storm event monitoring.

1.5 DOCUMENT ORGANIZATION

This Report is organized into the following sections:

Section 1.0 *Introduction*: Summarizes the project background information including study objectives, general scope of monitoring activities, and project organization and responsibilities.

Section 2.0 *Site Characteristics*: Describes each pilot site including the type of BMP tested and its location.

Section 3.0 *Data Collection Methods*: Describes the methodology and procedures employed to collect dry and wet weather data to be used for insert BMP evaluation purposes.

Section 4.0 *Project Results*: Presents the data analysis and results of the SDIPS.

Section 5.0 *Summary*: Summarizes the key project components of the SDIPS.

Section 6.0 *References*: Lists references used for the preparation of this Report.

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SECTION 2 SITE CHARACTERISTICS

This section describes the characteristics of the SDIPS pilot storm drain sites and the major features of the insert BMP product monitored at each site. For the purposes of this section and the following sections of the Report, "inlet" refers to the curb inlet opening of the pilot site storm drain. "Inlet bypass" indicates runoff flow that bypasses the curb inlet opening. "Insert bypass" or "product bypass" designates flows that enter the curb inlet opening, but bypass the insert BMP product.

2.1 SITE EVALUATIONS

Potential pilot study sites for the SDIPS were initially identified by the Division during the competitive vendor selection process, to assist the Vendors in providing product information and specifications. Based on feedback received from Vendors and panel members during the Vendor selection process, additional site visits were conducted to evaluate the suitability of the proposed locations for the pilot study.

Site evaluations of the proposed pilot project site locations were conducted from December 2010 to February 2011. Sites were evaluated to determine if: 1) site conditions facilitated the study monitoring objectives; 2) it was feasible to monitor the location; and 3) the site was a safe location for monitoring. Several criteria were evaluated for each of the proposed pilot storm drain locations, including but not limited to:

- Type of site/surrounding land use;
- Factors affecting monitoring capability, such as potential backwater conditions, presence of multiple inlet or outlet streams, depth of catch basin, steepness/slope of gutter;
- Presence of contributing offsite runoff;
- Temporary construction or other activities that may impact runoff quality and/or trash generation;
- Safety issues such as high traffic areas, or manholes located in the roadway; and
- Presence of a more suitable monitoring location nearby.

Sites located nearby or in the immediate vicinity of the originally-proposed sites were considered to be preferable as alternative monitoring locations since the Vendors participating in the RFQ process based their proposals on the locations initially identified in the RFQ. Of the eight locations originally proposed for study, seven alternative locations and one original location were ultimately selected for further consideration. After the alternative storm drain locations were identified, specific sites were assigned to each of the Vendors for product implementation.

Based on visible observations of accumulated trash adjacent to the inlet areas, surrounding land use and other factors observed during the site evaluations, site locations were assigned to the Vendors to encompass the range of field conditions expected. In many cases, the insert products can be fitted or modified to accommodate a particular catch basin configuration. For some SDIPS site locations however, the proposed siting of Vendor products needed to be adjusted due to considerations such as potential maintenance access issues, or siting issues related to the incompatibility of the existing infrastructure with a particular BMP product design. More specific information regarding product configuration siting issues is provided in the following subsections. Final siting of the storm drain insert products was complete after all Vendors had field-verified the compatibility of their products with the specific assigned pilot storm drain locations.

Subsequent to the siting process, installation of the BMPs was performed by the Vendors from February through April 2011. Installation procedures, tools and equipment utilized, level of effort, and other technical issues related to product installation were documented by the project team through photographs and collection of field data using standard forms. These are included as Appendix B of this Report.

2.2 PILOT SITE LOCATIONS AND BMP DESCRIPTIONS

The SDIPS pilot sites are distributed across four different watersheds, including the San Dieguito, San Diego River, San Diego Bay (Chollas Creek and Pueblo San Diego), and Tijuana River watersheds. Figure 2-1 below shows the eight pilot site locations for the SDIPS. Table 2-1 lists the final pilot site locations and specific storm drain insert product and product vendor for each site. The table also includes descriptions of the sites, including general land use type, street sweeping frequency, and estimated drainage area. The frequency of street sweeping at the pilot study locations was provided by Division O&M staff. Information regarding the procedure to estimate the pilot site drainage areas is provided in Section 3 of the Report.

Five different insert BMP products from four different Vendors were evaluated during the SDIPS. Descriptions of the characteristics and major features of the BMP products monitored at each site are contained in the following subsections. The subsections are organized by Vendor, followed by the site location(s) for each Vendor, and BMP product installed at each site. More detailed information regarding the BMP products, including Vendor-provided BMP product schematics, specifications, and warranty information are contained in Appendix B of the SDIPS OMMP (City of San Diego, 2011).

Figure 2-1. Storm Drain Insert Pilot Study Site Locations Map

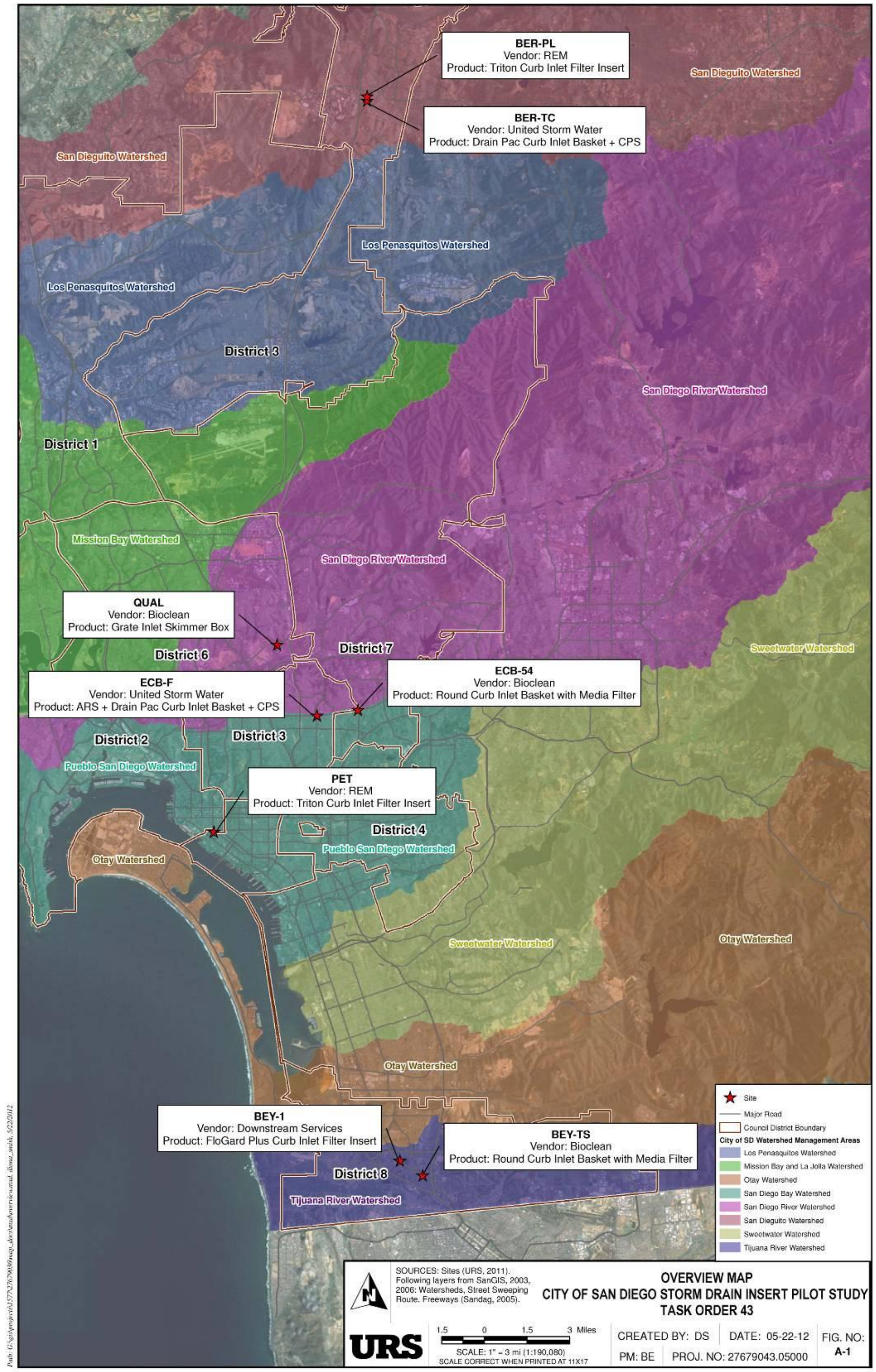


Table 2-1. Final Storm Drain Insert Pilot Study Locations and Site Descriptions

Site	Vendor	BMP Product	Location	Watershed	GPS Coordinates	Description	General Land Use	Street Sweeping Frequency	Drainage Area (acres)
BEY-TS	Bio Clean	Round Curb Inlet Basket with Media Filter	4035 Beyer Blvd (Beyer Blvd Trolley Station)	Tijuana River	N 32° 33.485' W 117° 02.811'	Curb inlet	Transportation, Residential	Weekly	0.1
ECB-54	Bio Clean	Round Curb Inlet Basket with Media Filter	El Cajon Blvd. & 54th Street (SW corner)	Chollas Creek, San Diego Bay	N 32° 45.459' W 117° 04.792'	Curb inlet	Mixed residential/ commercial	Weekly	1.0
QUAL	Bio Clean	Grate Inlet Skimmer Box	Qualcomm Stadium (parking lot section C3)	San Diego River	N 32° 47.138' W 117° 07.253'	Grate inlet	Municipal parking lot	Varies; after Special Events	1.0
BEY-1	Downstream Services	FloGard Plus Curb Inlet Filter Insert	3466 Beyer Blvd (south side)	Tijuana River	N 32° 33.865' W 117° 03.512'	Curb inlet	Residential	Weekly	0.1
BER-PL	Revel Environmental Manufacturing (REM)	Triton Curb Inlet Filter Insert	Bernardo Plaza Court & Bernardo Center Drive	San Dieguito	N 33° 01.218' W 117° 04.510'	Curb inlet	Commercial	Weekly	0.4
PET	Revel Environmental Manufacturing (REM)	Triton Curb Inlet Filter Insert	National Ave. and 13th Street (Petco Park)	San Diego Bay	N 32° 42.328' W 117° 09.183'	Curb inlet	Mixed transportation/ commercial/ parking lot	Weekly	0.4
BER-TC	United Storm Water	Drain Pac Curb Inlet Basket + CPS	Rancho Bernardo Town Center & Bernardo Center Drive	San Dieguito	N 33° 01.109' W 117° 04.513'	Curb inlet	Commercial	Weekly	2.4
ECB-F	United Storm Water	ARS + Drain Pac Curb Inlet Basket + CPS	El Cajon Blvd. & Fairmount Ave. (NE corner)	Chollas Creek, San Diego Bay	N 32o 45.313' W 117o 06.040'	Curb inlet	Mixed residential/ commercial	Weekly	8.5

ARS- Automatic Retractable Screen

CPS- Connector Pipe Screen

2.2.1 Bio Clean Environmental Services

Two BMP products, the Round Curb Inlet Basket and the Grate Inlet Skimmer Box (GISB) were provided by Bio Clean Environmental Services, Inc. (Bio Clean) for evaluation in the SDIPS. The Round Curb Inlet Basket was installed at two locations (BEY-TS and ECB-54), and the GISB was installed at one location (QUAL).

2.2.1.1 BEY-TS

The BEY-TS site is located in the Tijuana River Watershed, in the community of San Ysidro. The curb inlet is located near 4035 Beyer Blvd., adjacent to the Beyer Blvd. Metropolitan Transit System (MTS) Trolley Station parking lot. It is situated in a mixed land use area, consisting primarily of residential, and transportation (railway) land uses, with some light commercial operations nearby.

The sidewalk adjacent to the curb inlet has several large eucalyptus trees, which at the time of initial siting appeared to contribute a moderate amount of vegetative material (leaves) to the curb and gutter. However, during the course of the study, considerable amounts of organic debris (bark and leaves) were observed to deposit in the curb and gutter, and ultimately enter the storm drain inlet. Moderate levels of trash, likely originating from the adjacent sidewalk areas and the trolley station parking lot were also present. Figure 2-2 shows the BEY-TS site.

Figure 2-2. Bio Clean BEY-TS Pilot Site Location

The Round Curb Inlet Basket product installed at the BEY-TS location is a curb inlet insert that is mounted with the basket located directly beneath the manhole. A shelf system diverts low flows entering the catch basin to the basket for treatment. High flows are bypassed over the shelf system. The frame of the Round Curb Inlet Basket is constructed of marine-grade fiberglass, with stainless steel screens. The top rim of the basket accommodates a hydrocarbon-absorbent boom. The design employs a graduated series of screens with decreasing mesh size towards the bottom of the basket. The Round Curb Inlet Basket installed at this location incorporated a multi-layer media filter. Figure 2-3 shows the Round Curb Inlet Basket and shelf system installed, as viewed from the manhole opening. Figure 2-4 shows the basket removed from the manhole.

Figure 2-3. Bio Clean Round Curb Inlet Basket and Shelf System Installed at BEY-TS.

Figure 2-4. Bio Clean Round Curb Inlet Basket Removed from Manhole

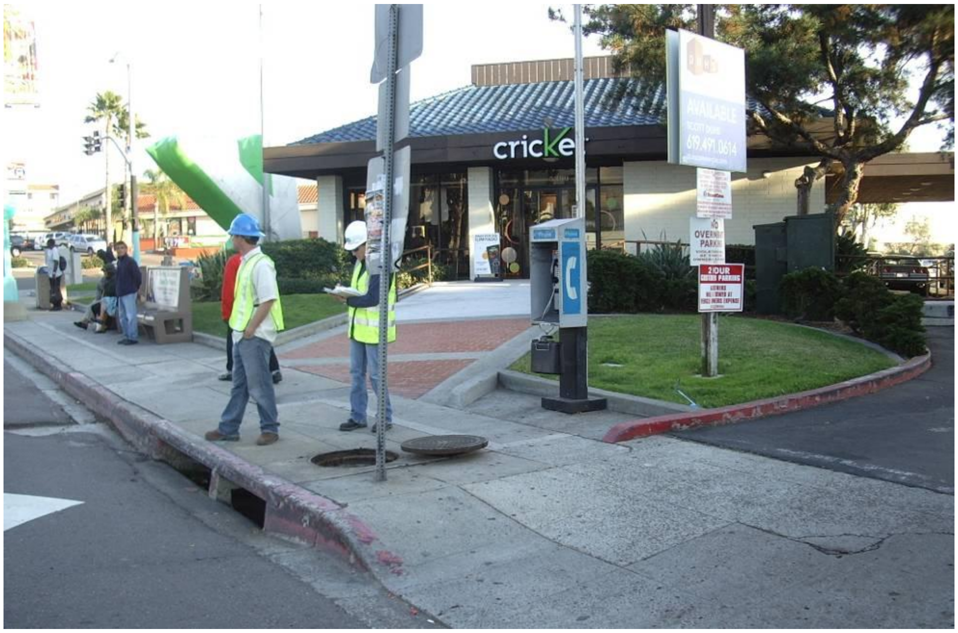
The Bio Clean Round Curb Inlet Basket was initially proposed by the project team to be installed at another location on Beyer Boulevard. It was re-located to an alternative site on the same street, because the storm drain configuration of the initial site would have made the product inaccessible for maintenance, per the Vendor's assessment of the location. The original location on Beyer Boulevard appeared to be a standard Type B-1 catch basin that has been modified.

2.2.1.2 ECB-54

The ECB-54 site is located in the San Diego Bay (Chollas Creek) Watershed. The curb inlet is located near the southwest corner of El Cajon Blvd. and 54th Street. It is situated in a mixed land use area, consisting primarily of residential and commercial land uses.

The sidewalk area adjacent to the curb inlet contains a bus stop and phone booth, and is downstream from an entrance to a small shopping area. There is heavy pedestrian usage, which generates a considerable amount of trash to the surrounding area, and ultimately to the storm drain inlet. Figure 2-5 shows the ECB-54 site.

Figure 2-5. Bio Clean ECB-54 Pilot Site Location



The same Round Curb Inlet Basket product installed at the BEY-TS location was installed at the ECB-54 site. The product incorporated a multi-layer media filter and hydrocarbon boom. Figure 2-6 shows the Round Curb Inlet Basket and shelf system being installed at the ECB-54 site.

Figure 2-6. Installation of Bio Clean Round Curb Inlet Basket at ECB-54 Pilot Site

2.2.1.3 QUAL

The QUAL site is located in the San Diego River Watershed, in the parking lot of Qualcomm Stadium (Section C3). This pilot site is the only location that contains a grate inlet (rather than a curb inlet) for the SDIPS.

Qualcomm Stadium is host to sporting and several special events year-round, and the intensive usage by the public generates a considerable amount of trash and debris. However, the parking lot is swept on a regular basis, and immediately following each event. Figure 2-7 shows the QUAL site.

Figure 2-7. Bio Clean QUAL Pilot Site Location

The GISB product is a drop-in type insert filter basket that fits grate inlets. The frame of the GISB is constructed of heavy duty marine-grade fiberglass, with stainless steel screens. The top rim of the GISB accommodates a hydrocarbon-absorbent boom, which was utilized at the QUAL location. The design employs a graduated series of screens with decreasing mesh size towards the bottom of the frame. Towards the top of the frame, a series of large orifices allow for bypass of higher flows. The GISB installed at this location also incorporated a multi-layer media filter. A flange to support the GISB was installed below the perimeter of the inlet to allow the grate to sit flush with the pavement after the product was put in place. Figure 2-8 is a schematic of the GISB. Figure 2-9 shows the product being installed at the QUAL site; the media filter can be seen on the bottom of the filter basket, when the skimmer is removed. Figure 2-10 shows the final product installation, with the skimmer placed inside the basket.

Figure 2-8. Schematic of Bio Clean Grate Inlet Skimmer Box

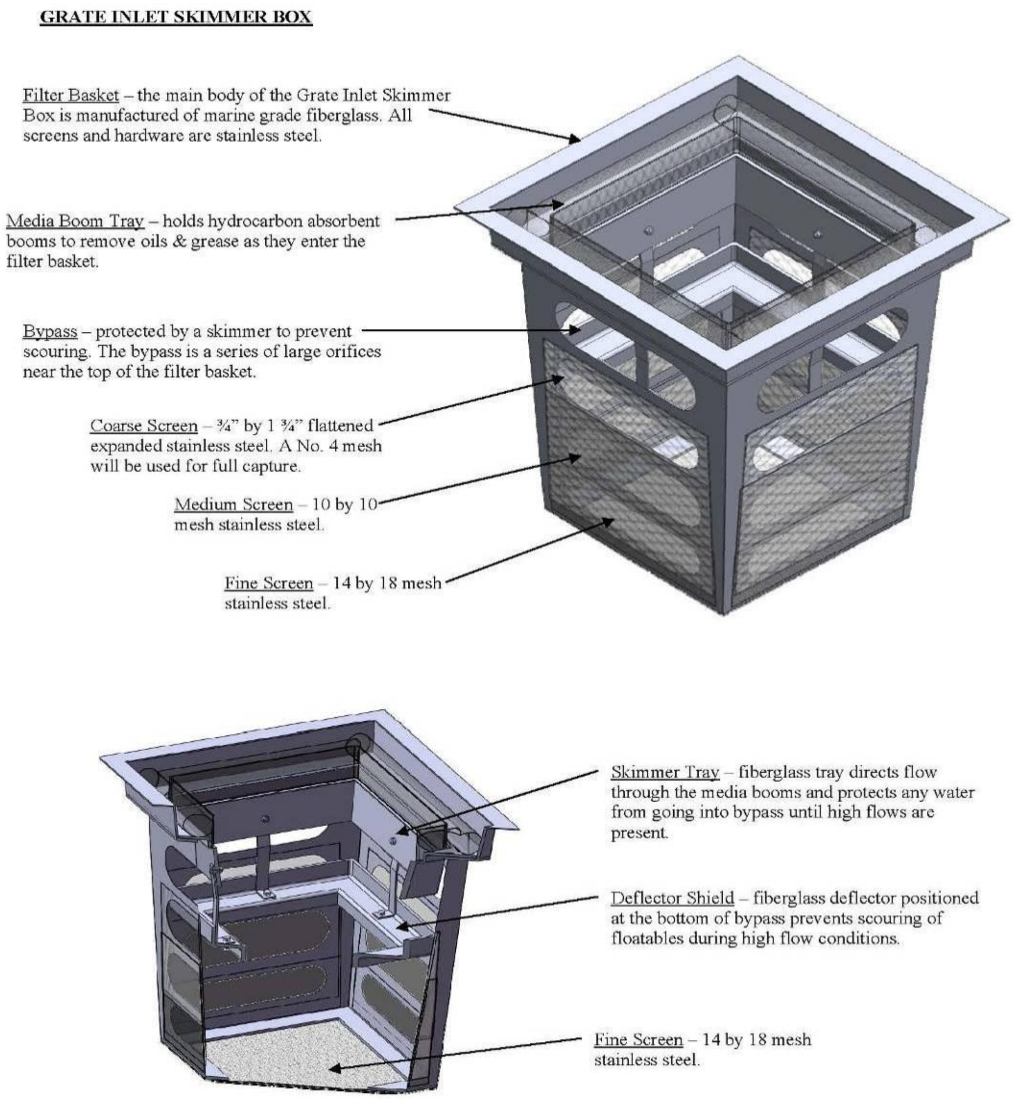


Figure 2-9. Bio Clean Grate Inlet Skimmer Box at QUAL Site with Skimmer Removed (Media Filter Shown)

Figure 2-10. Bio Clean Grate Inlet Skimmer Box at QUAL Site with Skimmer

2.2.2 Downstream Services

The FloGard Plus Curb Inlet Filter was provided by Downstream Services, Inc. for evaluation in the SDIPS. The FloGard Plus Curb Inlet Filter was installed at the BEY-1 pilot site location. Division staff recommended that this product be installed at a single location, because it was determined during the Vendor-selection process that this same BMP product was being implemented at another Division project site, and may therefore be evaluated at that site sometime in the future.

2.2.2.1 BEY-1

The BEY-1 site is located in the Tijuana River Watershed, in the community of San Ysidro. The curb inlet is located on the south side of Beyer Blvd., across the street from 3466 Beyer Blvd. The pilot site is situated in a primarily residential area, however the sidewalk is adjacent to the trolley railway.

The sidewalk adjacent to the curb inlet is used frequently by pedestrians, which generates significant amounts of trash and debris. In addition, a considerable amount of sediment was observed in the curb and gutter at the site. The source of the sediment is likely the MTS trolley railway slope, which has been observed to be largely unprotected. Figure 2-11 shows the BEY-1 site. Figure 2-12 shows trash left by pedestrians at the BEY-1 site.

Figure 2-11. Downstream Services BEY-1 Pilot Site Location

Figure 2-12. Trash Left by Pedestrians at Downstream Services BEY-1 Site

The FloGard Plus Curb Inlet Filter is a curb inlet basket-type insert, mounted below the curb inlet opening. The insert is constructed of a stainless steel frame that supports a polypropylene woven monofilament geotextile filter liner. The filter liner is supported by a polypropylene geogrid basket. The FloGard Plus Curb Inlet Filter accommodates clip-in filter pouches that contain proprietary media, which were installed at the BEY-1 location. Based on the length of the curb inlet, two inserts were mounted side-by-side to provide coverage of the entire length of the curb inlet opening. Rubber flanges/gaskets were installed on the basket edges between the two inserts, to prevent debris from passing through. Figure 2-13 is a schematic of the FloGard Plus Curb Inlet Filter. Figure 2-14 shows the FloGard Plus Curb Inlet Filter installed at the BEY-1 site.

Figure 2-13. Schematic of Downstream Services FloGard Plus Curb Inlet Filter

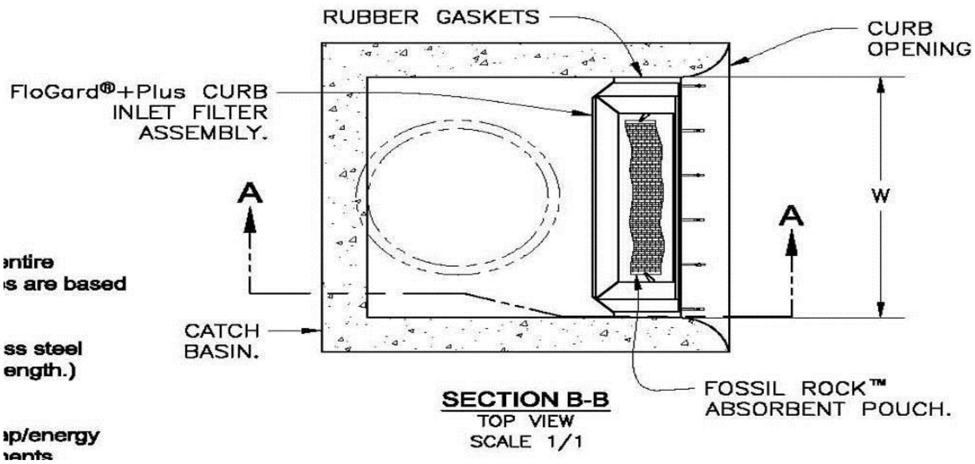


Figure 2-14. Downstream Services FloGard Plus Curb Inlet Filter Installed at BEY-1 Site (View from Catch Basin)

2.2.3 Revel Environmental Manufacturing (REM)

The Triton Curb Inlet Filter Insert was provided by Revel Environmental Manufacturing, Inc. (REM) for evaluation in the SDIPS. The Triton Curb Inlet Filter Insert was installed at two locations, the BER-PL and PET pilot sites.

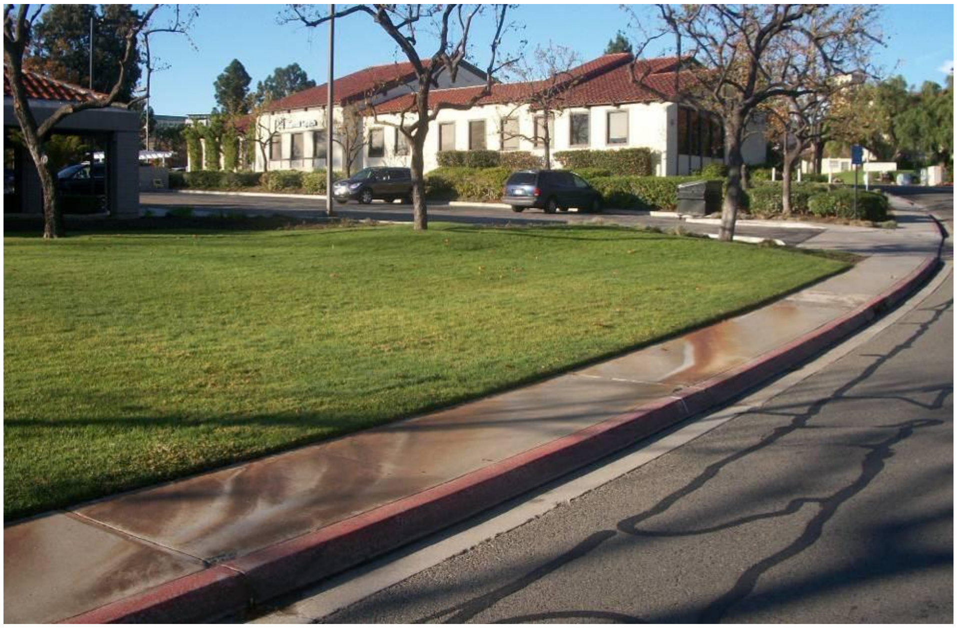
2.2.3.1 BER-PL

The BER-PL site is located in the San Dieguito Watershed, in Rancho Bernardo. The curb inlet is located at the southwest corner of Bernardo Center Drive and Bernardo Plaza Court. The site is situated in a light commercial area, consisting of banks, office buildings, restaurants, and retail stores.

The sidewalk adjacent to the curb inlet has several large trees, which contribute a considerable amount of vegetative material (leaves and small branches) to the curb and gutter, and ultimately to the storm drain inlet. Although not observed at the time of initial siting, the BER-PL site was observed later in the study to receive some dry weather runoff from a leaking irrigation system located on the adjacent commercial property. Low levels of trash were observed in the area. Figure 2-15 shows the BER-PL site. Figure 2-16 shows evidence of dry weather runoff at the site.

Figure 2-15. REM BER-PL Pilot Site Location

Figure 2-16. Evidence of Dry Weather Runoff at the REM BER-PL Site



The Triton Curb Inlet Filter Insert is a curb inlet basket-type insert, mounted below the curb inlet opening. The insert housing is constructed of high impact polystyrene plastic. The insert is fitted with a geotextile polypropylene-fabric media filter pack. Towards the top of the housing, a series of orifices allow for bypass of higher flows. An optional polypropylene web system (StormWeb) can be installed to assist in retention of large debris. The Storm Web was not initially installed at the BER-PL site, however was added later after the Vendor conducted the initial maintenance visit. Due to the particular configuration of the curb inlet and catch basin at the site, two inserts were installed overlapping at a 90-degree angle to provide full coverage of the inlet opening. A concrete shelf or "wing" adjacent to the curb inlet opening is present for a portion of the length of the curb inlet. One of the inserts was attached along the wall of the catch basin below the end of the wing, to capture material flowing off the wing and into the catch basin. Another insert was placed at the far end of the curb inlet, beyond the point where the wing is present. Figure 2-17 displays the configuration of the two inserts at the BER-PL site, during product installation. The edge of the wing can be seen on the right-hand side of the photo. The bottom of the photo shows the insert mounted below the remaining length of the curb inlet opening.

