TARGETED AGGRESSIVE STREET SWEEPING PILOT PROGRAM PHASE IV SPEED EFFICIENCY STUDY

FINAL REPORT

TASK ORDER #28

DOC ID# CSD-RT-11-URS28-02

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CITY OF SAN DIEGO

PREPARED BY URS CORPORATION

think BLUE
SAN DIEGO

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List of Acronyms and Abbreviations

BMP	Best Management Practices
Division	City of San Diego Transportation and Storm Water Department; Storm Water Division (Division)
Control Speed	6-12 mph
FY	fiscal year
GIS	Geographical Information System
HSP	Health and Safety Plan
MEP	maximum extent practicable
mph	miles per hour
MS4	Municipal Separate Storm Sewer System
MS4 Permit	California Regional Water Quality Control Board, San Diego Region, Order No. R9-2007-0001, NPDES No. CAS0108758, Waste Discharge Requirements for Discharges of Urban Runoff from the Municipal Separate Storm Sewer Systems Draining the Watersheds of the County of San Diego, the Incorporated Cities of San Diego County, the San Diego Unified Port District, and the San Diego County Regional Airport Authority
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
Phase IV	Speed Efficiency Study
Pilot Program	Targeted Aggressive Street Sweeping Pilot Program
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
Report	Speed Efficiency Study, Phase IV of the City's Targeted Aggressive Street Sweeping Pilot Program Report
RWQCB	Regional Water Quality Control Board
SWRCB	(California) State Water Resources Control Board
TMDL	Total Maximum Daily Load
Treatment Speed	3-6 mph
URS	URS Corporation
WMA	Watershed Management Area
Work Plan	Targeted Aggressive Street Sweeping Pilot Program Work Plan

EXECUTIVE SUMMARY

The City of San Diego Transportation and Storm Water Department; Storm Water Division (Division) manages a large Municipal Separate Storm Sewer System (MS4) that discharges storm water 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 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.

As part of the Targeted Aggressive Street Sweeping Pilot Program (Pilot Program), the City has developed a phased series of pilot projects designed to evaluate the feasibility, potential water quality benefits, and cost-effectiveness of various optimization techniques that may be applied to the current street sweeping program. Phases I and II of this Pilot Program assessed the relative pollutant removal efficiency of weekly and bi-weekly sweeping frequency regimes as well as comparison of mechanical, vacuum-assisted and regenerative-air sweeper machines. The Phase III effort evaluated sweeping of roadway medians adjacent to high traffic volume areas in order to determine the potential water quality benefits and feasibility of sweeping the median sweeping routes. Phase IV was designed to assess the pollutant removal efficiency of mechanical sweepers at two operational speeds.

This report presents the results of the Phase IV Speed Efficiency study and comparison of the Phase IV results with previous phases of the Pilot Program. The typical operating speed for City mechanical sweepers is between 6-12 miles per hour (mph). A reduced operating speed of 3-6 mph, which is more in line with manufacturers' recommended operating speed, was implemented in the Phase IV study for comparison to the typical operating speed. One existing commercial street sweeping route in both the San Diego Bay and Tijuana River Watershed Management Areas as selected for the study. Four sampling events were conducted where each of the two selected commercial routes were partially swept at the two operating speeds. During each sampling event, the weight of debris collected by the mechanical sweeper at both operating speeds was monitored. In addition, roadway debris samples on portions of the roadway swept at the typical and reduced operating speed were collected both prior to (pre-sweep) and after (post-sweep) the mechanical sweeping. Roadway debris samples were collected using a hand-held vacuum cleaner in three randomly selected 120 square foot (10 foot by 12 foot) areas approximately evenly distributed along the length of the selected routes. The pre- and post-samples were composited and sent to the laboratory for analysis of constituents commonly associated with roadway debris including metals, nutrients, and petroleum hydrocarbons.

Results from the Speed Efficiency study indicate that the operation of mechanical street sweepers at the two monitored operation speeds has little impact on the weight of debris collected in the field and the pollutant removal capability of the sweeping machines. The weight of material collected by the street sweepers was highly variable and did not correlate with operational speed. In addition, chemistry analysis of roadway debris samples collected prior to and after street sweeping activity revealed significant variability in both the pre-sweep and post-sweep sample results. This result is important in that the variability of the pollutant concentration at the scale of the roadway sample collection limited the ability to detect differences between the two operational speeds.

Comparison of the Phase IV results with previous Phase I-III data indicates that the average debris weights in Phase IV, calculated on a pound per broom mile basis, are comparable to those observed for the vacuum-assisted and regenerative-air sweepers (Phases I and II) and the three-week interval median sweeping technique (Phase III). The highest observed debris removal was achieved in the initial median sweeping event conducted during Phase III. Based on the correlation between the debris removal weight results and the associated calculation of the amount of pollutants removed, roadway pollutant removal data on a weight per broom mile basis follows the pattern exhibited by the debris weight data. These results indicate that roadway areas that are not commonly swept (i.e., median areas which are infrequently swept) potentially provide an effective way to increase debris removal (and associated pollutant removal) with limited increase in level of effort or cost.

As an ancillary portion of the Phase IV study, a preliminary cost analysis was conducted in order to provide the basis for a cost-efficiency assessment of the various street sweeping optimization techniques. In order to perform this preliminary cost analysis City street sweeping operational cost data was compiled by City staff from various sources. As a result of the current City fleet configuration and other factors, the compiled operational cost data was not sufficiently robust to allow a detailed cost estimate to be prepared for each type of sweeper machine in the City fleet. Recognizing these limitations, the preliminary cost analysis indicates that mechanical sweepers are approximately 33% more expensive to operate on a per mile basis than the vacuum-assisted and regenerative air machines.

SECTION 1 INTRODUCTION

The California State Water Resources Control Board (SWRCB) and nine Regional Water Quality Control Boards (RWQCB) regulate the waste discharge requirements for discharges of urban runoff from municipal separate storm sewer systems (MS4s) under the National Pollutant Discharge Elimination System (NPDES) permit program. The City of San Diego Transportation and Storm Water Department; Storm Water Division (Division) manages a large MS4 that discharges storm water and urban runoff to creek, bay, and ocean receiving waters throughout the City limits. The San Diego RWQCB regulates the discharge of urban runoff and the City is identified as a discharger (or "Copermittee") under the RWQCB Order No. R9-2007-0001 (MS4 Permit) (RWQCB 2007). Under the MS4 Permit, the City must reduce the discharge of pollutants in urban runoff to the maximum extent practicable (MEP) through a combination of pollution prevention, source control, and treatment control best management practices (BMPs).

In addition to compliance with the MS4 Permit, the City is committed to restoration and maintenance of water quality of creeks, streams, rivers, bays, and beaches throughout City jurisdiction. Urban runoff, also called storm water, has been identified as a major contributor of pollutants to receiving waters both locally and regionally. The City has developed a phased series of pilot projects designed to evaluate the feasibility, potential water quality benefits, and cost-effectiveness of modifications to its current street sweeping effort. As part of these efforts, the Targeted Aggressive Street Sweeping Pilot Program (Pilot Program) was initiated to develop optimization techniques that may be applied to the current City street sweeping program to more efficiently remove pollutants with potential water quality impacts from road surfaces. Phases I and II of this Pilot Program assessed the relative pollutant removal efficiency of increased sweeping frequency and advanced sweeper equipment technologies. Phase III of this Pilot Program assessed the relative pollutant removal efficiency of street sweeping median area routes adjacent to high volume roadways. The purpose of the Phase IV study (the Speed Efficiency Study) is to evaluate the feasibility, potential water quality benefits, and cost-effectiveness of street sweeper operation speed adjustments.

1.1 BACKGROUND

Storm water runoff, which can accumulate particulates and other pollutants from roadways and other impervious surfaces in urban areas, is a known contributor to water quality problems throughout the United States. Street sweeping is a common source control BMP used by municipalities nationwide to remove potential water pollutants from roadways. The MS4 Permit specifically requires sweeping of municipal areas as follows (RWQCB 2007):

> Each Copermittee shall implement a program to sweep improved (possessing a curb and gutter) municipal roads, streets, highways, and parking facilities. The program shall include the following measures:
>
> (a) Roads, streets, highways, and parking facilities identified as consistently generating the highest volumes of trash and/or debris shall be swept at least two times per month.

(b) Roads, streets, highways, and parking facilities identified as consistently generating moderate volumes of trash and/or debris shall be swept at least monthly.

(c) Roads, streets, highways, and parking facilities identified as consistently generating low volumes of trash and/or debris shall be swept as necessary, but no less than once per year.

In addition to MS4 Permit drivers, the Clean Water Act (CWA) identifies that streams, lakes and coastal waters that do not meet water quality standards must be identified as impaired. The CWA identifies that the RWQCB must prioritize impaired water bodies and develop Total Maximum Daily Loads (TMDLs). Given that a TMDL is a quantitative assessment of water quality problems, contributing sources, and load reductions or control actions needed to restore and protect bodies of water, jurisdictional agencies with MS4 discharges to impaired water bodies with TMDLs must develop implementation plans to reduce pollutant contributions. Several watersheds within City jurisdiction impending or currently have approved TMDLs for various pollutants. These water bodies include: Los Peñasquitos Creek (sediment), Chollas Creek (metals and pesticides), and miles of Pacific Ocean coastline adjacent to City jurisdiction (bacteria). It is generally acknowledged that street sweeping can effectively reduce sediment, metals and bacteria pollutants in storm water runoff. Accordingly, the development of optimization techniques that improve the efficiency of the City street sweeping program in removing roadway pollutants with potential water quality impacts may assist the City in meeting water quality regulatory standards such as TMDLs.

Given MS4 Permit, TMDL, and other regulatory drivers, the City has developed a phased series of pilot projects designed to evaluate potential water quality benefits, of various optimization techniques that may be applied to current street sweeping efforts (Table 1-1). Each phase of this Pilot Program was designed either to assess specific modifications to current street sweeping practices or to determine the relative pollutant removal efficiency of implementation of specific sweeper technologies and/or sweeping techniques. The overall goal in performing these pilot assessments is to identify and implement cost-efficient combination of street sweeping practices and technology that will maximize pollutant load reductions.

Table 1-1. Phases of the Targeted Aggressive Street Sweeping Pilot Program

Phase	Pilot Program Optimization Technique	Description
Phase I	Sweeping Frequency Study	Assess the pollutant removal efficiency of weekly and bi-weekly sweeping frequency regimes.
Phase II	Machine Technology Study	Assess the pollutant removal efficiency of mechanical, vacuum-assisted and regenerative-air sweeper machines.
Phase III	Median Sweeping Study	Assess the pollutant removal efficiency of sweeping median roadway areas.
Phase IV	Speed Efficiency Study	Assess the pollutant removal efficiency of mechanical sweepers at two operational speeds.

The City currently performs street sweeping on over 2,700 miles of roadway annually in a variety of areas with different adjacent land use types (including residential, commercial and other land uses), traffic patterns, and other factors that potentially impact the quality of urban runoff. It is generally accepted that many particulate pollutants tend to accumulate on the shoulders of roadways (typically near curb areas), adjacent to where traffic most often travels. Accordingly, the City's street sweeping program preferentially targets the curb and gutter areas to facilitate removal of roadway street debris.

The purpose of this report is to summarize the results of Phase IV of the pilot program. The Phase IV study focused on assessing the debris- and pollutant-removal efficiency of mechanical street sweepers at two operating speeds. The typical operating speed for City mechanical sweepers is between 6-12 miles per hour (mph). A reduced operating speed of 3-6 mph, which is more in line with manufacturers' recommended operating speed, was implemented in the study for comparison to the typical operating speed. One existing commercial street sweeping route in both the San Diego Bay and Tijuana River Watershed Management Areas was selected for the study. Field teams monitored the amount of debris removed by the sweepers at the two operating speeds and collected roadway debris samples for chemistry analysis in select areas within the two operational speed areas. In addition, a preliminary cost analysis of the current City street sweeping machines was performed. These data will likely provide City storm water managers valuable information that may be used to implement various optimization techniques to improve the pollutant-removal and cost-efficiency of the City street sweeping program.

The City is developing a Strategic Storm Water Business Plan to serve as a roadmap for a master storm water planning program (City of San Diego, 2010a). 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 City Storm Water Division activities. The Strategic Storm Water Business Plan identifies a mission statement, core values, and five goals for City Storm Water Division activities (Figure 1-1). Previous phases and the Phase IV portion of the Pilot Program are inline with three of the five strategic goals for the division. The Phase IV portion of the Pilot Program 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 the regulatory requirements (Goal E).

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

1.2 OBJECTIVE

The purpose of Phase IV of the pilot study is to assess the following project-specific management questions:

- What level of general debris removal benefit does limiting the speed of street sweepers to manufacturer-recommended operating speed provide?
- What level of metals removal benefit limiting the speed of street sweepers to manufacturer-recommended operating speed provide?
- What is the relative load reduction potential for street sweepers at various speeds?
- What type of street sweeping pilot study load reduction data may be collected and used to calibrate the City BMP Prototype Model?
- What is the relative cost-efficiency of limiting the speed of street sweepers to manufacturer-recommended operating speed?

1.3 GENERAL SCOPE OF ACTIVITIES

Phase IV of the City's Targeted Aggressive Street Sweeping Pilot Program Report (Report) documents the sample and analysis activities that were performed for Phase IV. Coordination with City Storm Water Division Operations and Maintenance (O&M), Education and Outreach, and other impacted City staff was used to perform the Pilot Program activities. The Targeted Aggressive Street Sweeping Pilot Program Phase IV Speed Efficiency Study Work Plan (City of San Diego, 2010b) identifies the operational design, route information, and data collection methods for this project. This Report contains a description of the data collection efforts, a summary of collected field data, and a comparison of observed conditions to other applicable data sets.

1.4 PROJECT ORGANIZATION AND RESPONSIBILITIES

The project team for this project consists of staff representing the City and URS Corporation (URS). The City Project Manager for this project is Clement Brown. The URS Task Order Manager is Bryn Evans.

1.5 DOCUMENT ORGANIZATION

This document is organized into the following sections:

Section 1 *Introduction:* Summarizes the project background information including objectives, general scope of activities, and project organization and responsibilities.

Section 2 *Summary of Pilot Program Phases I-III:* Describes the previous phases that were conducted and their results.

Section 3 *Phase IV Study Design and Site Characteristics:* Describes the routes selected within the City's jurisdiction.

Section 4 *Data Collection Methods:* Describes the monitoring methodology that was used to measure the effectiveness of the Phase IV study.

Section 5 *Project Results:* Presents the results and analysis of Phase IV of the Pilot Program.

Section 6 *Cost Analysis:* Presents a preliminary cost analysis for Phases I-IV of the Pilot Program to date.

Section 7 *Summary:* Summarizes key components of Phase IV of the Pilot Program.

Section 8 *References:* Provides a summary of Report references.

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SECTION 2 SUMMARY OF PILOT PROGRAM PHASES I-III

This section provides a brief summary of the four phases and associated optimization techniques for the Pilot Program.

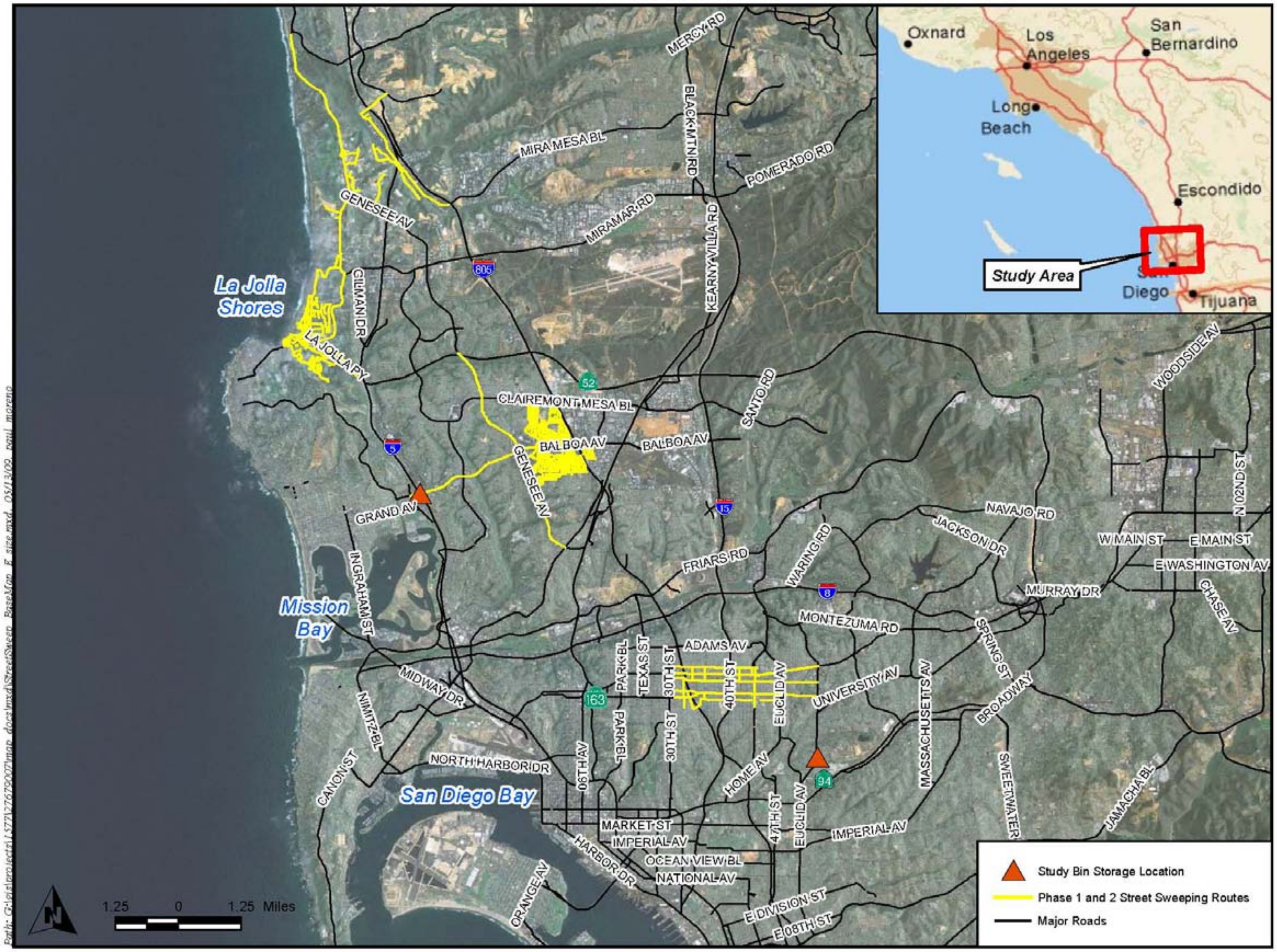
2.1 PHASES I AND II- SWEEPING FREQUENCY AND MACHINE EFFECTIVENESS ASSESSMENT

The City conducted the first two phases of the Pilot Program over an approximate two year period beginning in 2008. Phase I of the Pilot Project was designed to assess the relative effect in debris and pollutant removal of increasing the frequency of street sweeping. The study compared sweeping frequencies of once and twice per week. The Phase II portion of the Pilot Project compared the efficiency of three types of street sweeping machine technologies. The City's current street sweeping fleet is primarily composed of mechanical (or "broom") sweepers (Table 2-1). Recent studies have indicated that vacuum-assisted and regenerative machines may be more effective than mechanical sweepers in removing fine debris particles from streets (Pitt, et al, 2004). As part of this Pilot Program and as a result of other program drivers, the City recently purchased three vacuum-assisted and one regenerative-air sweeper. The mechanical, vacuum-assisted, and regenerative-air machines were used to sweep routes within the Chollas Creek watershed, La Jolla Shores subwatershed, and Tecolote Creek watershed at the two sweeping frequencies (Figure 2-1). Field teams monitored the amount of debris removed by the sweepers at the two sweeping frequencies and collected debris samples from the debris loads collected by the sweepers for chemistry analysis. The debris samples were analyzed for common roadway constituents with potential water quality impacts including metals, general chemistry, pesticides and hydrocarbons.

Table 2-1. City of San Diego Street Sweeper Types

Type		Description	Number in City Fleet
Mechanical Street Sweeper		Mechanical Street Sweepers are equipped with water tanks, sprayers, brooms and a vacuum system pump that gathers debris.	24
Regenerative-Air Sweeper		Regenerative-Air Sweepers are equipped with a "sweeping head" which creates a suction using forced air to transfer debris into the hopper.	1
Vacuum Sweeper		Vacuum Sweepers are equipped with a high-powered vacuum to suction debris from the road surface.	4

Figure 2-1. Phase I and II Route Locations



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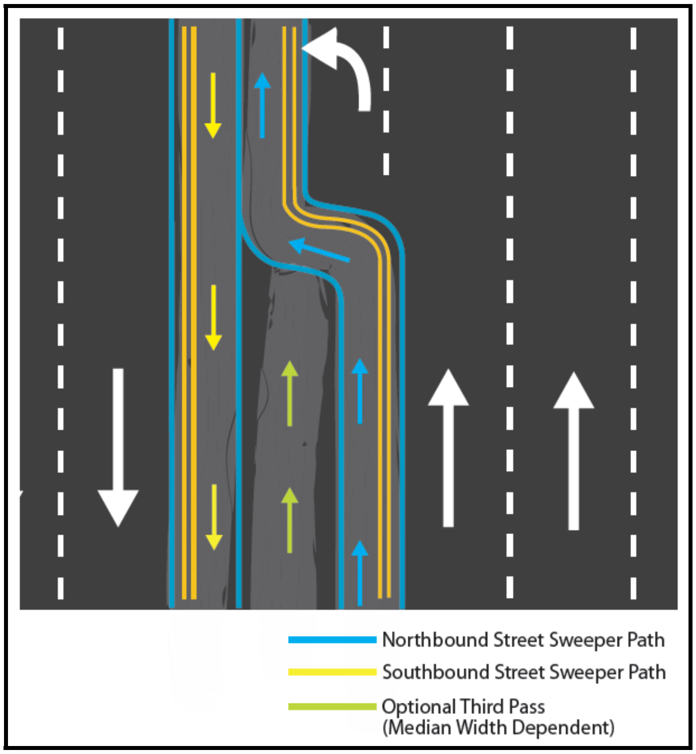
Generally, the Phase I and II study results indicated that increased sweeping frequency using vacuum-assisted sweepers provided a linear increase in debris removal benefit. That is, additional sweeping with the vacuum assisted sweeper resulted in similar debris removal rates across both the once per week and twice per week sweeping frequencies. In contrast, the results indicated that the mechanical sweepers were moderately less effective at debris removal on a weight of debris removed per mile swept basis when sweeping was conducted twice per week as opposed to the once per week frequency. The machine effectiveness results generally indicated that the vacuum-assisted sweepers were more effective than the mechanical and regenerative air machines. In addition, wet weather roadway sampling conducted during this study indicated a strong correlation between implementation of street sweeping optimization techniques with improved water quality. However, there was some evidence that site-specific variations in roadway surface condition, roadway grade, and presence of a curb and gutter may have limiting impacts on vacuum-assisted machine performance.