Figure 2-17. Configuration of the REM Triton Curb Inlet Filter Inserts at BER-PL Site

2.2.3.2 PET

The PET site is located in the San Diego Bay (Pueblo San Diego) Watershed, in Downtown San Diego, near Petco Park. The curb inlet is located near the intersection of National Avenue and 13th Street, across the street from the 12th Street MTS Station. The site is located in a mixed land use area, consisting primarily of commercial and transportation land uses.

Adjacent to the curb inlet there is a pay-parking lot with considerable pedestrian traffic. The large presence of pedestrians in the area initially generated large amounts of trash and debris at the site. Although not present at the time of initial siting and product installation, during the course of the study a fence was placed around the parking lot to provide a lay-down area for construction vehicles working in other downtown areas. The fence around the parking lot prevented pedestrians from congregating in the area, and a reduction in the amount of trash and debris generated at the PET site as compared to the time of initial siting was observed. Figure 2-18 shows the PET site.

Figure 2-18. REM PET Pilot Site Location

The same product, the Triton Curb Inlet Filter Insert, was installed at the PET site. Unlike the BER-PL location, the catch basin configuration at the PET site allowed installation of a single insert to cover the curb inlet opening. The optional Storm Web polypropylene system was also utilized at the PET site. Figure 2-19 shows the Triton Curb Inlet Filter Insert installed at the PET site.

Figure 2-19. REM Triton Curb Inlet Filter Insert Installed at PET Site

2.2.4 United Storm Water

Two BMP product systems were provided by United Storm Water, Inc., for evaluation in the SDIPS. The Automatic Retractable Screen (ARS) system is comprised of multiple components that can be combined to work together as a system depending upon the specific site characteristics and/or targeted pollutants for removal. The ARS unit is typically installed with one additional product component; the Drain Pac Curb Inlet Basket or the Connector Pipe Screen (CPS). In addition, the Drain Pac Curb Inlet Basket and/or the CPS can be used alone or together, depending upon the specific site characteristics. The BER-TC site was installed with the CPS and Drain Pac Curb Inlet Basket. The ECB-F site was installed with all three components: the ARS, CPS and Drain Pac Curb Inlet Basket.

2.2.4.1 BER-TC

The BER-TC site is located in the San DieguitoWatershed, in Rancho Bernardo. The curb inlet is located at the southeast corner of the entrance to Rancho Bernardo Town Center at Bernardo Center Drive. The site is situated in a light commercial area, consisting of banks, gas stations, office buildings, restaurants, and retail stores.

The sidewalk adjacent to the curb inlet is landscaped and the upstream tributary area contains several trees, which contribute a moderate amount of vegetative material (leaves, grass clippings) and sediment to the curb and gutter, and ultimately to the storm drain inlet. Low levels of trash were observed in the area. Figure 2-20 shows the BER-TC site.

Figure 2-20. United Storm Water BER-TC Pilot Site Location

The BER-TC site was installed with the CPS and Drain Pac Curb Inlet Basket. The Drain Pac Curb Inlet Basket is mounted below the curb inlet opening. The insert is constructed of a stainless steel frame that supports a polypropylene woven geotextile filter liner. The filter liner is supported by a polypropylene geogrid basket. The top rim of the basket can accommodate a hydrocarbon-absorbent boom. The CPS is a 5mm stainless steel screen that is fitted to cover the catch basin outlet pipe opening. The CPS prevents trash and other gross solids from entering the storm drain system by retaining the material in the catch basin. The CPS has an opening near the top of screen to provide bypass capability, and also is configured with a deflector plate or screen to prevent trash and gross solids from falling between the screen and catch basin outlet pipe.

Typically, the CPS and/or the Drain Pac Curb Inlet Basket are installed as a component of the ARS system. Originally, it was anticipated that all three components would be installed at the BER-TC site, however it was determined by the Vendor that the depth of the catch basin was insufficient to accommodate the three components together. Ultimately, the Vendor recommended installation of both the CPS and Drain Pac Curb Inlet Basket at the site. Figure 2-21 shows the CPS installed at the BER-TC site.

Figure 2-21. United Storm Water Connector Pipe Screen (CPS) Installed at BER-TC Site

Similar to the REM BER-PL site, the particular configuration of the curb inlet and catch basin at BER-TC required that two Drain Pac Curb Inlet Baskets be installed overlapping at a 90-degree angle to provide full coverage of the curb inlet opening. A concrete shelf or "wing" adjacent to the curb inlet opening is present for a portion of the length of the curb inlet. One of the inserts was attached along the wall of the catch basin below the end of the wing, to capture material flowing off the wing and into the catch basin. Another insert was placed at the far end of the curb inlet, beyond the point where the wing is present. Figure 2-22 shows the configuration of the two inserts at the BER-TC site during the dry weather inspection conducted at the end of the monitoring period. The edge of the wing can be seen in the lower left-hand corner of the photo, with one insert mounted to the catch basin wall directly below. The right-hand side of the photo shows the second insert positioned below the remaining length of the curb inlet opening.

Figure 2-22. Configuration of United Storm Water Drain Pac Curb Inlet Baskets at BER-TC Site

2.2.4.2 ECB-F

The ECB-F site is located in the San Diego Bay (Chollas Creek) Watershed, in the community of City Heights. The curb inlet is located near the northeast corner of El Cajon Blvd. and Fairmount Avenue. It is situated in a mixed land use area, consisting primarily of residential and commercial land uses.

There is heavy pedestrian usage of the sidewalk adjacent to the curb inlet, which generates a considerable amount of trash to the surrounding area, and ultimately to the storm drain inlet. Although not apparent at the time of initial siting and product installation, during the course of the study it was observed that the site received occasional discharges of large amounts of sediment. Evidence of sediment discharge from nearby construction sites was observed on at least two occasions during the course of the study. One observation resulted in the issuance of a Notice of Violation by the Division, and the responsible party was required to clean the gutter and catch basin at the ECB-F location. Figure 2-23 shows the ECB-F site during a storm event.

Figure 2-23. United Storm Water ECB-F Pilot Site Location

The ECB-F site was installed with three system components: the ARS, CPS and Drain Pac Curb Inlet Basket. The ARS unit consists of a stainless screen that covers the curb inlet opening, and is actuated and opens in response to runoff flows. When the force of the water is sufficient to activate the actuator, the actuator pulls the rotating linkage attached to the screen and holds the screen in an open position of approximately 45 to 55 degrees. This allows water to flow into the catch basin unimpeded by the screen. The screen cannot be opened from outside of the catch basin without a special rod.

The CPS and Drain Pac Curb Inlet Basket were described previously in Section 2.2.4.1 above. Unlike the BER-TC site, a single Drain Pac Curb Inlet Basket was sufficient to provide coverage for the entire length of the curb inlet opening at the ECB-F site. Figure 2-24 shows the ARS, and Figure 2-25 shows the Drain Pac Curb Inlet Basket installed at ECB-F.

The ARS, CPS and Drain Pac Curb Inlet Basket were initially proposed by the project team to be installed at another location on El Cajon Boulevard (the ECB-54 site, refer to Figure 2-5). It was re-located to the ECB-F site because the configuration of the catch basin and the curb inlet opening at the ECB-54 site could not accommodate the ARS mechanism, per the Vendor's assessment of the location. The ECB-54 site is an older-type, non-standard catch basin.

Figure 2-24. United Storm Water Automatic Retractable Screen Installed at ECB-F Site

Figure 2-25. United Storm Water Drain Pac Curb Inlet Basket Installed at ECB-F Location

SECTION 3 DATA COLLECTION METHODS

This section describes the methods and procedures performed to collect dry and wet weather data to be used for insert BMP evaluation purposes. As discussed in Section 1 of this Report, only Phase I monitoring, as identified in the OMMP (City of San Diego, 2011), was performed.

Monitoring was conducted from September 2011 through December 1, 2011 (refer to Figure 1-2). Phase I dry weather monitoring included five inspections (two pre-maintenance inspections, two post-storm inspections, and one additional dry weather inspection at the end of the monitoring period), and two maintenance observations (one conducted at the end of the dry season, and one conducted in the middle of the wet season, both before impending storm events). The first maintenance observation included a detailed trash characterization procedure.

Phase I wet weather monitoring included on-going weather monitoring for the duration of the monitoring period, and storm event performance monitoring for a single storm event. In addition, reconnaissance-level field visits were conducted at the sites during a storm event that occurred early in the monitoring period (October 5, 2011). Field conditions observed during the storm event reconnaissance were used to inform the monitoring approach and refine the storm event data collection procedures and field forms. Phase I data collection efforts also included a desktop analysis/estimation of the drainage area for each site.

The following subsections provide information regarding the specific data collection methods and observations performed for inspections, maintenance observations, detailed trash characterization, drainage area determination, and storm event performance monitoring.

3.1 HEALTH AND SAFETY

The data collection methods utilized for the SDIPS required careful consideration of health and safety. The pilot site locations are located within highly urbanized areas of the City, and there are numerous areas where natural and anthropogenic hazards provided the potential for injury. Installation of some monitoring equipment required the use of Confined Space Entry procedures. Consultant staff implemented traffic control procedures during scheduled dry and wet weather monitoring activities to help ensure the safety of the field team(s). Barricades were placed around open manholes to protect the field teams and the public from falling hazards, and open manholes were never left unattended. Field teams were required to wear the proper personal protective equipment (PPE) during monitoring events. Field team PPE included: ANSI-approved traffic safety vests, hard hats, Nitrile gloves, and rain gear (for wet weather). The Health and Safety Plan (HSP) for the SDIPS is documented in the OMMP (City of San Diego, 2011, Appendix D), and was adhered to throughout the course of the study.

3.2 INSPECTIONS

The purpose of the inspections was to estimate the volume and percent composition (by volume) of gross solids captured during dry weather periods and subsequent to storm events, and conduct empirical observations to document the general condition of the inserts. This information may be used to determine the effectiveness of the inserts to capture and retain gross solids during dry weather periods and after storm events, inform specific maintenance activities that may be required to optimize BMP performance, and provide information regarding the frequency of maintenance required.

The project team conducted a total of five inspections during the monitoring period. These inspections included two inspections conducted prior to BMP maintenance ("pre-maintenance"), two inspections conducted after storm events ("post-storm inspections"), and one additional dry weather inspection at the end of the monitoring period. Although the inspections were performed in response to different monitoring-related activities, the procedure and types of data collected for all inspections were the same. Field forms were standardized for all inspections. At least one inspection of the ARS (United Storm Water ECB-F site) was conducted within one to three days prior to street sweeping.

Inspections were performed by conducting visual observations/estimations, and documenting observed conditions on standard inspection field forms (refer to Appendix C) and with photographs. During each inspection at the site, the field crew performed the following tasks:

- Take photographs of site conditions and accumulation of gross solids.
- Record visual estimates of the total volume of gross solids and percent composition by volume of trash, sediment, and organic debris (i.e., leaf litter and other vegetative material) in the insert product and in the catch basin, if present.
- Assess inserts for apparent clogging.
- Check for presence of standing water.
- Note evidence of non-stormwater discharge.
- Note presence of vectors.
- Note presence of odors.
- Note obvious obstructions to the hydraulic capacity of the insert.
- Note condition of adsorbent media/filters/booms, if present.
- Document observations related to product integrity/structural condition.
- Document potential issues related to product installation (i.e., gaps between insert and drain inlet/catch basin).
- Document condition of ARS (if present).
- Document condition of CPS (if present).

If necessary, Division staff and Vendors were notified of potential maintenance issues that required immediate attention due to nuisance conditions.

3.3 MAINTENANCE OBSERVATIONS

Dry weather monitoring for the SDIPS included observations of BMP maintenance and documentation of Vendor maintenance procedures. This data was collected to provide information regarding the specific equipment and procedures utilized to maintain the BMPs, and document and verify the level of maintenance effort. In addition, the weight, volume and percent composition (by volume) of gross solids collected by the inserts were recorded.

Maintenance of the storm drain insert BMPs was performed by the Vendors according to their standard maintenance practices. Two rounds of maintenance were performed; one round before the beginning of the wet season, and the second round conducted in the middle of the monitoring period, in anticipation of an impending storm event. The second round of maintenance was performed at this particular point in the study because the Storm Event Performance Monitoring component was planned for this storm, and maintaining the insert BMPs before the start of wet weather monitoring was considered important to allow observation of BMP performance under optimal conditions. It should be noted that for the second round of maintenance, due to the timing of the impending storm event and Vendor scheduling constraints, maintenance was not performed by Bio Clean for their sites BEY-TS, ECB-54, and QUAL. As an alternative measure, the consultant team field crew removed the baskets, emptied the gross solids from the inserts, and replaced the baskets, so that the inserts were free of gross solids in anticipation of the Storm Event Performance Monitoring. Information regarding the weight, volume and percent composition (by volume) of gross solids was collected in the same manner as for the other maintenance events.

Maintenance Observation and Documentation tasks performed for the SDIPS included:

- Document the maintenance procedures, level-of-effort and potential issues with product functionality or integrity using field forms (Appendix C) and photos.
- Measure the weight of gross solids collected by the BMP.
- Measure the volume of gross solids collected by the BMP.
- Estimate the percent composition by volume of sediment, trash, and organic debris (i.e., leaf litter and other vegetative material) of the gross solids.
- Measure the weight of sediment collected by the BMP (when possible).

The project team observed and documented maintenance procedures performed by the Vendors. Maintenance-related data collected during Maintenance Observations and Documentation included:

- Vendor information
- Safety procedures/traffic control
- Confined Space Entry procedures (if utilized)
- Maintenance preparation procedures and duration
- General maintenance steps and duration

- Equipment/tools used
- Other maintenance, or specialized maintenance procedures as required.

Information was documented on standard field forms (Appendix C) and with photographs.

The following procedure was used to collect data for the weight, volume and percent composition by volume of gross solids:

- Gross Solids Weight- Trash, debris and gross solids were removed by the Vendor from the insert product either manually or using a vacuum truck. If material was to be collected using the vacuum truck, Vendors ensured that the holding tank of the vacuum truck was empty prior to maintenance. The collected material was transferred to a heavy-duty trash bag(s) and returned to the laboratory to be weighed and measured. If necessary, the gross solids were gravity drained for at least two minutes or until substantially drained of free water (e.g., no drips for 5 to 10 seconds), prior to transferring the gross solids to the plastic trash bag. If gravity draining on-site was determined to be insufficient to clear the gross solids of free water, the material was transported to the City Chollas Operations Yard for additional drying. Gross solids were transported in sealed and labeled trash bags, and spread over a tarp to air-dry for approximately 6 to 8 hours. Total gross solids were weighed in the laboratory on a scale with 0.1Kg (0.2 lb) accuracy. If possible, sediment was separated from the other gross solids and weighed separately. In some cases the consistency of the collected gross solids prevented the sediment weight from being determined separately from the total gross solids weight (i.e., sediment is heavily commingled with organic debris).

Figure 3-1. Collection of Gross Solids from Vacuum Truck

Figure 3-2. Drying of Gross Solids

- Gross Solids Volume- The plastic trash bags containing the gross solids were transferred to a container of known volume [i.e., standard 20-gallon (2.81 cu. Ft) trash can]. The top of the trash bag was opened to expose the surface of the collected gross solids. The material in the bag was made as level as possible across the entire surface area of the container. The depth of freeboard (i.e., height from the top of the container to the surface of the gross solids), and container diameter at the surface of gross solids were measured with a tape measure (Figure 3-3). The measured depth of freeboard and surface area diameter were used to calculate the volume of freeboard (i.e., frustrum volume) by using the following equation:

  $V= \Pi*(h/3)*(R^2+r^2+(R*r))$; where

  h= depth of freeboard (ft)

  R= Top radius of container, = ½ diameter of container (ft)

  r= Radius at surface of gross solids, = ½ diameter at surface of gross solids (ft)

  The freeboard volume was subtracted from the total known volume of the container (2.81 cu ft) to yield the volume of gross solids.

Figure 3-3. Measurement of Freeboard Depth and Diameter for Gross Solids Volume Calculation

- Percent Composition by Volume**-** After measurements of gross solids weight and volume were taken, visual estimates of the percent composition by volume of sediment, trash, and organic debris (i.e., leaf litter and other vegetative material) were documented on field forms. In some cases, the collected gross solids were distributed evenly on a tarp to facilitate estimation of the volume of sediment, trash and organic debris as a percent of the total gross solids volume.

3.4 DETAILED TRASH CHARACTERIZATION

As part of the initial round of Maintenance Observations and Documentation for the SDIPS, a detailed trash characterization was conducted. Observation and documentation of maintenance procedures, and measurement of gross solids weight and volume, were conducted according to the procedures described in Section 3.3 above. The collected gross solids were then spread out on a tarp, and the trash separated from the other gross solids. Visual estimates of the volume and category of trash (cigarette butts, plastic bags, food packaging, etc.) were documented, and the trash condition (i.e., potential threat to aquatic life, overall level of trash, etc.) was assessed and documented using the Detailed Trash Characterization field form (Appendix C). This form was based on the 2011 City of San Diego Trash Assessment Worksheet.

Figure 3-4. Performance of Detailed Trash Characterization

3.5 STORM EVENT RECONNAISSANCE

Reconnaissance-level field visits were conducted at all sites during a short-duration storm event that occurred early in the monitoring period (October 5, 2011). The early-season storm event provided the project team an opportunity to preview field conditions and insert BMP performance, as well as pilot-test the monitoring procedures and field forms. Digital photographs and video were used to document the observed conditions. A presentation (CSD-OT-URS-43.01) was given to Division staff in October 2011 to summarize the major findings of the storm event reconnaissance. Information collected during the storm event reconnaissance was used to refine the monitoring approach and modify Storm Event Performance Monitoring data collection procedures and field forms, as necessary.

3.6 STORM EVENT PERFORMANCE MONITORING

The purpose of the Storm Event Performance Monitoring was to quantitatively and qualitatively assess the operational performance of the storm drain insert BMPs at all locations during one wet weather event.

Documentation of empirical observations conducted during storm conditions is a critical component in determining the optimum maintenance requirements and overall performance of the BMPs. Factors such as maintenance activities, environmental variability, and physical processes, which cannot be determined analytically, can greatly influence the performance of the BMPs. Some of these factors such as flow, rainfall quantity and rainfall intensity were assessed through physical measurements. Other factors impacting BMP performance such as accumulation of gross solids during wet weather, gross solids re-suspension and deposition, and hydraulic factors such as overflow/bypass were assessed through carefully documented observations.

To monitor the operational performance of the inserts during the storm event, the following observations/measurements were conducted and documented every 15 minutes for the duration of the monitoring event:

- Meteorological characteristics
- Rainfall (on-site gauge)
- Flow entering inlet (both sides of curb inlet)
- Conditions in curb and gutter (gross solids, standing water, flooding)
- Insert/Basket estimated percent full gross solids (Total Percent Full, and Percent Trash, Percent Organics, Percent Sediment)
- Overflow/Bypass of Insert/Basket
- Gross solids re-suspension/deposition from Insert/Basket to Catch Basin
- Gross solids bypass of Insert/Basket
- Overflow/bypass of outlet screen/CPS
- Observations of ARS (if present)
- Water quality appearance (visual) to roughly assess changes in water quality.

Standardized field data collection forms were used to document measurements and observations for the Storm Event Performance Monitoring (refer to Appendix C) procedure. The field forms consisted of an initial assessment (Form A) to document site conditions upon the field teams arrival at the site, and a second form (Form B) to document the field observations/measurements for each 15-minute monitoring interval.

Another important component of the Storm Event Performance Monitoring was the documentation of field conditions and BMP operational performance through photographs and video. For each 15-minute monitoring interval, a standardized series of photos were taken to correlate with the observations documented on the field forms. In addition, a standardized 45 to 60-second video clip was taken every 15 minutes of the following locations at each site:

- Curb and gutter (both directions)
- Curb inlet (from street)
- Insert/Basket (holding camera down manhole)
- Catch basin and outlet pipe

The monitoring measurement/observation, location and frequency for the Storm Event Performance Monitoring components are summarized in Table 3-1.

Table 3-1. Summary of Storm Event Performance Monitoring Measurements and Observations

Monitoring Measurement	Sampling Location	Purpose	Frequency[1]
Meteorological Characteristics	Site	Visually assess and document the meteorological characteristics at the site (rainfall intensity, wind speed, gauge reading)	4 times per hour (every 15 minutes)
Runoff Flow Estimate/ Flow Bypass/Overflow Observations[2]	Curb and Gutter; both sides of curb inlet opening	Manually measure the velocity and the width of the runoff entering the curb inlet. Note observations of runoff flow that cannot be estimated (i.e., sheet flow into inlet).	4 times per hour (every 15 minutes)
	Insert/Basket	Note observations of flow bypassing/overflowing the storm drain insert product/basket and entering catch basin. Visually estimate the flow bypassing the insert/basket, as a percentage of the total flow entering the inlet.	4 times per hour (every 15 minutes)
	Catch Basin	Note observations of flow bypassing/overflowing the outlet pipe screen or CPS.	4 times per hour (every 15 minutes)
Gross Solids Capture/Bypass Observations[3]	Insert	Visually estimate the percent full (as a percentage of the total observed insert/basket capacity) of gross solids, and estimate the percent composition (i.e. trash, organic debris, sediment) by volume as a percentage of the total volume of gross solids captured.	4 times per hour (every 15 minutes)
	Catch Basin	Note observations of gross solids bypassing the storm drain insert product/basket and entering catch basin. Visually estimate the composition (i.e. trash, organic debris, sediment) of the bypassed gross solids, as a percentage of the total gross solids that have bypassed.	4 times per hour (every 15 minutes)
	Catch Basin- Outlet Pipe	Note observations of gross solids bypassing the outlet pipe screen or CPS.	4 times per hour (every 15 minutes)
Hydraulic Observations	All	Document hydraulic issues such as standing water, flow impediments, and/or potential flooding issues.	4 times per hour (every 15 minutes)
Solids Resuspension/ Deposition Observations	Insert, Catch Basin	Document observations of re-suspension/deposition of sediment, trash, and organic debris from the insert product/basket into the catch basin.	4 times per hour (every 15 minutes)
ARS Observations (ECB-F Site Only)	Curb Inlet	Note position of ARS (i.e., open or closed). Document appearance of ARS related to gross solids accumulation, if present (i.e., do gross solids appear to be clogging the screen).	4 times per hour (every 15 minutes)
Video Documentation	All	Record approximately 45 to 60 second video clip to document flow conditions and performance of insert/basket/ARS/CPS. Record the following areas in the same order for each video clip: curb and gutter (both directions), curb inlet (from street), insert/basket (holding camera down manhole), catch basin and outlet pipe.	4 times per hour (every 15 minutes)

1. The measurement frequencies indicated were considered ideal; field conditions or other factors may have affected the actual number of measurements performed per hour in some cases.
2. At the Bio Clean QUAL site, which is a grate inlet as opposed to a curb inlet, installation of a flow meter was required to measure flows, due to observed sheet flow into the inlet.
3. Outlet pipe screens were installed at all sites without a CPS (i.e., sites Bio Clean BEY-TS, ECB-54, QUAL; Downstream Services BEY-1; and REM BER-PL, and PET), to help retain and facilitate observations of gross solids in the catch basin that had bypassed the insert product. The outlet pipe screen was installed so that approximately ¾ of the outlet pipe opening was covered. An opening at the top of the outlet pipe screen was provided to allow bypass, in case accumulation of gross solids on the screen had potential to cause hydraulic impacts during storm events. The CPS is constructed with a bypass opening.

3.6.1 Monitoring Equipment and Installation

As discussed in Section 3.6 above, Storm Event Performance Monitoring for the SDIPS focused on observational and documentation methods to collect data, however some additional monitoring equipment was utilized at some locations to facilitate monitoring objectives. These included installation of a flow meter at the Bio Clean QUAL site, and installation of outlet pipe screens at sites Bio Clean BER-TS, Bio Clean ECB-54, Bio Clean QUAL, Downstream Services BEY-1, REM BER-PL, and REM PET.

3.6.1.1 Flow Meter

As described in Section 2, the Bio Clean QUAL pilot site location was the only grate inlet site (as opposed to a curb inlet) that was monitored for the SDIPS. Due to the absence of a curb and gutter at the site, flows could not be measured according to the same method used at the other sites. The presence of sheet flow at the grate inlet required flow measurement using a flow meter. An area-velocity bubbler flow meter was utilized, with the flow sensor installed in the catch basin outlet pipe. The area-velocity bubbler measures the liquid depth in the catch basin outlet pipe. To measure water depth, a stainless steel tube is mounted at the pipe invert at a specified measuring point. The tube is connected to a compressor and pressure transducer located on the meter device. Compressed air is fed into the tube, forcing bubbles of pressurized air out the end of the bubble tube at a constant rate. The hydrostatic pressure is measured by measuring the pressure it takes to maintain the bubble rate. In other words, the pressure in the tube can rise only until it equals the water pressure at the orifice of the tube. The water depth over the orifice is computed from the pressure in the tube. The flow meter measures the velocity of flowing water using doppler technology. By knowing the depth and velocity of flow and the conveyance configuration, the flow meter is capable of calculating the flow rate. The device was powered by 12 V, deep-cycle marine batteries.

Figure 3-5. Installation of Flow Meter at Bio Clean QUAL Pilot Site

3.6.1.2 Outlet Pipe Screens

Outlet pipe screens were installed at all sites without a CPS (i.e., sites Bio Clean BEY-TS, Bio Clean ECB-54, Bio Clean QUAL, Downstream Services BEY-1, REM BER-PL, and REM PET), to help retain and facilitate observations of gross solids in the catch basin that have bypassed the insert product. The outlet pipe screens were installed so that approximately ¾ of the outlet pipe opening was covered. An opening at the top of the outlet pipe was provided to allow bypass, in the case that collection of gross solids on the screen had potential to cause hydraulic impacts during storm events. The CPS also has an opening near the top of screen to provide bypass capability.

Figure 3-6. Outlet Pipe Screen Installed at Downstream Services BEY-1

3.6.2 Weather Monitoring

Storm Event Performance Monitoring included on-going weather monitoring for the duration of the monitoring period. For the purposes of the SDIPS, weather was tracked beginning September 1 through December 1. Weather monitoring was conducted to: a) allow appropriate mobilization criteria to be applied to deploy field teams for the Storm Event Performance Monitoring, b) allow the calculation of rainfall intensity and duration at or near the project sites for the monitored storm, and c) assist in scheduling of inspections and Vendor maintenance.

3.6.2.1 Storm Selection

Storm selection criteria for the SDIPS Storm Event Performance Monitoring component is described in Section 5.3 of the OMMP (City of San Diego, 2011). The following criteria were used to determine whether or not to conduct the Storm Event Performance Monitoring during an impending event:

- Storms monitored must be forecasted to produce at least 0.25 inch of rain.
- The probability of precipitation must be greater than 75 percent for a decision to be made without Division consultation.
- Division Project Manager must be consulted prior to monitoring storms with a probability of precipitation less than 75 percent or less than 0.25 inch of rain.
- Storm events must be preceded by at least 72 hr of dry conditions (<0.1 inch of precipitation)

In addition, it was determined that the Division Project Manager may direct the monitoring crews to mobilize to monitor storm events that fall outside of the established mobilization criteria. This was an important factor for the SDIPS, since a single storm event was to be monitored, and the monitoring period was of short duration (i.e., September 1 to December 1).

Quantitative Precipitation Forecasts (QPF) from the National Weather Service (NWS) were monitored and evaluated in relation to the criteria described above to inform mobilization for storm event monitoring.

3.6.2.2 Storm Duration

Storm Event Performance Monitoring for the SDIPS required field staff to perform repeated observations/activities throughout the duration of the storm event. Given the manual data collection strategy required, geographic distribution of the monitoring locations, health and safety requirements and the need for paired field staff, the storm selection criteria for the SDIPS ideally included provisions to select a relatively short duration storm for monitoring. This would also allow field teams the capability to observe product performance throughout an entire storm hydrograph. However, given the constraints identified above, it was determined that the field teams would be limited to a maximum of approximately ten hours of field observation.

The minimum duration for conducting the Storm Event Performance Monitoring field observations was for a period of 12 observations for each site (i.e., a total of 12 observations, with one observation every 15 minutes, or a total of 3 hours), if observed BMP performance indicated conditions of persistent overflow/bypass. In cases where persistent overflow/bypass was not observed, monitoring continued until 1) reduction of flow entering the curb inlet reached a level within ten percent of pre-storm flow levels, 2) after ten hours of field monitoring, or 3) upon Division Project Manager approval, whichever occurred first. Field teams were deployed prior to, and as close as possible to the onset of rainfall, in order to begin monitoring as soon as measurable flow was observed.

3.6.2.3 Training, Mobilization and Staffing

Two training sessions were held during the SDIPS to help ensure that field staff and other team members were properly trained in the monitoring procedures for the SDIPS, mobilization criteria and communication plan, and appropriate health and safety protocols. Specifically, the following elements were included in the training of all field personnel:

- Review of the SDIPS OMMP;
- Review of Health and Safety Plan, including traffic control procedures;
- Review of field forms and documentation procedures;
- Team assignments and contact information;
- Field equipment and materials; and
- Mobilization and demobilization procedures.

Because of the distances between the pilot site locations, each site was assigned one team made up of two individuals (one designated as team leader), with one additional field person acting as a "floater" for each region (South- Bio Clean BEY-TS and Downstream Services BEY-1; North- REM BER-PL and United Storm Water BER-TC; and Central- Bio Clean QUAL, REM PET, United Storm Water ECB-F and Bio Clean ECB-54). The floater served as field technical advisor and relief staff, as necessary. A staffing plan was prepared for the storm event that included:

- Personnel assigned for each position;
- Shift and zone designations;
- Equipment mobilization; and
- Communication channels.

All Storm Event Performance Monitoring activities were coordinated by Storm Control personnel. Storm Control was responsible for mobilizing field teams, monitoring the status of the monitoring stations and teams via telecommunications, interpreting the most recent weather forecasts to make informed decisions regarding the storm status, and notifying all personnel of shift start and end times.

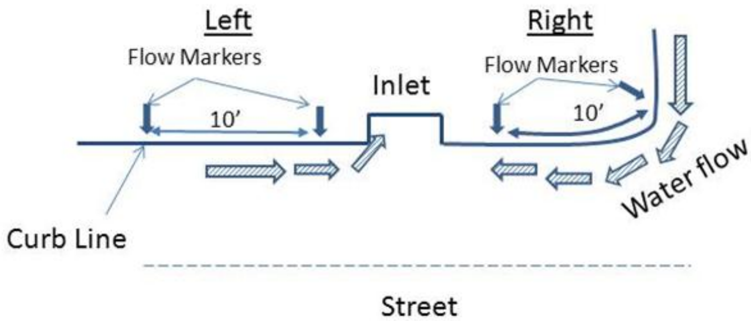
3.6.3 Manual Flow Measurement

In order to estimate flow entering the insert BMPs, manual measurement of flow entering the curb inlet (from both directions) was conducted. The following procedure was used to measure flows in the curb and gutter:

- Measure and mark the curb to define the length of flow:
    - Measure and mark a 10-foot distance on both sides of the curb inlet ("Flow Length") with a tape measure;
    - If an unobstructed 10-foot section is not available, measure and mark the maximum unobstructed distance possible;
    - Record marked distances ("Flow Length") on both sides of curb inlet on Field Form "A" under "Initial Assessment" Section.
- Measure the width of the flow path perpendicular to the curb at a fixed point with a tape measure:
    - Mark a line for flow width measurement at the end of the Flow Length closest to the inlet;
    - Record measurement of flow width on Field Form "B" every 15 minutes.
- Record the time it takes for a neutrally-buoyant object (provided in field kit) to travel the distance of the marked Flow Length using a stopwatch (provided).
    - Perform travel time measurement for each side of the curb inlet at 15 minute intervals;
    - Perform this measurement three times (an average will be used for calculation purposes), and record all three travel times in the space provided on Form B.

Figure 3-7 shows a schematic of a hypothetical flow measurement path in the field.

Figure 3-7. Schematic of Flow Measurement Path



To calculate the flow rate entering the curb inlet using the measurements recorded above, travel times were averaged for each 15-minute period to determine the average flow velocity (in ft./sec.) in the gutter. The geometry of the curb and gutter was determined and multiplied by the measured width of flow to calculate the cross-sectional area. Flow rates for each 15-minute interval were calculated by multiplying the cross-sectional area by the flow velocity. The direction of flow was also noted on field forms (i.e., into or away from the curb inlet). In one case (at site United Storm Water ECB-F), conditions observed in the field during the monitored storm event indicated a partial backwater/flow-reversal condition, and flow rates were adjusted based on review of documented conditions (video and photos) and using best professional judgment.

Figure 3-8. Flow Measurement Path at Downstream Services Site BEY-1

3.6.4 Rainfall

Rainfall data for the monitored storm event was obtained from the San Diego County Flood Control District (SDCFCD). Raw precipitation data from four gauges located in different parts of project area was used to generate hyetographs for the pilot sites. Fifteen-minute precipitation data was utilized to calculate rainfall intensity (for the purposes of this study, rainfall intensity was assumed to be constant over the 15-minute interval). Gauges were selected for the different pilot site locations based primarily on proximity, elevation and data availability. The rainfall gauge and corresponding SDIPS site are listed below:

- San Ysidro- Downstream Services BEY-1, Bio Clean BEY-TS
- Fashion Valley- Bio Clean QUAL, REM PET
- La Mesa- United Stormwater ECB-F, Bio Clean ECB-54
- Rancho Bernardo- United Storm Water BER-TC, REM BER-PL

Initially, field crews attempted to utilize portable, on-site rain gauges at each site to measure rainfall during the monitored storm event. However, windy and varied field conditions present at most sites during the storm event prevented accurate rainfall measurement and reading of the gauges. Ideally, field rain gauges should be mounted on tall (i.e., 12-foot) poles away from trees and other overhead structures to obtain representative measurements. The field procedure required frequent (i.e., every 15 minutes) observations which made this type of mounting infeasible using portable rain gauges. Gauges were supported in secondary containers and placed in open areas at each site, however this set-up was insufficient to in some cases to prevent the gauge from tipping over. In addition, budget limitations for this study prevented the installation of on-site tipping bucket rain gauges, which are commonly used in stormwater monitoring. For these reasons, the SDCFCD rainfall data was utilized.

3.7 DRAINAGE AREA DETERMINATION

Estimation of the size of the drainage area for each of the eight pilot project sites was performed through a desktop analysis. Topographic maps obtained from the City of San Diego were used to determine the drainage area size impacting each of the eight pilot site locations. Drainage area (basin) delineations were determined by following, and connecting, the high points in relation to the site location. After the basin delineation was determined, the area was then calculated.

Preliminary estimates of the drainage areas for each site were re-evaluated after field observations were made during storm event monitoring. In some cases, drainage area size was adjusted based on the observed field conditions, and using best professional judgment.

Runoff Coefficients were determined from viewing aerial photographic images for each of the eight pilot site locations. The City of San Diego’s Drainage Design Manual (April 1984), Table 2, Runoff Coefficients (Rational Method), was used to obtain the “C” Value for each of the watershed areas. Type D soil was used for all areas.

Flow-based BMPs are sized to filter or otherwise treat the peak flow of runoff from a water quality storm event. The Water Quality Flow Rate for each of the pilot site locations was calculated by multiplying the runoff coefficient for each site by a rainfall intensity of 0.2 inches/hour (consistent with MS4 permit criteria) and the site-specific drainage area.

Table 3-2 below summarizes the drainage area and Water Quality Flow Rate calculation for each site.

Table 3-2. Drainage Areas and Water Quality Flow Rates for SDIPS Pilot Sites

Vendor	Basin ID	Estimated Drainage Area (ac)	Runoff C	Rainfall Intensity (in/hr)	WQ Flow Rate (cfs)
Bio Clean	BEY-TS	0.1	0.95	0.2	0.02
	ECB-54	1.0	0.95	0.2	0.19
	QUAL	1.0	0.95	0.2	0.19
Downstream Services	BEY-1	0.1	0.70	0.2	0.01
REM	BER-PL	0.4	0.85	0.2	0.07
	PET	0.4	0.85	0.2	0.07
United Storm Water	BER-TC	2.4	0.85	0.2	0.41
	ECB-F	8.5	0.70	0.2	1.18

[1] Estimated drainage areas were determined using desktop analysis. Field verification of drainage area size was not included in this study.

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SECTION 4 RESULTS

The following section presents the results of the data collection efforts for the SDIPS. Project results regarding storm event reconnaissance, storm event performance monitoring, BMP maintenance level of effort, pollutant load analysis of gross solids retained by the BMPs, and BMP maintenance frequency requirements are presented in the following subsections.

4.1 STORM EVENT RECONNAISSANCE

Reconnaissance-level field visits were conducted at all sites during an early-season event that occurred on October 5, 2011. The storm was a short-duration event (approximately 4 hours), with storm totals ranging from 0.22 inch (NWS- National City), 0.46 inch (NWS- Rancho Bernardo) and 0.68 inch (NWS-Montgomery Field) in different parts of the project area.

The storm provided the project team an opportunity to preview field conditions and insert BMP performance, as well as pilot-test the monitoring procedures and field forms. Digital photographs and video were used to document the observed conditions. The major findings and observations from the storm event reconnaissance were provided to Division staff in a summary presentation (CSD-OT-URS-43.01). Observations from the storm event reconnaissance are summarized in Table 4-1. In addition, Table 4-1 contains observations documented during the first round of post-storm inspections, which were conducted after this storm event. For some products, two inserts are installed at the site [designated in the table as Drain Inlet Insert 1(DII1) and Drain Inlet Insert 2 (DII2]. Full bypass of the insert BMP was observed at five sites (United Storm Water BER-TC, REM BER-PL, Bio Clean QUAL, United Storm Water ECB-F and Downstream Services BEY-1). Flow bypass was not observed at sites Bio Clean ECB-54, REM PET and Bio Clean BEY-TS; these sites were visited later in the storm event and runoff flows into the curb inlet at these sites had ceased. Evidence of bypass and/or re-suspension of gross solids, indicated by the presence of gross solids in the catch basin, was observed at all sites with the exception of Bio Clean QUAL. Product configuration at this location made observations of gross solids bypass difficult, and therefore it is unknown whether any gross solids were released into the catch basin. Minimal amounts of gross solids were observed in the catch basin at site REM PET. Post-storm inspections indicated that maintenance was required at all sites. Three sites required maintenance due to the amount of gross solids accumulated in the insert (REM BER-PL, Bio Clean ECB-54, and Bio Clean BEY-TS). Other sites required maintenance due to apparent clogging of insert material/screens (which may impact hydraulic function) or other factors.

The monitoring approach and field forms for the Storm Event Performance Monitoring procedure were modified based on the information collected during the storm event reconnaissance.

Table 4-1. Summary of Storm Event Reconnaissance and Post-Storm Observations

Vendor	Site Name	Product	Drainage Area (ac)	Total Rainfall (in)	Storm Observation	Post-storm Inspection (% Full)	Re-suspension or Bypass of Gross Solids (Catch Basin)	Other Maintenance Concerns
Bio Clean	BEY-TS	Round Curb Inlet Basket with Media Filter	0.1	0.22	No bypass of flow observed at low flow; Basket full of gross solids; Evidence of bypass- presence of gross solids in catch basin	DII_1 – 120	Yes	
	ECB-54	Round Curb Inlet Basket with Media Filter	1.0	0.68	No bypass of flow observed at low flow; Basket appeared full of gross solids; Basket full of water and draining slowly	DII_1 – 80	Yes	
	QUAL	Grate Inlet Skimmer Box	1.0	0.68	Full flow bypass of filter media at peak flow; Cannot verify re-suspension during storms; Flow sensor accurate during target storm	DII_1 – 3	Suspected	Cracks in fiberglass frame
Downstream	BEY-1	FloGard Plus Curb Inlet Filter Insert	0.1	0.22	Full flow bypass of product; Re-suspension of sediment/gross solids; High water level in catch basin	DII_1 – 30 DII_2 – 30	Yes	Graffiti on sidewalk
REM	BER-PL	Triton Curb Inlet Filter Insert	0.4	0.46	Full flow bypass of product; Product full of gross solids; Re-suspension of sediment/gross solids	DII_1 - 120 DII_2 – 30	Yes	Non-stormwater discharge (over-irrigation)
	PET	Triton Curb Inlet Filter Insert	0.4	0.22	No flow bypass observed- no runoff or rainfall at time of visit; Basket approx. half-full of gross solids; Evidence of minor bypass- minimal gross solids in catch basin	DII_1 – 65	Minimal	
United Storm Water	BER-TC	Drain Pac Curb Inlet Basket + CPS	2.4	0.46	Full flow bypass of basket	DII_1 – 15 DII_2 – 1	Yes	Basket loose; Gaps behind basket; Loose bolts in catch basin
	ECB-F	ARS + Drain Pac Curb Inlet Basket + CPS	8.5	0.68	ARS closed during storm; ARS became clogged with gross solids; Street flooding; Full flow bypass of basket and CPS	DII_1 – 15	Yes	ARS appears non-functional; Gaps along sides of ARS; Roaches in DII and catch basin

$DII_{1,2}$- Designates presence of two Drain Inlet Inserts (DII) at the site; DII_1 is the first basket and DII_2 the second basket.

4.2 STORM EVENT PERFORMANCE MONITORING

Storm Event Performance Monitoring for the SDIPS was conducted on November 4, 2011. Field teams were mobilized at approximately 0730, and monitoring procedures were initiated at all pilot site locations by approximately 0900. Monitoring at all sites was completed by 1600. Several sites had shorter monitoring durations based on observations of persistent overflow and the criteria outlined in Section 3.6.2.2.

Post-storm inspections were conducted after the monitored storm event, from November 8 – 9, 2011. An interim storm event occurred on November 6, 2011 before post-storm inspections could be conducted.

The following subsections summarize the data and information collected from the Storm Event Performance Monitoring and post-storm inspections for each BMP pilot site. The information presented for each site includes:

- General observations related to storm event performance of the insert BMPs;
- Event hydrograph depicting flow, periods of significant bypass, Water Quality Flowrate (WQF), and rainfall intensity; and
- Photos documenting major storm event observations and post-storm inspection results.

Monitoring for the storm event was conducted according to the procedures described in Section 3.6. As described in that section, flow estimation using manual flow measurement techniques were utilized at all sites except for Bio Clean QUAL. Flow monitoring at the Bio Clean QUAL site employed the use of an automated flow meter.

The hydrographs were developed using flow data collected in the field at each site. Rainfall data for the pilot sites was obtained from nearby SDCFCD rain gauges, as described in Section 3.6.4. Storm totals from the monitored event were:

- San Ysidro (Downstream Services BEY-1, Bio Clean BEY-TS)- 0.68 in
- Fashion Valley (Bio Clean QUAL, REM PET)- 0.60 in
- La Mesa (United Storm Water ECB-F, Bio Clean ECB-54)- 0.64 in
- Rancho Bernardo (United Storm Water BER-TC, REM BER-PL)- 1.48 in

As described previously in Section 3.6.4, rainfall data was also collected in the field at each site using an on-site rain gauge, however due to the nature of field conditions during the monitored storm event (i.e., high winds), the accuracy of on-site rainfall measurements was determined to be limited.

The WQF for each site was calculated as described in Section 3.7. Periods of bypass, as designated on the event hydrographs and in subsequent discussion in this Report, are defined as follows: "initial bypass" refers to the point at which bypass first occurs, and "significant bypass" refers to observations of bypass where more than 50% of the total flow entering the curb inlet is BMP is bypassing the insert BMP.

"Basket % Full at Initial Point of Bypass" refers to the estimated amount of gross solids contained in the basket/insert at the time bypass begins.

Rainfall intensity is presented in terms of the intensity approximately prior to initial bypass. In some cases, the figure shows a peak in the hydrograph just prior to the corresponding peak in rainfall intensity. This shift is likely due to differences in the geographic distance between the SDCFCD rain gauges and the pilot sites.

4.2.1 Bio Clean BEY-TS

The major Storm Event Performance monitoring observations for the Bio Clean BEY-TS pilot site location are summarized below:

- Product: Bio Clean; Round Curb Inlet Basket with Media Filter
- Monitoring Duration: 0953 to 1423
- Cumulative Rainfall at Initial Bypass: 0.14 in
- Rainfall Intensity Approximately Prior to Initial Bypass: 0.16 in/hr (1200)
- Overflow, Significant Bypass Began at 12:23 pm
- Flowrate at Initial Bypass Estimated at 0.09 cfs
- WQF: 0.02 cfs
- Observations
    - Significant Bypass Continued for Duration of Monitoring, Until Flows became Insufficient to Measure During Last Observation
    - Initial Bypass Occurred above WQF; bypass occurred below the WQF for 2 observations during the remainder of the monitoring period
    - Bypass of Gross Solids Observed
    - Basket % Full at Initial Point of Bypass- Approximately 100%
    - Post-storm Inspection- Over 100% Full of Gross Solids and presence of gross solids in catch basin. Observed gross solids on top of outlet pipe screen.

Figure 4-1 below presents the event hydrograph for site Bio Clean BEY-TS.

Figure 4-1. Event Hydrograph for Bio Clean BEY-TS

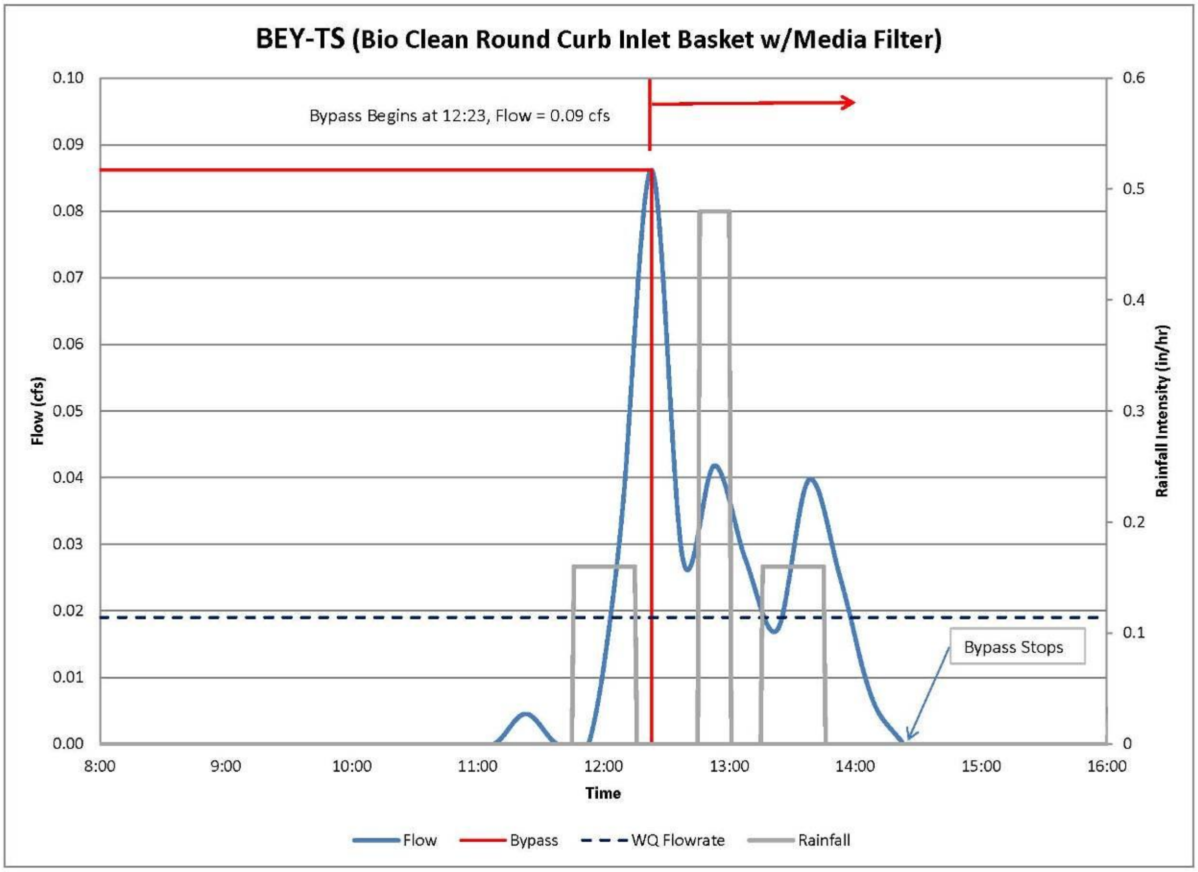


Figure 4-2 below shows a series of photographs highlighting the major storm event performance and post-storm inspection observations.

Figure 4-2. Summary of Storm Event Performance Monitoring Observations- Bio Clean BEY-TS

a) Flow bypass of insert product; full of gross solids.

b) Product full of water and draining slowly at end of monitoring period.

c) Post-storm inspection- Over 100% full of gross solids, largely organic debris and sediment.

d) Post storm inspection- Presence of gross solids in catch basin. Note gross solids on top of outlet pipe screen.

4.2.2 Bio Clean ECB-54

The major Storm Event Performance Monitoring observations for the Bio Clean ECB-54 pilot site location are summarized below:

- Product: Bio Clean; Round Curb Inlet Basket with Media Filter
- Monitoring Duration: 0905 to 1535
- Cumulative Rainfall at Initial Bypass: 0.04 in
- Rainfall Intensity Approximately Prior to Initial Bypass: 0.48 in/hr (1030)
- WQF: 0.19 cfs
- Observations:
    - Overflow – Significant Bypass Occurred at 1005
    - Flowrate at Initial Bypass Estimated at 0.43 cfs
    - Bypass occurred above the WQF
    - Significant Bypass Occurred During One Observation Period Only
    - Bypass of Gross Solids During Overflow, Minimal Re-suspension
    - Basket % Full at Initial Point of Bypass- Approximately 80%
    - Difficult to Observe Total Amount of Gross Solids During Monitoring Due to Standing Water in Basket

Figure 4-3 below presents the event hydrograph for site Bio Clean ECB-54.

Figure 4-3. Event Hydrograph for Bio Clean ECB-54

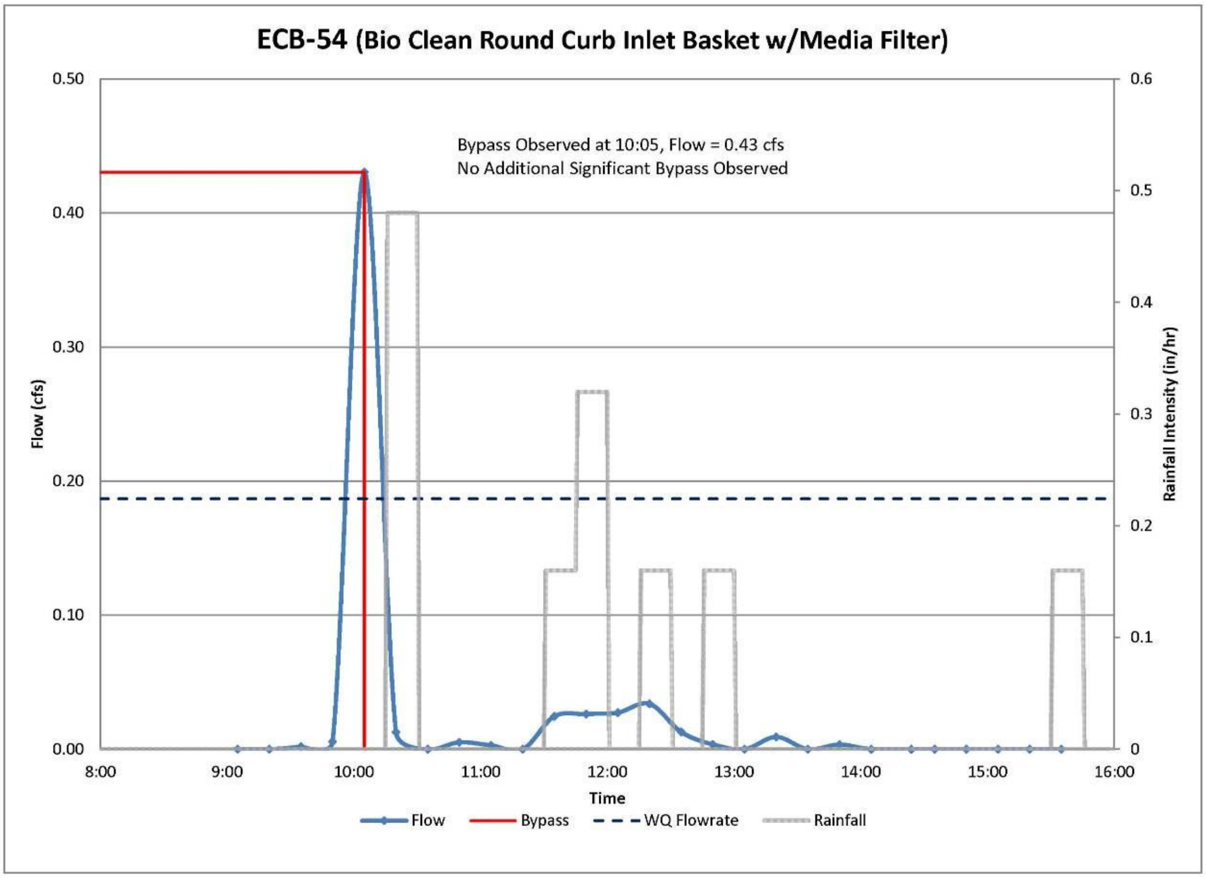


Figure 4-4 below shows a series of photographs highlighting the major storm event performance and post-storm inspection observations.

Figure 4-4. Summary of Storm Event Performance Monitoring Observations- Bio Clean ECB-54

a) Before initial bypass- Product full of water.

b) Flow bypass of BMP.

c) Post-storm inspection- Product nearly full of gross solids.

d) Post-storm inspection- Bypass of gross solids evident; Presence of gross solids in catch basin and on outlet screen.

4.2.3 Bio Clean QUAL

The major storm event performance monitoring observations for the Bio Clean QUAL pilot site location are summarized below:

- Product: Bio Clean; Grate Inlet Skimmer Box
- Monitoring Duration: 0919 to 1350
- Cumulative Rainfall at Initial Bypass: 0.10 in
- Rainfall Intensity Approximately Prior to Initial Bypass: 0.08 in/hr (1030)
- WQF: 0.19 cfs
- Flow Meter Data:
    - Total Rainfall: 0.60 in
    - Total Flow: 38.82 cf
    - Maximum Flow Rate: 0.014 cfs
- Observations:
    - Overflow – Significant Bypass Began at 1050
    - Flowrate at Initial Bypass Estimated at 0.004 cfs
    - Bypass occurred below the WQF
    - Significant Bypass Occurred Intermittently for Duration of Monitoring, Interspersed with Periods of No or Partial Bypass
    - Unable to Clearly Observe Bypass of Gross Solids due to Product Configuration
    - Basket % Full at Initial Point of Bypass- Approximately 1%

Figure 4-5 below presents the event hydrograph for site Bio Clean QUAL.

Figure 4-5. Event Hydrograph for Bio Clean QUAL

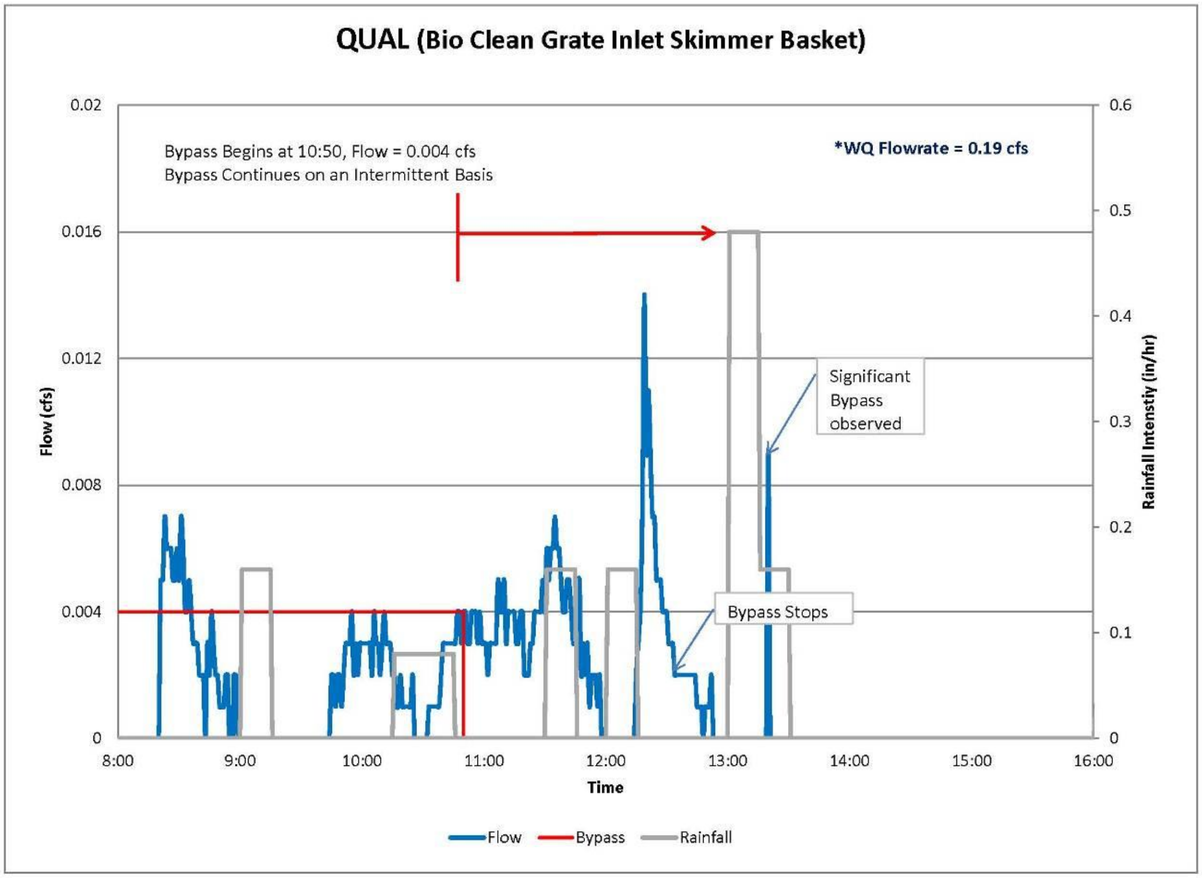


Figure 4-6 below shows a series of photographs highlighting the major storm event performance and post-storm inspection observations.

Figure 4-6. Summary of Storm Event Performance Monitoring Observations- Bio Clean QUAL

a) Point of initial bypass; product full of water.

b) Flow bypass continued intermittently; depth of water in BMP shown.

c) Post-storm inspection- Screen on bottom of filter basket; minimal gross solids present.

d) Post-storm inspection- Accumulation of gross solids on bypass orifice of filter basket.

4.2.4 Downstream Services BEY-1

The major Storm Event Performance Monitoring observations for the Downstream Services BEY-1 pilot site location are summarized below:

- Product: Downstream Services; FloGard Plus Curb Inlet Filter Insert
- Monitoring Duration: 0937 to 1440
- Cumulative Rainfall at Initial Bypass: 0.08 in
- Rainfall Intensity Approximately Prior to Initial Bypass: 0.16 in/hr (1200)
- WQF: 0.01 cfs
- Observations:
    - Overflow – Significant Bypass Began at 1210
    - Flowrate at Initial Bypass Estimated at 0.32 cfs
    - Bypass Occurred above the WQF
    - Significant Bypass Occurred Intermittently for Duration of Monitoring, Interspersed with Periods of No or Partial Bypass
    - Bypass/Re-suspension of Gross Solids
    - Basket % Full at Initial Point of Bypass- Approximately 35%
- Vendor Flow Specifications:
    - Clean Flow Rate = 1.0 cfs (each basket)
    - Bypass Occurred at Flow Rate below Vendor specification

Figure 4-7 below presents the event hydrograph for site Downstream Services BEY-1.