2.2 PHASE III MEDIAN SWEEPING ASSESSMENT

The third phase of the Pilot Program was focused on sweeping of median areas of high traffic volume roadways. The current City street sweeping program is primarily aimed at sweeping the curb and gutter areas adjacent to the periphery of roadway surfaces. However, City O&M staff and others have observed significant build-up of roadway debris in areas with both raised median (containing curb and gutter) and painted (median areas defined by painted double yellow lines) areas (Figure 2-2). Four routes were selected for the Phase III study based on traffic volume, length of contiguous sections of median-type roadway, adjacent land use, and watershed management area. The four median routes located in urbanized areas of the Los Peñasquitos, Mission Bay and La Jolla, San Diego River, San Diego Bay and adjacent to the Tijuana River watershed management areas. Mechanical broom sweepers were used to conduct street sweeping operations along the four study routes at three week intervals over approximately 3 months. Similar to the Phase I and II studies, representative samples of collected debris were analyzed for common roadway constituents including metals, general chemistry, pesticides and hydrocarbons. In addition, a limited hand-sweeping pilot was conducted using manual methods to preliminarily assess the amount of roadway constituent concentrations present on the impervious surface area of raised medians. Finally, a literature review of available national, regional and local street sweeping studies was also conducted as part of the phase III effort. The literature review provided guidance in the data collection and assessment design of the Phase IV study.

The Phase III results indicated that the initial median sweeping event collected 3-5 times more debris than subsequent 3-week interval sweeping events. This suggests a significant buildup of roadway debris occurs within and adjacent to median areas. The results also indicated that debris collected from median areas is similar in pollutant concentrations to the curb and gutter areas on the peripheral edges of the roadway surface. The preliminary hand sweeping pilot sweeping results indicated there are potentially significant concentrations of common roadway constituents present on raised median surfaces. It is recognized however that logistical considerations likely will limit the feasibility of sweeping raised median areas using mechanical methods.

Figure 2-2. Example Painted Median Sweeping Pattern



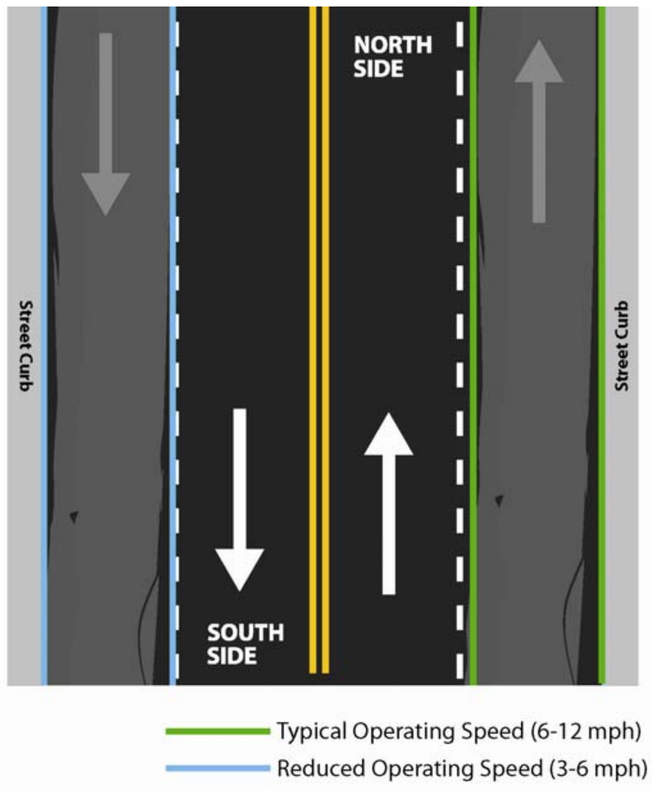
SECTION 3 PHASE IV STUDY DESIGN AND SITE CHARACTERISTICS

This section describes the general study design for the Phase IV speed efficiency study and the site characteristics of the selected study sites.

3.1 STUDY DESIGN

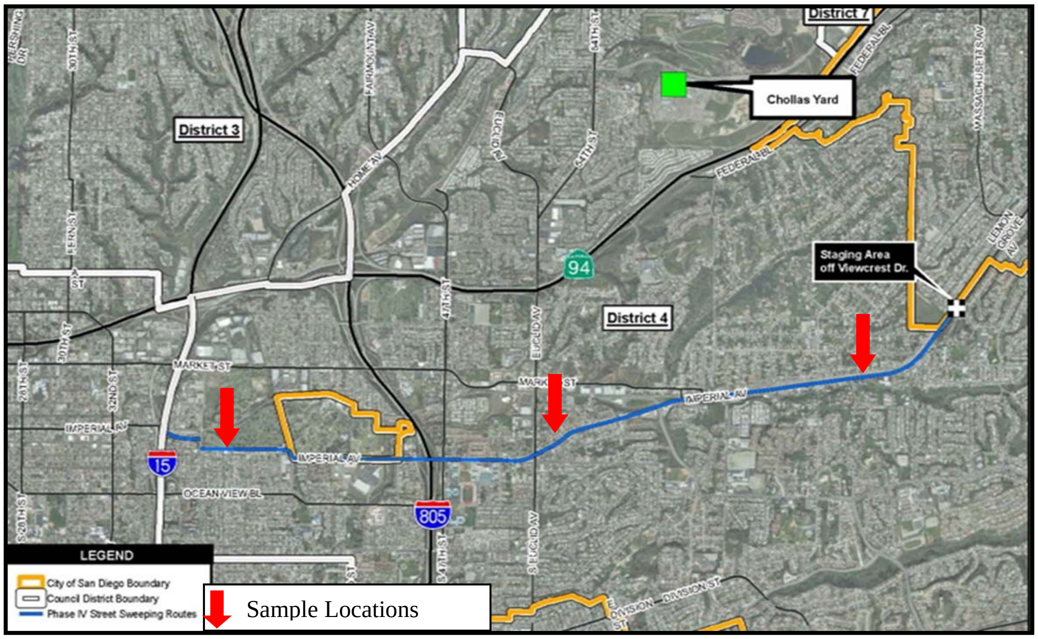
The study design for the Pilot program Phase IV speed efficiency was derived from the project management questions, previous work in Phases I-III, and review of available national, regional and local street sweeping literature. The general study design included comparison of two mechanical street sweeper operation speeds on commercial routes typically swept on a weekly basis. The typical operating speed for City mechanical sweepers is between 6-12 miles per hour (mph). A reduced operating speed of 3-6 mph, which is more in line with manufacturers' recommended operating speed, was implemented in the study for comparison to the typical operating speed. Four sampling events were conducted where each of the two selected commercial routes were partially swept at the two operating speeds. During each event, one "side" of the route roadway was swept at the typical operating speed and the other "side" of the route roadway was swept at the reduced operating speed (Figure 3-1). For each event, the sweeper speed treatment applied to a particular side of the roadway was alternated in order to reduce potential bias resulting from uncontrolled environmental variables.

Figure 3-1. Example of the Phase IV Study Street Sweeping Pattern



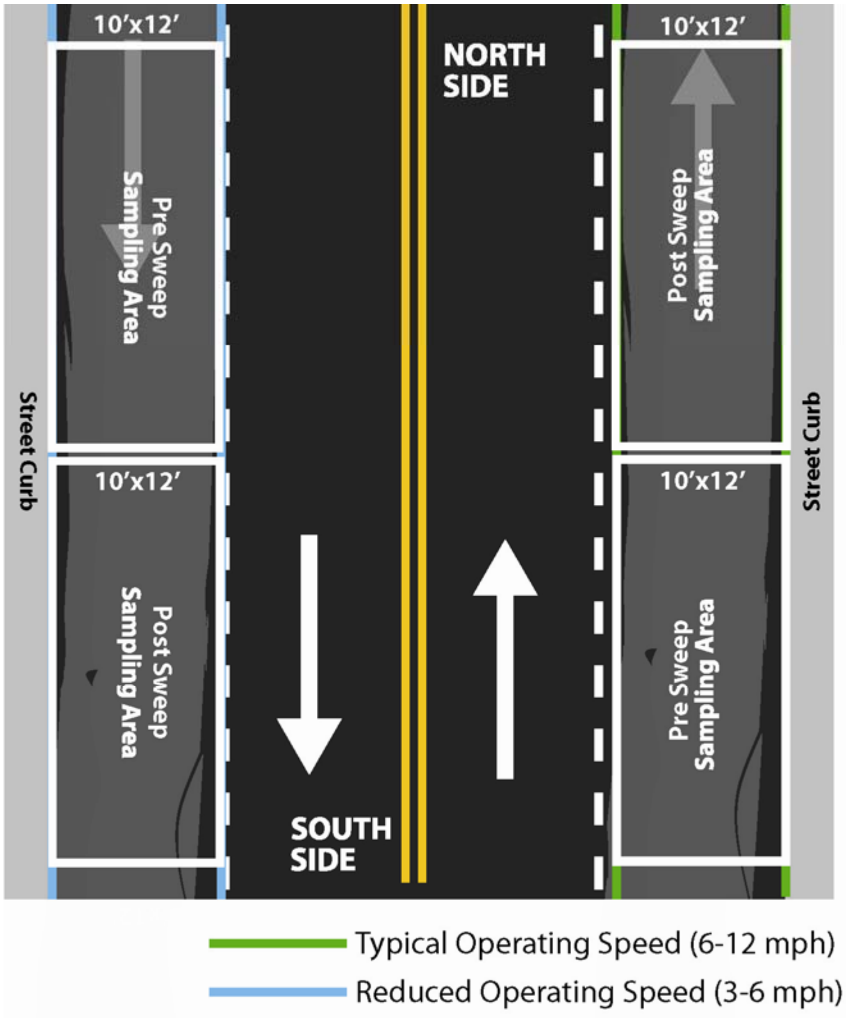
During each sampling event, the weight of debris weight collected by the mechanical sweeper at both operating speeds was collected. In addition, roadway debris samples on both sides of the roadway were collected in three randomly selected 120 square foot (10’ by 12’) areas roughly evenly distributed along the length of the Phase IV routes (Figure 3-2).

Figure 3-2. Example of Distribution of Roadway Debris Sample Locations



At each of the three roadway debris sample locations, debris samples were collected using a portable vacuum cleaner (“shop-vac”) both prior to (pre-sweep) and after (post-sweep) the mechanical sweeper operation. It should be noted that the pre-sweep samples were generally collected within several hours prior to the sweeper pass. Due to operational and logistical constraints, the post-sweep samples were collected approximately 24 hours after the sweeper pass. For each sampling event, the samples collected at the three pre-sweep locations and the three samples collected at the post-sweep locations were separately composited to allow a single pre-sweep and a single post-sweep sample for each route to be submitted for laboratory analysis. This method of sample collection was derived using available literature sources (CSD-RT-10-URS18-02) and consultation with City staff regarding Storm Water Division storm water modeling needs.

Figure 3-3. Example of Pre- and Post-Sweep Sample Collection Areas



As described above, the Phase IV study design somewhat varies from the methods used in Phases I-III of the Pilot Program (Figure 3-4). During Phases I-III composite samples were collected from the debris collected by the street sweepers. Generally, the sweeper collection bins were used to collect a composite sample representative of the debris collected during the pilot study. Laboratory analytical results of the collected debris-based composites were then used to calculate the amount of roadway constituents removed by the focal sweeping activity. While this method provides relatively reliable data related to debris and constituent removal, it does not allow the amount of material left on the roadway surface after sweeping activity to be measured. In the Phase IV study, the roadway debris collection prior to and after the sweeper pass allows calculation of both the amount of removed (by measuring the weight of the collected debris) and also calculation of the relative efficiency of sweeper debris collection at the two focal operating speeds. These data provide the basis for future BMP modeling efforts as the percent removal, as it relates to various street sweeping optimization techniques, can be calculated and extrapolated to model wide-spread implementation.

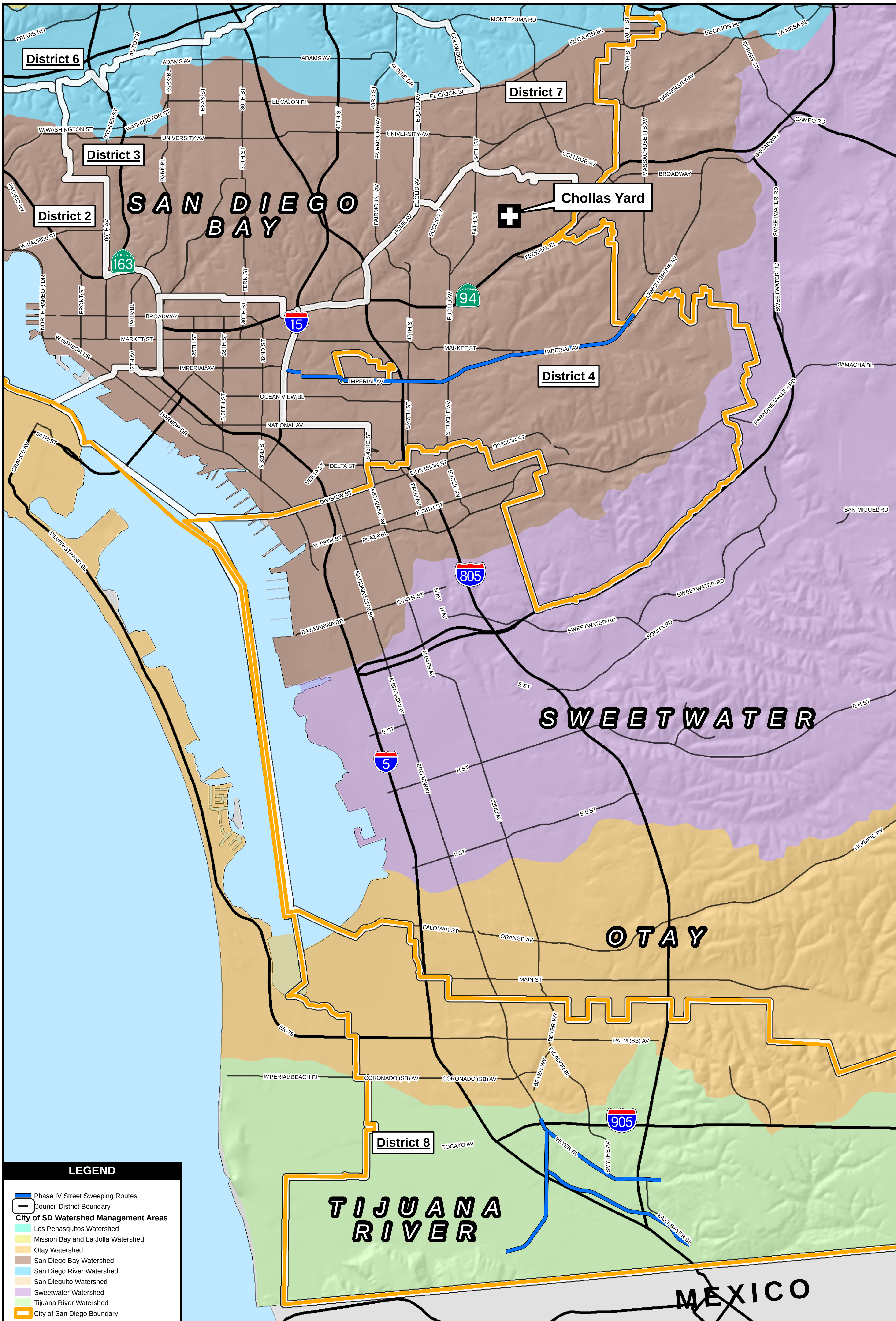
Figure 3-4. Illustration of Roadway Debris Collection Methods in Phases I-III and Phase IV

	
a) Phases I-III utilized sweeper-collected debris for analytical sample collection.	b) Phase IV utilized roadway-collected debris for analytical sample collection.

3.2 SITE CHARACTERISTICS

The City boundary encompasses more than 324 square miles and includes six Watershed Management Areas (WMAs): Mission Bay and La Jolla; Los Peñasquitos; San Diego River; San Dieguito River; San Diego Bay; and Tijuana River. Currently, the City actively sweeps over 2,700 miles of streets within its jurisdiction distributed throughout these WMAs. A review of existing City street sweeping route data was conducted in order to identify two commercial sweeping routes within the City's jurisdiction for implementation of the Phase IV study. Based on siting and other criteria presented in the project Work Plan (CSD-RT-10-URS28-01), efficient use of O&M staff resources, and other logistical constraints, two existing commercial routes were selected for the Phase IV study (Figure 3-5). A description of each route project area is discussed in the subsequent sections of this Report. Route 4-B (hereafter referred to as the "Imperial" route) is located along Imperial Avenue within the Pueblo San Diego hydrological unit (HU). Route 8-A is located along Dairy Mart Boulevard, San Ysidro Boulevard and Beyer Boulevard (hereafter referred to as the "San Ysidro" route) and is located within the Tijuana HU.

Figure 3-5. Phase IV Speed Efficiency Study Routes



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SOURCES: SanGIS 2009, Sandag 2008.

CITY OF SAN DIEGO
PHASE IV SPEED EFFICIENCY STUDY ROUTES

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3000 0 3000 6000 Feet

SCALE: 1" = 6000 Feet (1:72,000)
SCALE CORRECT WHEN PRINTED AT 11X17

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3.3 PHASE IV ROUTE-SPECIFIC INFORMATION

The sweeping routes selected for Phase IV of the Pilot Program were selected based on specific site selection criteria identified in the project Work Plan. The criteria included: site representativeness, WMA, council district, impaired water bodies, logistical constraints, geographic location, and potential adjacent pollutant sources. Potential routes and staging areas were then mapped using supplied Geographical Information System (GIS) data supplied by the City and SANDAG. Staging locations were used as meeting locations for the field teams and City staff during sampling activities.

3.3.1 Imperial Route

The Imperial route is City route 4-B and is 5.85 miles in length and located in the Pueblo San Diego HU within the San Diego Bay WMA. Beneficial uses for receiving waters in the Pueblo San Diego HU are identified as non-contact recreation, warm freshwater habitat and wildlife habitat. Land use types in the Pueblo San Diego HU is dominated by residential (40% of the WMA area) and transportation (28% of the WMA area). The Imperial route is also located in City Council District 4. Figure 3-6 presents the Imperial route and associated sample staging locations used for the Phase IV study.

3.3.2 San Ysidro Route

The San Ysidro route is City route 8-A and is 5.11 miles in length and located within the Tijuana River WMA. Beneficial uses for receiving waters in the Tijuana HU are identified as contact and non-contact recreation, warm freshwater habitat and wildlife habitat. Land use types in the Tijuana WMA is dominated by undeveloped (60% of the WMA area) and open space (26% of the WMA area). However, dominant land uses adjacent to the route location are residential and open space. The San Ysidro route is also located in City Council District 8. Figure 3-7 presents the San Ysidro route and associated sample staging locations used for the Phase IV study.

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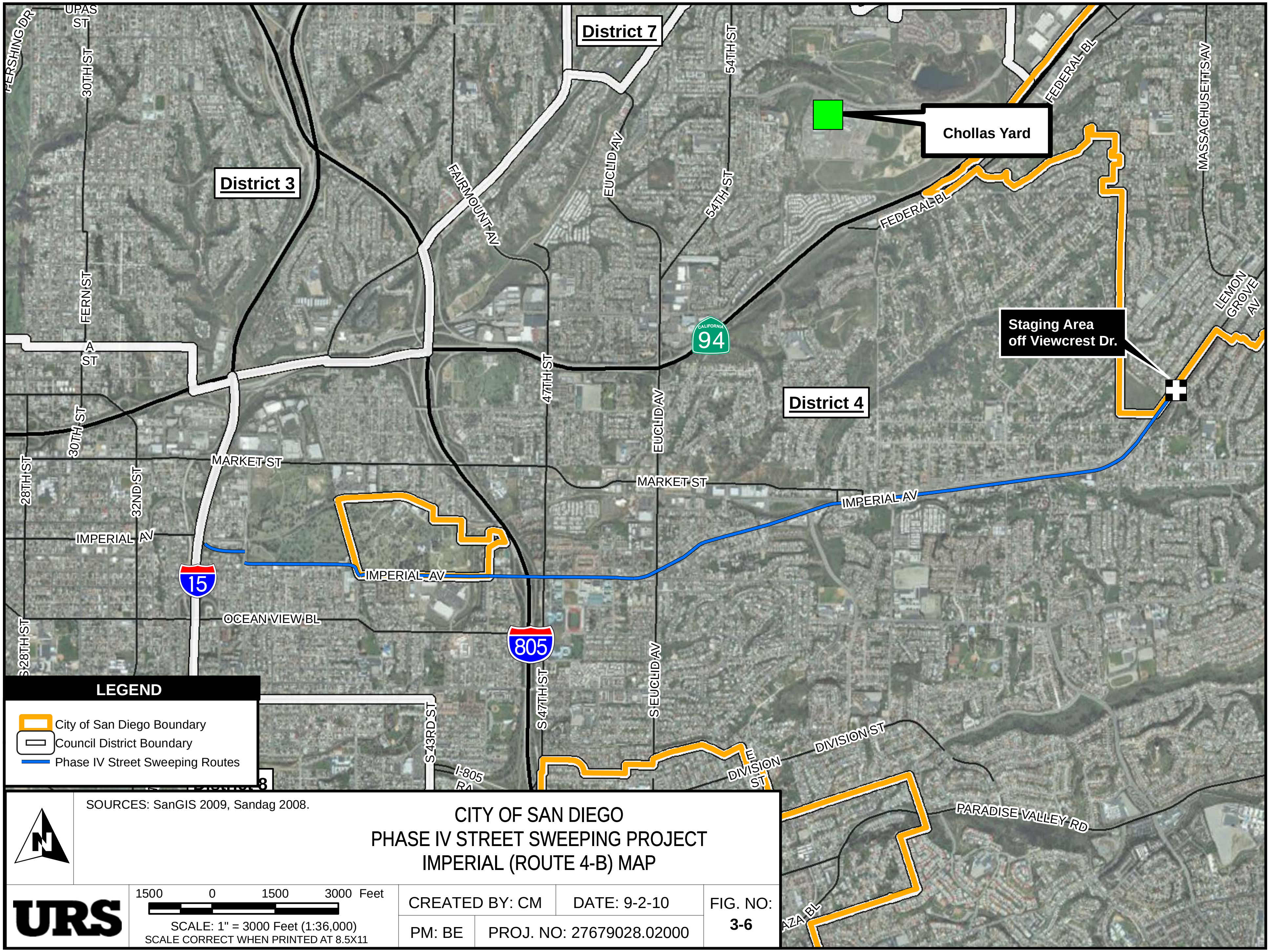
Figure 3-6. Imperial (Route 4-B) Map



SOURCES: SanGIS 2009, Sandag 2008.