Figure 4-7. Event Hydrograph for Downstream Services BEY-1

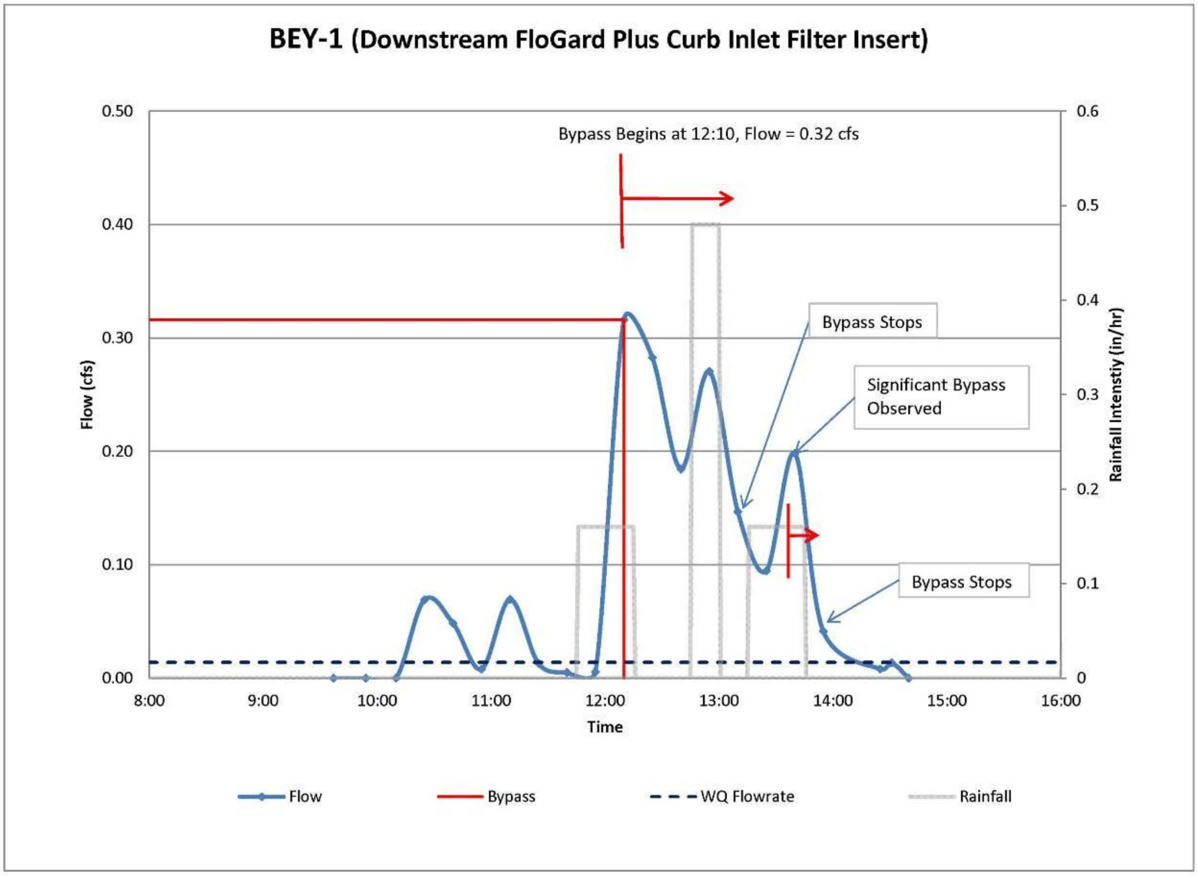


Figure 4-8 below shows a series of photographs highlighting the major storm event performance and post-storm inspection observations.

Figure 4-8. Summary of Storm Event Performance Monitoring- Downstream Services BEY-1

a) At initial point of bypass- Left basket; product full of water

b) Flow bypass of BMP- Right basket

c) Post-storm inspection- Product nearly full of gross solids, re-suspension/bypass of gross solids into catch basin.

d) Post-storm inspection- Large amount of sediment present in catch basin.

4.2.5 REM BER-PL

The major Storm Event Performance Monitoring observations for the REM BER-PL pilot site location are summarized below:

- Product: REM; Triton Curb Inlet Filter Insert
- Monitoring Duration: 0900 to 1245
- Cumulative Rainfall at Initial Bypass: 0.04 in
- Rainfall Intensity Approximately Prior to Initial Bypass: 0.12 in/hr (0915)
- WQF: 0.07 cfs
- Observations:
    - Overflow – 100% Bypass Began at Time of Third Observation (0930)
    - Heavy Rain Noted
    - Flowrate at Initial Bypass Estimated at 0.30 cfs
    - Bypass Occurred above the WQF
    - Significant Bypass Continued for Duration of Monitoring
    - Bypass/Re-suspension of Gross Solids in Basket
    - Basket % Full at Initial Point of Bypass- Approximately 10%
    - At 0945 Basket 100% Full of Gross Solids

Figure 4-9 below presents the event hydrograph for site REM BER-PL.

Figure 4-9. Event Hydrograph for REM BER-PL

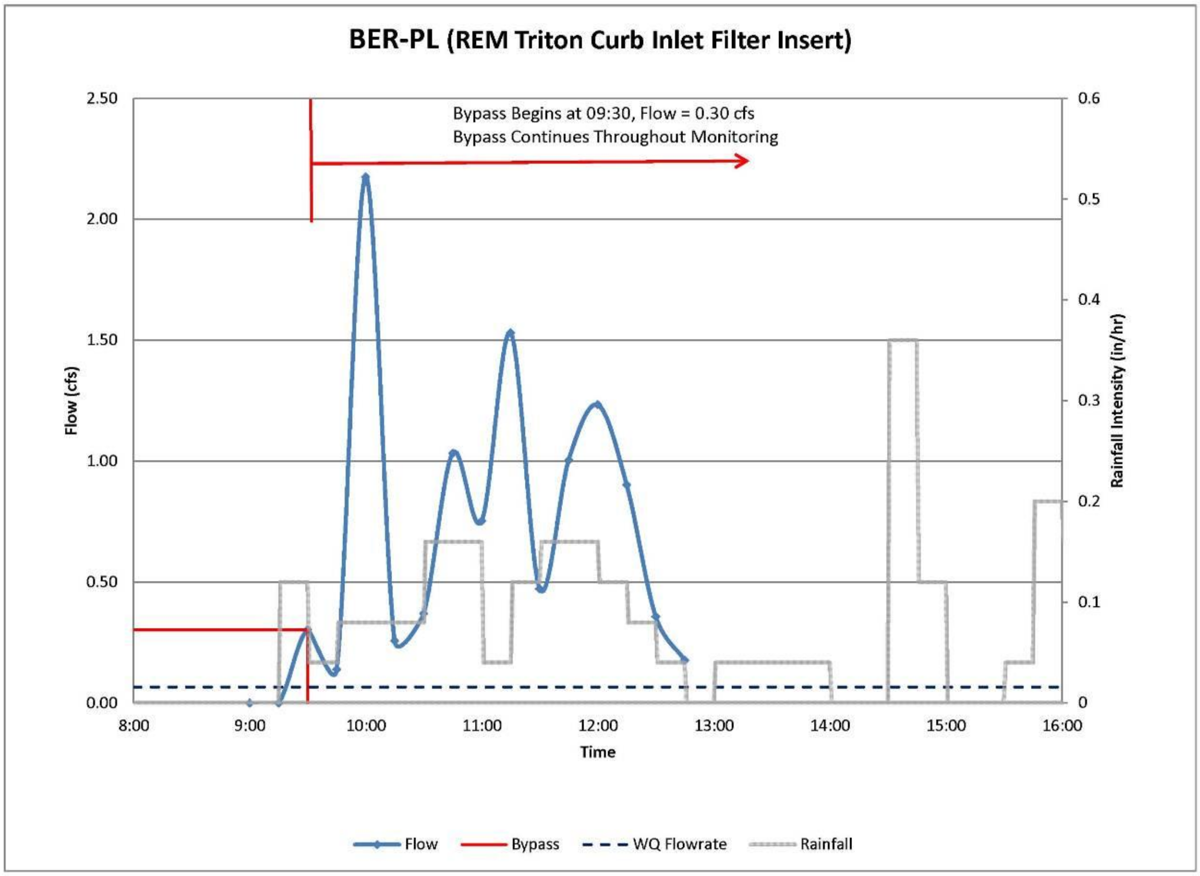


Figure 4-10 below shows a series of photographs highlighting the major storm event performance and post-storm inspection observations.

Figure 4-10. Summary of Storm Event Performance Monitoring- REM BER-PL

a) At initial point of bypass- View down manhole; product full of water, larger gross solids retained by webbing.

b) Flow bypass of BMP; top of webbing unsecured allowing bypass of gross solids.

c) Post-storm inspection- Product nearly full of gross solids, webbing unsecured.

d) Post-storm inspection- Presence of gross solids in catch basin and on top of outlet screen.

4.2.6 REM PET

The major Storm Event Performance Monitoring observations for the REM PET pilot site location are summarized below:

- Product: REM; Triton Curb Inlet Filter Insert
- Monitoring Duration: 0905 to 1428
- Cumulative Rainfall at Initial Bypass: 0.12 in
- Rainfall Intensity Approximately Prior to Initial Bypass: 0.08 in/hr (1045)
- WQF: 0.07 cfs
- Observations:
    - Overflow – Significant Bypass Began at 1120
    - Flowrate at Initial Bypass Estimated at 0.04 cfs
    - Bypass Occurred below the WQF
    - Significant Bypass Continued, Until Flows became Insufficient to Measure
    - Bypass of Gross Solids; Small Material Only
    - Basket % Full at Initial Point of Bypass- Approximately 15%

Figure 4-11 below presents the event hydrograph for site REM PET.

Figure 4-11. Event Hydrograph for REM PET

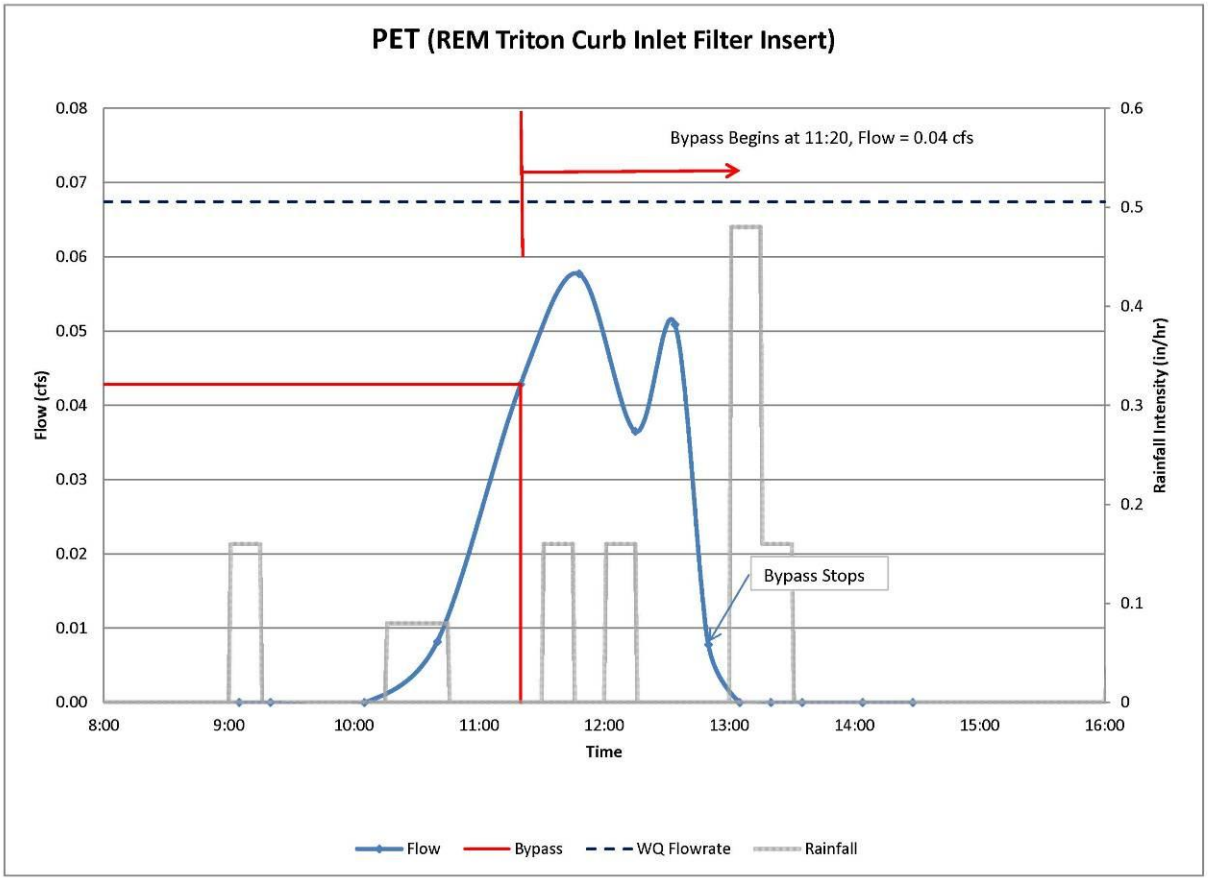


Figure 4-12 below shows a series of photographs highlighting the major storm event performance and post-storm inspection observations.

Figure 4-12. Summary of Storm Event Performance Monitoring Observations- REM PET

a) Before initial bypass; product full of water.

b) Flow bypass of BMP; smaller gross solids are re-suspended and bypass, larger gross solids retained by webbing.

c) Post-storm inspection- Product nearly full of gross solids; larger gross solids retained by webbing.

d) Post-storm inspection- Presence of smaller-sized gross solids in catch basin and on outlet screen.

4.2.7 United Storm Water BER-TC

The major Storm Event Performance Monitoring observations for the United Storm Water BER-TC pilot site location are summarized below:

- Product: United Storm Water; Drain Pac Curb Inlet Basket with CPS
- Monitoring Duration: 0915 to 1245
- Cumulative Rainfall at Initial Bypass: 0.04 in
- Rainfall Intensity Approximately Prior to Initial Bypass: 0.12 in/hr (0916)
- WQF: 0.41 cfs
- Observations:
    - Overflow – 100% Bypass Began at Time of Second Observation (0930)
    - Flowrate at Initial Bypass Estimated at 0.37 cfs
    - Bypass Occurred below the WQF
    - Full Bypass Continued for Duration of Monitoring
    - Bypass/Re-suspension of Gross Solids
    - Basket % Full at Initial Point of Bypass- Approximately 20%
    - Bypass of CPS Observed Beginning at 0930, Flowrate Estimated at 0.37 cfs

Figure 4-13 below presents the event hydrograph for site United Storm Water BER-TC.

Figure 4-13. Event Hydrograph for United Storm Water BER-TC

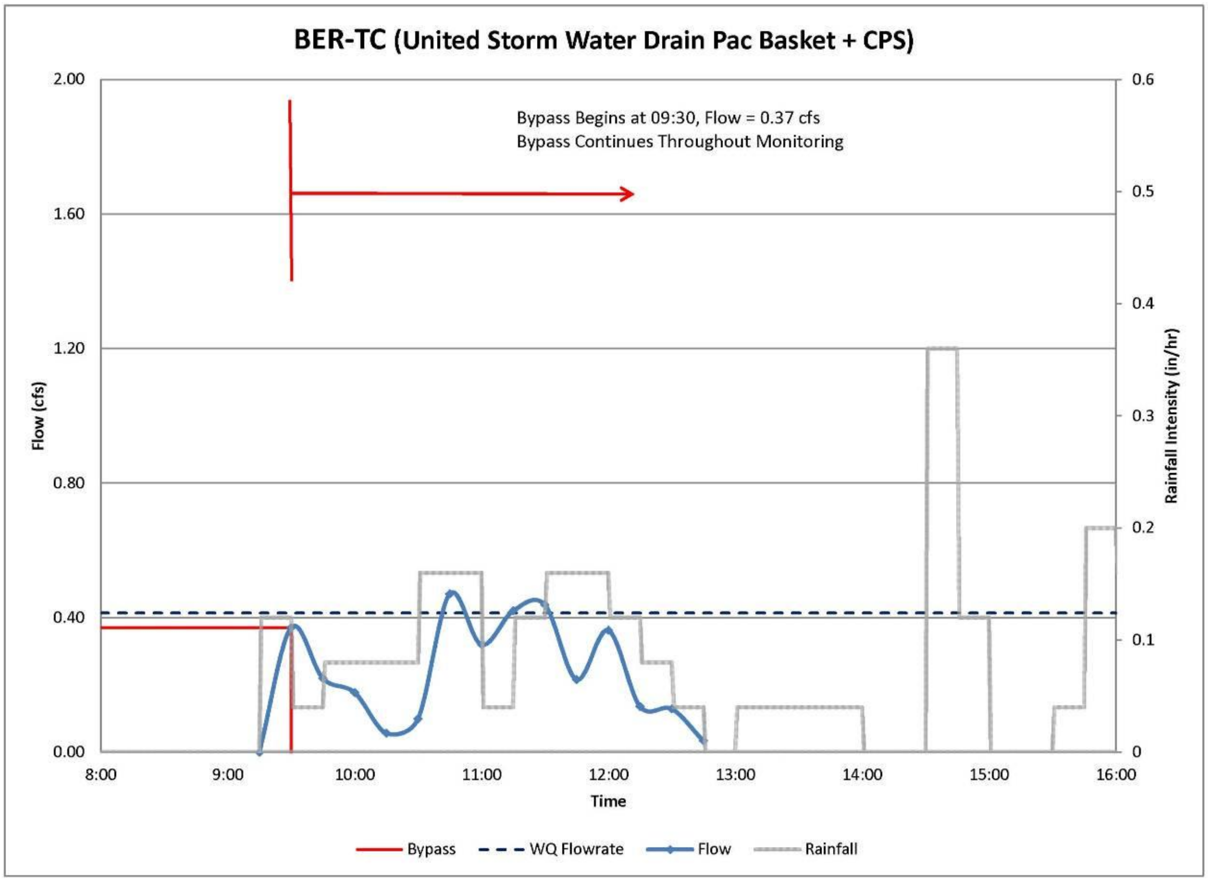


Figure 4-14 below shows a series of photographs highlighting the major storm event performance and post-storm inspection observations.

Figure 4-14. Summary of Storm Event Performance Monitoring Observations- United Storm Water BER-TC

a) Initial bypass of BMP- Curb inlet basket shown from inside catch basin.

b) Flow bypass of BMP- Lower wing basket below concrete shelf shown.

c) Bypass of CPS; gross solids exiting through overflow.

d) Post-storm inspection- Evidence of gross solids overtopping basket; sediment and organic debris clogging fabric.

e) Post-storm inspection- Evidence of gross solids bypass of CPS; clogging of CPS with sediment and organic debris.

f) Post-storm inspection- Gross solids in bottom of catch basin.

4.2.8 United Storm Water ECB-F

The major Storm Event Performance Monitoring observations for the United Storm Water ECB-F pilot site location are summarized below:

- Product: United Storm Water; Drain Pac Curb Inlet Basket with ARS and CPS
- Monitoring Duration: 0915 to 1245
- Cumulative Rainfall at Initial Bypass: 0.04 in
- Rainfall Intensity Approximately Prior to Initial Bypass: 0.48 in/hr (1030)
- WQF: 1.18 cfs
- Observations:
    - Overflow – Significant Bypass Began at Time of Third Observation (0945)
    - Flowrate at Initial Bypass Estimated at 1.5 cfs
    - Initial Bypass Occurred above the WQF; subsequent Bypass Occurred below the WQF
    - Significant Bypass Continued for Duration of Monitoring
    - Bypass/Re-suspension of Gross Solids Observed
    - Basket % Full at Initial Point of Bypass- Unable to Determine; runoff appears to contain high levels of sediment
    - ARS screen clear of gross solids upon arrival
    - ARS remained in closed position for duration of monitoring period
    - Minimal clogging of ARS with gross solids; street flooding apparent
    - Flow Bypass of Curb Inlet Observed; Estimated Inlet Flows Reduced by 30% (refer to Section 3.6.3)
    - Bypass of CPS Observed Starting at 1045 (Flow = 0.84 cfs)
- Vendor Flow Specifications:
    - ARS - Opens between 1” to 4” depth of flow
    - Basket – 0.31 cfs/ft2 of material surface area
    - CPS – None Provided

Figure 4-15 below presents the event hydrograph for site United Storm Water ECB-F.

Figure 4-15. Event Hydrograph for United Storm Water ECB-F

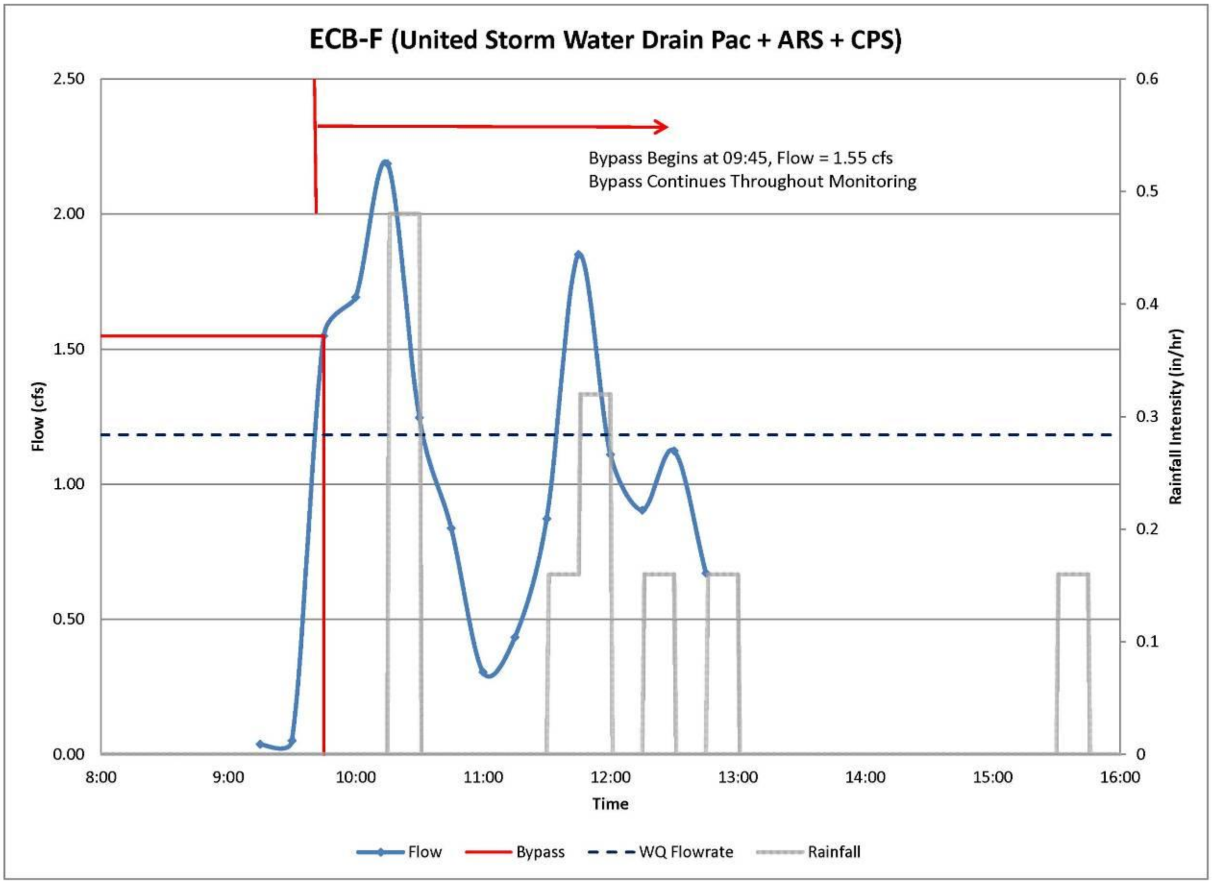


Figure 4-16 below shows a series of photographs highlighting the major storm event performance and post-storm inspection observations.

Figure 4-16. Summary of Storm Event Performance Monitoring- United Storm Water ECB-F

a) ARS remained in closed position for duration of storm event.

b) Initial point of flow bypass- View down manhole of basket.

c) Flow bypass of basket (on left) and CPS.

d) Post-storm inspection- Accumulation of gross solids and debris on front of ARS.

e) Post-storm inspection- Sediment and organic debris clogging basket fabric.

f) Post-storm inspection- Evidence of gross solids bypass of CPS; clogging of CPS with sediment, trash and organic debris.

4.3 DRY WEATHER MONITORING RESULTS

4.3.1 Maintenance Level of Effort

Observation and documentation of Vendor maintenance procedures for the different insert BMP products was performed to determine the level of effort required to maintain the BMPs. Specifically, data was collected for the following maintenance factors:

- Logistics- Number of Personnel, Traffic Controls, Confined Space Entry
- Type of Equipment and Tools Required
- Maintenance Steps Conducted
- Time Required to Perform the Maintenance Steps

Table 4-2 below provides a summary of the data collected for these maintenance factors for the different insert BMP products. The table presents the results for level of effort related to routine maintenance only; non-routine maintenance such as structural repair is not included. The information contained in the table is comprised of data combined for the first (M1) and second (M2) maintenance visits. It was anticipated by the project team that the total maintenance time per insert required for M1 would exceed the total maintenance time required per insert for M2, due to the large volumes of material accumulated over the long dry weather period preceding M1. However, analysis of the maintenance data showed that the range of time required for M1 (20 to 30 minutes) was only slightly higher than the range for M2 (15 to 28 minutes). As noted in Section 3.3, due to the timing of the impending storm event and Vendor scheduling constraints for the second maintenance visit, maintenance was not performed by the Vendor (Bio Clean) for sites BEY-TS, ECB-54, and QUAL.

For all products, two personnel were utilized for maintenance. The total time required to perform maintenance ranged from 15 to 30 minutes per site (for M1 and M2, combined). Three Vendors (Bio Clean, REM, and United Stormwater) employed pressure-washing as a maintenance step. The Downstream FloGard Plus curb inlet insert did not utilize pressure-washing as a routine maintenance step. Pressure washing is considered a required maintenance step for the Bio Clean and REM products, and is recommended by the Vendor for the United Stormwater products (Drain Pac Curb Inlet Basket, CPS, ARS). Cleaning of ARS and CPS components added approximately five minutes to overall routine maintenance.

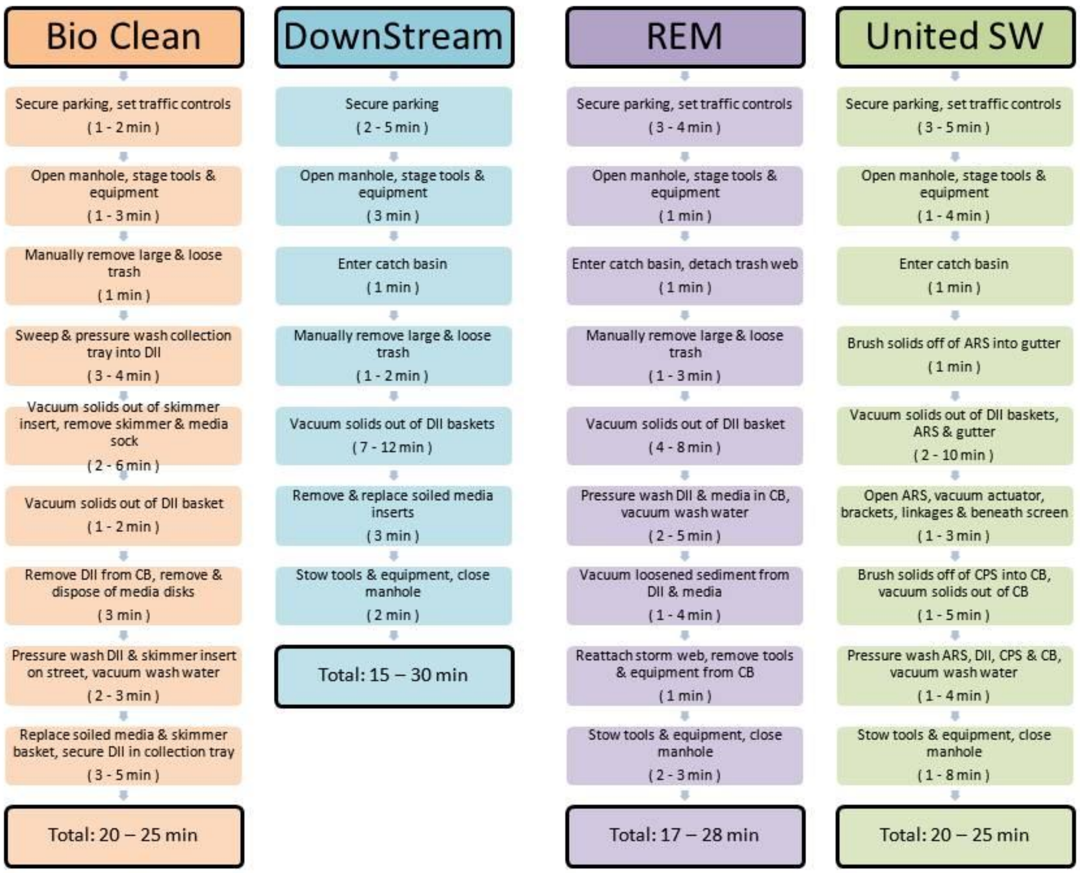
None of the Vendors utilized confined space entry procedures to maintain their products. Bio Clean products (Round Basket and Grate Inlet Skimmer Box) do not require confined space entry procedures because the products can be removed from street-level through the manhole, without entering the catch basin. Maintenance of all other BMPs evaluated required entry into the catch basin, and therefore the use of confined space entry procedures while performing maintenance is recommended by the project team.

Table 4-2. Maintenance Information Summary for Maintenance Visits 1 and 2

General Information			Prior Condition	Logistics			Equipment				Steps								Total Effort
Vendor	Site ID	Product	% Full	Personnel	Traffic Controls	Confined Space Entry	Vacuum Truck	Hose	Pressure Washer	Tools	Setup	Remove Solids	Clean Device	Replace Media	ARS	CPS	Gen. Maint.	Breakdown	
Bio Clean	BEY-TS	High Capacity Round	100	2	CLOSE SHOULDER	NOT REQ'D	FULL SIZE	4"	REQ'D	BROOM CUTTING PLIERS SHOVEL	0:05	0:08	0:05	0:05	-	-	0:01	0:01	0:25
Bio Clean	ECB-54	High Capacity Round	100	2	CLOSE SHOULDER	NOT REQ'D	FULL SIZE	4"	REQ'D	BROOM CUTTING PLIERS SHOVEL	0:05	0:05	0:04	0:05	-	-	-	0:01	0:20
Bio Clean	QUAL	Grate Inlet Skimmer	100	2	NONE	NOT REQ'D	FULL SIZE	4"	REQ'D	BROOM CUTTING PLIERS SHOVEL	0:01	0:08	0:03	0:07	-	-	-	0:01	0:20
DownStream Services	BEY-1	Kristar FloGard	25 - 100	2	ROOF BEACON	REC	MINI	3"	NOT REQ'D	BROOM BAGS	0:06 - 0:10	0:06 - 0:15	-	0:03	-	-	0:01	0:02	0:15 - 0:30
REM	BER-PL	Triton TRC-7	80 - 150	2	CLOSE SHOULDER ROOF BEACON	REQ'D	MINI	3"	REQ'D	BAGS CUTTING PLIERS LADDER SOCK BOOM	0:04	0:09 - 0:14	0:06 - 0:07	-	-	-	0:02	0:03	0:24 - 0:28
REM	PET	Triton TRC 4.0	110 - 150	2	CLOSE SHOULDER ROOF BEACON	REC	MINI	3"	REQ'D	BAGS CUTTING PLIERS SOCK BOOM	0:04 - 0:05	0:06 - 0:13	0:03 - 0:05	-	-	-	0:01	0:01 - 0:02	0:17 - 0:23
United Storm Water	BER-TC	DrainPac w/ CPS	35 - 60	2	CLOSE LANE PEDESTRIAN BARRICADE	REQ'D	FULL SIZE MINI	4"	REQ'D	BROOM CUTTING PLIERS SHOVEL	0:05	0:03 - 0:09	0:02 - 0:03	-	-	0:02 - 0:05	0:02	0:01 - 0:08	0:20 - 0:25
United Storm Water	ECB-F	DrainPac w/ ARS + CPS	20 - 30	2	CLOSE LANE PEDESTRIAN BARRICADE	REQ'D	FULL SIZE MINI	4"	REQ'D	BROOM CUTTING PLIERS SHOVEL	0:04 - 0:09	0:02 - 0:06	0:01 - 0:02	0:01	0:02 - 0:03	0:01 - 0:03	0:01 - 0:03	0:01 - 0:04	0:20 - 0:23
ALL VENDORS	ALL SITES		20 - 150	2	-	-	-	-	-	-	0:01 - 0:10	0:02 - 0:15	0:01 - 0:07	0:01 - 0:07	0:02 - 0:03	0:01 - 0:05	0:01 - 0:03	0:01 - 0:08	0:15 - 0:30

Figure 4-17 below highlights the major maintenance steps performed by each Vendor, and the range of time required to perform each step for the different insert BMP products. In general, steps to remove solids from the insert BMPs required the most time out of the total time to perform maintenance. Selected photos for the maintenance performed at each site are provided in Appendix E. These selected photos serve as a general summary or "highlights" of the maintenance procedures performed by the Vendors for the different BMPs.

Figure 4-17. General Maintenance Steps and Range of Maintenance Level of Effort by Vendor



4.3.2 Pollutant Load Analysis

The following section presents an analysis of pollutant loads retained by the insert BMPs. Gross solids weight, volume, and percent composition of sediment, organics and trash by volume, were collected as part of the Maintenance Observations protocol, according to the procedures described in Section 3.3. It should be noted that the values presented in this analysis are reflective only of the amount of pollutants (i.e., gross solids including sediment, vegetative material/organic debris and trash) retained by the insert BMPs at the time the Vendor Maintenance Observations were conducted.

The total loading of gross solids to the storm drain system cannot be fully ascertained from this study. Differences in the inputs of sediment, organic debris and trash to the eight pilot sites from the surrounding drainage areas appeared to be highly variable, which is consistent with the dearth of information available related to pollutant loading rates of trash and debris in urban runoff. Outlet pipe screens or CPS units were installed to help retain gross solids in the catch basin to the extent possible, thereby facilitating observations of the quantity and composition of gross solids that bypassed the insert BMPs. However, installation of the outlet pipe screens required that bypass capability be provided, in order to prevent total blockage of the outlet pipes caused by gross solids accumulation on the screen, and avoid potential flooding issues/hydraulic impacts caused by high flows during storm events. The CPS units (United Storm Water sites BER-TC and ECB-F) also have an opening near the top of screen to provide bypass capability.

Gross solids bypass of the insert BMPs was observed at all sites during the Storm Event Performance Monitoring, as described in Section 4.3. In some cases, gross solids initially retained in the insert BMPs during the storm event were re-suspended under higher flows and/or as gross solids accumulated in the inserts. Observations of gross solids entering the outlet pipe (i.e., bypassing the outlet screens or CPS) were documented by the field teams during the storm event, as described in Section 3.6. Gross solids were observed entering the outlet pipe at five out of the eight sites (Bio Clean BEY-TS, Downstream Services BEY-1, REM BER-PL, and United Storm Water BER-TC and ECB-F). Bypass of gross solids into the outlet pipe was not observed at sites Bio Clean ECB-54 and REM PET. The product configuration at the Bio Clean QUAL site prevented observation of the outlet pipe, and therefore bypass of gross solids could not be evaluated during the storm event.

Observations conducted during the inspections (pre-maintenance, post-storm and dry weather inspections) confirmed that varying amounts of gross solids had bypassed the insert BMPs and were deposited into the catch basins. In addition, inspection of the outlet pipe screens and CPS sites demonstrated that gross solids had also bypassed the screens and entered the storm drain system at some point.

Although it is not possible to quantify the volume of gross solids that bypassed the insert BMPs and entered the storm drain system, it is possible to quantify the number of monitoring observations conducted during the storm event where field crews documented bypass of gross solids past the CPS or outlet pipe screen, and entering the outlet pipe. Table 4-3 below summarizes the number of observations of gross solids bypass, as a percentage of the total number of observations with measurable flow.

Table 4-3. Observations of Gross Solids Bypass of Outlet Pipe Screen/CPS (Storm Event)

Vendor	Site	# Observations of Gross Solids Bypass of Outlet Pipe Screen/CPS	Total # Observations with Measurable Flow	Percentage
Bio Clean	BEY-TS	8	10	80
	ECB-54	0	14	0
	QUAL[1]	N/A	N/A	N/A
Downstream Services	BEY-1	8	18	44
REM	BER-PL	10	14	71
	PET	0	6	0
United Storm Water	BER-TC[2]	14	14	100
	ECB-F[2]	4	15	27

[1]Outlet Pipe Screen not visible at this location due to product configuration.

[2]Type of screen is a CPS.

It should be noted that for sites without a CPS (which is a component of the BMP), any gross solids that bypass the insert will likely eventually enter the storm drain system during wet weather, because an outlet pipe screen is typically not present. The CPS is designed to retain gross solids in the catch basin, and gross solids will bypass the CPS and enter the storm drain system as a function of the CPS hydraulics (i.e., CPS dimensions, flow, clogging of the screen, etc.). For sites with an outlet pipe screen, rather than a CPS, the actual occurrence of gross solids entering the storm drain system may be more closely related to the volume of runoff that bypasses the insert.

Table 4-4 below presents an estimate of the volume of bypass as a percentage of the total volume of runoff entering the curb inlet for the eight SDIPS pilot sites. For all sites, the bypass volume represents the estimated volume of runoff that bypassed the inserts/baskets. For the six pilot sites without a CPS (Bio Clean BEY-TS, Bio Clean ECB-54, Bio Clean QUAL, Downstream Services BEY-1, REM BER-PL, and REM PET), the bypass volume can be considered the portion of runoff that is essentially "untreated". For the CPS sites (United Storm Water BER-TC and ECB-F), the bypass volume would be the estimated volume of runoff that bypassed the CPS, however calculating the volume of runoff that bypassed the CPS is beyond the scope of this study. For the CPS sites, the "untreated" runoff is evidenced by the percentage of observations of gross solids bypass of the CPS, as shown in Table 4-3 above (100% for United Storm Water BER-TC, and 27% for United Storm Water ECB-F). The bypass volume presented in Table 4-4 was calculated by multiplying the estimated inlet flow (cfs) measured in the field by the estimated observed percent bypass (%) by the time period over which the bypass occurred (i.e., for each monitoring interval where bypass was observed, the flow rate was assumed to be constant over the entire 15 minute interval).

Table 4-4. Estimated Percent Bypass of Insert (by Runoff Volume)

Vendor	Site	# Observations with Bypass of Insert	Total # Observations with Measurable Flow	Bypass volume (cu ft)	Total Runoff Volume (cu ft)	Percent Bypass (%)
Bio Clean	BEY-TS	8	10	229	277	83
	ECB-54	2	14	194	540	36
	QUAL	12	19	21	37	57
Downstream Services	BEY-1	9	18	1009	1597	63
REM	BER-PL	14	14	9385	9636	97
	PET	4	6	89	184	49
United Storm Water	BER-TC*	14	14	3105	3105	100
	ECB-F*	13	15	10914	13385	82

*Site with CPS

As shown in Table 4-4, seven out of eight total sites exhibited estimated insert bypass volumes near or greater than 50 percent. For those sites without a CPS, there were four out of six sites with bypass volumes greater than 50 percent. For these sites, over half of the runoff that enters the curb inlet passes by the BMP untreated, and enters the storm drain system. Any amount of gross solids contained in the runoff that bypasses the insert will enter the catch basin. For sites without a CPS, this amount of gross solids will then enter the MS4. For sites with a CPS, the portion of runoff that bypassed the insert will enter the catch basin, and any portion of that flow that bypasses the CPS may also contribute gross solids to the MS4, as shown in Table 4-3.

Table 4-5 below presents the total weight of gross solids removed (in pounds) by the insert BMPs for M1 and M2. In addition to the gross solids collected in the insert/basket, where designated in the table the total weight of gross solids collected includes solids that were trapped in the BMP collection tray (Bio Clean Round Curb Inlet Baskets at BER-TS and ECB-54) and/or overflow netting (REM Storm Web at BER-PL and PET), or in/on existing infrastructure due to presence of device. For example, if the presence of the BMP caused gross solids to be retained on the wing of the catch basin, those solids were considered to be "collected" by the BMP. At sites where a CPS is also installed (United Storm Water BER-TC and ECB-F), the total amount of gross solids collected includes solids retained in the bottom of the catch basin, and solids removed from the surface of the CPS, since the CPS is a component of the BMP.

Table 4-5. Gross Solids Removed by Insert BMPs Measured During Maintenance Visits

Gross Solids Removed (lbs)			
		M1 (Sept/Oct)	**M2 (Oct/Nov)**
BIO CLEAN	BEY-TS*	26.2	18.7
	ECB-54*	58.8	13.5
	QUAL	45.6	1.0
DOWNSTREAM SERVICES	BEY-1	101.2	14.8
REM	BER-PL*	101.2	103.7
	PET*	10.0	1.6
UNITED STORM WATER	BER-TC**	142.2	32.3
	ECB-F**	79.6	60.0

*Totals include solids trapped in BMP collection tray and/or overflow netting, or in/on existing infrastructure due to presence of device.

**Totals include gross solids that were retained in the catch basin by the CPS, and removed from the surface of the CPS.

In general, more pounds of gross solids were removed during the first maintenance visit (M1) than the second (M2). The first maintenance visit was preceded by a long dry weather period, allowing for greater accumulation of gross solids in the BMPs. Fewer pounds of gross solids were collected for M2, likely as a result of a shorter period of gross solids accumulation, lower amounts of sediment and/or possible loss/re-suspension of sediment and organic debris from the BMPs into the catch basin as a result of storm flows. This is evidenced in many cases by the presence of gross solids observed in the catch basins during post-storm inspections, as described in section 4.3 above. The variation in the weight of material collected from site to site may also be influenced by the difference in trash, sediment and organic debris loading inputs at the specific sites. In addition, gross solids were dried according to the procedure described in Section 3.3, however some variation in gross solids moisture content was noted during some characterizations, and may have affected the total weight of gross solids. It was also noted during the Maintenance Observations that sediment and organic debris were frequently commingled and not able to be well characterized separately, which may also account for some variation in the weight and estimated composition of gross solids.

Table 4-6 below shows the volume of gross solids collected by the insert BMPs in cubic feet, and also presents the estimated percent composition by volume of sediment, organics and trash in the gross solids collected.

Table 4-6. Gross Solids Total Volume and Estimated Percent Composition by Volume

			Gross Solids Vol. (cu ft)	Composition (% by Vol.)		
				Sediment	Organics	Trash
BIO CLEAN	BEY-TS*	M1	1.73	40%	55%	5%
		M2	2.50	5%	90%	5%
	ECB-54*	M1	1.55	2%	3%	95%
		M2	0.97	40%	10%	50%
	QUAL	M1	0.89	85%	10%	5%
		M2***	0.01	10%	50%	40%
DOWNSTREAM SERVICES	BEY-1	M1	1.81	70%	2%	28%
		M2	0.58	50%	10%	40%
REM	BER-PL*	M1	1.58	70%	29%	1%
		M2	3.38	49%	49%	2%
	PET*	M1	1.44	10%	15%	75%
		M2	1.55	0%	60%	40%
UNITED STORM WATER	BER-TC**	M1	2.76	80%	17%	3%
		M2	0.78	78%	20%	2%
	ECB-F**	M1	0.88	85%	12%	3%
		M2	0.98	75%	1%	24%

*Totals include solids trapped in BMP collection tray and/or overflow netting, or in/on existing infrastructure due to presence of device.

**Totals include gross solids that were retained in the catch basin by the CPS, and removed from the surface of the CPS.

***Volume calculated for QUAL M2 was -.01 cu ft due to collected volume being less than the resolution of frustrum calculation method. Reported 0.01 cu ft, based on empirical observations.

In most cases higher levels of organic debris were seen in M2, which may account for reported higher gross solids load removal for M2 as compared to M1 for a few sites (Bio Clean BEY-TS, REM BER-PL). Percent composition of sediment varied between M1 and M2 and by site, and certain sites had consistently high levels of sediment composition (Downstream Services BEY-1, and United Storm Water ECB-F, and BER-TC). In addition to sediment inputs/site contributions of sediment, sites Downstream Services BEY-1, REM BER-PL and United Storm Water ECB-F and BER-TC had generally higher levels of sediment composition, possibly to some extent due to the fabric incorporated in the insert construction, which may retain more sediment than screen-type materials.

Overall, levels of trash were much lower than expected, except for Bio Clean ECB-54 and PET. This may be a result of differences in trash loading rates of the different drainage areas, and an apparent large capacity for retention of larger gross solids. The addition of the Storm Web between M1 and M2 at the REM BER-PL site likely contributed to the increase in volume of gross solids collected. The Storm Web is installed to assist in the retention of large debris, but smaller gross solids (such as cigarette butts) are able to pass through. United Storm Water ECB-F exhibited low volumes of gross solids collected during both M1 and M2, likely due to the presence of the ARS, which excluded larger gross solids from the curb inlet.

Table 4-7 below shows the volume of gross solids removed in cubic feet, by category of gross solids.

Table 4-7. Volume of Gross Solids Removed by Category

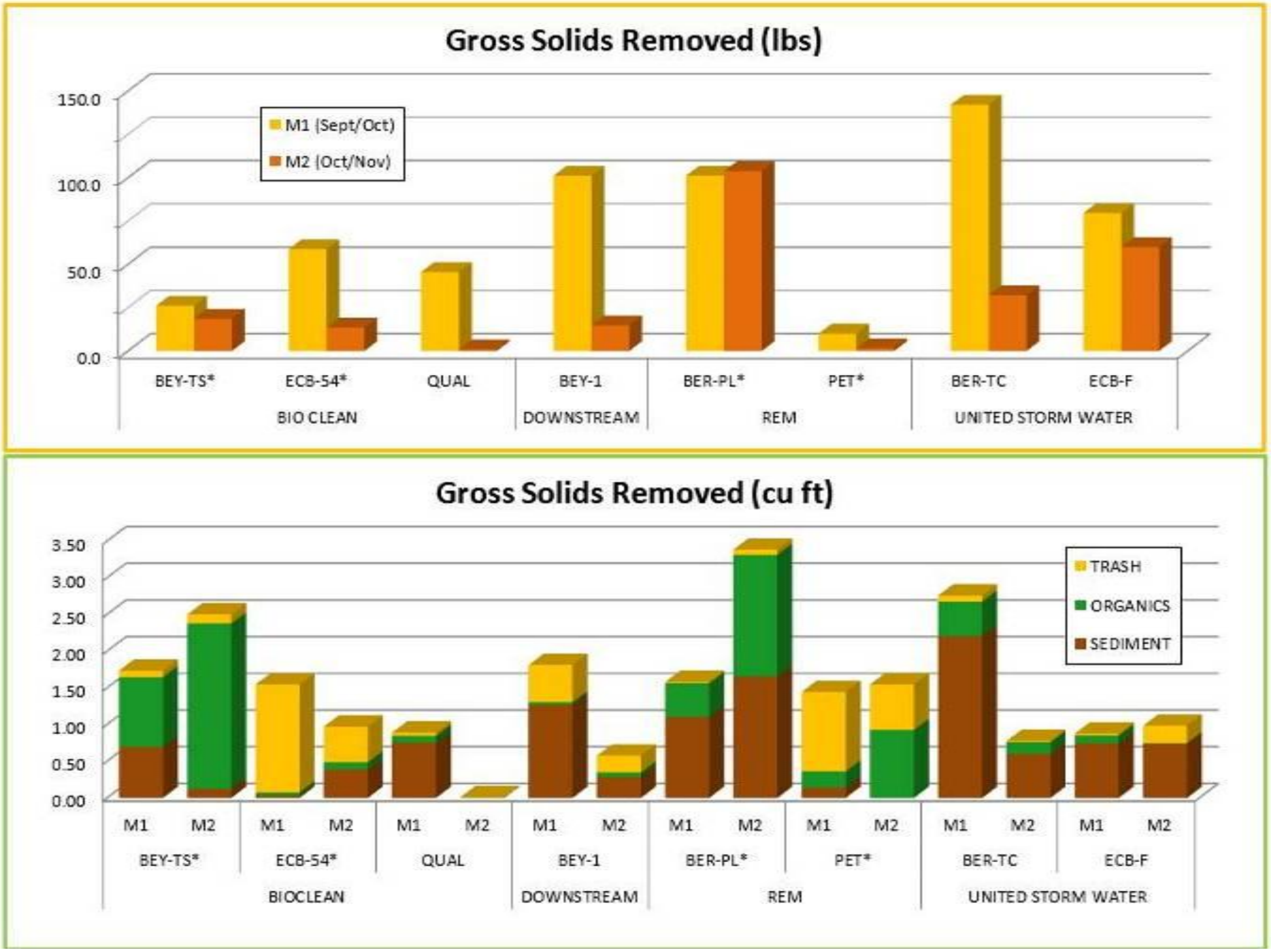
Gross Solids Removed (cu ft)					
			SEDIMENT	**ORGANICS**	**TRASH**
BIO CLEAN	BEY-TS*	M1	0.69	0.95	0.09
		M2	0.13	2.25	0.13
	ECB-54*	M1	0.03	0.05	1.47
		M2	0.39	0.10	0.49
	QUAL	M1	0.76	0.09	0.04
		M2	0.00	0.01	0.00
DOWNSTREAM SERVICES	BEY-1	M1	1.27	0.04	0.51
		M2	0.29	0.06	0.23
REM	BER-PL*	M1	1.11	0.46	0.02
		M2	1.66	1.66	0.07
	PET*	M1	0.14	0.22	1.08
		M2	0.00	0.93	0.62
UNITED STORM WATER	BER-TC**	M1	2.21	0.47	0.08
		M2	0.60	0.16	0.02
	ECB-F**	M1	0.75	0.11	0.03
		M2	0.74	0.01	0.24

*Totals include solids trapped in BMP collection tray and/or overflow netting, or in/on existing infrastructure due to presence of device.

**Totals include gross solids that were retained in the catch basin by the CPS, and removed from the surface of the CPS.

Figure 4-18 below shows a graphical representation of the gross solids removed by weight and by volume.

Figure 4-18. Gross Solids Removed by Weight (Lbs) and Volume (cu ft)



4.3.3 Maintenance Frequency Requirements

The following section presents a summary of the observed maintenance frequency required to maintain the BMPs at optimal levels. The observed maintenance frequency was determined based on observations and data collected for the dry weather (including "pre-maintenance") and post-storm inspections. Determinations of when maintenance was required is based on a quantitative assessment of the percent full (of product capacity), qualitative assessments of conditions that may impact hydraulic functioning of the BMP, based on observations and documentation of insert fabric/filter material/screen clogging, and other maintenance issues documented during the inspections. Data and information for the inspections was collected according to the procedures documented in Section 3.2.

Table 4-6 below is a summary of the results from the dry weather (including "pre-maintenance") and post-storm inspections. The table also includes estimates of the percent composition of gross solids determined during the inspections.

Table 4-8. Inspection Results- Percent Full, Percent Composition by Volume and Estimated Maintenance Frequency

		September 22 - October 5					October 10					October 27 - November 4					November 8 - November 9					November 30				
		Pre-Maintenance BMP Inspection					Post-Storm BMP Inspection					Pre-Maintenance BMP Inspection					Post-Storm BMP Inspection					Dry Weather BMP Inspection				
Vendor	Site ID	% Full	% SED	%ORG	%TRA	Maint Req'd	% Full	% SED	%ORG	%TRA	Maint Req'd	% Full	% SED	%ORG	%TRA	Maint Req'd	% Full	% SED	%ORG	%TRA	Maint Req'd	% Full	% SED	%ORG	%TRA	Maint Req'd
Bio Clean	BEY-TS*	100	20%	60%	20%	YES	120	15%	70%	15%	YES	140	15%	80%	5%	YES	150	29%	70%	1%	YES	150	15%	80%	5%	YES
	ECB-54*	100	40%	30%	30%	YES	90	85%	10%	5%	YES	100	45%	10%	45%	YES	30	55%	10%	35%	YES**	75	70%	15%	15%	YES
	QUAL	100	50%	35%	15%	YES	3	10%	60%	30%	NO	5	10%	40%	50%	NO	1	50%	30%	20%	NO	5	35%	35%	30%	NO
Downstream Services	BEY-1	100	5%	5%	90%	YES	25	30%	35%	35%	NO***	25	15%	40%	45%	NO***	45	50%	20%	30%	NO***	60	80%	5%	15%	NO***
REM	BER-PL*	80	15%	85%	0%	YES	75	20%	80%	0%	YES	150	5%	95%	0%	YES	75	35%	65%	0%	YES	100	29%	70%	1%	YES
	PET*	150	5%	50%	45%	YES	65	0%	40%	60%	NO	110	1%	39%	60%	YES	50	0%	60%	40%	NO	90	0%	40%	60%	YES
United Storm Water	BER-TC	60	85%	14%	1%	YES**	15	15%	80%	5%	YES**	35	60%	39%	1%	YES**	10	50%	45%	5%	YES**	15	60%	35%	5%	YES**
	ECB-F	30	97%	3%	0%	YES**	15	75%	15%	10%	YES**	20	70%	15%	15%	YES**	25	80%	15%	5%	YES**	25	85%	5%	10%	YES**

*Percent full includes solids trapped in BMP collection tray and/or overflow netting, or in/on existing infrastructure due to presence of device.
**Maintenance required to relieve severe clogging
***Maintenance recommended to relieve clogging

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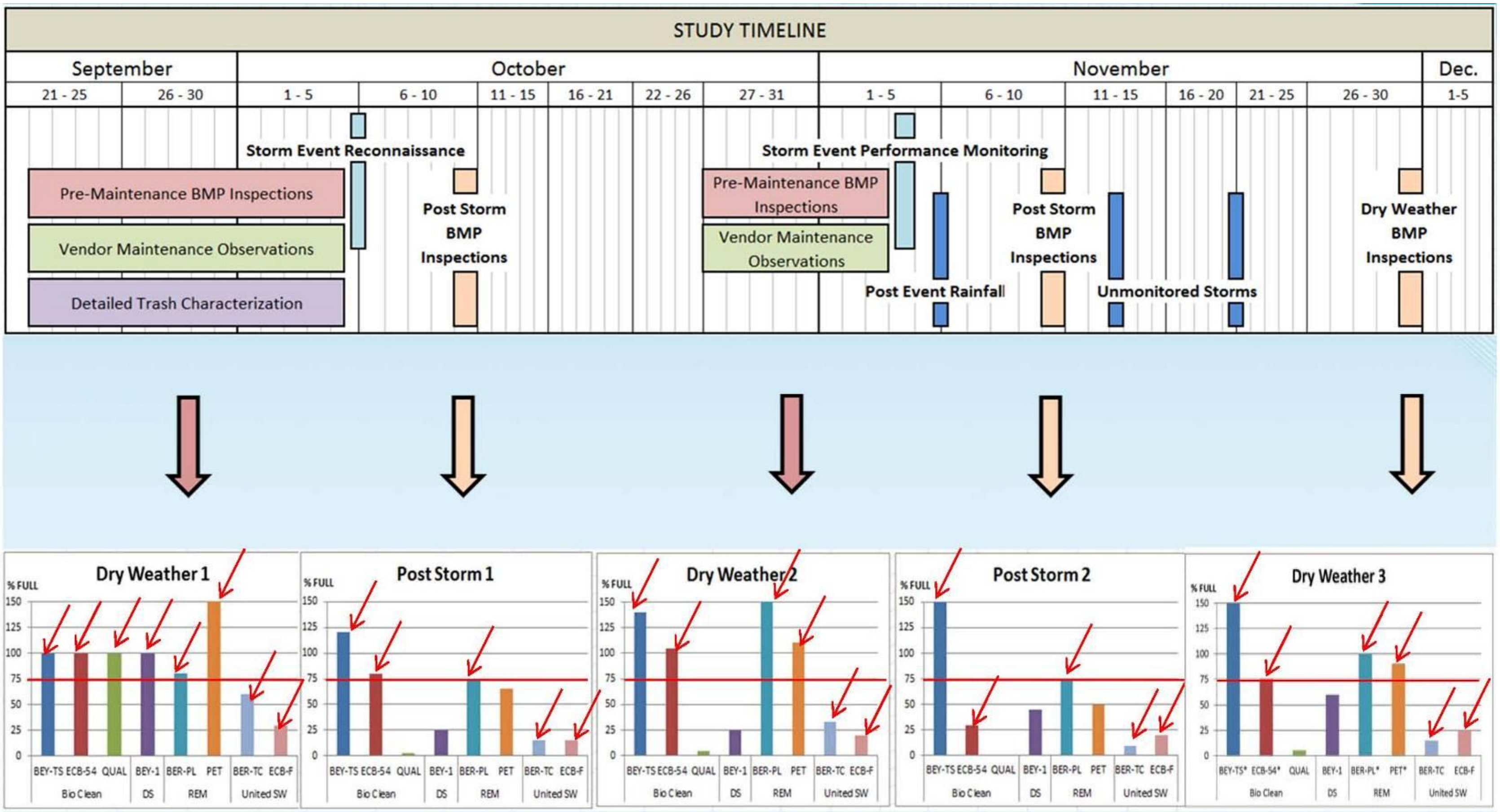
Figure 4-19 below summarizes the estimated maintenance frequency required for the different insert BMPs, based upon the observations documented during the dry weather and post-storm inspections. The information from each inspection is presented as it relates to the overall project timeline, that is, in relation to when the inspection was conducted during the project period. Storm events and dry weather periods are shown on the figure to demonstrate how these factors may impact required maintenance frequency.

As shown on the figure, red arrows indicate the occasions where maintenance was determined by the project team to be required. The arrows designate where the product capacity was above 75% full of gross solids, or if below 75% full of gross solids, maintenance was required for some other reason (i.e., clogging of BMP fabric/material/screen). As indicated by Figure 4-19 and Table 4-8, maintenance was determined to be recommended more than once during the project period for all eight BMPs. Five BMPs required maintenance every inspection (BEY-TS, ECB-54, BER-PL, BER-TC, and ECB-F), one BMP required maintenance three times during the project period (PET), and for one BMP, maintenance was recommended every inspection based on observed clogging of filter fabric (BEY-1).

Figure 4-19. Estimated Maintenance Frequency Requirements for SDIPS BMPs



SECTION 5 SUMMARY

The objective of the SDIPS was to assess the performance, and operation and maintenance requirements of five different storm drain insert BMPs, provided by the product Vendors for evaluation. The monitoring program was developed to quantitatively and qualitatively assess the performance of the storm drain insert technologies during both dry and wet weather. This section provides a summary of the project findings as they relate to BMP performance during storm events, maintenance level-of-effort, pollutant load analysis of gross solids retained by the BMPs, and BMP maintenance frequency requirements.