CITY OF SAN DIEGO
PHASE IV STREET SWEEPING PROJECT
IMPERIAL (ROUTE 4-B) MAP

URS

1500 0 1500 3000 Feet

SCALE: 1" = 3000 Feet (1:36,000)
SCALE CORRECT WHEN PRINTED AT 8.5X11

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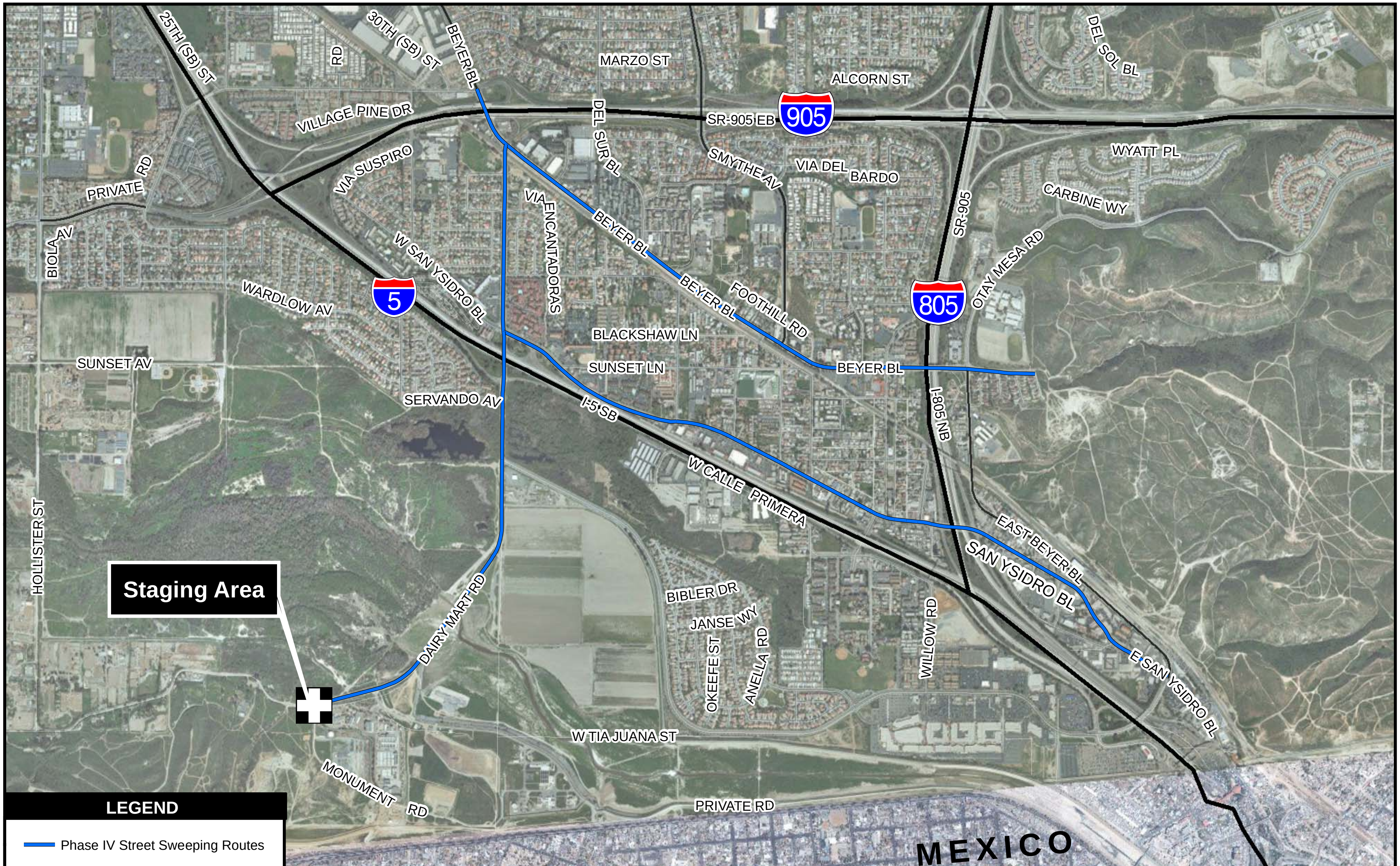
Figure 3-7. San Ysidro (Route 8-A) Map



SOURCES: SanGIS 2009, Sandag 2008.

CITY OF SAN DIEGO
PHASE IV STREET SWEEPING PROJECT
SAN YSIDRO (ROUTE 8-A) MAP

1000 0 1000 2000 Feet
SCALE: 1" = 2000 Feet (1:24,000)
SCALE CORRECT WHEN PRINTED AT 8.5X11

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SECTION 4 DATA COLLECTION METHODS

This section describes the observation and data collection methods that were performed in the field. Field observation methods include those that were utilized by the field teams while collecting samples. Data collection methods include the techniques used to collect samples, the constituents that were tested, and the Quality Assurance/Quality Control (QA/QC) performed by the laboratory.

4.1 HEALTH AND SAFETY

The data collection method utilized for this study required careful consideration of health and safety. The project route locations are located within a highly urbanized section of City and there are numerous areas where natural and anthropogenic hazards provided the potential for injury. The City O&M staff provided traffic control during scheduled sampling events to ensure the safety of the field sampling team. Field teams were required to wear the proper personal protective equipment (PPE) during sampling events. Field team PPE included: ANSI-approved traffic safety vests, Nitrile gloves, safety glasses, steel-toe boots, and dust masks. Field teams were also provided various forms of sanitary solutions to thoroughly clean hands and exposed skin once sampling was complete. The Health and Safety Plan (HSP) for this project is documented within the Work Plan and was adhered to throughout the course of the study.

4.2 STREET SWEEPER DEBRIS COLLECTION

Prior to the commencement of the Phase IV study, route-specific bins were assigned, weighed, and labeled at specified City operations yard locations. City O&M staff was engaged to perform various components of the pilot study, including such elements as: route sweeping, disposal procedures, limited data collection and reporting procedures. Four sample events occurred over a two month period (Table 4-1).

Table 4-1. Sample Event Dates

Sample Event	Pre-Sweep Sample Collection	Post-Sweep Sample Collection
Event 1	09/24/2010	09/25/2010
Event 2	10/14/2010	10/15/2010
Event 3	11/04/2010	11/05/2010
Event 4	11/18/2010	11/19/2010

Table 4-2 presents the schedule of the Phase IV study. The sweeping speed schedule was designed to allow alternation of the sweeper operation speed to opposite sides during consecutive sampling events. For example, the “north-bound’ side of Imperial Avenue was swept at an operation speed of 6-12 mph (Control Speed) in event 1, while the “south-bound” side was swept at the 3-6 mph operation speed (Treatment Speed). In event 2, the pattern was reversed where the “north-bound’ side of Imperial Avenue was swept at an operation speed of 3-6 mph (Treatment Speed), while the “south-bound” side was swept at the 6-12 mph operation speed (Control Speed).

At the conclusion of each sample event, the bins were taken to the Miramar Transfer Station. Trucks were weighed upon entering the transfer station. The debris was then emptied at the station and trucks were weighed again when leaving the transfer station. For effectiveness assessment purposes, daily sweeper logs were prepared and weights and costs were recorded (Appendix A).

Table 4-2. Sweeping Speed Schedule

Event	Date	Sample Collection	Sweeper Speed	Control Speed (6-12 mph)	Treatment Speed (Low 3-6 mph)
1	9/23/10 9/24/10	☒Yes ☐No	Modified	Imperial (north-bound)	Imperial (south-bound)
				San Ysidro (north-bound)	San Ysidro (south-bound)
--	10/07/10 10/08/10	☐Yes ☒No	Normal	Resume regular sweeping speed.	
2	10/14/10 10/15/10	☒Yes ☐No	Modified	Imperial (south-bound)	Imperial (north-bound)
				San Ysidro (south-bound)	San Ysidro (north-bound)
--	10/21/10 10/22/10	☐Yes ☒No	Normal	Resume regular sweeping speed.	
--	10/28/10 10/29/10	☐Yes ☒No	Normal	Resume regular sweeping speed.	
3	11/04/10 11/05/10	☒Yes ☐No	Modified	Imperial (north-bound)	Imperial (south-bound)
				San Ysidro (north-bound)	San Ysidro (south-bound)
--	11/11/10 11/12/10	☐Yes ☒No	Normal	Resume regular sweeping speed.	
4	11/18/10 11/19/10	☒Yes ☐No	Modified	Imperial (south-bound)	Imperial (north-bound)
				San Ysidro (south-bound)	San Ysidro (north-bound)

4.3 ROADWAY DEBRIS COLLECTION

Sample activities for the Phase IV study were conducted during dry weather periods where the antecedent dry period was at least 3-4 days. Roadway debris was collected by a two-person field team using a standard industrial type "shop-vac" vacuum. Both prior to and after sweeper activity on each of the study routes, a 120 square foot area was delineated on the pavement surface. The shop-vac was then used to collect the roadway debris present in a 10 foot by 12 foot area adjacent to the curb and gutter at each sampling location. The 10 foot by 12 foot area is roughly equivalent to the "footprint" of a mechanical street sweeping machine. In addition, this was sufficient area to allow the collection of adequate volume of roadway debris material to allow laboratory analysis for the suite of constituents targeted for this study. The roadway debris sample was then emptied from the shop-vac into laboratory-cleaned jars for each sampling location. The post-sweep sample was collected immediately adjacent to the area of the pre-sweeping sampling location.

The discrete samples collected along each route were sieved with a No.4 sieve and combined into a single container to create a route composite sample. A pre-sweep and post-sweep composite sample was submitted for each route for each of the four sampling events. Sample collection was documented using a sampling field form (Appendix B). Photographs were also taken of the sampling site and the samples collected as part of the documentation efforts.

4.3.1 Analytical Constituents

The analytical constituents selected for this analysis were based on the findings of the previous phases of the Pilot Program, literature sources, and best professional judgment. The constituents selected for analysis in the Phase IV study, along with their analytical methods and target reporting limits, are presented in Table 4-3. The following section provides a brief overview of the purpose of the selected constituents.

Metals are of concern with regards to storm water pollution due to their relative solubility in natural waters, affinity for complexation with humic substances, and potentially toxic effects on bioaccumulation in biota and aquatic organisms (Driscoll, 1994). Typically, copper, zinc, cadmium, and lead are the primary metals monitored because they are generally detected at elevated concentrations in most urban roadway runoff locations, and they display similar transport characteristics to other metals (Driscoll, 1994; Strecker, 1994). Common sources of metals in street sediment pollution include: brake pads (copper and lead), vehicle tires (zinc and cadmium), and paints (copper and lead) (Sansalone et al, 1997).

Nutrients are a common urban runoff constituent particularly in residential, agricultural, and heavily landscaped areas. Common nutrient sources include fertilizers, leaves, other tree debris, automobile exhaust, and decaying organic matter. Elevated nitrogen and phosphorus levels may over-stimulate biological growth and lead to detrimental water-quality conditions (e.g., eutrophication and hypoxia) (Driscoll, 1994).

Petroleum hydrocarbons are common roadway pollutants that are typically sorbed onto street sediments due to their hydrophobic nature. There are numerous potential sources of hydrocarbon pollution including automobiles and roadway materials.

It should be noted that analysis for pesticides was considered for inclusion in the analytical suite; however, the significant number of non-detect results for organophosphorus pesticides and relatively high variability of synthetic pyrethroid results in Phases I-III combined with the relatively high analytical cost for these constituents, a decision was made to remove pesticide constituents from the analytical suite.

Table 4-3. Analytical Constituents

Analyte	Analytical Procedure	Reporting Limits	Units
% Solids	% calculation	0.1	%
Particle Size	-	-	-
Metals			
Aluminum	EPA 6010B	5.0	mg/kg
Antimony	EPA 6010B	1.0	mg/kg
Arsenic	EPA 6010B	1.0	mg/kg
Barium	EPA 6010B	1.0	mg/kg
Beryllium	EPA 6010B	1.0	mg/kg
Cadmium	EPA 6010B	1.0	mg/kg
Chromium	EPA 6010B	1.0	mg/kg
Cobalt	EPA 6010B	1.0	mg/kg
Copper	EPA 6010B	1.0	mg/kg
Iron	EPA 6010B	1.0	mg/kg
Lead	EPA 6010B	1.0	mg/kg
Manganese	EPA 6010B	1.0	mg/kg
Mercury	EPA 7471A	0.050	mg/kg
Molybdenum	EPA 6010B	1.0	mg/kg
Nickel	EPA 6010B	1.0	mg/kg
Selenium	EPA 6010B	1.0	mg/kg
Silver	EPA 6010B	1.0	mg/kg
Strontium	EPA 6010 B	1.0	mg/kg
Thallium	EPA 6010B	1.0	mg/kg
Tin	EPA 6010B	5.0	mg/kg
Titanium	EPA 6010B	1.0	mg/kg
Vanadium	EPA 6010B	1.0	mg/kg
Zinc	EPA 6010B	1.0	mg/kg
General Chemistry			
Ammonia as N	SM 4500-NH3 G	0.5	mg/kg
Nitrate as N	EPA 353.2	0.5	mg/kg
Nitrite as N	EPA 353.2	0.5	mg/kg
Phosphorus, Total as P	EPA 365.4	1.0	mg/kg
Total Kjeldahl Nitrogen	EPA 351.2	1.0	mg/kg

Analyte	Analytical Procedure	Reporting Limits	Units
Hydrocarbons			
Benzene	EPA 8260B	0.1	ug/kg
Diesel	EPA 8015DRO	2.5	mg/kg
Di-isopropyl ether	EPA 8260B	0.1	ug/kg
Dimethoate	EPA 8141	50	ug/kg
Ethyl tert-butyl ether	EPA 8260B	0.1	ug/kg
Ethylbenzene	EPA 8260B	0.1	ug/kg
Gasoline	EPA 8015M	0.05	mg/kg
Methyl tert-butyl ether	EPA 8260B	0.1	ug/kg
m,p-Xylene	EPA 8260B	0.1	ug/kg
Oil & Grease (HEM)	EPA 1664	50	mg/kg
o-Xylene	EPA 8260B	0.1	ug/kg
Toluene	EPA 8260B	0.1	ug/kg

Acronyms:
EPA –United States Environmental Protection Agency
HEM - n-hexane extractable material
mg/kg – milligrams per kilogram
ug/kg – micrograms per kilogram

4.3.2 Quality Control Sampling

The laboratory was responsible for the QA/QC of the street debris samples. QA/QC within the laboratory consisted of field blanks, laboratory duplicates, and matrix spikes. Samples that were QA/QC analyzed were all within reporting limits.

4.3.3 Sample Containers and Preservation

The analytical lab provided certified clean, eight ounce, sample collection containers. Sample container quality protocols were strictly enforced and assured by the laboratory. The laboratory retains certificates of analyses for a period of at least five years.

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SECTION 5 RESULTS

This section presents the Phase IV project results for debris collection weight and pollutant removal efficiency for samples collected from the San Ysidro and Imperial routes at the control and treatment speeds. Pre- and post-sweep data from both routes were evaluated to assess whether slowing sweeper speed resulted in higher debris collection weight and greater pollutant removal. In addition, debris collection weight and pollutant removal results from the Phase IV analysis were compared to summary data from Phases I-III to determine the overall effectiveness of different sweeping optimization techniques.

5.1 PHASE IV RESULTS

During Phase IV, street debris was collected using two different methods. As described in detail in Section 4, the weight of debris collected by the sweepers for the treatment and control speeds along the San Ysidro and Imperial routes was determined by measuring the total bin weight for each speed for each route. In addition, pre- and post-sweep debris samples for the treatment and control speeds along both routes were collected using a hand vacuum. The hand vacuum samples were weighed and also submitted for laboratory analysis of constituents. The collection of pre-sweep hand vacuum samples allows for an evaluation of the initial distribution of debris and pollutants on both sides of the street for both routes. The post-sweep samples allow a determination of the amount of pollutants left on the street after the sweepers have passed at either the treatment or control speed. Comparison of the pre- and post-sweep debris weights and pollutant concentrations provide the basis to evaluate debris and pollutant removal efficiency for both the treatment and control speeds.

5.1.1 Debris Collection

5.1.1.1 Weight of Debris Collected by Sweepers

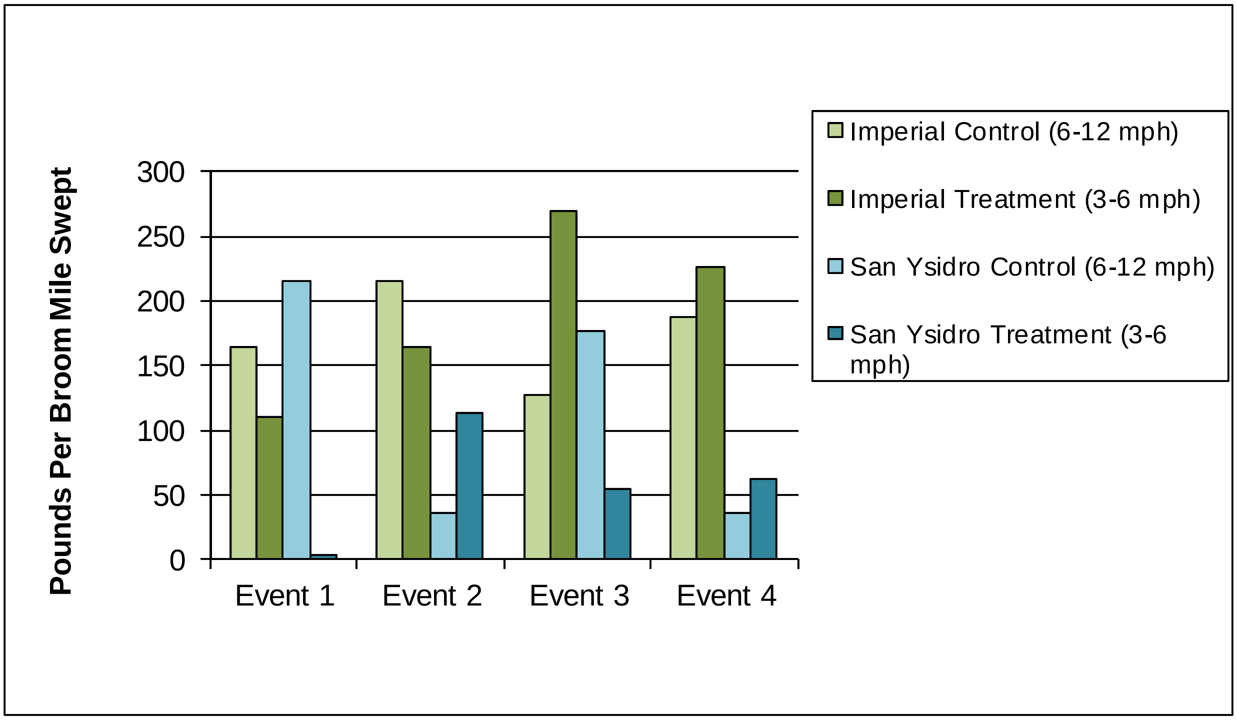
Weight of street debris collected by the sweepers (in pounds) was obtained from the Street Debris Disposal Records included as Appendix C. Table 5-1 shows the bin weight for each sampling event for the control and treatment speeds, the length of each route, and the calculated pounds collected per broom mile swept.

Table 5-1. Weight of Debris Collected by Sweepers

Route	Sample Date	Route Length (Broom Miles)		Debris Weight (Pounds)		Debris Weight (Pounds per Broom Mile)	
		Control	Treatment	Control	Treatment	Control	Treatment
Imperial	Event 1	5.85	5.85	960	640	164	109
	Event 2	5.85	5.85	1260	960	215	164
	Event 3	5.85	5.85	740	1580	127	270
	Event 4	5.85	5.85	1100	1320	188	226
	Average					174	192
San Ysidro	Event 1	5.11	5.11	1100	20	215	3.9
	Event 2	5.11	5.11	180	580	35	114
	Event 3	5.11	5.11	900	280	176	55
	Event 4	5.11	5.11	180	320	35	63
	Average					115	59

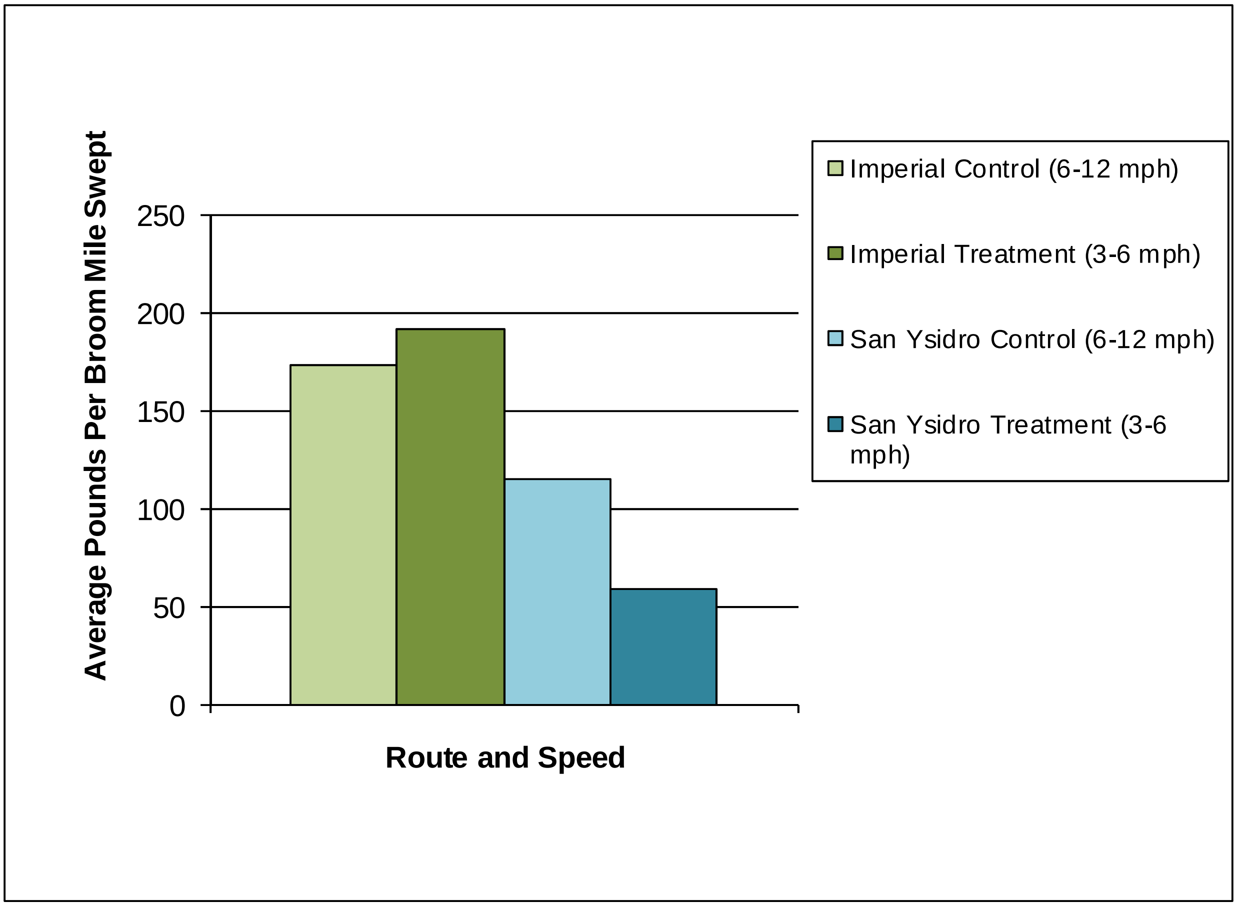
The weight of debris collected for each sampling event at the control and treatment speeds is shown graphically in Figure 5-1. Figure 5-1 shows the variability in the amount of debris collected by the sweepers between the two routes, and also when comparing individual sampling events. In addition, slowing the speed of the sweeper did not consistently increase the amount of debris collected. For both the Imperial and San Ysidro routes, more debris was collected at the control (current) speed in two out of the four sampling events (Event 1 and 2 for Imperial, and Event 1 and 3 for San Ysidro).