Table 5-1 summarizes the major findings of the Storm Event Performance Monitoring conducted on November 4, 2011. The Storm Event Performance Monitoring results show that many of the insert BMPs evaluated for this study demonstrated appreciable levels of flow bypass during the monitored storm event. Five out of the eight products evaluated (Bio Clean BEY-TS, Bio Clean QUAL, REM PET, United Storm Water BER-TC, and United Storm Water ECB-F) bypassed below the WQF (calculated based on estimated drainage areas) at some point during the monitored period. Six out of the eight BMPs (Bio Clean BEY-TS, Bio Clean QUAL, REM BER-PL, REM PET, United Storm Water BER-TC, and United Storm Water ECB-F) exhibited significant bypass (i.e., flow bypass greater than 50 percent of the total flow entering the curb inlet) for more than 40 percent of the monitoring period. One BMP that only bypassed above the WQF (Downstream Services BEY-1), did so at a flowrate below the stated Vendor specifications for the BMP (i.e., Clean Flow Rate of 1.0 cfs per basket). At one site, Bio Clean ECB-54, the BMP experienced flow bypass during one monitoring observation only.

Estimates of the amount of gross solids present in the insert at the time of initial significant bypass were documented as part of the observations conducted for the Storm Event Performance Monitoring, and are provided in Table 5-1. These observations were conducted in an attempt to determine if the accumulation of gross solids was the primary reason for bypass. As shown in Table 5-1, only two products (Bio Clean ECB-54 and Bio Clean BEY-TS) contained gross solids in amounts over 50 percent of insert capacity at the time of initial bypass. For one site, United Storm Water ECB-F, field teams were unable to determine the amount of gross solids present in the basket at the time of bypass, due to apparent high levels and re-suspension of sediment in the runoff. Two other contributing factors that prevent the direct observation of the reason for bypass include the re-suspension of deposited gross solids in the insert, and the potential for clogging of insert materials due to sediment and small organic particles. Re-suspension of accumulated gross solids was observed during the storm event at all sites, although appeared to be minimal at sites REM PET and Bio Clean ECB-54. Post-storm inspections conducted after the monitored storm event confirmed evidence of gross solids bypass and/or re-suspension and deposition of gross solids in the catch basins at all sites. Clogging of insert filter material/fabric/screens was difficult to observe during the storm, however observations from post-storm inspections showed that clogging of filter material/fabric/screens was prevalent, and was likely a contributing factor for bypass. This is also evidenced at some sites by the continuation of bypass throughout the storm event hydrograph, even as runoff flows decreased. At many sites however, significant and sometimes full bypass of flows occurred almost immediately after storm monitoring was initiated. In these cases, it is likely that the runoff flows exceeded the BMPs capacity for treatment.

Table 5-1. Summary of Storm Event Performance Monitoring Observations

Vendor	Site Name	Product	Rainfall Intensity at Initial Bypass[1] (in/hr)	Flowrate at Initial Bypass[2] (cfs)	WQ Flowrate (cfs)	Product Bypassed Below WQ Flowrate at Any Time?	Percent of Observations with Significant Bypass[3] (%)	Percent Full Gross Solids at Initial Bypass[4]	Evidence of Gross Solids Bypass/Re-suspension?	Estimated Percent Runoff Volume Untreated[5]
Bio Clean	BEY-TS	Round Curb Inlet Basket with Media Filter	0.16	0.09	0.02	Yes	80	100	Yes	83
	ECB-54	Round Curb Inlet Basket with Media Filter	0.48	0.43	0.19	No	< 1	80	Yes	36
	QUAL	Grate Inlet Skimmer Box	0.08	0.004	0.19	Yes	42	1	Yes	57
Downstream Services	BEY-1	FloGard Plus Curb Inlet Filter Insert	0.16	0.32	0.01	No	28	35	Yes	63
REM	BER-PL	Triton Curb Inlet Filter Insert	0.12	0.30	0.07	No	100	8	Yes	97
	PET	Triton Curb Inlet Filter Insert	0.08	0.04	0.07	Yes	50	15	Yes, small material	49
United Stormwater	BER-TC	Drain Pac Curb Inlet Basket + CPS	0.12	0.37	0.41	Yes	100	20	Yes	100
	ECB-F	ARS + Drain Pac Curb Inlet Basket + CPS	0.48	1.55	1.18	Yes	87	Unable to Determine	Yes	82

[1]Rainfall intensity is presented in terms of the intensity approximately prior to initial bypass. In some cases, a peak in the hydrograph is present just prior to the corresponding peak in rainfall intensity. This shift is likely due to differences in the geographic distance between the SDCFCD rain gauges and the pilot sites.

[2]Initial bypass designates the start of "significant" bypass, i.e., flow bypass greater than 50% of total flow.

[3]Number of observations with greater than 50% bypass divided by the total number of observations with measurable flow.

[4]Designates insert/basket percent full of gross solids at the start of "significant" bypass.

[5]Estimated percent untreated volume is the estimated volume of runoff that bypassed the insert, as a percentage of the total runoff volume that entered the curb inlet. *For BMPs with CPS, this refers to the volume that bypasses the insert only. The volume of runoff that bypassed the CPS was not determined in this study. Refer to section 4.4.

An important component of the SDIPS was to determine the level of effort required to maintain the BMPs. It was anticipated by the project team that total maintenance time per insert may be related to the amount of accumulated gross solids collected by the BMPs and/or antecedent dry period. However, analysis of the maintenance data showed that the range of time required for the first maintenance visit (20 to 30 minutes) was only slightly higher than the range for the second maintenance visit (15 to 28 minutes).

For all products, two personnel were utilized for maintenance. The total time required to perform maintenance ranged from 15 to 30 minutes per site (for the first and second maintenance visits, combined). Pressure-washing the insert BMPs added minimal time to overall maintenance (1 to 5 minutes). Cleaning of ARS and CPS components added approximately five minutes to overall routine maintenance. Although the range of time required to maintain each BMP appears reasonable, it should be emphasized that none of the Vendors utilized confined space entry procedures to maintain their products. Maintenance of all BMPs evaluated except for the Bio Clean products, required entry into the catch basin and therefore employment of confined space entry procedures while performing maintenance is strongly recommended by the project team. Bio Clean products (Round Basket and Grate Inlet Skimmer Box) do not require confined space entry procedures because the products can be removed from street-level through the manhole without entering the catch basin. Therefore it is anticipated that maintenance of the Bio Clean products may be less time-intensive, due to the fact that they do not require confined space entry.

Weight, volume, and percent composition by volume of gross solids retained by the insert BMPs were collected as part of the Maintenance Observations data collection effort. Measurements and observations of gross solids are reflective only of the amount of pollutants (i.e., gross solids including sediment, vegetative material/organic debris and trash) retained by the insert BMPs at the time the Vendor Maintenance Observations were conducted, and are not reflective of the total pollutant loading of gross solids to the storm drain system.

Gross solids data from the eight pilot sites appeared to be highly variable, likely primarily due to the differences in pollutant loading rates of the site drainage areas. Outlet pipe screens or CPS units were installed to help retain gross solids in the catch basin to the extent possible, to facilitate observations of the quantity and composition of gross solids that bypassed the insert BMPs. However, observations of gross solids bypass of the CPS and outlet pipe screens documented during the storm (at sites Bio Clean BEY-TS, Downstream Services BEY-1, REM BER-PL, and United Storm Water BER-TC and ECB-F), and during the inspections (all sites except for REM PET), demonstrated that gross solids were entering the storm drain system, thereby making a complete characterization of the gross solids pollutant loading and removal by the BMPs impossible.

Some measure of the loading of gross solids to the storm drain system as a result of gross solids bypass of the BMPs can be ascertained by estimating the volume of runoff that bypasses the BMPs, or the "untreated" runoff volume. Table 5-1 shows the estimated percent runoff volume untreated for the eight sites, which is the estimated volume of runoff that bypassed the insert/basket as a percentage of the total volume of runoff entering the curb inlet. Seven out of eight total sites exhibited estimated insert bypass volumes near or greater than 50 percent. For the six pilot sites without a CPS (Bio Clean BEY-TS, Bio

Clean ECB-54, Bio Clean QUAL, Downstream Services BEY-1, REM BER-PL, and REM PET), the bypass volume can be considered the portion of runoff that is essentially "untreated". For the CPS sites (United Storm Water BER-TC and ECB-F), the bypass volume would be the estimated volume of runoff that bypassed the CPS, however calculating the volume of runoff that bypassed the CPS was beyond the scope of the SDIPS. For the CPS sites, the "untreated" runoff is better informed by the number of observations of gross solids bypass, as a percentage of the total number of observations with measurable flow. The percentage of gross solids bypass observations of the CPS were 100% for United Storm Water BER-TC, and 27% for United Storm Water ECB-F.

The final key component of the SDIPS was an evaluation of the maintenance frequency required to maintain the BMPs at optimal levels. A determination of the required maintenance frequency was based on both quantitative assessment of the amount of gross solids present, (as percent full of product capacity), and qualitative assessments of other conditions that may impact hydraulic functioning of the BMP. Observations and documentation of insert fabric/filter material/screen clogging, and other maintenance issues were documented during the inspections.

Based on the evaluation conducted by the project team, the frequency of maintenance required was determined to be more than one time during the project period for all eight BMPs. Five BMPs required maintenance every inspection (BEY-TS, ECB-54, BER-PL, BER-TC, and ECB-F), one BMP required maintenance three times during the project period (PET), and for one BMP, maintenance was recommended every inspection based on observed clogging of filter fabric (BEY-1). The frequency of required maintenance was therefore determined to be greater than at least quarterly for the monitored period.

The results of the SDIPS should be interpreted within the context of the specific conditions encountered during the course of the study. The SDIPS monitoring efforts were conducted over a relatively short time period during one wet season. The observed gross solids (trash, sediment and organic debris) loading rates and estimated runoff flows were highly variable among the eight pilot sites. The estimated size of the drainage areas varied widely between the sites. Although the SDIPS was limited in duration, the study results provide valuable information regarding the specific performance and operation and maintenance requirements of the selected BMPs under the given study conditions. This information can be used to assist the Division when considering potential future implementation of various BMPs as part of their integrated, tiered BMP implementation approach.

SECTION 6 REFERENCES

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Appendix A Site Maps

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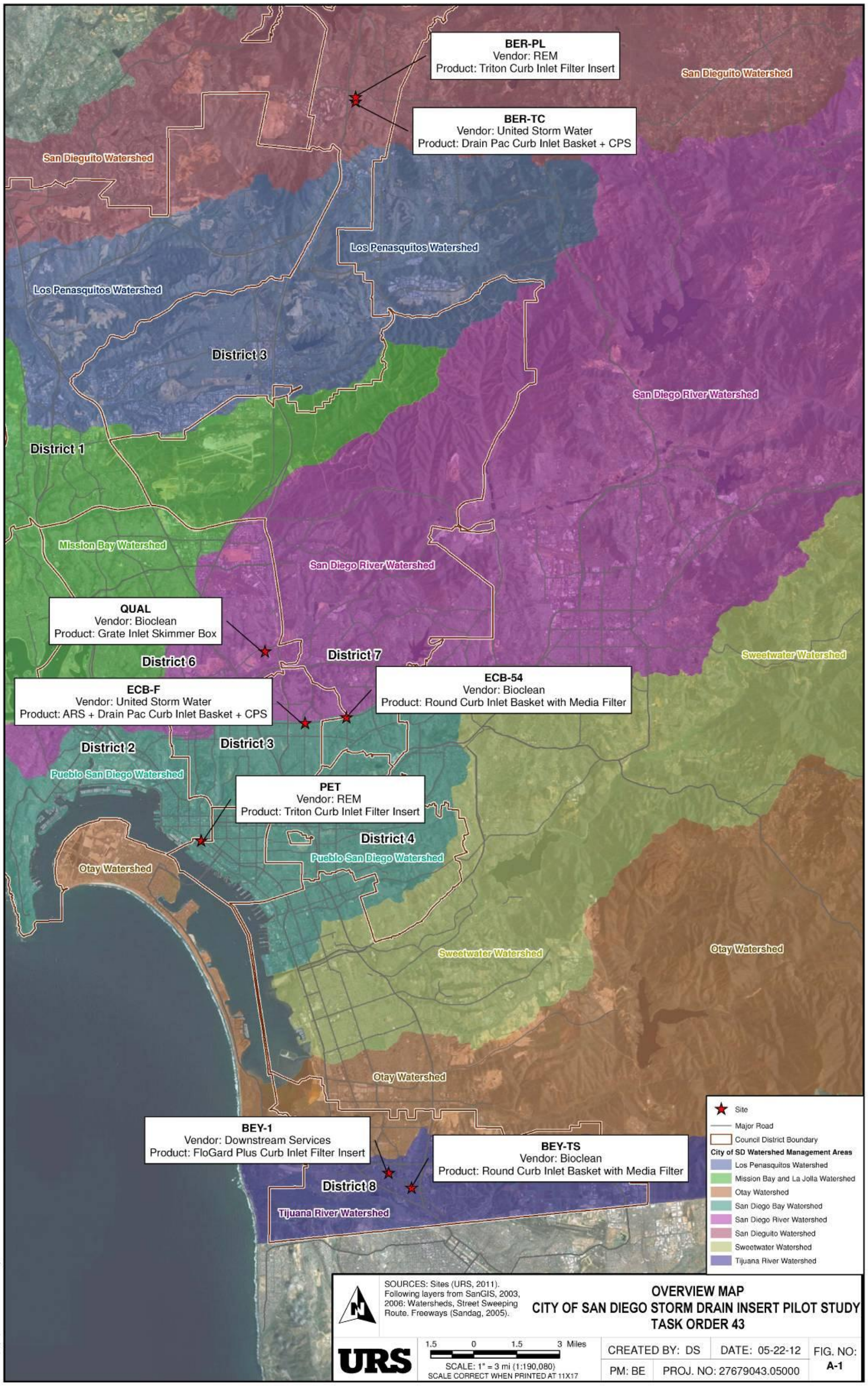
BER-PL
Vendor: REM
Product: Triton Curb Inlet Filter Insert
BER-TC
Vendor: United Storm Water
Product: Drain Pac Curb Inlet Basket + CPS
San Dieguito Watershed
San Dieguito Watershed
Los Penasquitos Watershed
Los Penasquitos Watershed
District 3
San Diego River Watershed
District 1
Mission Bay Watershed
San Diego River Watershed
QUAL
Vendor: Bioclean
Product: Grate Inlet Skimmer Box
District 6
District 7
Sweetwater Watershed
ECB-F
Vendor: United Storm Water
Product: ARS + Drain Pac Curb Inlet Basket + CPS
ECB-54
Vendor: Bioclean
Product: Round Curb Inlet Basket with Media Filter
District 2
District 3
Pueblo San Diego Watershed
PET
Vendor: REM
Product: Triton Curb Inlet Filter Insert
District 4
Otay Watershed
Pueblo San Diego Watershed
Sweetwater Watershed
Otay Watershed
Otay Watershed
BEY-1
Vendor: Downstream Services
Product: FloGard Plus Curb Inlet Filter Insert
BEY-TS
Vendor: Bioclean
Product: Round Curb Inlet Basket with Media Filter
District 8
Tijuana River Watershed
Site
Major Road
Council District Boundary
City of SD Watershed Management Areas
Los Penasquitos Watershed
Mission Bay and La Jolla Watershed
Otay Watershed
San Diego Bay Watershed
San Diego River Watershed
San Dieguito Watershed
Sweetwater Watershed
Tijuana River Watershed
SOURCES: Sites (URS, 2011).
Following layers from SanGIS, 2003,
2006: Watersheds, Street Sweeping
Route. Freeways (Sandag, 2005).
OVERVIEW MAP
CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY
TASK ORDER 43
URS
1.5 0 1.5 3 Miles
SCALE: 1" = 3 mi (1:190,080)
SCALE CORRECT WHEN PRINTED AT 11X17
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DATE: 05-22-12
FIG. NO:
A-1
PM: BE
PROJ. NO: 27679043.05000

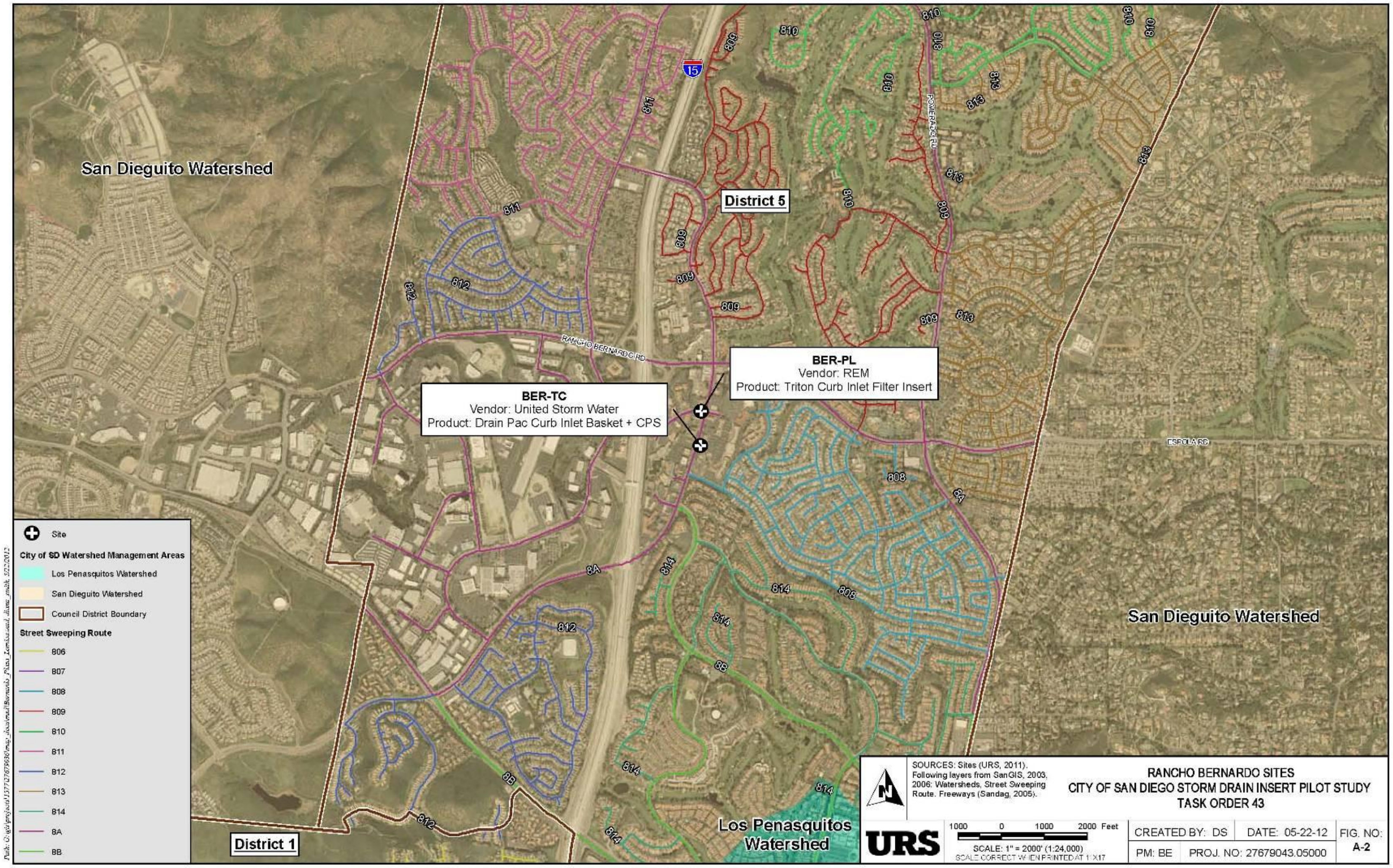
San Dieguito Watershed
District 5
BER-PL
Vendor: REM
Product: Triton Curb Inlet Filter Insert
BER-TC
Vendor: United Storm Water
Product: Drain Pac Curb Inlet Basket + CPS
RANCHO BERNARDO RD
ESPOLA RD
San Dieguito Watershed
Los Penasquitos Watershed
District 1
Site
City of SD Watershed Management Areas
Los Penasquitos Watershed
San Dieguito Watershed
Council District Boundary
Street Sweeping Route
806
807
808
809
810
811
812
813
814
8A
8B
SOURCES: Sites (URS, 2011). Following layers from SanGIS, 2003, 2006: Watersheds, Street Sweeping Route. Freeways (Sandag, 2005).
RANCHO BERNARDO SITES
CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY
TASK ORDER 43
URS
1000 0 1000 2000 Feet
SCALE: 1" = 2000' (1:24,000)
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FIG. NO: A-2
PM: BE
PROJ. NO: 27679043.05000

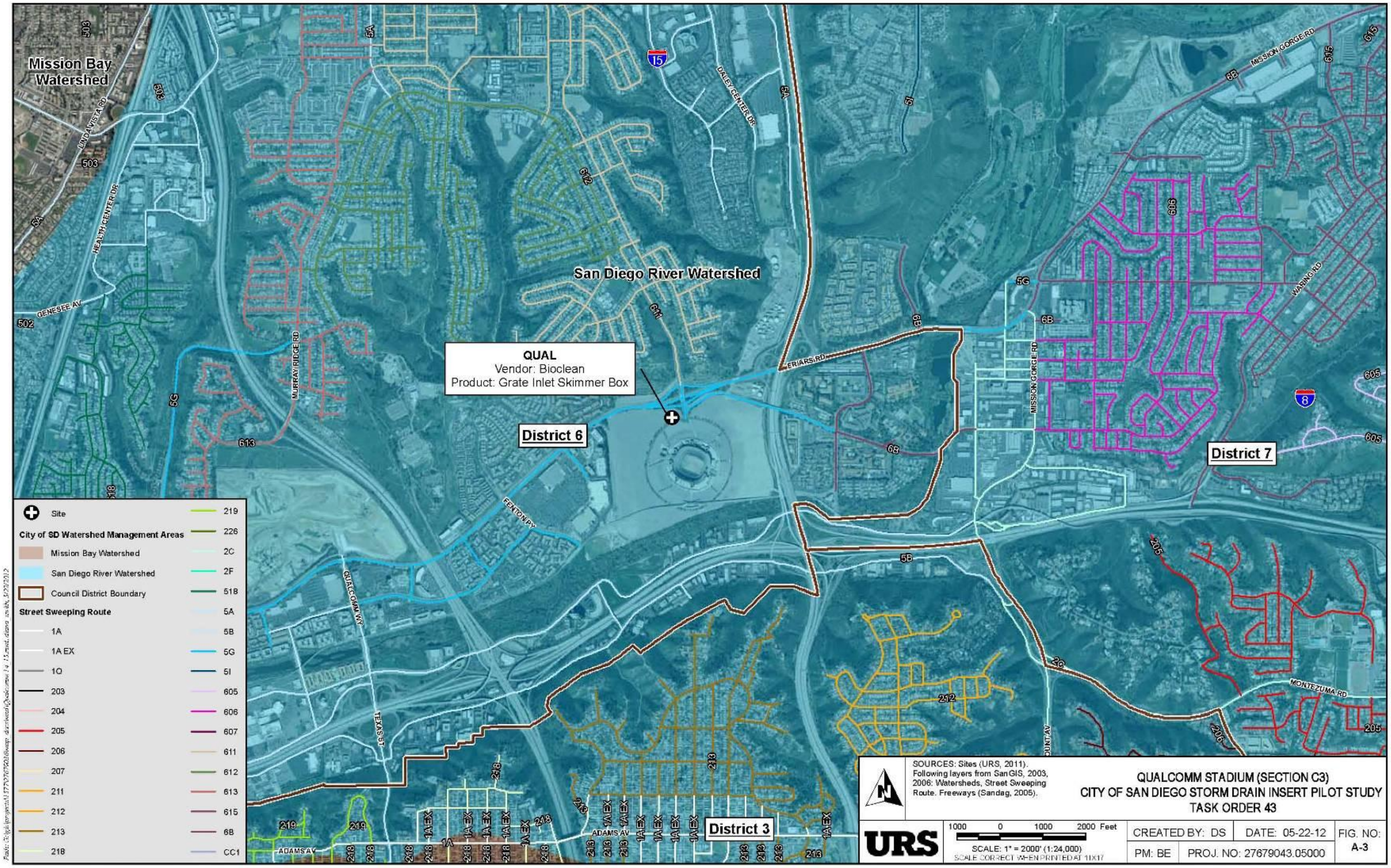
Mission Bay Watershed
San Diego River Watershed
QUAL
Vendor: Bioclean
Product: Grate Inlet Skimmer Box
District 6
District 7
District 3
Site
City of SD Watershed Management Areas
Mission Bay Watershed
San Diego River Watershed
Council District Boundary
Street Sweeping Route
1A
1A EX
1O
203
204
205
206
207
211
212
213
218
219
226
2C
2F
51B
5A
5B
5G
5I
605
606
607
611
612
613
615
6B
CC1
SOURCES: Sites (URS, 2011). Following layers from SanGIS, 2003, 2006: Watersheds, Street Sweeping Route. Freeways (Sandag, 2005).
QUALCOMM STADIUM (SECTION C3)
CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY
TASK ORDER 43
URS
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FIG. NO: A-3
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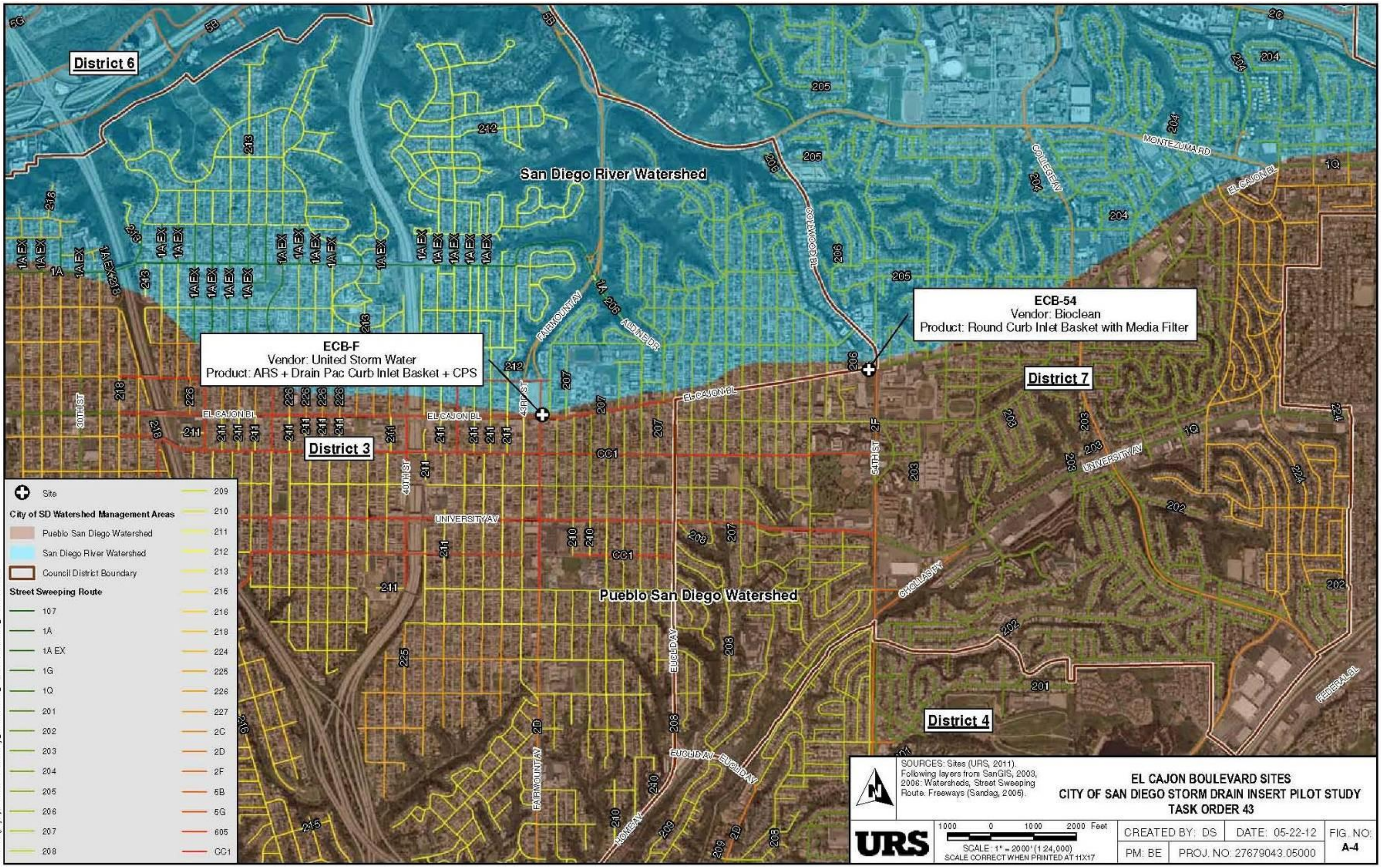
PROJ. NO: 27679043.05000