Figure 5-1. Weight of Debris Collected by Sweepers by Sample Event



Average debris weight collected in pounds per broom mile was calculated for the Imperial and San Ysidro routes for both the control and treatment speeds, and is shown in Figure 5-2. The average debris weight collected for both the treatment and control speeds were higher for the Imperial route than for the San Ysidro route. More debris was collected at the treatment speed as compared to the control speed for the Imperial route; however, for the San Ysidro route more debris was collected at the control (current) speed than the treatment speed. In addition, this data shows that slowing the speed of the sweeper did not consistently increase the amount of debris collected.

Figure 5-2. Average Weight of Debris Collected by Sweepers

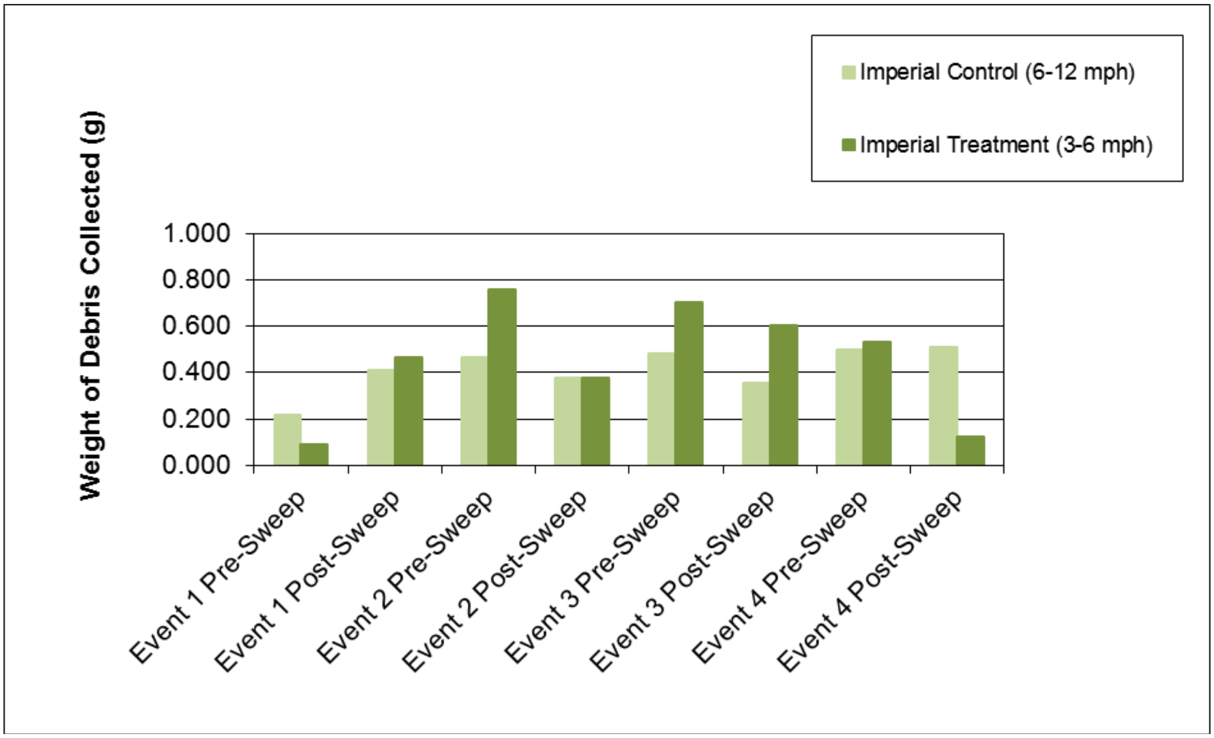


5.1.1.2 Weight of Debris Collected by Hand Vacuum

Pre- and post-sweep debris samples for the treatment and control speeds along both routes were collected using a hand vacuum. The collection of pre-sweep hand vacuum samples allows for an evaluation of the initial distribution of debris on both sides of the street for both routes. The post-sweep samples allow a determination of the amount of debris left on the street after the sweepers have passed at either the treatment or control speed. Comparison of the pre- and post-sweep debris weights for the two speeds provide the basis to compare the debris removal efficiency.

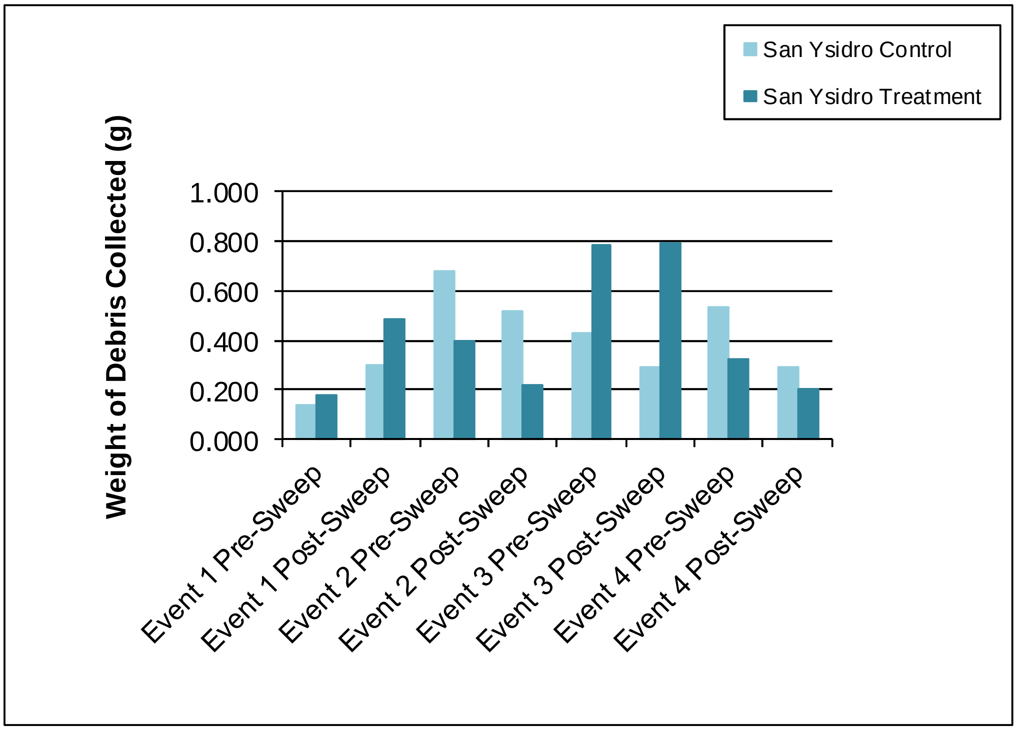
Figure 5-3 and Figure 5-4 show the weight of debris collected by hand vacuum for the Imperial and San Ysidro routes, respectively. Figure 5-6 shows the average pre- and post-sweep weight of debris collected by hand vacuum.

Figure 5-3. Weight of Debris Collected by Hand Vacuum- Imperial Route



For the Imperial route, the pre-sweep debris data shows that there is some variability in the amount of debris collected for the control and treatment speeds, reflective of the differing amounts of debris on opposite sides of the street (i.e., the control and treatment routes). Post-sweep data for the four events shows that in most cases post-sweep debris weights are lower than pre-sweep debris weights, indicating that sweeping is an effective means to remove street debris. The data presented in Figure 5-3 also shows that the post-sweep debris weight collected for the control speed was lower than or equal to the post-sweep debris weight for the treatment speed in 3 out of 4 events (Events 1, 2, and 3).

Figure 5-4. Weight of Debris Collected by Hand Vacuum - San Ysidro Route



For the San Ysidro route, the pre-sweep debris data also shows that there is variability in the amount of debris collected for the control and treatment speeds, reflective of the differing amounts of debris on opposite sides of the street (i.e., the control and treatment routes). Similar to the Imperial route, the post-sweep data for the four events shows that in most cases post-sweep debris weights are lower than pre-sweep debris weights. The data presented in Figure 5-4 also shows that the post-sweep debris weight collected for the control speed was lower than the post-sweep debris weight for the treatment speed in 2 out of 4 events (Events 1 and 3).

Figure 5-5. Average Weight of Debris Collected by Hand Vacuum

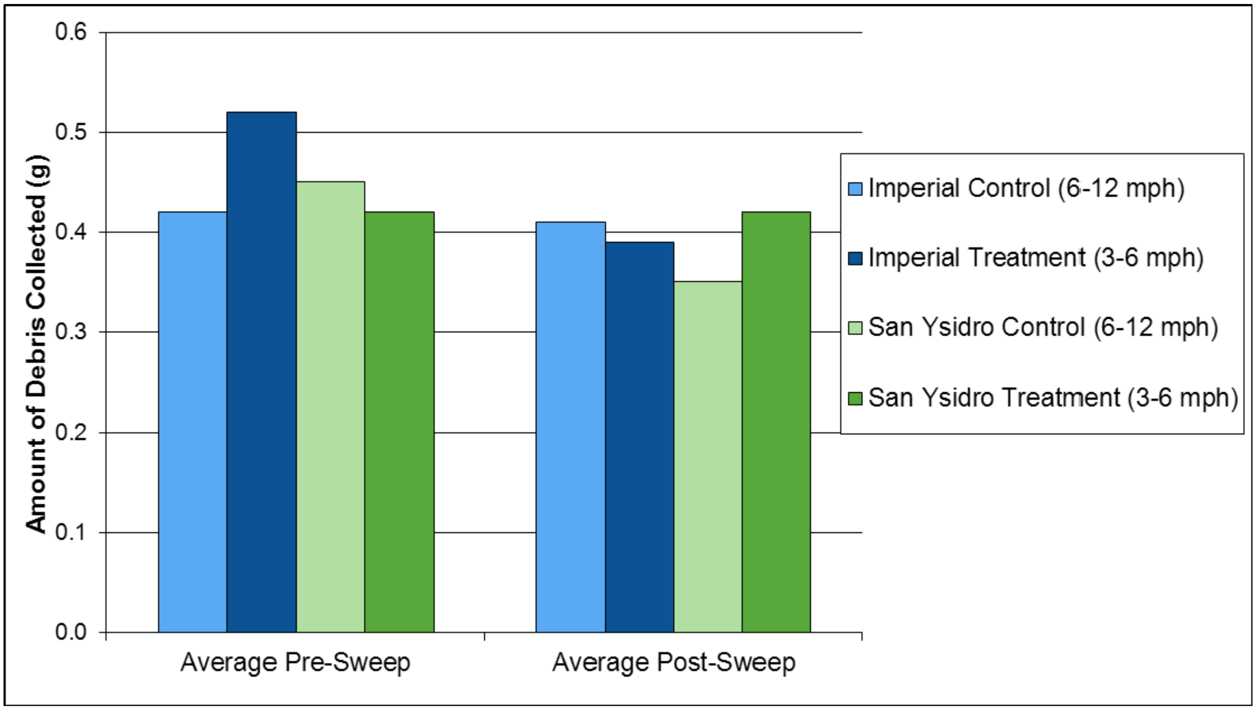
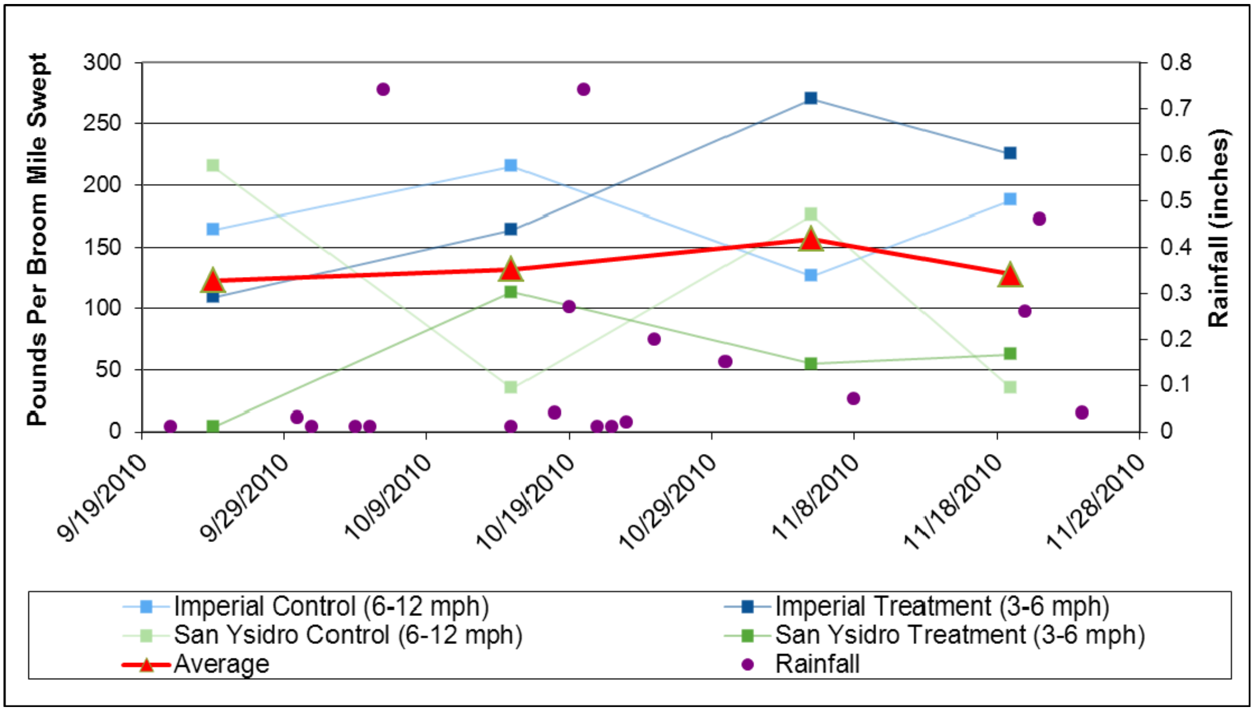


Figure 5-5 compares the average pre- and post-sweep data for the San Ysidro and Imperial routes at the control and treatment speeds. More debris was collected at the treatment speed as compared to the control speed for the San Ysidro route, however for the Imperial route more debris was collected at the control (current) speed than the treatment speed. Similar to the weight of debris collected by the sweeper, the hand vacuum data shows that slowing the speed of the sweeper did not consistently increase the amount of debris collected.

5.1.1.3 Effect of Rainfall

Data related to the timing of rain events and amount of rainfall that occurred during the study period were evaluated to determine if rainfall had an effect on the amount of debris collected by the street sweepers. Figure 5-6 shows the rain events, amount of rainfall, and the weight of debris collected by the street sweepers in pounds per broom mile. The data indicates that the average weight of debris collected by the sweepers was similar before and after rain events. Therefore, it was determined that rain events did not significantly impact the weight of debris collected during the study period.

Figure 5-6. Debris Collected by Sweepers and Rainfall



5.1.2 Pollutant Removal

Pre- and post-sweep debris samples collected by hand vacuum were submitted for laboratory analysis for metals, hydrocarbons, general chemistry and nutrients. The analysis of pre-sweep data allowed for the evaluation of the initial distribution of pollutants on both sides of the street (i.e., treatment and control) for the San Ysidro and Imperial routes. Post-sweep data represents the amount of pollutants remaining on the street after the sweepers had passed at either the treatment or control speed. Comparisons of pre- and post-sweep pollutant concentrations were performed to evaluate the pollutant removal efficiency for various constituents at both the treatment and control speeds.

5.1.2.1 Copper, Lead and Zinc

Detailed analysis of pre- and post-sweep data for copper, lead and zinc was performed to evaluate the distribution, abundance, and pollutant removal effectiveness of street sweeping at control and treatment speeds. Table 5-2 summarizes the concentration of copper, lead and zinc in pre- and post-sweep debris.

Table 5-2. Copper, Lead, and Zinc Concentrations in Debris

Route	Sweep	Sample Date	Copper (mg/kg)		Lead (mg/kg)		Zinc (mg/kg)	
			Control	Treatment	Control	Treatment	Control	Treatment
Imperial	Pre-sweep	Event 1	78	200	54	47	190	230
		Event 2	190	6100	67	510	280	230
		Event 3	120	73	120	38	200	210
		Event 4	200	160	120	47	240	190
	Post-sweep	Event 1	150	64	54	37	250	190
		Event 2	240	120	58	150	350	210
		Event 3	82	48	33	27	220	140
		Event 4	110	260	75	86	150	270
San Ysidro	Pre-sweep	Event 1	180	130	16	34	170	210
		Event 2	120	140	17	38	180	250
		Event 3	210	59	25	18	220	120
		Event 4	83	270	28	28	140	230
	Post-sweep	Event 1	110	98	53	27	170	170
		Event 2	130	240	50	32	220	220
		Event 3	110	110	31	41	190	210
		Event 4	320	300	58	95	230	270

Figure 5-7 displays the pre-sweep results for copper, and demonstrates the variable distribution and abundance of copper on both sides of the street (treatment and control). For Event 2, a spike in the pre-sweep concentration of copper was noted, and was determined to be an outlier.

Similar variability was observed in pre-sweep concentrations of lead and zinc for the treatment and control routes.

Figure 5-7. Pre-sweep Concentrations of Copper

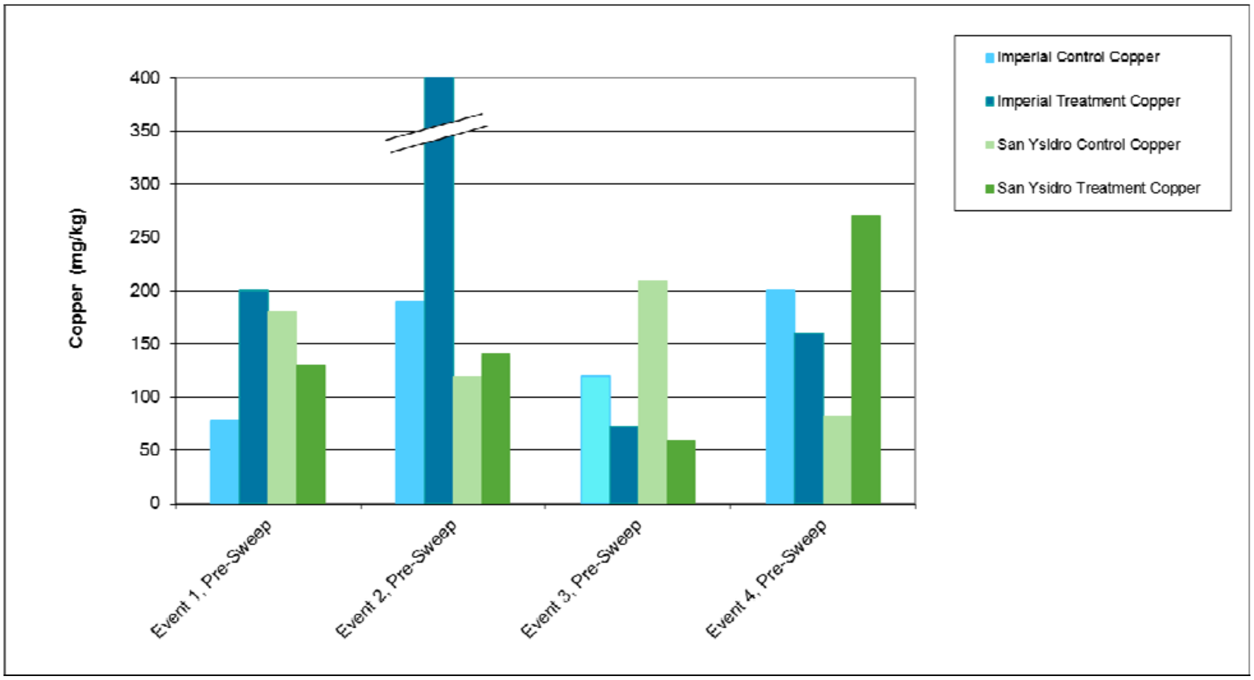


Figure 5-8. Average Percent Removal for Copper, Lead and Zinc

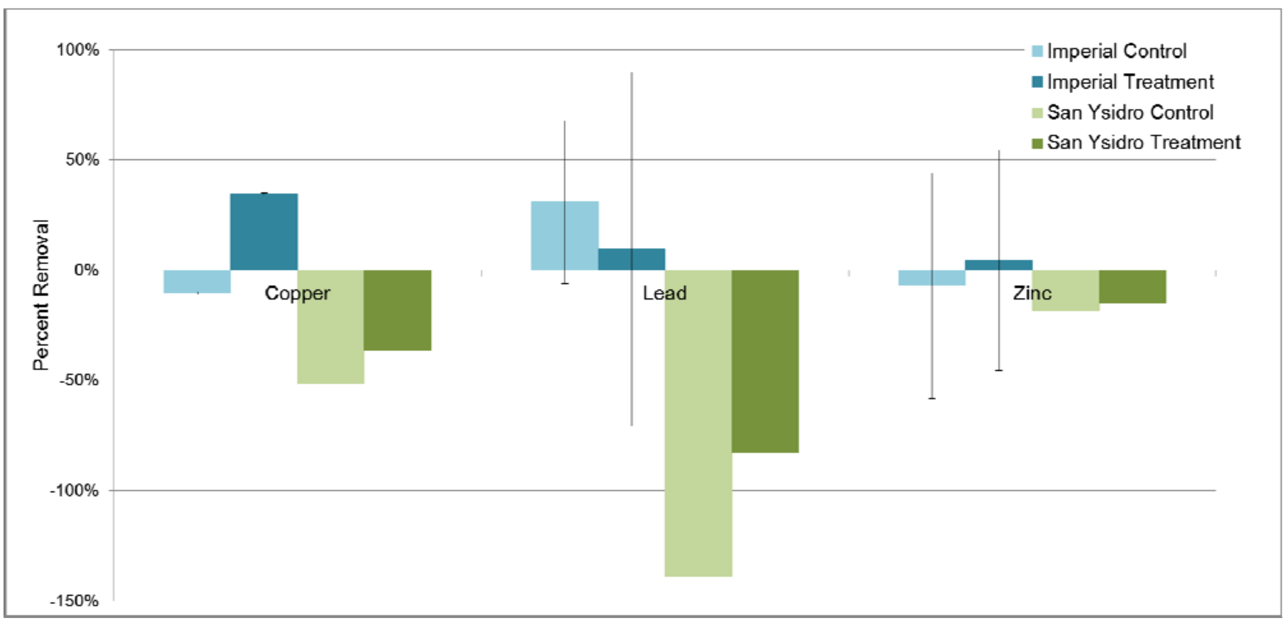


Figure 5-8 shows the average percent removal for copper, lead and zinc for the Imperial and San Ysidro routes. Average percent removal for the control and treatment speeds are compared side-by-side for both routes for each constituent. Percent removal of constituents was calculated by subtracting the post-sweep (final) concentration from the pre-sweep (initial) concentration, dividing by the pre-sweep (initial) concentration, and converting to a percentage. The percent removal for each sampling event was calculated in this manner, and the results were averaged.