District 6
San Diego River Watershed
ECB-54
Vendor: Bioclean
Product: Round Curb Inlet Basket with Media Filter
ECB-F
Vendor: United Storm Water
Product: ARS + Drain Pac Curb Inlet Basket + CPS
District 7
District 3
Pueblo San Diego Watershed
District 4
EL CAJON BL
UNIVERSITY AV
MONTEZUMA RD
COLLEGE AV
FAIRMOUNT AV
EUCLID AV
54TH ST
40TH ST
30TH ST
CHOLLAS PY
FEDERAL BL
Site
City of SD Watershed Management Areas
Pueblo San Diego Watershed
San Diego River Watershed
Council District Boundary
Street Sweeping Route
107
1A
1A EX
1G
1Q
201
202
203
204
205
206
207
208
209
210
211
212
213
215
216
218
224
225
226
227
2C
2D
2F
5B
5G
605
CC1
SOURCES: Sites (URS, 2011). Following layers from SanGIS, 2003, 2006: Watersheds, Street Sweeping Route. Freeways (Sandag, 2005).
EL CAJON BOULEVARD SITES
CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY
TASK ORDER 43
URS
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A-4
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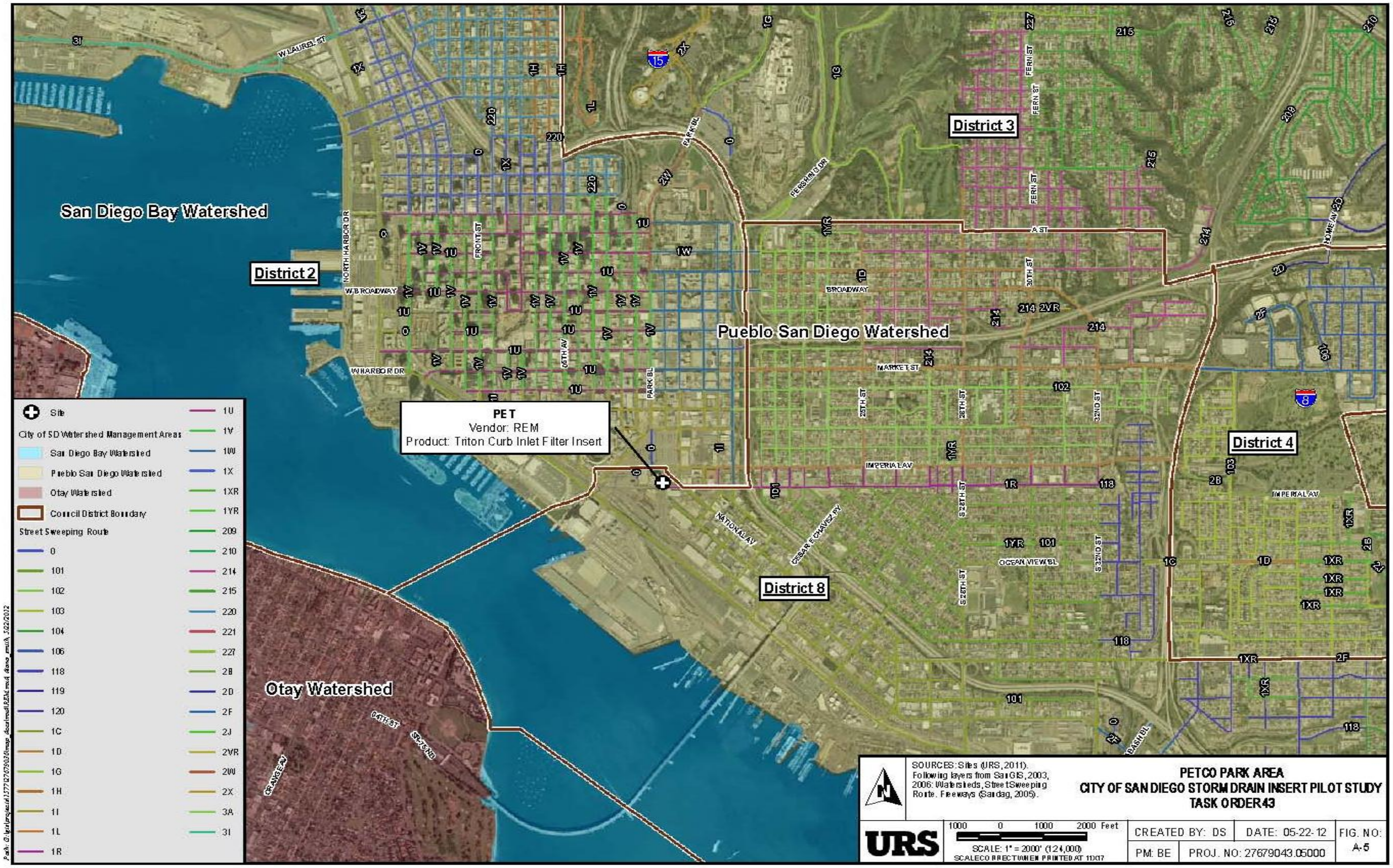
San Diego Bay Watershed
Pueblo San Diego Watershed
Otay Watershed
District 2
District 3
District 4
District 8
PET
Vendor: REM
Product: Triton Curb Inlet Filter Insert
Site
City of SD Watershed Management Areas
San Diego Bay Watershed
Pueblo San Diego Watershed
Otay Watershed
Council District Boundary
Street Sweeping Route
0
101
102
103
104
106
118
119
120
1C
1D
1G
1H
1I
1L
1R
1U
1V
1W
1X
1XR
1YR
209
210
214
215
220
221
227
2B
2D
2F
2J
2VR
2W
2X
3A
3I
SOURCES: Sites (URS, 2011). Following layers from SanGIS, 2003, 2006: Watersheds, Street Sweeping Route. Freeways (Sandag, 2005).
PETCO PARK AREA
CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY
TASK ORDER 43
URS
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FIG. NO: A-5
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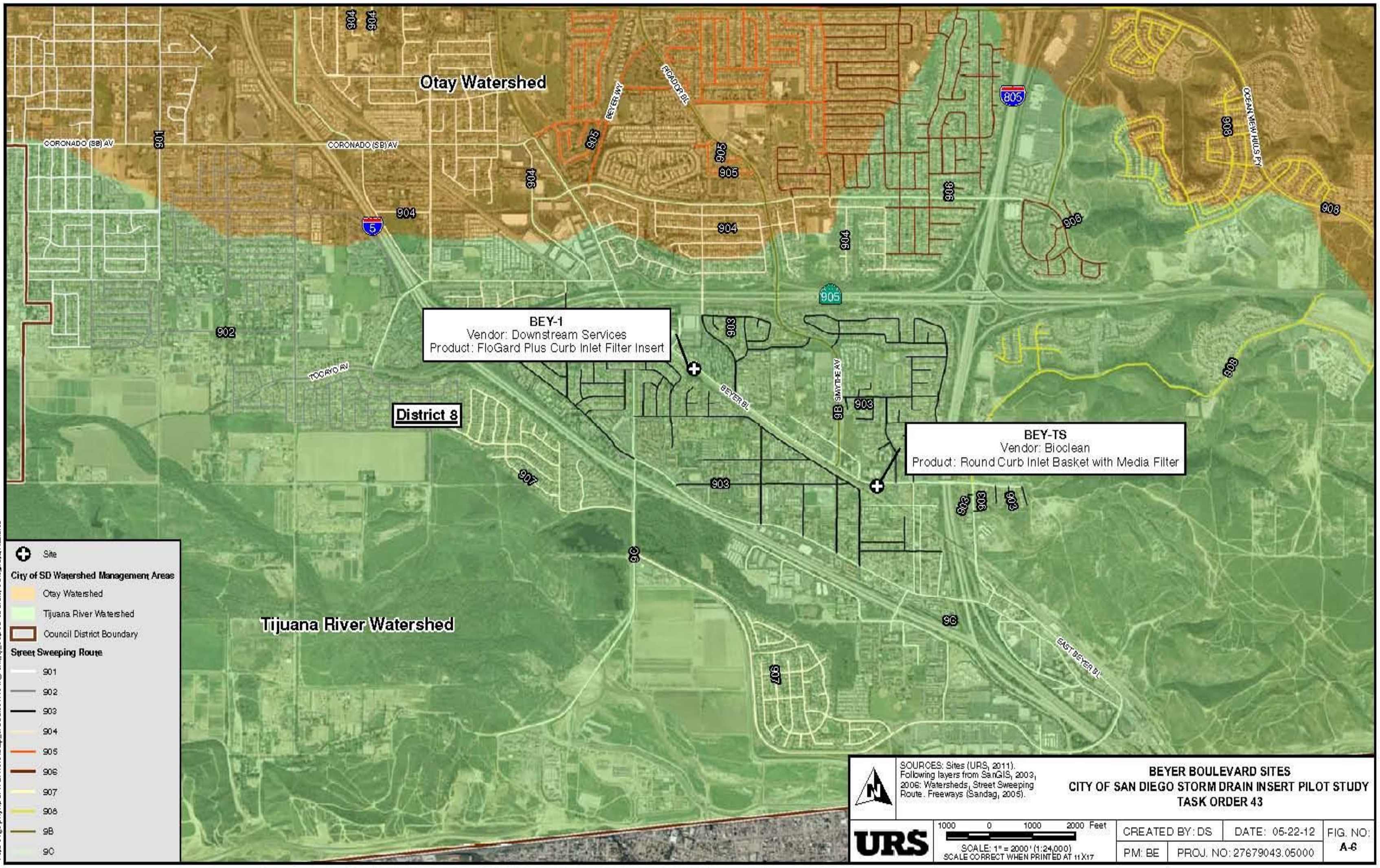
PROJ. NO: 27679043.05000


Otay Watershed
Tijuana River Watershed
District 8
CORONADO (SB) AV
TOCAYO AV
BEYER WY
PICADOR BL
BEYER BL
SMYTHE AV
EAST BEYER BL
OCEAN VIEW HILLS PY
BEY-1
Vendor: Downstream Services
Product: FloGard Plus Curb Inlet Filter Insert
BEY-TS
Vendor: Bioclean
Product: Round Curb Inlet Basket with Media Filter
Site
City of SD Watershed Management Areas
Otay Watershed
Tijuana River Watershed
Council District Boundary
Street Sweeping Route
901
902
903
904
905
906
907
908
9B
9C
SOURCES: Sites (URS, 2011). Following layers from SanGIS, 2003, 2006: Watersheds, Street Sweeping Route. Freeways (Sandag, 2005).
BEYER BOULEVARD SITES
CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY
TASK ORDER 43
URS
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SCALE CORRECT WHEN PRINTED AT 11X17
CREATED BY: DS
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PM: BE
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FIG. NO: A-6

Appendix B BMP Installation Photos and Documentation

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ADD BMP Installation Photos and Documentation

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Appendix C Field Forms

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ADD Completed Field Forms

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INSPECTION FORMS

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CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY
BMP INSPECTION CHECKLIST FOR DRAIN INLET INSERTS

GENERAL INFORMATION:		
Date:	Time In:	Time Out:
Team Leader's Name:	Stormwater Consultant:	
Other Team Member(s):	GPS Coordinates:	
Site ID:	Location:	
Type of Inspection:	☐ POST-STORM	☐ DRY WEATHER

METEOROLOGICAL CHARACTERISTICS:

Present rainfall: ☐ None ☐ Mist ☐ Drizzle ☐ Sprinkle ☐ Light, Steady ☐ Moderate ☐ Heavy

Time last rain event ended, if known: ________________________

Wind speed: ☐ 0-5 mph (light) ☐ 5-10 mph (moderate) ☐ 10-15 mph (brisk) ☐ >15 mph (strong)

Cloud cover: _____ % Temperature: _____

Meteorological characteristics comments:

VEGETATION:		Maintenance Reqd?
Are any weeds impeding the Drain Inlet Insert (DII)?	☐ yes ☐ no	☐ yes ☐ no
Comments:		

STRUCTURAL: *(See ARS and/or CPS Sections if Applicable)*		Maintenance Reqd?
Are inlet grates are in good condition?	☐ not applicable ☐ yes ☐ no	☐ yes ☐ no
Is there evidence of structural deterioration of existing infrastructure (curb & gutter, catch basin, etc.)? If yes, describe:	☐ yes ☐ no	☐ yes ☐ no
Is there evidence of structural deterioration of DII?	☐ yes ☐ no	☐ yes ☐ no
Comments:		

ANIMAL CONCERNS/VECTORS:		Maintenance Reqd?
Is there evidence of small animals (burrows, droppings, trails, gnawing marks, or stained rub marks)?	☐ yes ☐ no	☐ yes ☐ no
Presence of mosquitos or other vectors?	☐ yes ☐ no	☐ yes ☐ no
Comments:		

CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY
BMP INSPECTION CHECKLIST FOR DRAIN INLET INSERTS

SEDIMENT AND FILTER MATERIAL:	Maintenance Reqd?
Is there standing water inside DII? *(if yes, indicate depth: __________)* ☐ yes ☐ no	☐ yes ☐ no
Oil, oily water, or other liquid in the DII or catch basin? ☐ yes ☐ no Amount, type and location:	☐ yes ☐ no
Flow? *(if yes, rate: ____________________)* ☐ yes ☐ no	☐ yes ☐ no
Are there rips or tears of the insert material? ☐ yes ☐ no Explain:	☐ yes ☐ no
Trash or debris? ☐ yes ☐ no Indicate type:	☐ yes ☐ no
Is there sediment inside DII? ☐ yes ☐ no Does sediment appear to clog the unit or interfere with proper functioning of insert? ☐ Not Applicable ☐ yes ☐ no Sediment depth (estimated): _______________(cm)	☐ yes ☐ no
What is the color of the adsorbent boom and/or media? *(if present)* ☐ not applicable ☐ white ☐ light gray ☐ dark gray ☐ black ☐ other: ______________ Type:	☐ yes ☐ no
Are any adsorbent granules able to escape into the DII or catch basin? ☐ not applicable ☐ yes ☐ no	☐ yes ☐ no
Comments:	

Automatic Retractable Screen (ARS) OBSERVATIONS: ☐ **Not Applicable**	Maintenance Reqd?
Position of screen? ☐ open ☐ closed Is screen in good condition? ☐ yes ☐ no Is actuator in good condition? ☐ yes ☐ no Is linkage in good condition? ☐ yes ☐ no	☐ yes ☐ no
Comments:	
Trash/debris accumulation in front of screen? ☐ yes ☐ no	☐ yes ☐ no
Trash/debris trapped under screen? ☐ yes ☐ no	☐ yes ☐ no
Trash/debris accumulation around linkage, actuator or support brackets? ☐ yes ☐ no	☐ yes ☐ no
Other Comments:	

CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY
BMP INSPECTION CHECKLIST FOR DRAIN INLET INSERTS

			Maintenance Reqd?
Connector Pipe Screen (CPS) OBSERVATIONS: ☐ **Not Applicable**			Maintenance Reqd?
Is CPS structurally intact? Is CPS screening material in good condition?	☐ yes ☐ yes	☐ no ☐ no	☐ yes ☐ no
Are there gaps between the CPS and the walls of the catch basin?	☐ yes	☐ no	☐ yes ☐ no
Is there evidence of bypass of CPS (presence of gross solids in catch basin outlet pipe)?	☐ yes	☐ no	☐ yes ☐ no
Trash/debris accumulation around CPS? Evidence of clogging of CPS material?	☐ yes ☐ yes	☐ no ☐ no	☐ yes ☐ no
Comments:			
GENERAL DRAIN INLET INSERT OBSERVATIONS:			Maintenance Reqd?
Are there gaps between the drain inlet insert and the drain inlet?	☐ yes	☐ no	☐ yes ☐ no
Does trash or debris clog the insert or inlet?	☐ yes	☐ no	☐ yes ☐ no
Is there evidence of bypass of DII (presence of gross solids in catch basin)? Type *(trash/sediment/organics)*:	☐ yes	☐ no	☐ yes ☐ no
Evidence of resuspension of trapped material?	☐ yes	☐ no	☐ yes ☐ no
Any unusual or unpleasant odors emanating from inserts? Explain:	☐ yes	☐ no	☐ yes ☐ no
Comments:			

TRASH AND DEBRIS:

Estimated Volume of Gross Solids:

Estimated depth of gross solids in insert: ______________ **in**

Estimated percent of insert capacity: ______________ **%**

Insert length _______ **in** and width _______ **in** **OR** if round, diameter: _______ **in**

Estimated Percent Volume Composition of Gross Solids:

Trash: ______________ **%**

Organic Debris (leaf litter or vegetative material): _________**%**

Sediment _______________**%**

Comments:

CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY
BMP INSPECTION CHECKLIST FOR DRAIN INLET INSERTS

AESTHETIC CONCERNS:		Maintenance Reqd?
Debris (non-trash)? Type, amount and location:	☐ yes ☐ no	☐ yes ☐ no
Trash? Type, amount and location:	☐ yes ☐ no	☐ yes ☐ no
Graffiti or vandalism? Description and location:	☐ yes ☐ no	☐ yes ☐ no
Theft? Description and location:	☐ yes ☐ no	☐ yes ☐ no
Other aesthetic concerns/comments:		

NON-STORMWATER CONCERNS:

Non-storm water discharge to BMP	☐ yes ☐ no
BMP wet from obvious non-stormwater discharge (no rain)	☐ yes ☐ no
If yes, contact City of San Diego Think Blue Hotline at 619-235-1000	

PHOTOGRAPHS (mandatory):

Time	Description	Direction Facing	Photograph No.

OVERALL:

Other concerns affecting operation:

Date for maintenance to be completed:

MAINTENANCE OBSERVATION FORM

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CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY
BMP MAINTENANCE OBSERVATIONS FOR DRAIN INLET INSERTS

MAINTENANCE OBSERVATIONS:

Date:	Maintenance Start Time:	Maintenance End Time:

Team Leader's Name:	Contractor/Vendor:

Vendor Representative Name(s):

Vendor Representative Contact Info (Phone/Email):

Other Team Member(s):	GPS Coordinates:
Site ID:	Location:

Type of Product:

Product Name:

Number of Vendor Personnel Performing Maintenance:

Tools Used:

Is a power source required? ☐ yes ☐ no

WEATHER IMPACTS:

Is there potential for weather to impact normal maintenance procedures? ☐ yes ☐ no	Is there a potential safety issue? ☐ yes (see Safe Work Plan) ☐ no

How or Other Comments:

TRAFFIC CONTROL:

Is some form of traffic control utilized? ☐ yes ☐ no	Is there a potential safety issue? ☐ yes (see Safe Work Plan) ☐ no

What type or Other Comments:

CONFINED SPACE:

Is some form of confined space entry utilized? ☐ yes ☐ no	Is there a potential safety issue? ☐ yes (see Safe Work Plan) ☐ no

What type/equipment or Other Comments:

INFRASTRUCTURE OR PRODUCT MODIFICATIONS:

Is any modification to the existing infrastructure or product required during maintenance? ☐ yes ☐ no	Is there a potential safety issue? ☐ yes (see Safe Work Plan) ☐ no

Describe modification or Other Comments:

GENERAL PROBLEMS:

Were any problems encountered during maintenance? ☐ yes ☐ no	Is there a potential safety issue? ☐ yes (see Safe Work Plan) ☐ no

Describe or General Comments:

CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY
BMP MAINTENANCE OBSERVATIONS FOR DRAIN INLET INSERTS

MAINTENANCE PREPARATION:

Order	Approx. Duration	Description	Photo No.
1.			

Additional Comments:

MAINTENANCE STEPS:

Order	Approx. Duration	Description	Photo No.
1.			

Additional Comments:

CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY
BMP MAINTENANCE OBSERVATIONS FOR DRAIN INLET INSERTS

MAINTENANCE OF INSERTS:

☐ ***Replacement of insert***
Start time: End time: Total time: More work required? ☐ yes ☐ no
Equipment used:
Comments:

☐ ***Proper storage/disposal of used insert***
Start time: End time: Total time: More work required? ☐☐ yes ☐ no
Equipment used:
Comments:

☐ ***Replacement of used absorbent media/filters/booms***
Start time: End time: Total time: More work required? ☐ ☐ yes ☐ no
Equipment used:
Comments:

☐ ***Proper storage/disposal of used absorbent media/filters/booms***
Start time: End time: Total time: More work required? ☐☐ yes ☐ no
Equipment used:
Comments:

☐ ***Removal of trash, sediment, & debris***
Start time: End time: Total time: More work required? ☐ ☐ yes ☐ no
Equipment used:
Comments:

☐ ***Proper storage/disposal of trash, sediment, & debris***
Start time: End time: Total time: More work required? ☐ yes ☐ no
Equipment used:
Comments:

☐ ***Cleaning of trough and screens***
Start time: End time: Total time: More work required? ☐☐ yes ☐ no
Equipment used:
Comments:

CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY
BMP MAINTENANCE OBSERVATIONS FOR DRAIN INLET INSERTS

MAINTENANCE OF INSERTS (cont'd):

☐ ***Automatic Retractable Screen (ARS)***
Start time: End time: Total time: More work required? ☐ ☐ yes ☐ no
Equipment used:
Comments:

☐ ***Connector Pipe Screen (CPS)***
Start time: End time: Total time: More work required? ☐☐ yes ☐ no
Equipment used:
Comments:

☐ ***Other (describe):***
Start time: End time: Total time: More work required? ☐ ☐ yes ☐ no
Equipment used:
Comments:

GENERAL MAINTENANCE:

☐ ***Debris and trash removal***
Start time: End time: Total time: More work required? ☐☐ yes ☐ no
Equipment used:
Comments:

☐ ***Weed control***
Start time: End time: Total time: More work required? ☐ yes ☐ no
Equipment used:
Comments:

☐ ***Structural repairs (describe):***
Start time: End time: Total time: More work required? ☐☐ yes ☐ no
Equipment used:
Comments:

☐ ***Vector control (describe):***
Start time: End time: Total time: More work required? ☐ yes ☐ no
Equipment used:
Comments:

CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY
BMP MAINTENANCE OBSERVATIONS FOR DRAIN INLET INSERTS

GENERAL MAINTENANCE (cont'd):

☐ ***Graffiti removal or replacement of vandalized or stolen equipment***

Start time: End time: Total time: More work required? ☐ ☐ yes ☐ no

Equipment used:

Comments:

GROSS SOLIDS VOLUME & WEIGHT:

Total Weight: ________ **lbs** Sediment Weight: ________ **lbs**

Composition: Trash ________ **%** Sediment ________ **%** Organics ________ **%**

Estimated Volume of Gross Solids:

Measured container diameter (D) at surface of gross solids: ____________ **ft**

Measured height of container freeboard (= Ht from top of container to surface of gross solids): ______ **ft**

ADDITIONAL ACTIVITES & PHOTOGRAPHS:

Order	Approx. Duration	Description	Photo No.
1.			

Additional Comments:

____
(Team Leader's Signature)

General Comments:

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MAINTENANCE OBSERVATION FORM
DETAILED TRASH CHARACTERIZATION

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CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY
BMP MAINTENANCE OBSERVATIONS FOR DRAIN INLET INSERTS
DETAILED TRASH CHARACTERIZATION

MAINTENANCE OBSERVATIONS:

Date:	Maintenance Start Time:	Maintenance End Time:
Team Leader's Name:	Contractor/Vendor:	
Vendor Representative Name(s):		
Vendor Representative Contact Info (Phone/Email):		
Other Team Member(s):	GPS Coordinates:	
Site ID:	Location:	
Type of Product:		
Product Name:		
Number of Vendor Personnel Performing Maintenance:		
Tools Used: Is a power source required? ☐ yes ☐ no		

WEATHER IMPACTS:

Is there potential for weather to impact normal maintenance procedures? ☐ yes ☐ no	Is there a potential safety issue? ☐ yes (see Safe Work Plan) ☐ no
How or Other Comments:	

TRAFFIC CONTROL:

Is some form of traffic control utilized? ☐ yes ☐ no	Is there a potential safety issue? ☐ yes (see Safe Work Plan) ☐ no
What type or Other Comments:	

CONFINED SPACE:

Is some form of confined space entry utilized? ☐ yes ☐ no	Is there a potential safety issue? ☐ yes (see Safe Work Plan) ☐ no
What type/equipment or Other Comments:	

INFRASTRUCTURE OR PRODUCT MODIFICATIONS:

Is any modification to the existing infrastructure or product required during maintenance? ☐ yes ☐ no	Is there a potential safety issue? ☐ yes (see Safe Work Plan) ☐ no
Describe modification or Other Comments:	

GENERAL PROBLEMS:

Were any problems encountered during maintenance? ☐ yes ☐ no	Is there a potential safety issue? ☐ yes (see Safe Work Plan) ☐ no
Describe or General Comments:	

CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY
BMP MAINTENANCE OBSERVATIONS FOR DRAIN INLET INSERTS
DETAILED TRASH CHARACTERIZATION

MAINTENANCE PREPARATION:

Order	Approx. Duration	Description	Photo No.
1.			

Additional Comments:

MAINTENANCE STEPS:

Order	Approx. Duration	Description	Photo No.
1.			

Additional Comments:

CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY
BMP MAINTENANCE OBSERVATIONS FOR DRAIN INLET INSERTS
DETAILED TRASH CHARACTERIZATION

MAINTENANCE OF INSERTS:

☐ ***Replacement of insert***
Start time: End time: Total time: More work required? ☐ yes ☐ no
Equipment used:
Comments:

☐ ***Proper storage/disposal of used insert***
Start time: End time: Total time: More work required? ☐☐ yes ☐ no
Equipment used:
Comments:

☐ ***Replacement of used absorbent media/filters/booms***
Start time: End time: Total time: More work required? ☐ ☐ yes ☐ no
Equipment used:
Comments:

☐ ***Proper storage/disposal of used absorbent media/filters/booms***
Start time: End time: Total time: More work required? ☐☐ yes ☐ no
Equipment used:
Comments:

☐ ***Removal of trash, sediment, & debris***
Start time: End time: Total time: More work required? ☐ ☐ yes ☐ no
Equipment used:
Comments:

☐ ***Proper storage/disposal of trash, sediment, & debris***
Start time: End time: Total time: More work required? ☐ yes ☐ no
Equipment used:
Comments:

☐ ***Cleaning of trough and screens***
Start time: End time: Total time: More work required? ☐☐ yes ☐ no
Equipment used:
Comments:

CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY
BMP MAINTENANCE OBSERVATIONS FOR DRAIN INLET INSERTS
DETAILED TRASH CHARACTERIZATION

MAINTENANCE OF INSERTS (cont'd):

☐ ***Automatic Retractable Screen (ARS)***

Start time: End time: Total time: More work required? ☐ ☐ yes ☐ no
Equipment used:
Comments:

☐ ***Connector Pipe Screen (CPS)***

Start time: End time: Total time: More work required? ☐☐ yes ☐ no
Equipment used:
Comments:

☐ ***Other (describe):***

Start time: End time: Total time: More work required? ☐ ☐ yes ☐ no
Equipment used:
Comments:

GENERAL MAINTENANCE:

☐ ***Debris and trash removal***

Start time: End time: Total time: More work required? ☐☐ yes ☐ no
Equipment used:
Comments:

☐ ***Weed control***

Start time: End time: Total time: More work required? ☐ yes ☐ no
Equipment used:
Comments:

☐ ***Structural repairs (describe):***

Start time: End time: Total time: More work required? ☐☐ yes ☐ no
Equipment used:
Comments:

☐ ***Vector control (describe):***

Start time: End time: Total time: More work required? ☐ yes ☐ no
Equipment used:
Comments:

CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY
BMP MAINTENANCE OBSERVATIONS FOR DRAIN INLET INSERTS
DETAILED TRASH CHARACTERIZATION

GENERAL MAINTENANCE (cont'd):

☐ ***Graffiti removal or replacement of vandalized or stolen equipment***

Start time: End time: Total time: More work required? ☐ ☐ yes ☐ no

Equipment used:

Comments:

TRASH CONDITION CATEGORY:

Trash Assessment Parameter	Optimal	Sub-optimal	Marginal	Poor	Very Poor
Overall Level of Trash	No trash visible. Close inspection of BMP reveals little or no trash (<10 pieces).	Little trash visible. Close inspection of BMP reveals small quantity of trash (10-50 pieces).	Trash is evident at low to medium levels. Close inspection of BMP reveals significant quantity of trash (51- 100 pieces).	Close inspection of BMP reveals substantial quantity of trash (101-400 pieces).	Close inspection of BMP reveals excessive quantity of trash (>400 pieces).
SCORE	**1**	**2**	**3**	**4**	**5**
Threat to Aquatic Life	Trash, if any, is mostly paper or wood products or other biodegradable materials.	Little or no (<10 pieces) persistent, buoyant litter such as: hard or soft plastics, Styrofoam, balloons, cigarette butts. Presence of settleable, degradable, and nontoxic debris such as glass or metal.	Medium prevalence (10-50 pieces) of persistent, buoyant litter such as: hard or soft plastics, Styrofoam, balloons, cigarette butts. Medium prevalence (10-50 pieces) of settleable debris such as glass or metal.	Large amount (51-100 pieces) of persistent, buoyant litter such as: hard or soft plastics, balloons, Styrofoam, cigarette butts; toxic items such as batteries, lighters, or spray cans; or large amount (51-100 pieces) of settleable debris such as glass or metal.	Excessive amount (>100 pieces) of persistent, buoyant litter such as: hard or soft plastics, balloons, Styrofoam, cigarette butts; toxic items such as batteries, lighters, or spray cans; or excessive amount (>100 pieces) of settleable debris such as glass or metal.
SCORE	**1**	**2**	**3**	**4**	**5**
Threat to Human Life	No evidence of bacteria or virus hazards such as medical waste, diapers, animal or human waste. No toxic substances such as chemical containers or batteries. No ponded water for mosquito production. No evidence of puncture and laceration hazards such as broken glass or metal debris.	No bacteria or virus hazards or sources of toxic substances, but small presence (<10 pieces) of puncture and laceration hazards such as broken glass and metal debris. Presence of ponded water in trash items such as tires or containers for mosquito production, but no presence of mosquitoes.	Presence of **any one** of the following: mosquitoes, hypodermic needles or other medical waste; used diaper, animal waste, or human feces; any toxic substance such as chemical containers, batteries, or fluorescent light bulbs. Medium prevalence (10-50 pieces) of puncture or laceration hazards.	Presence of **two of** the items described in the marginal condition category. High prevalence (51-100 pieces) of puncture or laceration hazards.	Presence of **more than two of** the items described in the marginal condition category. Extremely high prevalence (>100 pieces) of puncture or laceration hazards.
SCORE	**1**	**2**	**3**	**4**	**5**
Littering	Tossed/dropped litter is incidental (< 5 pieces).	Evidence of some tossed/dropped litter (5-10 pieces).	Tossed/dropped litter is prevalent (10-50 pieces).	Large amount of tossed/dropped litter (51-100 pieces).	Excessive amount of tossed/dropped litter (>100 pieces).
SCORE	**1**	**2**	**3**	**4**	**5**
ADD TOTAL OF EACH COLUMN					

TOTAL OVERALL SCORE:	________				
OVERALL CONDITION (CIRCLE)	**Optimal** 4	**Sub-optimal** 5-8	**Marginal** 9-12	**Poor** 13-16	**Very Poor** 17-20

CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY
BMP MAINTENANCE OBSERVATIONS FOR DRAIN INLET INSERTS
DETAILED TRASH CHARACTERIZATION

DETAILED TRASH CHARACTERIZATION:

		Potential Source of Trash					Potential Method of Disposal		
Trash Category	% of Total Trash Volume (To Nearest 5 %)	General Public	Business Related (specify)	School	Homeless/ Transient	Other	Littering	Dumping	Other
Cigarette Butts		☐	☐	☐	☐	☐	☐	☐	☐
Plastic Groc. Bags		☐	☐	☐	☐	☐	☐	☐	☐
Food Packaging		☐	☐	☐	☐	☐	☐	☐	☐
Biohazard		☐	☐	☐	☐	☐	☐	☐	☐
Automotive		☐	☐	☐	☐	☐	☐	☐	☐
Construction		☐	☐	☐	☐	☐	☐	☐	☐
Fabrics/Clothing		☐	☐	☐	☐	☐	☐	☐	☐
Other Household		☐	☐	☐	☐	☐	☐	☐	☐
Other (specify)		☐	☐	☐	☐	☐	☐	☐	☐
TOTAL	**100%**								

Comments:

GROSS SOLIDS VOLUME & WEIGHT:

Total Weight: ________ **lbs** Sediment Weight: ________ **lbs**

Composition: Trash ________ **%** Sediment ________ **%** Organics ________ **%**

Estimated Volume of Gross Solids:

Measured container diameter (D) at surface of gross solids: _____________ **ft**

Measured height of container freeboard (= Ht from top of container to surface of gross solids): ______ **ft**

ADDITIONAL ACTIVITES & PHOTOGRAPHS:

Order	**Approx. Duration**	**Description**	**Photo No.**
1.			