The percent removal results show that the data is variable, and in some cases the post-sweep concentrations are above the pre-sweep concentrations, as indicated by the negative percent removal values. Comparison of pollutant removal between the control and treatment speeds shows there is no clear pattern indicating slower sweeper speed results in greater pollutant removal efficiency.

5.1.2.2 Hydrocarbons

Table 5-3 summarizes the results for analysis of gasoline, diesel and oil and grease concentrations in street debris. These constituents were analyzed to determine if slowing sweeper speed increased the removal of these common roadway pollutants.

Table 5-3. Concentrations of Hydrocarbons in Debris

Route	Sweep	Sample Date	Gasoline (mg/kg)		Diesel (mg/kg)		Oil & Grease (mg/kg)	
			Control	Treatment	Control	Treatment	Control	Treatment
Imperial	Pre-sweep	Event 1	0.76	0.21	110	98	5970	4530
		Event 2	0.39	0.18	110	110	6740	5360
		Event 3	0.24	0.33	430	260	6540	5150
		Event 4	0.17	0.12	370	310	6280	5180
	Post-sweep	Event 1	0.98	0.57	460	520	4000	4550
		Event 2	0.17	0.35	350	360	3640	4810
		Event 3	0.10	0.060	440	310	5170	2910
		Event 4	0.053	0.12	310	250	3180	3000
San Ysidro	Pre-sweep	Event 1	0.30	0.11	65	55	5460	5200
		Event 2	0.18	0.22	65	65	4170	4560
		Event 3	0.10	0.23	260	280	6220	5760
		Event 4	0.13	0.18	350	310	5830	6220
	Post-sweep	Event 1	0.65	0.21	650	350	4590	3900
		Event 2	0.27	0.13	420	380	4260	4030
		Event 3	0.057	0.18	410	630	4680	5150
		Event 4	0.11	0.066	370	440	6640	5860

Figure 5-9. Average Percent Removal for Diesel, Gasoline and Oil and Grease

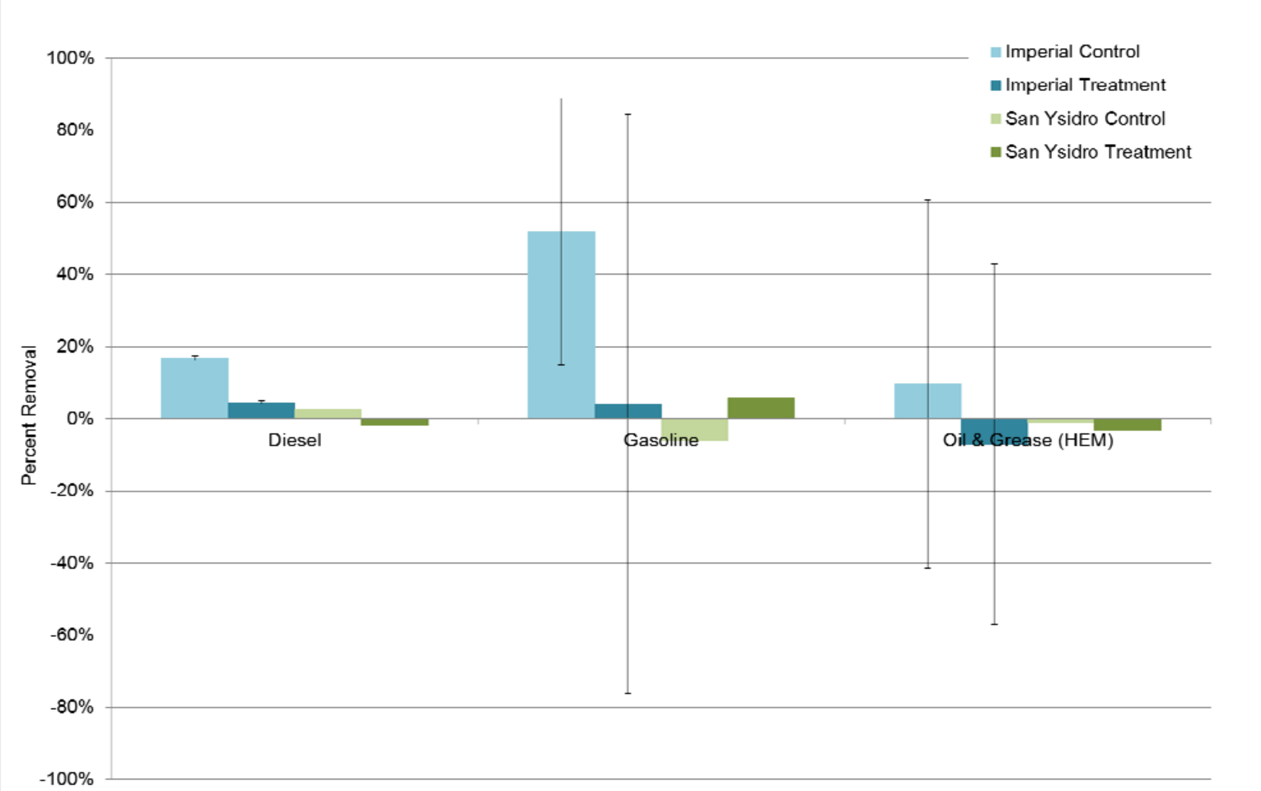


Figure 5-9 shows the average percent removal for gasoline, diesel and oil and grease for the Imperial and San Ysidro routes. Average percent removal for the control and treatment speeds are compared side-by-side for both routes for each constituent. Percent removal of constituents was calculated in the same manner as that for copper, lead and zinc.

The average percent removal results show that the data is variable, and in some cases the post-sweep concentrations are above the pre-sweep concentrations, as indicated by the negative percent removal values. Comparison of pollutant removal between the control and treatment speeds shows there is no clear pattern indicating slower sweeper speed results in greater pollutant removal efficiency. There was greater percent removal of diesel and gasoline at the control speed for the Imperial route.

5.1.2.3 Nutrients

Table 5-4 summarizes the pre- and post-sweep concentrations of Total Kjeldahl Nitrogen (TKN) and total phosphorus (TP). TKN and TP are representative nutrients common in urban runoff in residential, agricultural, and landscaped areas. These constituents were analyzed to determine if slowing sweeper speed increased the removal of these pollutants commonly present in roadway runoff.

Table 5-4. Concentrations of Nutrients in Debris

Route	Sweep	Sample Date	TKN (mg/kg)		TP (mg/kg)	
			Control	Treatment	Control	Treatment
Imperial	Pre-sweep	Event 1	1200	1000	317	231
		Event 2	1400	860	314	272
		Event 3	890	770	244	254
		Event 4	1000	770	290	252
	Post-sweep	Event 1	870	1200	218	259
		Event 2	3900	960	295	230
		Event 3	810	4200	287	353
		Event 4	520	640	250	284
San Ysidro	Pre-sweep	Event 1	1100	960	298	249
		Event 2	760	1000	283	288
		Event 3	570	1000	219	229
		Event 4	720	950	247	228
	Post-sweep	Event 1	1000	730	243	174
		Event 2	800	940	252	207
		Event 3	530	2900	199	278
		Event 4	1100	310	295	272

Figure 5-10. Average Percent Removal for TKN and TP

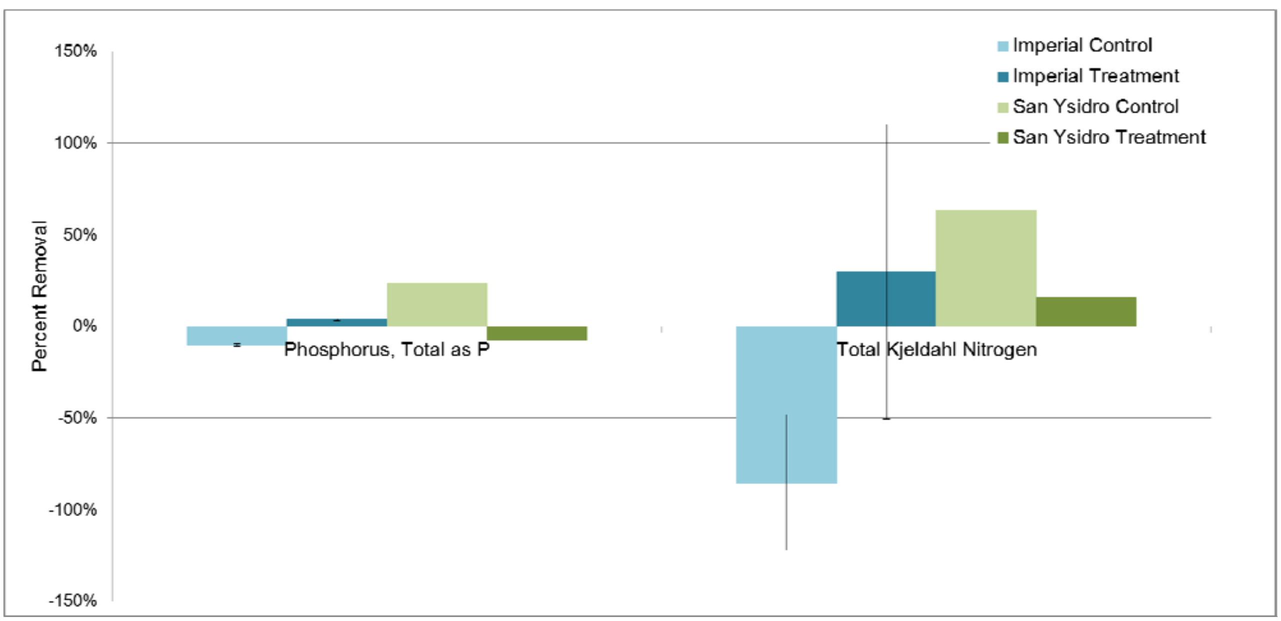


Figure 5-10 shows the average percent removal for TKN and TP. Similar to the results for metals and hydrocarbons, the average percent removal results show that the data is variable, and in some cases the post-sweep concentrations are above the pre-sweep concentrations, as indicated by the negative percent removal values. Again, there is no clear pattern indicating that slower sweeper speed results in greater pollutant removal efficiency.

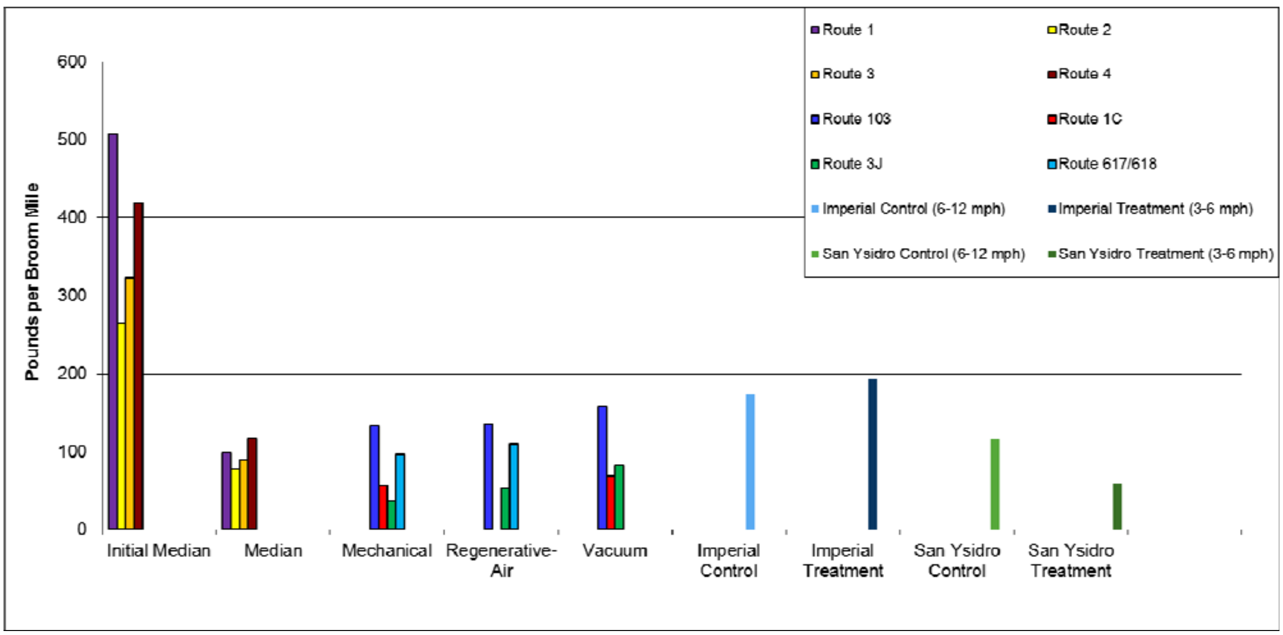
5.2 PHASE I-IV ANALYSIS

Debris collection weight and pollutant removal results from the Phase IV analysis were compared to summary data from Phases I-III to determine the overall effectiveness of different sweeping optimization techniques.

5.2.1 Weight of Debris Collected

Figure 5-11 shows the average debris weight collected in pounds per broom mile for each of the different sweeping optimization technologies/techniques for Phases I through IV. The data show that Phase IV average debris weights are comparable to those measured for mechanical, regenerative and vacuum sweepers. The highest removal of debris was achieved with implementation of the initial median sweeping optimization technique.

Figure 5-11. Comparison of Debris Collected for All Phases

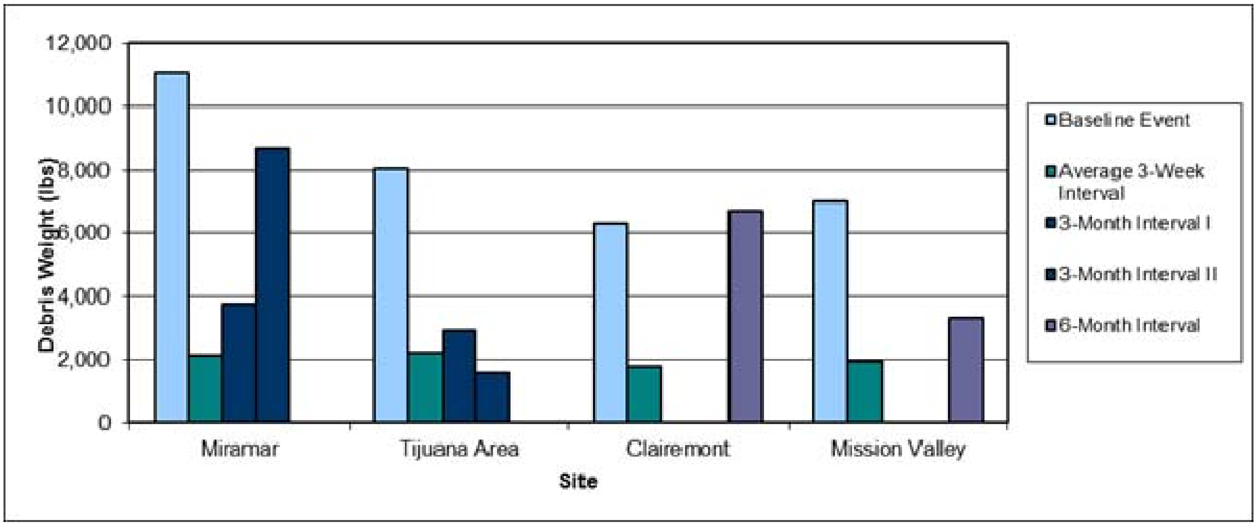


5.2.2 Median Sweeping Frequency Assessment

As a result of the Phase III median sweeping results, a preliminary median sweeping frequency assessment was conducted. A simple pilot study was designed to determine the amount of debris collected on the Phase III median routes at three- and six-month sweeping intervals using mechanical sweepers. The Miramar and Tijuana Area routes were swept twice at three month intervals. The

Clairemont and Mission Valley routes were swept once at a six month interval. The weight of debris collection was monitored in each sweeping event. Sample collection and analysis of debris was not performed as part of this pilot. The median sweeping frequency analysis results are presented in Figure 5-12.

Figure 5-12. Preliminary Median Sweeping Frequency Assessment Results



5.2.3 Pollutant Removal

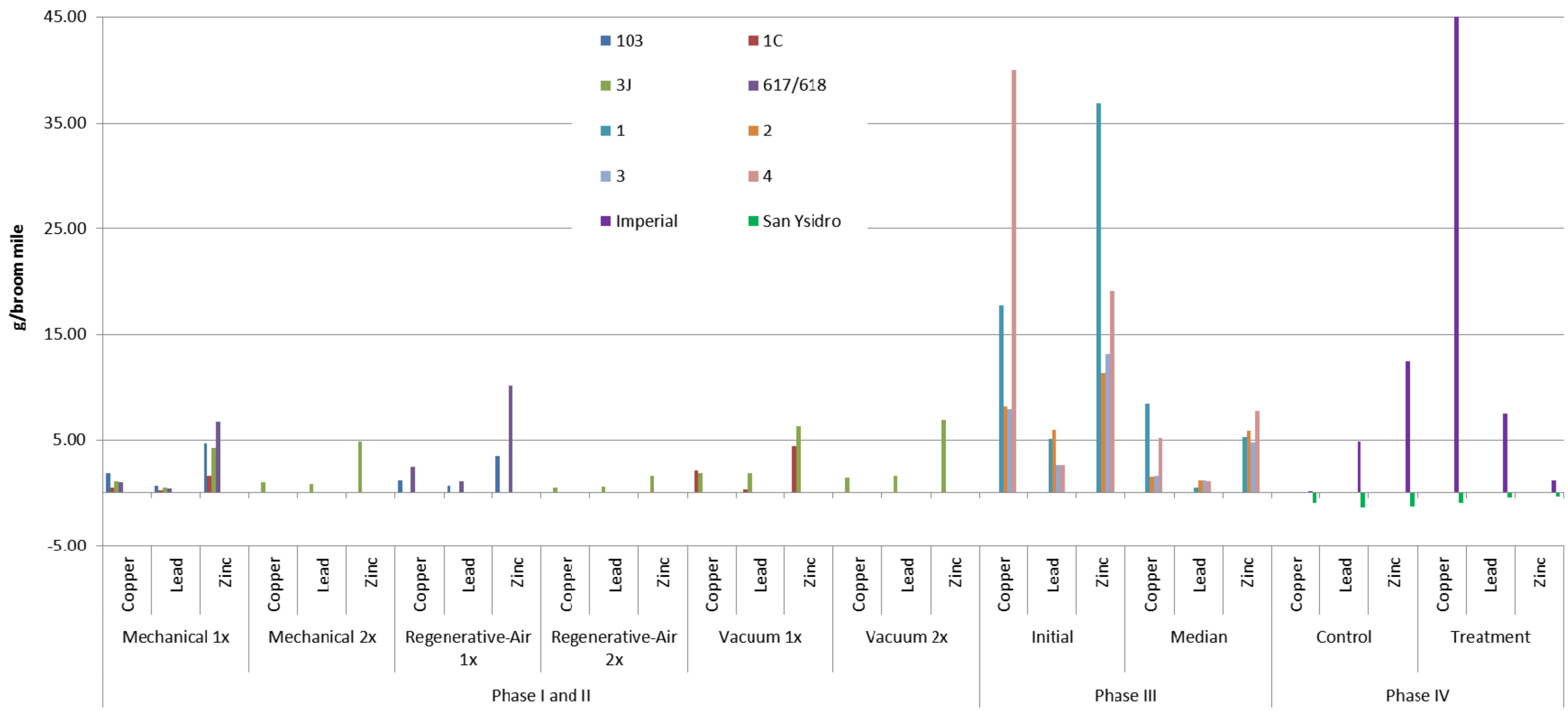
As discussed previously, Phase IV pollutant concentrations were measured in pre- and post-sweep samples collected using a hand vacuum. The collection of pre- and post-sweep data allows for an evaluation of the initial distribution of debris and pollutants on both sides of the street, as well as a determination of the amount of pollutants left on the street after the sweepers have passed. Pollutant removal in grams per broom mile for Phase IV was calculated by subtracting the post-sweep pollutant concentration from the pre-sweep pollutant concentration, multiplying the difference by the average weight of debris collected by the sweeper for the respective route, and dividing by the number of broom miles for that route. This method of extrapolation is different from the method used to calculate pollutant removal in Phases I-III. In Phases I-III, pollutant removal in grams per broom mile was calculated by multiplying the pollutant concentration of a sub-sample of the total debris collected for the entire route by the total bin debris weight for that route, and dividing by the total number of broom miles. Average pollutant removal, in grams per broom mile, for each of the sweeping optimization technologies/techniques is shown in Figure 5-13.

One implication of the Phase IV sampling method, as evidenced by the data for the San Ysidro route shown in Figure 5-13, is that negative pollutant removal values are possible since some sampling events had post-sweep pollutant concentrations that were higher than the pre-sweep concentrations, likely due to the variability of the data.

For the Imperial route, however, pollutant removal in grams per broom mile is consistent with those levels of pollutant removal seen for other sweeping technologies/techniques implemented in Phases I-III.

As illustrated in Figure 5-13, a consistently high level of pollutant removal was achieved with the initial median sweeping technique.