Additional Comments:

______________________________ (Team Leader's Signature)	General Comments:

STORM EVENT PERFORMANCE MONITORING FORM

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CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY STORM EVENT PERFORMANCE MONITORING – FORM "A"			
GENERAL INFORMATION:			
Date:	Time In:	Time Out:	
Team Leader's Name:	Site ID:		
Other Team Member(s):	Location:		
METEOROLOGICAL CHARACTERISTICS:			
Present rainfall:	☐ None ☐ Mist ☐ Drizzle ☐ Sprinkle ☐ Light, steady ☐ Moderate ☐ Heavy		
Distribution of rainfall:	☐ Uniform ☐ Localized Cells ☐ Scattered Showers		
Wind speed:	☐ 0-5 mph (light) ☐ 5-10 mph (moderate) ☐ 10-15 mph (brisk) ☐ >15 mph (heavy)		
Cloud cover (%):	Comments:		
INITIAL ASSESSMENT:			
CURB AND GUTTER			
Street flooding?	☐ No	☐ Yes	Approximate depth: Comments:
Sediment?	☐ No	☐ Yes	Approximate depth: Comments:
Trash or debris?	☐ No	☐ Yes	Type & volume: Comments:
Flow Length: Left Side* of Inlet = _________ ft Right Side* of Inlet = _______ ft *See Diagram on Checklist			
DRAIN INLET INSERT (DII) or "BASKET"			
Flow into curb inlet?	☐ No	☐ Yes	Approximate depth:
Standing water?	☐ No	☐ Yes	Approximate depth:
Basket overflowing?	☐ No	☐ Yes	Describe:
Odor(s)?	☐ No	☐ Yes	Describe:
Sediment?	☐ No	☐ Yes	Approximate depth:
Trash or debris?	☐ No	☐ Yes	% Full: % Trash: % Organic: % Sediment:
Inlet Clogged? Did you clear clog?	☐ No ☐ N/A	☐ Yes ☐ Yes	Describe: ☐ No (could not manually unclog insert)
Tears in DII material?	☐ No	☐ Yes	Describe:
Structural or other concerns?	☐ No	☐ Yes	Describe:
AUTOMATIC RETRACTABLE SCREEN (ARS)- [SITE ECB-F Only] ☐ N/A – No ARS at this location			
Sediment in front?	☐ No	☐ Yes	Approximate depth:
Trash or debris?	☐ No	☐ Yes	Type & volume:
Is ARS in OPEN or CLOSED position?	☐ Open	☐ Open due to flow into inlet ☐ Stuck open due to clogging or mechanical failure (cannot unclog/repair)	
	☐ Closed	☐ Closed due to absence of flow into inlet ☐ Stuck closed due to clogging or mechanical failure (cannot unclog/repair)	
Structural or other concerns?	☐ No	☐ Yes	Describe:
CATCH BASIN			
Standing water?	☐ No	☐ Yes	Approximate depth: Comments:
Sediment?	☐ No	☐ Yes	Approximate depth: Comments:
Trash or debris?	☐ No	☐ Yes	Type & volume: Comments:
CONNECTOR PIPE SCREEN (CPS = Box) or OUTLET SCREEN (=Flat) (Circle One) *See Diagram on Checklist			
Clogged? Cleared?	☐ No ☐ N/A	☐ Yes ☐ Yes	Describe: ☐ No (could not manually unclog screen)
Bypassing evident?	☐ No	☐ Yes (presence of gross solids in catch basin outlet pipe)	

CITY OF SAN DIEGO STORM DRAIN INSERT PILOT STUDY
STORM EVENT PERFORMANCE MONITORING – FORM "B"

TIME ____ : ____	Team Leader's Name:	Site ID:

WEATHER

Rainfall:	☐ None	☐ Mist	☐ Drizzle	☐ Sprinkle	☐ Light, steady	☐ Moderate	☐ Heavy
Wind:	☐ 0-5 mph (light)		☐ 5-10 mph (moderate)		☐ 10-15 mph (brisk)	☐ >15 mph (heavy)	

Amount of Rainfall (Gauge Reading) : _________ inches

Comments:

CURB-LEFT

FLOW RATE	Time 1	Time 2	Time 3	Width	DIRECTION OF FLOW	PHOTO NO.
	sec	sec	sec	in	☐ Into Inlet ☐ Away from Inlet	

CURB-RIGHT

FLOW RATE	Time 1	Time 2	Time 3	Width	DIRECTION OF FLOW	PHOTO NO.
	sec	sec	sec	in	☐ Into Inlet ☐ Away from Inlet	

Presence of gross solids in gutter ? ☐ No ☐ Yes Describe:

Does presence of gross solids impede flow into curb inlet (i.e., standing water or flooding)? ☐ No ☐ Yes
Describe:

Any sheet flow from street into curb inlet? ☐ No ☐ Yes Describe:

Is ARS open (if present)? ☐ No ☐ Yes

Does ARS appear clogged with gross solids? ☐ No ☐ Yes

Comments:

DII / BASKET

Estimated % Full:	% Trash:	% Organics:	% Sediment:	PHOTO NO.

Is there any overflow/bypass of the DII/Basket ? ☐ No ☐ Yes If Yes, Estimate % of total water flow that bypasses the basket: _________%

Any resuspension/deposition of sediment, trash and/or organic debris from the basket into the catch basin? ☐ No ☐ Yes
Describe:

Other Comments:

CATCH BASIN

Are gross solids bypassing basket and entering catch basin? ☐ No ☐ Yes If Yes, indicate type of gross solids and relative percentage of type in boxes below (if possible).

GROSS SOLIDS	% Trash:	% Organics:	% Sediment:	PHOTO NO.

Is water flowing over the Outlet Screen or bypassing the CPS? ☐ No ☐ Yes

Are gross solids entering the outlet pipe (i.e., bypassing the Outlet Screen or CPS)? ☐ No ☐ Yes

Comments:

VIDEO LOG

VIDEO START TIME:	VIDEO NO.	

Please record approximately 45 to 60 second video to document flow conditions, and performance of DII/Basket/ARS/CPS. The following areas should be recorded:

- Curb and Gutter- (Both Directions)
- Curb Inlet- from street
- Drain Inlet Insert /Basket (holding camera down manhole)
- Catch Basin and Outlet Pipe

Please attempt to use same angles, order of filming and approximate length of time recording during each video segment.

Comments:

Appendix D Dry Weather Inspections- Selected Photos

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EXEMPLARY DRY WEATHER OBSERVATIONS

BER-PL TRITON TRC-7 REM

A. Curb insert basket and storm web from rear

B. Wing insert basket and storm web from above

C. Catch basin floor and connector pipe from above

D. Curb gutter, dry weather flow into inlet

EXEMPLARY DRY WEATHER OBSERVATIONS

BER-TC	DRAINPAC WITH CPS UNITED STORM WATER
	
A. Interior of curb inlet basket from side	B. Interior of wing inlet basket from above
	
C. Catch basin floor from above	D. CPS from inside catch basin

EXEMPLARY DRY WEATHER OBSERVATIONS

BEY-1	KRISTAR FLOGARD PLUS	DOWNSTREAM SERVICES

A. Curb insert basket from street

B. Curb inlet basket from rear, media packet at top right

C. Catch basin floor and connector pipe from inside catch basin

D. Trash and debris on sidewalk behind drain inlet

EXEMPLARY DRY WEATHER OBSERVATIONS

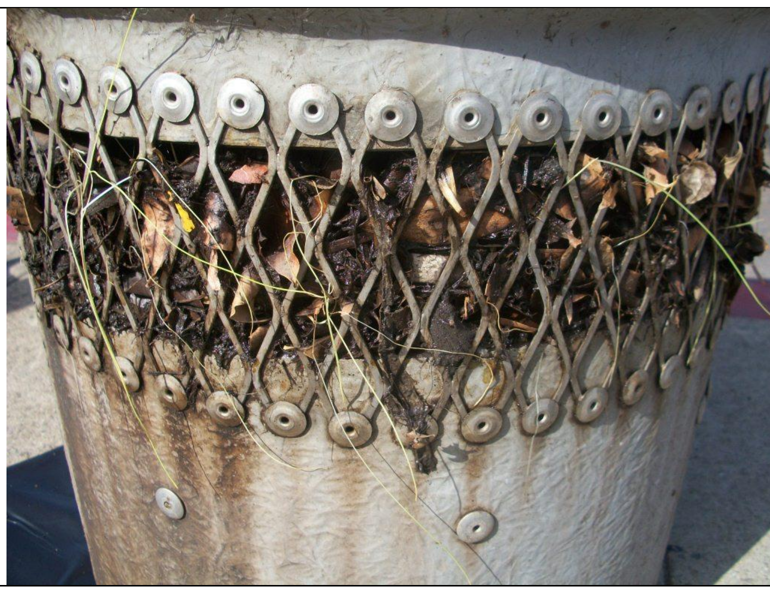
BEY-TS	HIGH CAPACITY ROUND BASKET / BIO CLEAN
	
A. Curb inlet basket and collection tray from above	B. Curb inlet basket overflow mesh from rear
	
C. Curb gutter, eucalyptus bark	D. Catch basin floor from inside catch basin

EXEMPLARY DRY WEATHER OBSERVATIONS

ECB-54 | HIGH CAPACITY ROUND BASKET | BIO CLEAN

A. Curb insert basket and collection tray from street

B. Curb inlet basket and media boom from above



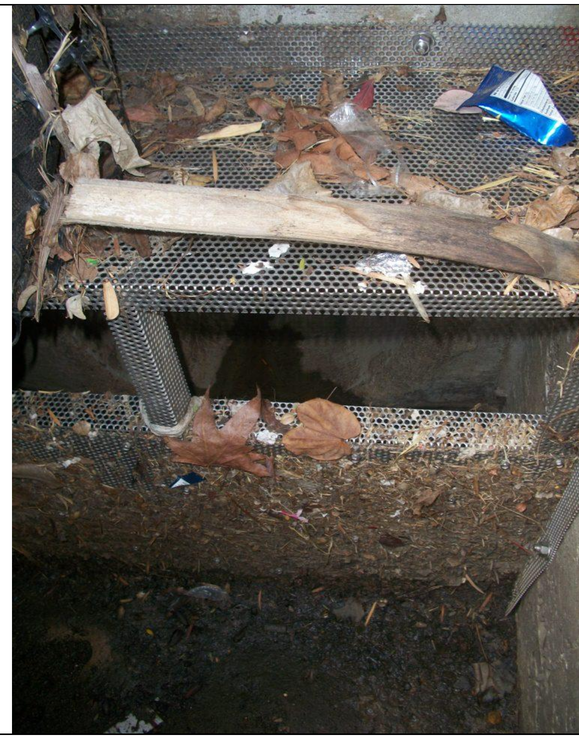
C. Curb inlet basket overflow mesh from rear

D. Catch basin floor from above

EXEMPLARY DRY WEATHER OBSERVATIONS

ECB-F	DRAINPAC WITH ARS & CPS	UNITED STORM WATER

A. Curb inlet basket from above



B. CPS from inside catch basin

C. ARS from street, debris trapped beneath screen

D. Catch basin floor from above

EXEMPLARY DRY WEATHER OBSERVATIONS

PET | TRITON TRC 4.0 | REM

A. Curb insert basket from street

B. Curb inlet basket and storm web from street

C. Curb inlet basket and storm web from rear

D. Catch basin floor from above

EXEMPLARY DRY WEATHER OBSERVATIONS

QUAL	GRATE INLET SKIMMER BOX	BIO CLEAN

A. Grate inlet basket and skimmer insert from above, full

B. Grate inlet basket from above, empty

C. Overflow mesh from inside grate inlet basket

D. Catch basin floor from above, roaches at left

Appendix E Maintenance Observations- Selected Photos

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VENDOR MAINTENANCE PROCEDURES

BER-PL	TRITON TRC-7	REM

A. Park vac truck, close shoulder, open manhole

B. Vacuum gross solids out of DII baskets


C. Pressure wash DII media, vacuum wash water

D. Pressure wash DII baskets, vacuum wash water

E. Vacuum DII wash water from catch basin floor


F. Vacuum loosened solids from DII fabric and media

VENDOR MAINTENANCE PROCEDURES

BER-TC	DRAINPAC WITH CPS	UNITED STORM WATER

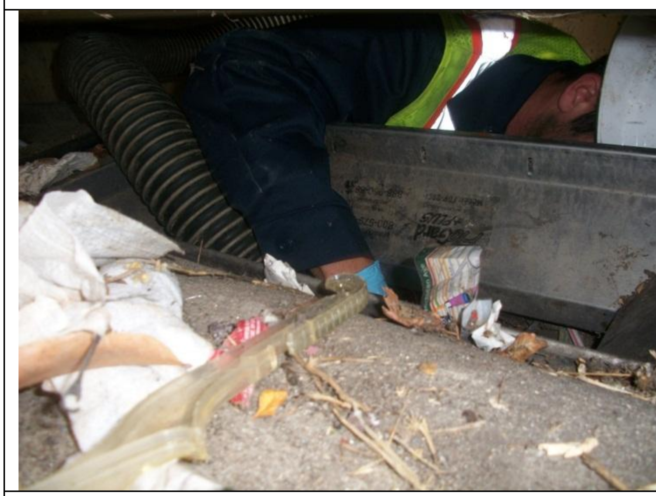
	
A. Park vac truck, close lane, open manhole and stage pedestrian barricade	B. Vacuum gross solids out of DII baskets
	
C. Vacuum gross solids off of CPS and catch basin floor	D. Pressure wash DII baskets, vacuum wash water
	
E. Pressure wash CPS and catch basin floor	F. Vacuum wash water off of catch basin floor

VENDOR MAINTENANCE PROCEDURES

BEY-1 KRISTAR FLOGARD PLUS DOWNSTREAM SERVICES

A. Park vac truck, stage tools, open manhole

B. Manually remove large items, stow in trash bag



C. Vacuum gross solids out of DII baskets

D. Manually agitate settled, compacted solids on fabric

E. Vacuum loosened solids from DII fabric

F. Remove and replace soiled media packets

VENDOR MAINTENANCE PROCEDURES

BEY-TS	HIGH CAPACITY ROUND BASKET	BIO CLEAN

A. Park vac truck, close shoulder, open manhole

B. Push gross solids on collection tray into DII basket

C. Pressure wash collection tray, vacuum gross solids and wash water out of DII basket

D. Remove DII basket from catch basin and pressure wash in gutter, vacuum wash water

E. Remove and replace soiled filter media

F. Remove and replace soiled adsorbent boom

VENDOR MAINTENANCE PROCEDURES

ECB-54	HIGH CAPACITY ROUND BASKET	BIO CLEAN

A. Park vac truck, close shoulder, open manhole

B. Pressure wash collection tray into DII basket


C. Vacuum gross solids and wash water out of DII basket

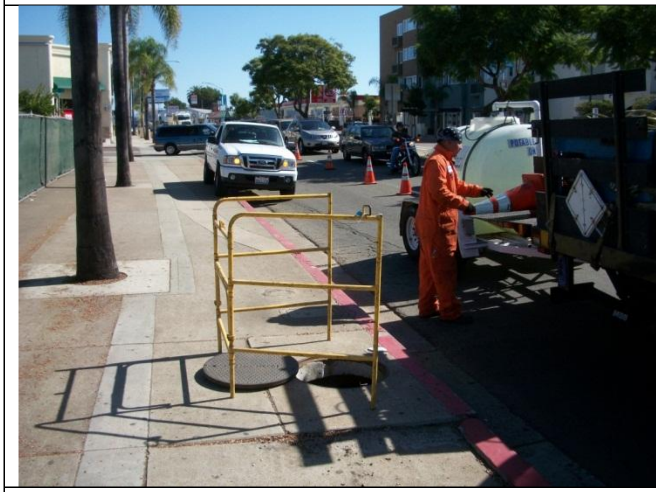

D. Remove DII basket from catch basin, remove soiled filter media


E. Pressure wash DII basket in gutter, vacuum wash water


F. Replace soiled adsorbent boom and filter media, reassemble DII basket

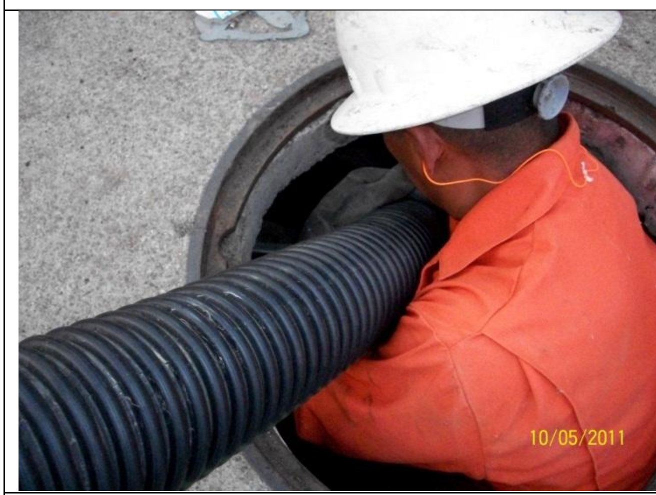
VENDOR MAINTENANCE PROCEDURES

ECB-F	DRAINPAC WITH ARS & CPS	UNITED STORM WATER



A. Park vac truck, close lane, open manhole and stage pedestrian barricade

B. Brush gross solids off of ARS, vacuum ARS and curb gutter



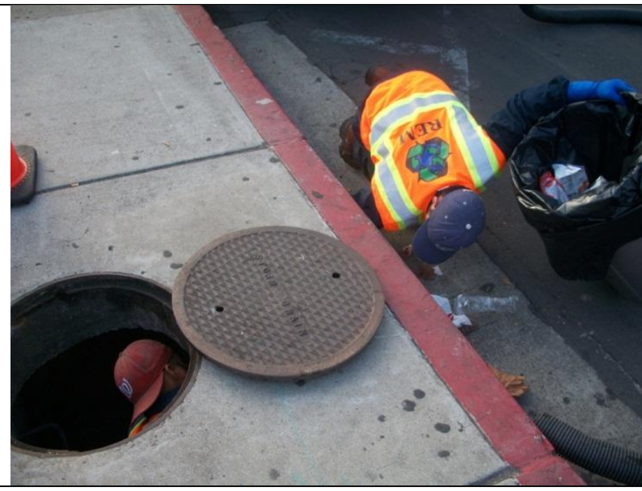
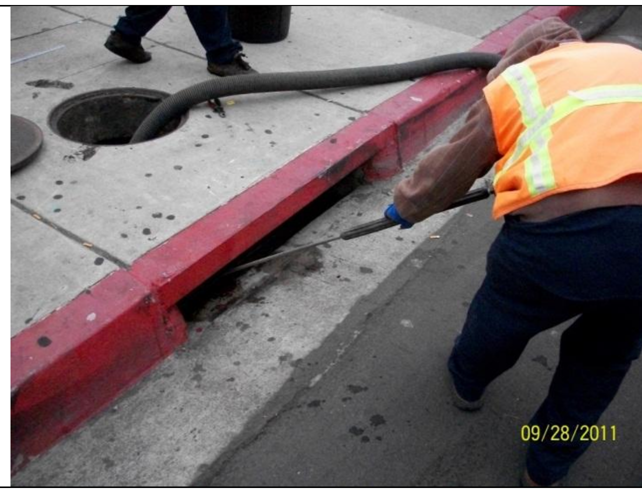
C. Vacuum gross solids out of DII basket, catch basin, and off of CPS

D. Pressure wash ARS and DII basket, vacuum wash water

E. Pressure wash CPS and catch basin floor

F. Vacuum wash water off of catch basin floor

VENDOR MAINTENANCE PROCEDURES

PET	TRITON TRC 4.0 REM
	
A. Park vac truck, close shoulder, open manhole	B. Manually remove large items, stow in trash bag
	
C. Vacuum gross solids out of DII basket	D. Pressure wash DII basket, vacuum wash water
	
E. Vacuum loosened solids from DII fabric and media	F. Vacuum DII wash water from catch basin floor

VENDOR MAINTENANCE PROCEDURES

QUAL	GRATE INLET SKIMMER BOX	BIO CLEAN

A. Remove inlet grate

B. Vacuum gross solids out of skimmer insert

C. Remove skimmer insert, vacuum gross solids out of DII basket

D. Pressure wash DII basket and skimmer insert on ground, vacuum wash water

E. Restore DII basket in catch basin, replace soiled filter media

F. Replace soiled adsorbent boom, restore skimmer insert in DII basket

Appendix F Post-Storm Inspections- Selected Photos

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EXEMPLARY POST STORM OBSERVATIONS

BER-PL TRITON TRC-7 REM

A. Curb inlet basket and storm web from rear

B. Wing inlet basket from above

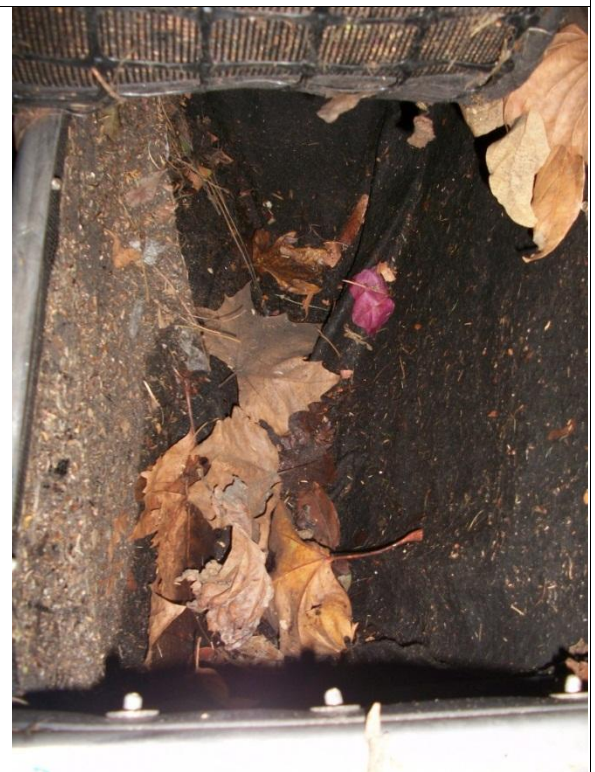
C. Wing inlet basket and storm web from street

D. Catch basin floor and connector pipe from above

EXEMPLARY POST STORM OBSERVATIONS

BER-TC	DRAINPAC WITH CPS	UNITED STORM WATER

A. Curb inlet basket from side



B. Wing inlet basket from above

C. CPS from inside catch basin

D. Catch basin floor from above

EXEMPLARY POST STORM OBSERVATIONS

BEY-1 | KRISTAR FLOGARD PLUS | DOWNSTREAM SERVICES

A. Curb inlet basket from side

B. Curb inlet basket from rear

C. Catch basin floor from within catch basin

D. Sediment, trash and debris in adjacent gutter and along sidewalk

EXEMPLARY POST STORM OBSERVATIONS

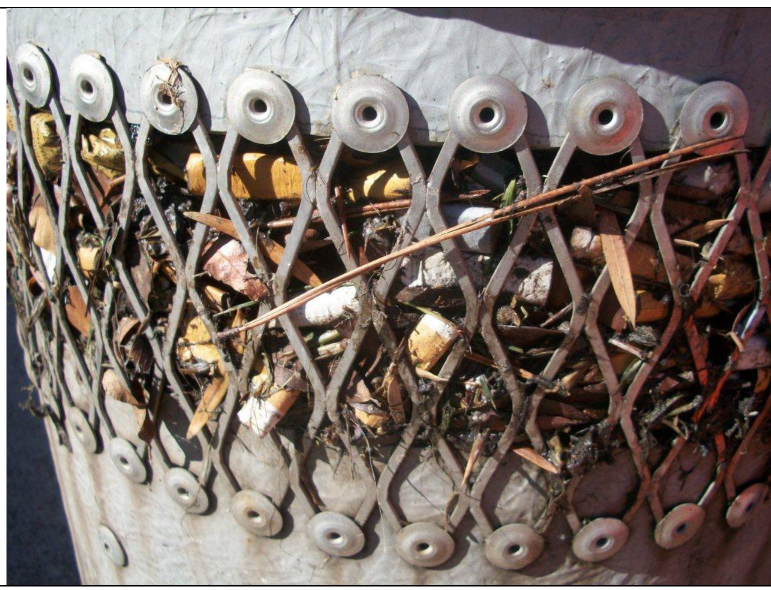
<table>
<tr><td>BEY-TS</td><td>HIGH CAPACITY ROUND BASKET</td><td>BIO CLEAN</td></tr>
<tr><td colspan="2"></td><td></td></tr>
<tr><td colspan="2">A. Curb inlet basket and collection tray from above</td><td>B. Catch basin floor from above</td></tr>
<tr><td colspan="2"></td><td></td></tr>
<tr><td colspan="2">C. Curb inlet basket and collection tray from street</td><td>D. Curb gutter, eucalyptus bark</td></tr>
</table>

EXEMPLARY POST STORM OBSERVATIONS

ECB-54	HIGH CAPACITY ROUND BASKET	BIO CLEAN

A. Curb inlet basket and collection tray from street

B. Curb inlet basket and media boom from above



C. Curb inlet basket overflow mesh from rear

D. Catch basin floor from above

EXEMPLARY POST STORM OBSERVATIONS

ECB-F	DRAINPAC WITH ARS & CPS	UNITED STORM WATER

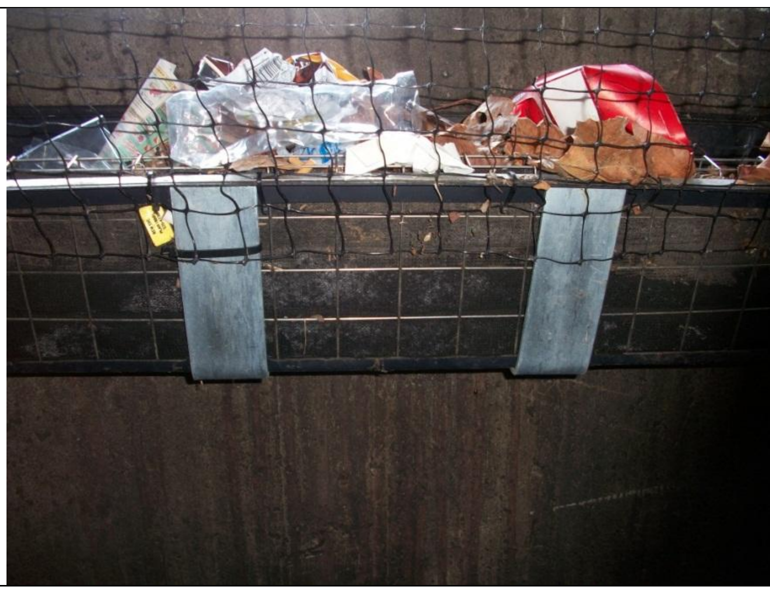
	
A. Curb inlet basket from side	B. ARS from street
	
C. CPS from above	D. Catch basin floor from above

EXEMPLARY POST STORM OBSERVATIONS

PET | TRITON TRC 4.0 | REM

A. Curb inlet basket from street

B. Curb inlet basket and storm web from street



C. Curb inlet basket and storm web from rear

D. Catch basin floor from above

EXEMPLARY POST STORM OBSERVATIONS

QUAL	GRATE INLET SKIMMER BOX	BIO CLEAN

	
A. Grate inlet basket from above	B. Grate inlet basket filter media (beneath screen) from above
	
C. Catch basin floor from above, roach at left	D. Overflow mesh from inside grate inlet basket