Figure 5-13. Comparison of Pollutant Removal for Copper, Lead and Zinc for All Phases



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SECTION 6 COST ANALYSIS

An important component of the Pilot Program is assessment of the relative pollutant removal capability and cost-efficiency of the various street sweeping optimization techniques. As described above, each phase of the Pilot Program has focused on an optimization technique(s) to enhance the City's current street sweeping efforts. As part of the Phase IV study, a preliminary cost-efficiency assessment was performed using City financial and vehicle performance data.

In order to allow the preliminary cost-efficiency assessment, City staff queried and compiled data from several sources. A summary of the data sources used in the preliminary cost-efficiency assessment is presented in Table 6-1.

Table 6-1. Summary of Preliminary Cost-efficiency Assessment Data Sources

Data Source	Data Description	Application
Street Sweeper Operating Costs	Summary spreadsheet of actual fuel, preventative maintenance and repair labor and parts for each machine in City fleet.	Development of average operating cost per mile for mechanical, vacuum-assisted and regenerative air machines.
Performance Measures Report	Summary spreadsheet of operator-reported miles swept, water usage, debris collected (estimated volume and weight), and other parameters for commercial, residential, and Pilot Study routes.	Development and enhancement of estimated debris disposal, mileage and other costs for City street sweeping program.
Sweeper Program Personnel and Non-personnel Costs	Summary spreadsheet of street sweeping program labor and non-sweeper equipment costs.	Development of personnel and non-sweeper equipment costs associated with mechanical, vacuum-assisted and regenerative air sweeping machines.
Vehicle Performance Summary Report	Summary report of actual sweeper vehicle global positioning system (GPS) information.	Development of machine-specific mileage data.

The data sources presented in Table 6-1 were used to develop a preliminary cost-efficiency assessment for each of the sweeper types utilized in the City street sweeping fleet. It should be noted that comparison of several of the data sources utilized in the preliminary cost-efficiency assessment identified a number of minor discrepancies and/or data gaps for key usage and financial metrics. A summary of the key identified issues and associated assumptions that were utilized to allow preparation of the preliminary cost-efficiency assessment is presented in Table 6-2.

Table 6-2. Summary of Identified Preliminary Cost-efficiency Assessment Data Source Issues and Gaps

Data Source	Key Data Issue	Applied Assumption/Resolution
Performance Measures Report Vehicle Performance Summary Report	Staff-recorded sweeper mileage data is inconsistent with vehicle GPS records.	Generally, GPS-recorded daily mileage data was utilized to estimate vehicle usage. Staff identified that individual vehicle GPS units are occasionally non-operational and therefore may underestimate vehicle usage. When GPS data for specific sweepers were not available, driver-reported mileage estimates were used.
Vehicle Performance Summary Report	Vehicle mileage for vacuum-assisted and regenerative air machines in City Fiscal Year (FY) 2010 was significantly lower than mechanical sweepers. FY 2011 vehicle mileage records (9 months of data available) indicate increased usage of vacuum-assisted and regenerative air machines relative to FY 2010 data. For FY 2011, only 6 months of fuel, preventative maintenance and repair cost data is available.	Best professional judgment was used to project annual vehicle mileage and fuel, preventative maintenance and repair costs for mechanical, vacuum-assisted and regenerative air machines.
Sweeper Program Personnel and Non-personnel Costs	Application of reported number of staff and associated personnel costs exceeds known actual staff costs for City FY 2010.	Best professional judgment was used to apply reported number of staff and associated costs to analysis. It is recognized that this resolution slightly overestimates labor costs. However, due to the application of estimated operator and support team labor costs to machine types based simply on the number of machines in the fleet, it is anticipated this difference does not have significant impact on interpretation of the overall cost-efficiency analysis at this preliminary stage.
Source Not Available	Accurate machine-specific debris removal efficiency data is currently not available. Current data identifies subjective measurements of debris volume collected on a route-specific basis. A direct linkage between these subjective volume measurements and debris weight data for typical routes is not available.	This data gap is unable to be addressed with current data collection mechanisms.

A preliminary estimate of annual usage and assignment, fuel, preventative maintenance and repair costs for each of the sweeper types utilized in the City street sweeping fleet is presented in Table 6-3. Given that a number of disparate and partially complete data sets were compiled to generate this summary information, it is recommended that these preliminary results be interpreted with caution. However based on available data, the vacuum-assisted and regenerative air sweeper types are estimated to be approximately 33% more cost-effective to operate on a per-mile of operation basis when compared to the mechanical sweeper type.

Table 6-3. Estimated Annual Sweeper Vehicle Usage and Cost Data

Usage Parameter	Mechanical Sweeper	Vacuum-Assisted Street Sweeper	Regenerative-Air Street Sweeper
Number of Sweeper Vehicles in City Fleet	23	4	1
Sweeper Usage[1]	7,500 miles	8,776 miles	4,181 miles
Assignment[2] Fee	$17,853	$20,049	$15,267
Fuel Cost[3]	$6,844	$5,044	$1,945
Preventative Maintenance Cost[3]	$4,487	$1,467	$1,773
Repair Cost[3]	$33,662	$20,742	$4,445
Total Sweeper Vehicle Operation Cost	**$62,845**	**$47,303**	**$23,430**
Sweeper Vehicle Operation Cost	**$8.38/mile**	**$5.39/mile**	**$5.60/mile**

1 Annual sweeper mileage estimated using 9 months of available data (July 1, 2010-April 1, 2011).
2 Assignment fee is the assessment for future replacement of a vehicle.
3 Annual fuel, maintenance and repair costs estimated using 6 months of available data (July 1, 2010-December 31, 2010).

Additional costs associated with the City street sweeping program include support vehicle assignment and maintenance fees, operator and support team labor, and disposal fees. Given the complexity of the City street sweeping program and associated labor and support activities and equipment, it is difficult to determine the relative proportion of costs that should be assigned the various sweeping technology types. As an example, there are 17 identified support vehicles for the street sweeping program including: roll-off trucks, dump trucks, and ¾ ton and compact pickup trucks. Given the data and operational knowledge limitations of this study, the number of sweeper vehicles in the City fleet was used as a proxy to assign a proportional allocation of additional costs to each sweeper type as presented in Table 6-4. It is recognized that the actual costs for vehicle operation and support activities may significantly vary by sweeper type. Therefore the preliminary assignment of cost-efficiency assessment data for operations and support activities should be used for informational purposes until more detailed sweeper-specific information can be obtained.

Table 6-4. Estimated Annual Street Sweeping Operations and Support Cost Data

Parameter	Mechanical Sweeper	Vacuum-Assisted Street Sweeper	Regenerative-Air Street Sweeper
Percentage of Sweeping Fleet	82%	14%	4%
Support Vehicle Operation Cost	$79,601	$10,383	$3,461
Operations Labor	19.6 FTE[1]	2.6 FTE	0.9 FTE
Operations Labor Cost	$2,700,626	$352,256	$117,419
Support Labor	3.4 FTE	0.4 FTE	0.1 FTE
Support Labor Cost	$389,826	$203,388	$16,949
Disposal	$371,653	$48,476	$16,159
Total	**$3,604,552**	**$661,805**	**$177,417**

1 FTE- Full Time Equivalent

SECTION 7 SUMMARY

The City has developed a series of pilot projects under the Targeted Aggressive Street Sweeping Pilot Program designed to evaluate the feasibility, potential water quality benefits, and cost-effectiveness of modifications to its current street sweeping program. Phases I and II of this program assessed the relative pollutant removal and cost-efficiency of increased sweeping frequency and advanced sweeper equipment technologies. The purpose of Phase III of the pilot Program was to evaluate the relative pollutant removal efficiency of increased street sweeping routes such as roadway medians adjacent to high volume roadways. Phase IV was designed to determine whether sweeping at a slower operational speed than the current operational speed would increase debris and pollutant removal efficiency.

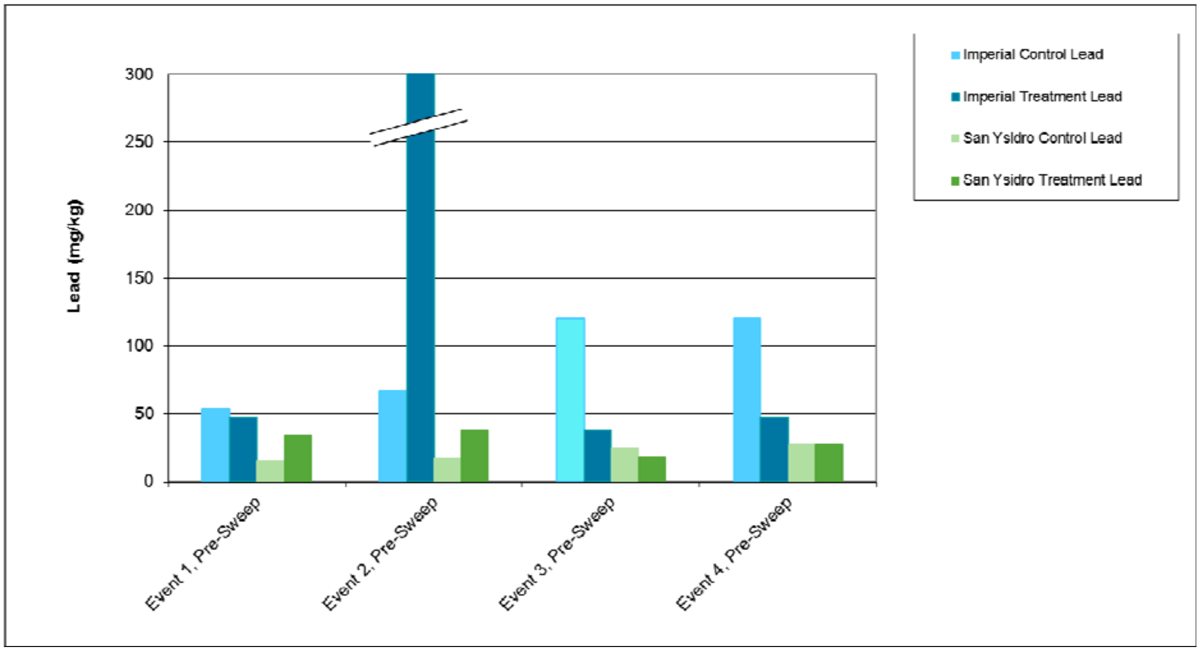
7.1 SUMMARY OF RESULTS

Results from the Phase IV Speed Efficiency study indicate that the operational speed of mechanical street sweepers has little impact on the weight of debris collected in the field. The weight of material collected by the street sweepers on the portions of the routes that were swept at the treatment operation speed (3-6mph) and the control operational speed (6-12 mph) was highly variable. In some cases the treatment operational speed collected a higher weight of material and in other cases the control operational speed collected a higher weight of material. There did not appear to be a consistent pattern to the variability, comparison of results between the Imperial and San Ysidro routes and between sample events showed similar inconsistent results.

The street debris hand vacuum data indicate similar inconsistent results when comparing the treatment and control speed samples. More street debris was collected at the treatment speed as compared to the control speed for the San Ysidro route, while the opposite was true for the Imperial route. Similar to the weight of debris collected by the sweeper, the hand vacuum data shows that slowing the speed of the sweeper did not consistently increase the amount of debris collected by hand vacuuming in the sample plot areas.

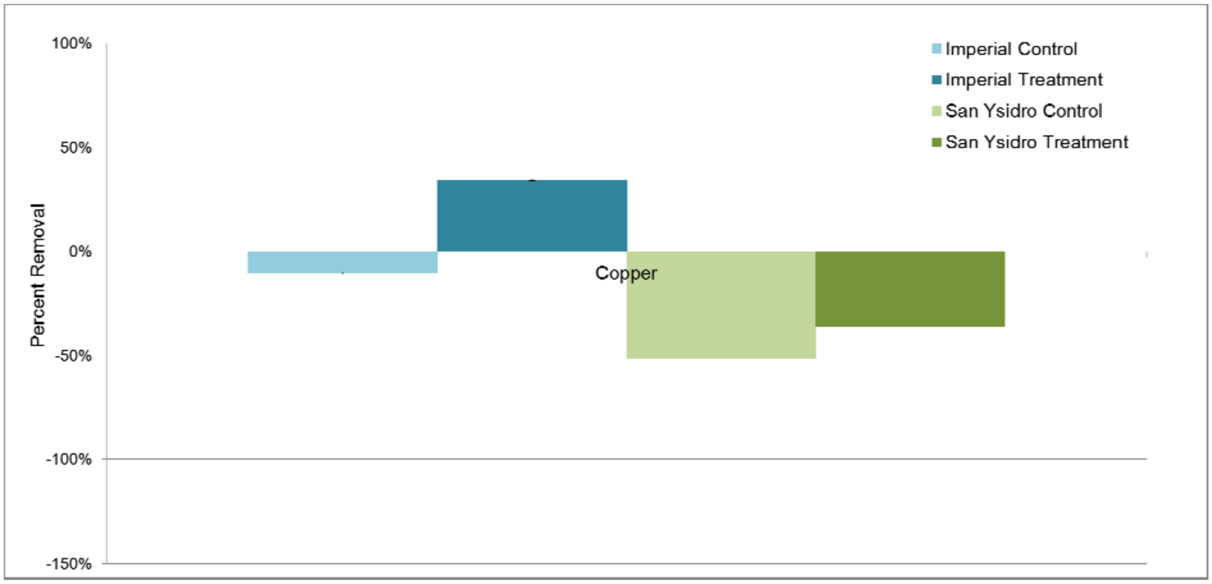
In addition, chemistry analysis of roadway debris samples collected prior to and after street sweeping activity on the focal routes indicates that there is significant variability in the pre-sweep sample results (Figure 7-1). The comparison of pre-sweep data allowed for the evaluation of the initial distribution of pollutants on the roadway surface. The results indicate that for both the San Ysidro and Imperial routes, the concentration of roadway pollutants is highly variable. This fact is likely a primary driver for the inconsistency observed in the pollutant removal data.

Figure 7-1. Pre-sweep Concentrations of Lead



In Phase IV, pollutant removal was calculated by subtracting the post-sweep sample concentration from the pre-sweep sample concentration, dividing by the pre-sweep concentration, and then converting to a percentage. As discussed above, the percent removal results show that the data is variable, and in some cases the post-sweep concentrations are above the pre-sweep concentrations. This pattern results in negative percent removal values for some constituents and routes. An example of this variable pattern of percent removal for copper is presented in Figure 7-2. This pattern is likely an artifact of the variability of the pre- and post-sweep sample data. Comparison of pollutant removal between the control and treatment speeds shows there is no clear pattern indicating slower sweeper speed results in greater pollutant removal efficiency. The variability presented for copper in Figure 7-2 is representative of other results for conventional, metals, nutrients and hydrocarbon constituents.

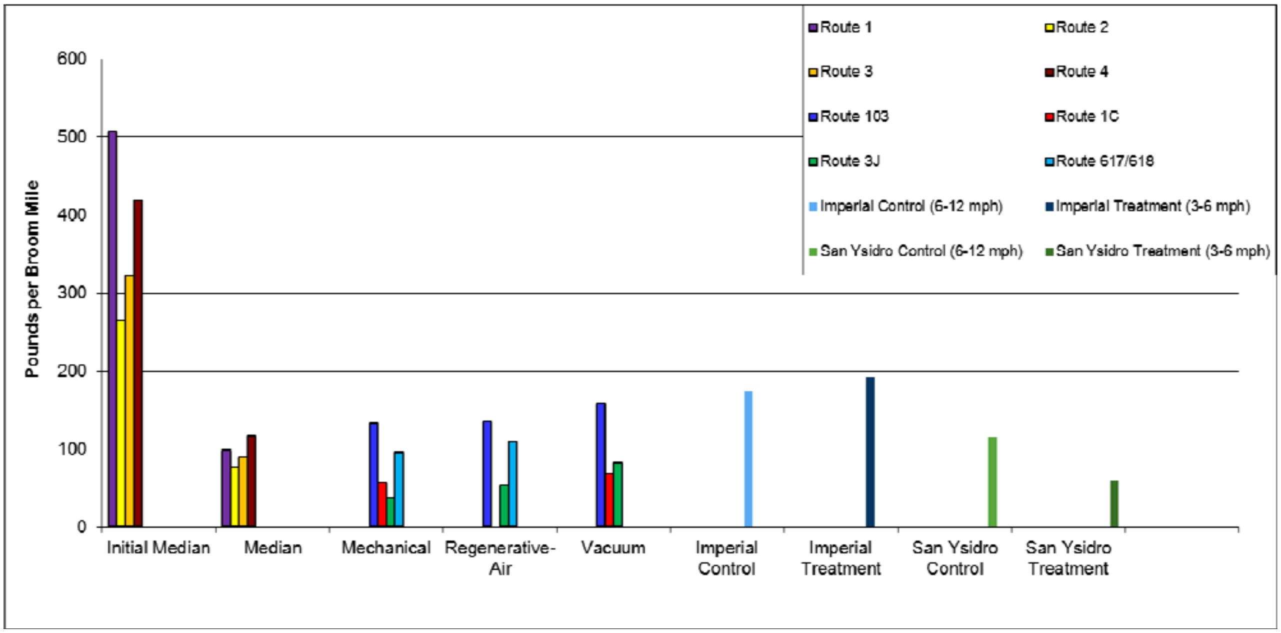
Figure 7-2. Percent Removal of Copper for Treatment and Control Sweeper Speeds



Given the variability in the results for Phase IV, there is no clear pattern indicating slower sweeper operation speed results in greater debris or pollutant removal efficiency. Based on the presented results, it is likely that the study design and methods used to collect the roadway debris samples are highly sensitive to the variable distribution and abundance of roadway pollutants in the field. Accordingly, future efforts to understand the effectiveness of various street sweeping optimization techniques may benefit from a study design that combines collected machine debris monitoring with other types of pollutant concentration sampling.

In order to assess the relative effectiveness of operational speed changes and the other street sweeping optimization techniques piloted in Phases I-III of the Pilot Program, an expanded analysis of the Phase I-IV data was conducted. A comparison of the debris removal results derived from the various optimization techniques and technologies studied in Phases I-IV is presented in Figure 7-3.

Figure 7-3. Comparison of Debris Collected for Pilot Program Phases I-IV

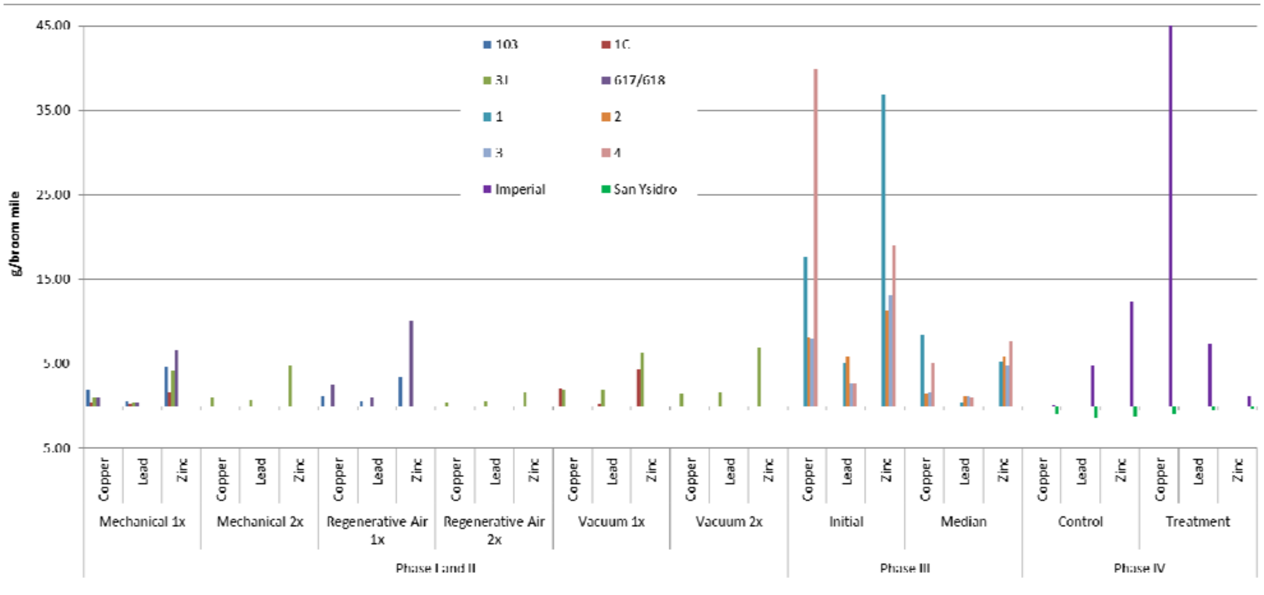


The data indicates that the average debris weights in Phase IV, calculated on a pound per broom mile basis, are comparable to those observed for the vacuum-assisted and regenerative-air sweepers (Phases I and II) and the three-week interval median sweeping technique (Phase III). The highest observed debris removal was achieved in the initial median sweeping event conducted during Phase III. These results indicate that roadway areas that are not commonly swept (i.e. median areas which are infrequently swept) potentially provide the most effective way to increase debris removal (and associated pollutant removal) with limited increase in level of effort or cost.

As discussed above, pollutant removal (in grams per broom mile) for Phase IV was calculated by extrapolating pre- and post-sweep pollutant concentration data. This method of extrapolation is different from the method used to calculate pollutant removal in Phases I-III. In Phases I-III, pollutant removal in grams per broom mile was calculated by multiplying the pollutant concentration of a sub-sample of the debris collected by the sweeper over entire route by the total debris weight for that route, and then dividing by the total number of broom miles. In the Phase IV study, the roadway debris collection prior to and after the sweeper pass allows calculation of both the amount of debris removed (by measuring the weight of the collected debris) and also calculation of the relative efficiency of sweeper debris collection at the two focal operating speeds.

Even considering these sampling method and pollutant removal calculation differences, pollutant removal in Phase IV, calculated in grams per broom mile, is consistent with the various sweeping optimization technologies/techniques implemented in Phases I-III. As illustrated in Figure 7-4, a consistently high level of pollutant removal was achieved with the initial median sweeping technique. In addition, as discussed above the apparent negative pollutant removal in Phase IV is likely driven by highly variable roadway pollutant concentrations and relatively sensitive sampling techniques. Based the Phase I-IV data, it is recognized that mechanical sweepers are effective at removing roadway debris and pollutants on a large scale.

Figure 7-4. Comparison of Copper, Lead and Zinc Removal in Phases I-IV



Finally, as part of the Phase IV study, a preliminary cost analysis was conducted in order to provide the basis for a cost-efficiency assessment of the various street sweeping optimization techniques. In order to perform the preliminary cost analysis City street sweeping operational cost data was compiled by City staff from various sources. In some instances, the compiled operational cost data presented incomplete and/or contradictory data. Accordingly, it is recommended that the preliminary cost analysis results be interpreted with caution. The preliminary cost analysis results indicate that the mechanical sweepers are approximately 33% more costly to operate than the vacuum-assisted and regenerative-air sweepers (Table 7-1). This preliminary result is at least partially driven by the fact that City street sweeper fleet is currently predominantly (approximately 85%) mechanical sweepers and therefore provides a robust data set for comparison.

Table 7-1. Summary of Estimated Sweeper Vehicle Type Cost Data

Sweeper Type	Operational Cost ($/mile operation)
Mechanical	$8.38
Vacuum-Assisted	$5.39
Regenerative-Air	$5.60

This Report presents the results of the Phase IV Speed Efficiency Study, a comparison of Phase IV results to the previous Phase I-III results and a preliminary street sweeping operational cost analysis. Given the limitations above, these data and analysis will likely provide City storm water managers valuable information that may be used to implement various optimization techniques to improve the pollutant-removal and cost-efficiency of the City street sweeping program.

A potential application of the pilot program data is to provide long-term sweeper type procurement recommendations based on pollutant removal, cost-efficiency, and other considerations. The Phase I-IV pollutant removal data does not provide significantly compelling results to provide long-term sweeper procurement recommendations. The data does indicate increased pollutant removal capability for vacuum-assisted sweepers for some roadway conditions, correlation between sweeping frequency and concentrations of constituents in wet weather water quality samples, and significant debris removal capability for median area sweeping. However, improved debris removal tracking and more detailed operational cost data is required to develop a realistic cost-benefit analysis that may be used to optimize the machine-type composition of the City street sweeping fleet.

SECTION 8 REFERENCES

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Appendix A Daily Sweeper Logs

9/24/10

SPECIAL 15/518672 41702?45

SPECIAL 48 25/340772

SPECIAL 25/340779

SWEEPER DAILY REPORT

Date: 9-25-2010 | Equipment #: 718 057 | Operator: Othwdl, T

							Grand Total
01 Route/Job No.	Sp(1)	Imperial	8A Dairy MART	10.19			
02 Complete Incomplete	Comp.	Comp	SAN ?S1D RD Comp				Comp.
03 Speedometer Stop	18346	18372	18399	18416			
04. Speedometer Start	18330	18346	18372	18399			
05. Total Mileage	16	26	27	17		0	86
06. Broom Meter Stop	18346	18367	18399				
07. Broom Meter Start	18345	18363	18391				
08. Total Broom Mileage	1	4	8			26	13
09. Total Travel Mileage	15	17	19	17			68
10. Dump Milage (Information only)		5					5
11. Equipment/ Manual Hours							
12. Maintenance Hours							
13. Breaks							
14. Down Time							
15. Total Hours							
16. Water Usage (cubic feet)	10	175	200				385
17. Debris Collected (cu. ft.)	.5	1.5	2.5				4.5

Dump Location	Cubic Yards
Chollas	4.5

REMARKS: (reason for down time, unusual conditions of route, location of special job, etc.)

Sp(1) Rosecrances @ Nothing Glass In st.

Call out by Snelling 6:30 pm

Imperial - study sweeps

SWEEPER DAILY REPORT

9-25-10 SPECIAL 4B 25/340766 SPECIAL 8A 25/340776

Date: 9/24/10 Equipment #: 718049 Operator: Childress

							Grand Total
01. Route/Job No.	IMPERIAL		South Bay ~~SAN ISIDRO~~				
02. Complete Incomplete							
03. Speedometer Stop	51013		51061				
04. Speedometer Start	51992		51013				
05. Total Mileage	21		48			0	69
06. Broom Meter Stop	51008		51043				
07. Broom Meter Start	51000		51035				
08. Total Broom Mileage	8		8			8.3	16
09. Total Travel Mileage							
10. Dump Milage (Information only)							
11. Equipment/ Manual Hours							
12. Maintenance Hours							
13. Breaks							
14. Down Time							
15. Total Hours							
16. Water Usage (cubic feet)	150		100				250
17. Debris Collected (cu. ft.)	1 yd		1				2yds

Dump Location	Cubic Yards
Special Bins 6-12	2

REMARKS: (reason for down time, unusual conditions of route, location of special job, etc.)

Route was swept today Sch

Route was pertty clean.

SWEEPER DAILY REPORT

10/16/10 SPECIAL 4171951 SPECIAL 4171952

Date ~~10/15/10~~ 4B | Equipment # 718039 | Operator Childress

							Grand Total
01. Route/Job No.	IMPERIAL		SOUTHBAY 8A				
02. Complete Incomplete							
03. Speedometer Stop	47290		47329				
04. Speedometer Start	47265		47290				
05. Total Mileage	35		39			655	74
06. Broom Meter Stop	47284		47311				
07. Broom Meter Start	47279		47306				
08. Total Broom Mileage	5		5			127	10
09. Total Travel Mileage							
10. Dump Milage (Information only)							
11. Equipment/ Manual Hours							
12. Maintenance Hours							
13. Breaks							
14. Down Time							
15. Total Hours							
16. Water Usage (cubic feet)	200		150				350
17. Debris Collected (cu. ft.)	2		1				3

Dump Location	Cubic Yards
6-12 IMPERIAL 6-12 SOUTHBAY	

REMARKS (reason for down time, unusual conditions of route, location of special job, etc.)

SPECIAL SPECIAL

Date 10-16-10 ~~10.15.10~~		Equipment # 718-060		Operator BOOKER		

01 Route/Job No.	4B/36mph		8A/36mph				Grand Total
02 Complete Incomplete	Comp.		Comp				
03 Speedometer Stop	3700		3751				
04 Speedometer Start	3689		3700				
05 Total Mileage	11		51			0	62
06 Broom Meter Stop	3700		3726				
07 Broom Meter Start	3695		3720				
08 Total Broom Mileage	5		6			34.4	11
09 Total Travel Mileage	6		45				51
10 Dump Milage (Information only)	5						
11 Equipment/ Manual Hours							
12 Maintenance Hours							
13 Breaks							
14 Down Time							
15 Total Hours							
16 Water Usage (cubic feet)	220		220				440
17 Debris Collected (cu. ft.)	2YDS		1YDA				3YDA

Dump Location	Cubic Yards
Cholla	3YDA

REMARKS (reason for down time, unusual conditions of route, location of special job, etc.)

COPY

Date 11.5.10 SPECIAL SPECIAL [illegible] 718-CLO [illegible] BCCLER

[illegible]	Imperial	S. Bay				Grand Total
02 Complete Incomplete	Comp.	Comp				C
03 Speedometer Stop	4568	4618				
04 Speedometer Start	4557	4568				
05 Total Mileage	11	50			0	61
06 Broom Meter Stop	68	4600				
07 Broom Meter Start	4562	4595				
08 Total Broom Mileage	6	5			25.9	11
09 Total Travel Mileage	5	45				50
10 Dump Milage (Information only)	5	–				
11 Equipment/ Manual Hours						
12 Maintenance Hours						
13 Breaks						
14 Down Time						
15 Total Hours						
16 Water Usage (cubic feet)	220	220				440
17 Debris Collected (cu. ft.)	2YDS	2YDS				4YDS

Dump Location	Cubic Yards
Chollas	4YDS

REMARKS (reason for down time, unusual conditions of route, location of special job, etc.)

COPY

Date 1/5/10 Equipment # 718058 Name Childress

	SPECIAL 4B	SPECIAL 8A					
Route No.	IMPERIAL	San Ysidro ~~[illegible]~~					Grand Total
02 Complete/Incomplete	3-6	3-6					
03 Speedometer Stop	20579	20608					
04 Speedometer Start	20561	20579					
05 Total Mileage	18	29				0	47
06 Broom Meter Stop	20575	20601					
07 Broom Meter Start	20570	20597					
08 Total Broom Mileage	5	4				7	9
09 Total Travel Mileage							
10 Dump Milage (Information only)							
11 Equipment/ Manual Hours							
12 Maintenance Hours							
13 Breaks							
14 Down Time							
15 Total Hours							
16 Water Usage (cubic feet)	200	200					400
17 Debris Collected (cu. ft.)	2	1					3

Dump Location	Cubic Yards
3-6 Imperial 3-6 San Ysidro	~~4~~ 3yds

REMARKS (reason for down time, unusual conditions of route, location of special job, etc.)

SAN YSIDRO → 8A

IMPERIAL → 4B

SPECIAL Y-B
SPECIAL 8-A

[illegible]	11/19/10		[illegible]	718039	[illegible]	Childress	
[illegible]	IMPERIAL		SAN YSIDRO				Grand Total
02 Complete Incomplete	6-12		6-12				
03 Speedometer Stop	47988		48024				
04 Speedometer Start	47978		47993				
05 Total Mileage	10		31				41
06 Broom Meter Stop	47988		48012				
07 Broom Meter Start	47983		48006				
08 Total Broom Mileage	5		6				11
09 Total Travel Mileage							
10 Dump Milage (Information only)							
11 Equipment/ Manual Hours							
12 Maintenance Hours							
13 Breaks							
14 Down Time							
15 Total Hours							
16 Water Usage (cubic feet)	100		150				250
17 Debris Collected (cu. ft.)	2		2				4

Dump Location	Cubic Yards
6-12 IMPERIAL 6-12 SAN YSIDRO	4yds

REMARKS (reason for down time, unusual conditions of route, location of special job, etc.)

SWEEPER DAILY REPORT

SPECIAL 4-13 SPECIAL 8-A

Date: 11.19.10		Equipment # 718-060		Operator Booker		
01. Route / Job No.	Imperial 3-6	South Bay 3-6				Grand Total
02. Complete Incomplete	Comp.	Comp				C
03. Speedometer Stop	48	94				
04. Speedometer Start	5038	5048				
05. Total Mileage	10	46				56
06. Broom Meter Stop	48	75				
07. Broom Meter Start	5043	5071				
08. Total Broom Mileage	5	4				9
09. Total Travel Mileage	5	42				47
10. Dump Milage (Information only)						
11. Equipment/ Manual Hours						
12. Maintenance Hours						
13. Breaks						
14. Down Time						
15. Total Hours						
16. Water Usage (cubic feet)	200	200				400
17. Debris Collected (cu. ft.)	2YD	1YD				3YDS

Dump Location	Cubic Yards
Chollas	3YDS

REMARKS: (reason for down time, unusual conditions of route, location of special job, etc.)

Appendix B Sampling Field Form

TARGETED AGGRESSIVE STREET SWEEPING PILOT PROGRAM
PHASE IV SPEED EFFICIENCY STUDY
HAND SWEEPING DEBRIS SAMPLING FIELD FORM

GENERAL INFORMATION		
Date (mm/dd/yy):		Time (24 hr):
Field Lead:		
Field Support:		
Choose Route:	☐ Route 4-B San Diego Bay Watershed ☐ Route 8-A Tijuana River Watershed	
Choose Phase:	☐ Pre-Route Sweeping Sampling ☐ Post-Route Sweeping Sampling	

CONTROL ROUTE (6-12 MPH) SAMPLING		
C1	Description:	
	Date (mm/dd/yy):	Time (24 hr):
	Sample Volume:	Sample Weight:
C2	Description:	
	Date (mm/dd/yy):	Time (24 hr):
	Sample Volume:	Sample Weight:
C3	Description:	
	Date (mm/dd/yy):	Time (24 hr):
	Sample Volume:	Sample Weight:
C4	Description:	
	Date (mm/dd/yy):	Time (24 hr):
	Sample Volume:	Sample Weight:

TREATMENT ROUTE (3-6 MPH) SAMPLING		
T1	Description:	
	Date (mm/dd/yy):	Time (24 hr):
	Sample Volume:	Sample Weight:
T2	Description:	
	Date (mm/dd/yy):	Time (24 hr):
	Sample Volume:	Sample Weight:
T3	Description:	
	Date (mm/dd/yy):	Time (24 hr):
	Sample Volume:	Sample Weight:
T4	Description:	
	Date (mm/dd/yy):	Time (24 hr):
	Sample Volume:	Sample Weight:

QUALITY ASSURANCE

- ☐ 4 samples from Control Route and 4 samples from Treatment Route?
- ☐ Sample containters labeled correctly (Location ID-YYMMDDHHMM)?
- ☐ Field form filled out completely and accurately?
- ☐ Sampling event completed?

Date (mm/dd/yy):	Field Lead Signature:
Time (24 hr):	

Appendix C Disposal Records

ENVIRONMENTAL SERVICES DEPARTMENT
REFUSE DISPOSAL DIVISION
9601 RIDGEHAVEN CT., SUITE 310 • SAN DIEGO, CA 92123-1636
(858) 694-7000

5180 CONVOY STREET
SAN DIEGO, CA 92111

GENERAL SERVIC
STREET SWEEPI
940554 -

Transaction #: 8457336
Account #: 940554/STORM WATER/O&M
Decal #: 41346, 44954, 0
Fleet #: 835002 Tag #: 1167889
Transaction Type: 08/CITY OTHER DEPTS
Payment Type: CT/CITY
Hauler Type: 08/CITY OTHER DEPTS
Vehicle Type: 030/A - 20 CY OR LESS
Material Type: 004/DEMO
Origin: 001/SAN DIEGO CITY
Special Fees:

Date: 9/25/2010 07:56:07
Scale Operator: TIR
Incoming /FB 01

	LBS	TONS
Gross Weight	22000.00	11.00
Tare Weight	21360.00	10.68
Net Weight	640.00	0.32

Tip Fee	$ 27.00
Spec Fee	$ 0
RCBus Tax	$ 0
Recycle	$ 1.00
Total	**$ 28.00**

Self-Haul Flat Rate Disposal Fee, Admin Fee & Spec Handling Fee increase effective 7/1/2010.

Imperial 3-6mph

DREW

SIGNATURE

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(858) 694-7000

MIRAMAR LANDFILL
5180 CONVOY STREET
SAN DIEGO, CA 92111

922
MWATER
ATIONS & MAINTENANCE
554 -

Transaction #: 8464731
Account #: 940554/STORM WATER/O&M
Decal #: 32566, 44953, 0
Fleet #: 806016 Tag #:
Transaction Type: 08/CITY OTHER DEPTS
Payment Type: CT/CITY
Hauler Type: 08/CITY OTHER DEPTS
Vehicle Type: 030/A - 20 CY OR LESS
Material Type: 001/REFUSE
Origin: 001/SAN DIEGO CITY
Special Fees:

Date: 10/2/2010 13:31:50
Scale Operator: TIR
Incoming /FB 02

	LBS	TONS
Gross Weight	28580.00	14.29
Tare Weight	27620.00	13.81
Net Weight	960.00	0.48

Tip Fee	$ 18.00
Spec Fee	$ 0
RCBus Tax	$ 0
Recycle	$ 1.00
Total	**$ 19.00**

Self-Haul Flat Rate Disposal Fee, Admin Fee & Spec Handling Fee increase effective 7/1/2010.

6-12 mph
Richard / IMPERIAL AVE
SIGNATURE

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(858) 694-7000

MIRAMAR LANDFILL
5180 CONVOY STREET
SAN DIEGO, CA 92111

Transaction #: 8464497
Account #: 940554/STORM WATER/O&M
Decal #: 32566, 40818, 0
Fleet #: 806016 Tag #:
Transaction Type: 08/CITY OTHER DEPTS
Payment Type: CT/CITY
Hauler Type: 08/CITY OTHER DEPTS
Vehicle Type: 030/A - 20 CY OR LESS
Material Type: 001/REFUSE
Origin: 001/SAN DIEGO CITY
Special Fees:

Date: 10/2/2010 11:41:03
Scale Operator: BS2
Incoming /FB 01

STORMWATER
OPERATIONS & MAINTENANCE
940554 -

	LBS	TONS
Gross Weight	27520.00	13.76
Tare Weight	26420.00	13.21
Net Weight	1100.00	0.55

Tip Fee	$ 18.00
Spec Fee	$ 0
RCBus Tax	$ 0
Recycle	$ 1.00
Total	**$ 19.00**

Self-Haul Flat Rate Disposal Fee, Admin Fee & Spec Handling Fee increase effective 7/1/2010.

Richard / 6-12 mph
SAN YSIDRO

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(858) 694-7000

804-022
STORMWATER
OPERATIONS & MAINTENANCE
940554 -

MIRAMAR LANDFILL
5180 CONVOY STREET
SAN DIEGO, CA 92111

Transaction #: 8464347
Account #: 940554/STORM WATER/O&M
Decal #: 32566, 45171, 0
Fleet #: 806016 Tag #:
Transaction Type: 08/CITY OTHER DEPTS
Payment Type: CT/CITY
Hauler Type: 08/CITY OTHER DEPTS
Vehicle Type: 030/A - 20 CY OR LESS
Material Type: 001/REFUSE
Origin: 001/SAN DIEGO CITY
Special Fees:

Date: 10/2/2010 10:22:40
Scale Operator: TIR
Incoming /FB 03

	LBS	TONS
Gross Weight	28540.00	14.27
Tare Weight	28520.00	14.26
Net Weight	20.00	0.01

Tip Fee	$ 18.00
Spec Fee	$ 0
RCBus Tax	$ 0
Recycle	$ 1.00
Total	**$ 19.00**

Self-Haul Flat Rate Disposal Fee, Admin Fee & Spec Handling Fee increase effective 7/1/2010.

Richard / 3-6 mph
SAN YSIDRO
SIGNATURE

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5180 CONVOY STREET
SAN DIEGO, CA 92111

SV

835-001
GENERAL SERVICES
STREET SWEEPING

Transaction #: 8479425
Account #: 940554/STORM WATER/O&M
Decal #: 41346, 40818, 0
Fleet #: 835002 Tag #: 1167889
Transaction Type: 08/CITY OTHER DEPTS
Payment Type: CT/CITY
Hauler Type: 08/CITY OTHER DEPTS
Vehicle Type: 030/A - 20 CY OR LESS
Material Type: 004/DEMO
Origin: 001/SAN DIEGO CITY
Special Fees:

Date: 10/17/2010 11:14:00
Scale Operator: CCX
Incoming /FB 02

940554 -

	LBS	TONS
Gross Weight	20960.00	10.48
Tare Weight	20380.00	10.19
Net Weight	580.00	0.29

Tip Fee	$ 27.00
Spec Fee	$ 0
RCBus Tax	$ 0
Recycle	$ 1.00
Total	**$ 28.00**

Self-Haul Flat Rate Disposal Fee, Admin Fee & Spec Handling Fee increase effective 7/1/2010.

SAN YSIDRO 3-6 MPH
SW - STUDY
WK OF 10/11/10

SIGNATURE

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MIRAMAR LANDFILL
5180 CONVOY STREET
SAN DIEGO, CA 92111

Transaction #: 8479225
Account #: 940554/STORM WATER/O&M
Decal #: 41346, 44948, 0
Fleet #: 835002 Tag #: 1167889
Transaction Type: 08/CITY OTHER DEPTS
Payment Type: CT/CITY
Hauler Type: 08/CITY OTHER DEPTS
Vehicle Type: 030/A - 20 CY OR LESS
Material Type: 004/DEMO
Origin: 001/SAN DIEGO CITY
Special Fees:

Date: 10/17/2010 08:12:08
Scale Operator: P3K
Incoming /FB 01

835-001
GENERAL SERVICES
STREET SWEEPING
940554

	LBS	TONS
Gross Weight	22120.00	11.06
Tare Weight	21940.00	10.97
Net Weight	180.00	0.09

Tip Fee	$ 27.00
Spec Fee	$ 0
RCBus Tax	$ 0
Recycle	$ 1.00
Total	**$ 28.00**

Self-Haul Flat Rate Disposal Fee, Admin Fee & Spec Handling Fee increase effective 7/1/2010.

SAN YSIDRO 6-12 MPH
SW - STUDY
WK OF 10/11/10

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(858) 694-7000

MIRAMAR LANDFILL
5180 CONVOY STREET
SAN DIEGO, CA 92111

835-001
GENERAL SERVICES
STREET SWEEPING
940554 -

Transaction #: 8479287
Account #: 940554/STORM WATER/O&M
Decal #: 41346, 44954, 0
Fleet #: 835002 Tag #: 1167889
Transaction Type: 08/CITY OTHER DEPTS
Payment Type: CT/CITY
Hauler Type: 08/CITY OTHER DEPTS
Vehicle Type: 030/A - 20 CY OR LESS
Material Type: 004/DEMO
Origin: 001/SAN DIEGO CITY
Special Fees:

Date: 10/17/2010 09:10:35
Scale Operator: P54
Incoming /FB 01

	LBS	TONS
Gross Weight	22320.00	11.16
Tare Weight	21360.00	10.68
Net Weight	960.00	0.48

Tip Fee	$ 28.00
Spec Fee	$ 0
RCBus Tax	$ 0
Recycle	$ 5.00
Total	**$ 33.00**

Self-Haul Flat Rate Disposal Fee, Admin Fee & Spec Handling Fee increase effective 7/1/2010.

IMPERIAL 3-6 MPH
SW-STUDY
WK OF 10/11/0

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(858) 694-7000

MIRAMAR LANDFILL
5180 CONVOY STREET
SAN DIEGO, CA 92111

1M

835-001
GENERAL SERVICES
STREET SWEEPING

Transaction #: 8479357
Account #: 940554/STORM WATER/O&M
Decal #: 41346, 44953, 0
Fleet #: 835002 Tag #: 1167889
Transaction Type: 08/CITY OTHER DEPTS
Payment Type: CT/CITY
Hauler Type: 08/CITY OTHER DEPTS
Vehicle Type: 030/A - 20 CY OR LESS
Material Type: 004/DEMO
Origin: 001/SAN DIEGO CITY
Special Fees:

Date: 10/17/2010 10:14:14
Scale Operator: RTA
Incoming /FB 02

940554 -

	LBS	TONS
Gross Weight	22840.00	11.42
Tare Weight	21580.00	10.79
Net Weight	1260.00	0.63

Tip Fee	$ 37.00
Spec Fee	$ 0
RCBus Tax	$ 0
Recycle	$ 6.00
Total	**$ 43.00**

Self-Haul Flat Rate Disposal Fee, Admin Fee & Spec Handling Fee increase effective 7/1/2010.

IMPERIAL 6-12 MPH
SW- STUDY
WK OF 10/11/10

SIGNATURE

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MIRAMAR LANDFILL
5180 CONVOY STREET
SAN DIEGO, CA 92111

835-001
GENERAL SERVICES
STREET SWEEPING
940554 -

Transaction #: 8498164
Account #: 940554/STORM WATER/O&M
Decal #: 41346, 44954, 0
Fleet #: 835002 Tag #: 1167889
Transaction Type: 08/CITY OTHER DEPTS
Payment Type: CT/CITY
Hauler Type: 08/CITY OTHER DEPTS
Vehicle Type: 030/A - 20 CY OR LESS
Material Type: 004/DEMO
Origin: 001/SAN DIEGO CITY
Special Fees:

Date: 11/7/2010 08:10:53
Scale Operator: RTA
Incoming /FB 02

	LBS	TONS
Gross Weight	22940.00	11.47
Tare Weight	21360.00	10.68
Net Weight	1580.00	0.79

Tip Fee	$ 46.00
Spec Fee	$ 0
RCBus Tax	$ 0
Recycle	$ 8.00
Total	**$ 54.00**

Self-Haul Flat Rate Disposal Fee, Admin Fee & Spec Handling Fee increase effective 7/1/2010.

IMPERIAL 3-6 MPH.
WK OF NOV. 1

SIGNATURE

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5180 CONVOY STREET
SAN DIEGO, CA 92111

835-001
GENERAL SERVICES
STREET SWEEPING
940554 -

Transaction #: 8498324
Account #: 940554/STORM WATER/O&M
Decal #: 41346, 45171, 0
Fleet #: 835002 Tag #: 1167889
Transaction Type: 08/CITY OTHER DEPTS
Payment Type: CT/CITY CT/CITY
Hauler Type: 08/CITY OTHER DEPTS
Vehicle Type: 030/A - 20 CY OR LESS
Material Type: 004/DEMO
Origin: 001/SAN DIEGO CITY
Special Fees:

Date: 11/7/2010 10:24:57
Scale Operator: P54
Outgoing /FB 05

	LBS	TONS
Gross Weight	22000.00	11.00
Tare Weight	21720.00	10.86
Net Weight	280.00	0.14

Tip Fee	$ 27.00
Spec Fee	$ 0
RCBus Tax	$ 0
Recycle	$ 1.00
Total	**$ 28.00**

Self-Haul Flat Rate Disposal Fee, Admin Fee & Spec Handling Fee increase effective 7/1/2010.

SAN YSIDRO 3-6 MPH
WK OF NOV. 1

SIGNATURE

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5180 CONVOY STREET
SAN DIEGO, CA 92111

835-001
GENERAL SERVICES
STREET SWEEPING
940554

Transaction #: 8498413
Account #: 940554/STORM WATER/O&M
Decal #: 41346, 44953, 0
Fleet #: 835002 Tag #: 1167889
Transaction Type: 08/CITY OTHER DEPTS
Payment Type: CT/CITY
Hauler Type: 08/CITY OTHER DEPTS
Vehicle Type: 030/A - 20 CY OR LESS
Material Type: 004/DEMO
Origin: 001/SAN DIEGO CITY
Special Fees:

Date: 11/7/2010 11:10:49
Scale Operator: BS2
Incoming /FB 02

	LBS	TONS
Gross Weight	22320.00	11.16
Tare Weight	21580.00	10.79
Net Weight	740.00	0.37

Tip Fee	$ 27.00
Spec Fee	$ 0
RCBus Tax	$ 0
Recycle	$ 1.00
Total	**$ 28.00**

Self-Haul Flat Rate Disposal Fee, Admin Fee & Spec Handling Fee increase effective 7/1/2010.

IMPERIAL 6-12 MPH
WK OF NOV. 1

SIGNATURE

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5180 CONVOY STREET
SAN DIEGO, CA 92111

835-001
GENERAL SERVICES
STREET SWEEPING
940554 -

Transaction #: 8498238
Account #: 940554/STORM WATER/O&M
Decal #: 41346, 44948, 0
Fleet #: 835002 Tag #: 1167889
Transaction Type: 08/CITY OTHER DEPTS
Payment Type: CT/CITY
Hauler Type: 08/CITY OTHER DEPTS
Vehicle Type: 030/A - 20 CY OR LESS
Material Type: 004/DEMO
Origin: 001/SAN DIEGO CITY
Special Fees:

Date: 11/7/2010 09:09:34
Scale Operator: P54
Incoming /FB 01

	LBS	TONS
Gross Weight	22840.00	11.42
Tare Weight	21940.00	10.97
Net Weight	900.00	0.45

Tip Fee	$ 27.00
Spec Fee	$ 0
RCBus Tax	$ 0
Recycle	$ 1.00
Total	**$ 28.00**

Self-Haul Flat Rate Disposal Fee, Admin Fee & Spec Handling Fee increase effective 7/1/2010.

SAN YSIDRO 6-12 MPH
WK OF NOV. 1

SIGNATURE

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MIRAMAR LANDFILL
5180 CONVOY STREET
SAN DIEGO, CA 92111

835-001
GENERAL SERVICES
STREET SWEEPING
940554

Transaction #: 8511613
Account #: 940554/STORM WATER/O&M
Decal #: 41346, 44953, 0
Fleet #: 835002 Tag #: 1167889
Transaction Type: 08/CITY OTHER DEPTS
Payment Type: CT/CITY
Hauler Type: 08/CITY OTHER DEPTS
Vehicle Type: 030/A - 20 CY OR LESS
Material Type: 004/DEMO
Origin: 001/SAN DIEGO CITY
Special Fees:

Date: 11/20/2010 09:23:02
Scale Operator: M2M
Incoming /FB 01

	LBS	TONS
Gross Weight	22680.00	11.34
Tare Weight	21580.00	10.79
Net Weight	1100.00	0.55

Tip Fee	$ 32.00
Spec Fee	$ 0
RCBus Tax	$ 0
Recycle	$ 6.00
Total	**$ 38.00**

Self-Haul Flat Rate Disposal Fee, Admin Fee & Spec Handling Fee increase effective 7/1/2010.

imperial 6-12 mph
DPEW

SIGNATURE

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ENVIRONMENTAL SERVICES DEPARTMENT
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(858) 694-7000

MIRAMAR LANDFILL
5180 CONVOY STREET
SAN DIEGO, CA 92111

835-001
GENERAL SERVICES
STREET SWEEPING

Transaction #: 8511683
Account #: 940554/STORM WATER/O&M
Decal #: 41346, 44954, 0
Fleet #: 835002 Tag #: 1167889
Transaction Type: 08/CITY OTHER DEPTS
Payment Type: CT/CITY
Hauler Type: 08/CITY OTHER DEPTS
Vehicle Type: 030/A - 20 CY OR LESS
Material Type: 004/DEMO
Origin: 001/SAN DIEGO CITY
Special Fees:

Date: 11/20/2010 10:47:52
Scale Operator: P54
Incoming /FB 01

940554 -

	LBS	TONS
Gross Weight	22680.00	11.34
Tare Weight	21360.00	10.68
Net Weight	1320.00	0.66

Tip Fee	$ 38.00
Spec Fee	$ 0
RCBus Tax	$ 0
Recycle	$ 7.00
Total	**$ 45.00**

Self-Haul Flat Rate Disposal Fee, Admin Fee & Spec Handling Fee increase effective 7/1/2010.

Imperial 3-6 mph

DREW

SIGNATURE

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(858) 694-7000

MIRAMAR LANDFILL
5180 CONVOY STREET
SAN DIEGO, CA 92111

835-001
GENERAL SERVICES
STREET SWEEPING

Transaction #: 8511529
Account #: 940554/STORM WATER/O&M
Decal #: 41346, 45171, 0
Fleet #: 835002 Tag #: 1167889
Transaction Type: 08/CITY OTHER DEPTS
Payment Type: CT/CITY
Hauler Type: 08/CITY OTHER DEPTS
Vehicle Type: 030/A - 20 CY OR LESS
Material Type: 004/DEMO
Origin: 001/SAN DIEGO CITY
Special Fees:

Date: 11/20/2010 07:43:35
Scale Operator: P54
Incoming /FB 01

940554 -

	LBS	TONS
Gross Weight	22800.00	11.40
Tare Weight	22480.00	11.24
Net Weight	320.00	0.16

Tip Fee	$ 27.00
Spec Fee	$ 0
RCBus Tax	$ 0
Recycle	$ 1.00
Total	**$ 28.00**

Self-Haul Flat Rate Disposal Fee, Admin Fee & Spec Handling Fee increase effective 7/1/2010.

3-6 mph

SAN YSIDRO

DREW

SIGNATURE

ES-072 (REV. 5-09)

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Appendix D Assessment Framework Scorecard

Scorecard to Assess Costs and Benefits of Stormwater Projects and Activities

PRE-IMPLEMENTATION

Completed by City Staff

PROJECT/ACTIVITY TITLE	DATE	ASSESSED BY
TARGETED AGGRESSIVE STREET SWEEPING PILOT PROJECT, PHASE IV SPEED EFFICIENCY STUDY	5/2/2011	BRYN EVANS

WATERSHED(S) ☐ LPQ ☐ MIB ☒ SDB ☐ SDG ☐ SDR ☒ TJR ☐ TBD

PROJECT TYPE ☐ Structural ☒ Non-structural ☐ Educational

MANAGEMENT QUESTIONS	*What level of general debris removal benefit does limiting the speed of street sweepers to optimal operating speed provide?* *What level of metals removal benefit limiting the speed of street sweepers to optimal operating speed provide?* *What is the relative load reduction potential for street sweepers at various speeds?* *What is the relative cost-efficiency of limiting the speed of street sweepers to optimal operating speed?* *What type of street sweeping pilot study load reduction data may be collected and used to calibrate the City BMP prototype Model?* *What level of planning and coordination effort is required for implementation of Phase V Posted Route Study?*

Completed by the Consultant

ASSESSMENT METHODOLOGY	Targeted Outcome(s)	*Compare debris removal changes resulting from two operating speeds of mechanical street sweepers.* *Compare metals and other pollutant removal changes resulting from mechanical street sweeper speed adjustments.* *Compare the relative cost and pollutant removal efficiency of the two operating speeds. It should be noted that the scope of work expanded during project implementation to include development of preliminary cost estimates for various aspects of the City street sweeping program including vacuum and regenerative air sweeping machines.*
	Assessment Method(s)	*Monitoring of debris removal rates from two operating speeds of mechanical street sweepers.* *Roadway debris sample collection both before and after mechanical street sweeping at two operating speeds.* *Examination of roadway debris sample analytical results.* *Compilation of City street sweeping program expenditure data.*
	Data	*Weight of collected debris at two operating speeds.* *Weight of roadway debris samples from both before and after mechanical street sweeping.* *Roadway debris analytical results.* *Street sweeping program cost data.*

PROJECT SIZE	Treatment area or volume (if applicable/known): Approximately 22 miles of street sweeping pilot routes.	Drainage area affected (if applicable): Unknown

ENVIRONMENTAL

Sediment/Debris	☐ 100%–75%	☐ 75%–50%	☐ 50%–25%	☒ 25%–5%	☐ 5%–0%	☐ < 0%
Metals	☐ 100%–75%	☐ 75%–50%	☐ 50%–25%	☒ 25%–5%	☐ 5%–0%	☐ < 0%
Petroleum hydrocarbons/nutrients	☐ 100%–75%	☐ 75%–50%	☐ 50%–25%	☒ 25%–5%	☐ 5%–0%	☐ < 0%
Flow	*N/A*					
Volume	*N/A*					
Regulatory	*Minimum to moderate contribution to MS4 NPDES permit requirements (long term pollutant removal and operation efficiency potential).*					
Ecosystem	*Potential reduction in pollutants impacting water quality.*					

ECONOMIC

Category	Estimated Cost	Percent of Total	High	Medium	Low
Planning	*$30,000*	*24%*	3	**2**	1
Construction	*0*		3	2	1
Operation and Maintenance	*$20,001*	*16%*	3	**2**	1
Education and Outreach	*$5,000*	*<1%*	3	2	**1**
Leveraging w/ other CIPs	*0*		3	2	1
Sample costs and reporting	*$70,000*	*56%*	3	**2**	1
Total Accumulative Cost	$125,000	100%	8		

SOCIAL

Category	Excellent	Good	Fair	Poor
Aesthetics	4	**3**	2	1
Public Education	4	**3**	2	1

	Community Engagement	4	3	**2**	1
	Public Support	4	**3**	2	1
	Partnership and Leveraging	4	**3**	2	1
	Interdepartmental Support	4	3	**2**	1
	Other (specify):	 4 4 4	 3 3 3	 2 2 2	 1 1 1
PRE-IMPLEMENTATION RATING		**ENVIRONMENTAL SCORE**	**ECONOMIC SCORE** *12*	**SOCIAL SCORE** *4*	**PRE-IMPLEMENTATION RATING** *16*

POST-IMPLEMENTATION

ENVIRONMENTAL	*Roadway debris/trash*	Measured Change
	Is this a target pollutant? Yes ☒ No ☐	Measured change in concentration/load/behavior **or** Estimated change in concentration/ load/behavior ☐ 100%–75% ☐ 75%–50% ☐ 50%–25% ☐ 25%–5% ☒ 5%–0% ☐ < 0%
	Metals pollutants	Measured Change
	Is this a target pollutant? Yes ☒ No ☐	Measured change in concentration/load/behavior **or** Estimated change in concentration/load/behavior ☐ 100%–75% ☐ 75%–50% ☐ 50%–25% ☐ 25%–5% ☒ 5%–0% ☐ < 0%
	Nutrients	Measured Change
	Is this a target pollutant? Yes ☒ No ☐	Measured change in concentration/load/behavior **or** Estimated change in concentration/load/behavior ☐ 100%–75% ☐ 75%–50% ☐ 50%–25% ☐ 25%–5% ☒ 5%–0% ☐ < 0%
	Flow	Measured Change
	Is this a target pollutant? Yes ☐ No ☐	Measured change in flow **or** Estimated change in flow
	Volume	Measured Change
	Is this a target pollutant? Yes ☐ No ☐	Measured change in flow **or** Estimated change in flow

ENVIRONMENTAL	Additional Benefits	Excellent	Good	Fair	Poor	Weighting Factor	Score
	Multi-Pollutant Benefits	4	**3**	2	1	**1** 2 3	3
	Regulatory Benefits	4	**3**	2	1	**1** 2 3	3
	Ecosystem Benefits	4	**3**	2	1	**1** 2 3	3
ECONOMIC	Category	Actual Cost	Percent of Total	High	Medium	Low	Score
	Planning	*$30,000*	*24%*	3	**2**	1	2
	Construction	*0*		3	2	1	
	Operation and Maintenance	*$20,001*	*16%*	3	**2**	1	2
	Education and Outreach	*$5,000*	*<1%*	3	2	**1**	1
	Leveraging with Other CIPs	*0*		3	2	1	
	Sample costs and reporting	*$70,000*	*56%*	3	**2**	1	2
	Total Accumulative Cost	$125,000	100%				
SOCIAL	Category	Excellent	Good	Fair	Poor	Weighting Factor	Score
	Aesthetics	4	**3**	2	1	**1** 2 3	3
	Public Education	4	**3**	2	1	**1** 2 3	3
	Community Engagement	4	3	**2**	1	**1** 2 3	2
	Public Support	4	**3**	2	1	**1** 2 3	3
	Partnership and Leveraging	4	**3**	2	1	**1** 2 3	3
	Interdepartmental Support	4	3	**2**	1	**1** 2 3	2

Other (specify):	4 4 4	3 3 3	2 2 2	1 1 1	1 2 3 1 2 3 1 2 3	
Technical Feasibility and Scalability	**4**	3	2	1	**1** 2 3	4

OVERALL PROJECT/ACTIVITY RATING AND FEASIBILITY	ENVIRONMENTAL SCORE	ECONOMIC SCORE	SOCIAL SCORE	OVERALL RATING
	9	7	16	36

ADDITIONAL DOCUMENTATION

Justification for the use of a higher weighting factor (if applicable):

Description of project impacts:

Analysis of Phase IV data provides little evidence that reducing the current operational speed of 6-12 miles per hour for City operated mechanical street sweepers will result in increased debris and associated pollutant removal efficiency. A direct impact of this finding is that the best available science supports the current operation speed of City mechanical sweepers as a cost-efficient way to remove a portion of roadway pollutants from City streets. Accordingly, changes to the current sweeping schedule and level-of-effort to accommodate slower sweeping speeds are likely not necessary.

OTHER ISSUES TO BE CONSIDERED

Assumptions and notes pertinent to full-scale implementation:

As part of the Targeted Aggressive Street Sweeping Pilot Program (Pilot Program), the City has developed a phased series of pilot projects designed to evaluate the feasibility, potential water quality benefits, and cost-effectiveness of various optimization techniques that may be applied to the current street sweeping program. Phases I and II of this Pilot Program assessed the relative pollutant removal efficiency of weekly and bi-weekly sweeping frequency regimes as well as comparison of mechanical, vacuum-assisted and regenerative-air sweeper machines. The Phase III effort evaluated the potential water quality benefits and feasibility of sweeping of roadway medians adjacent to high traffic volume areas. Phase IV was designed to assess the pollutant removal efficiency of mechanical sweepers at two operational speeds. This project scorecard is primarily focused on the results of the Phase IV pilot study. However, a portion of the Phase IV reporting effort aimed to compare the results of the operational speed comparison results to the other optimization techniques studied in the Phases I-III. Accordingly, the project report provides general street sweeping optimization technique implementation considerations based on the results of all four phases of the Pilot Program. These considerations include associated environmental, economic, and social benefits that may not be fully captured by the project activity rating contained in this scorecard.

Other benefits or constraints with full-scale implementation:

The Phase IV study provided a preliminary cost analysis for portions of the City street sweeping program. The preliminary cost analysis results were partially limited by the fact that the current City street sweeping fleet is predominantly mechanical sweepers (85% of the fleet are mechanical machines). Further, the City vacuum-assisted and regenerative-air machines have only recently (over the past 6-12 months) generated usage information that is consistent with the fleet mechanical machines. Accordingly, operational cost estimates for the vacuum-assisted and regenerative-air machines are based on limited data. It is recommended that the existing vacuum-assisted and regenerative air machines be, to the extent feasible, utilized more frequently on numerous targeted routes. It is also recommended that a simple and operationally-efficient improvement to the data collection methodology for machine use, performance, and operational cost be developed. The data collection methodology should be designed so that representative data for daily use of the vacuum-assisted and regenerative-air machines may be tracked and used to enhance comparative cost estimates for the City street sweeping program. These data may then be combined with machine-specific debris and pollutant removal data. It is anticipated that these data could, in a relatively short implementation period such as one year, allow a more comprehensive cost to pollutant removal "index" to be developed. The analysis of route-specific debris accumulation may provide a unique, low-cost and comprehensive dataset that will allow focused implementation of targeted street sweeping and/or other pollution prevention and source control activities to improve water quality within City jurisdiction.

Instructions

PRE-IMPLEMENTATION

This section should be completed during the project/activity planning phase to identify project characteristics, management questions, expected outcomes, and assessment methods.

The following are to be completed by City Staff or drawn from the database:

PROJECT/ACTIVITY TITLE

To be completed by City staff. The official project or activity name, or a descriptive title if no official project/activity title exists.

DATE

The date the scorecard is completed

ASSESSED BY

Name of staff person or consultant who completes the scorecard

WATERSHED(S)

The watershed or watersheds in which the project or activity was, is, or will be implemented, if known

PROJECT TYPE

Indicate whether the project is a structural BMP, non-structural investigation or management program, or an education or outreach program.

MANAGEMENT QUESTIONS

The fundamental management question the City of San Diego is working to answer in its efficiency assessment program is: "What is the most efficient combination of storm water programs and activities that will maximize pollutant load reductions most cost-effectively?" Therefore, to answer this question the City is working to answer two program-wide management questions:

(1) Has each individual program or activity optimized its efficiency (i.e., pollutant load reduction/cost)?
(2) What is the optimal efficiency of each program or activity, so that the City can direct resources to the most efficient programs?.

To answer these program-wide questions, the City identifies project-specific management questions to be evaluated as part of targeted watershed activities. The management questions should be developed with the application or use of the findings in mind and should be specific, measurable, and time-based. The following is an example of an effective management question for a Weather-Based Irrigation Controller and Turf Conversion pilot project: *What is the most cost effective are weather-based irrigation controllers and other types of low-flow distribution hardware (e.g., drip and micro spray sprinkler heads) in reducing the volume of dry weather runoff annually?* This question is specific, in that it addresses specific types of hardware. It is measurable because it focuses on the volume of dry weather runoff, which can be measured and compared pre- and post-installation. This question can be answered through monitoring of implementation sites and will produce a quantitative answer (percent reduction of runoff volume). It is time-based because it quantifies runoff volume reduction on an annual basis.

The following question is less effective: *Does the implementation of rain barrels and downspout disconnection reduce wet weather runoff?* Ideally the management questions will allow for a quantitative or qualitative measurement rather than a "yes" or "no" question. The answer to this question is "yes" or "no" and does not indicate the extent to which runoff from wet weather events is reduced. This question also lacks measurable and time-based elements. It can be improved as follows: *What volume of annual wet weather runoff can be reduced by installing rain barrels to treat a defined roof area?* This question allows for a quantified amount of runoff reduction per area per year, which can be extrapolated to larger areas (i.e., Citywide) for modeling purposes. The question specifically targets runoff volume reduction and is measurable and time-based (data collected from an event basis can be extrapolated to a one-year period of a "typical" year).

Management questions should consider technical performance of a BMP (pollutant reduction, stormwater volume control, etc.) as well as less quantifiable factors, such as public education opportunities, neighborhood involvement, neighborhood beautification, blight removal, and enhancement of public safety, for example. These factors, though less quantifiable in a traditional sense, can be measured qualitatively (e.g., poor, moderate, good, excellent).

The following items are to be completed by the Consultant implementing or monitoring the Activity.

ASSESSMENT METHODOLOGY

The purpose of this section is to establish, prior to BMP implementation, a set of desired outcomes for the project, keeping in mind how the project's efficiency will be assessed, both quantitatively and qualitatively. These outcomes need to be considered early in the process to plan for any data collection that will be required to rate outcomes.

Targeted Measurable Outcomes should facilitate assessment of performance, cost, and community factors. The following are examples of targeted measurable outcomes for a hypothetical rain barrel project that allow for an objective assessment of project success:

The reduction in volume of wet weather runoff achieved by installing rain barrel(s) on a residential property, extrapolated on an annual basis

Measurement of the change in annual residential water use after rain barrel implementation

Assessment of homeowner acceptance of the rain barrels

Assessment Methods should be identified for each of the Targeted Measurable Outcomes included above. The Assessment Methods should produce quantifiable information wherever possible, particularly for pollutant load reductions and costs, to facilitate modeling efforts. In some cases qualitative information is more appropriate, such as when gauging community acceptance, determining ease of implementation, and assessing other non-stormwater benefits. The following are Assessment Methods for the Targeted Measurable Outcomes described above:

Monitor the volume of wet weather runoff from one or more candidate residential properties prior to rain barrel implementation and after rain barrel implementation.

Examine water use records for the year prior and the year following rain barrel implementation.

Conduct a survey of participants in the program to determine their opinions regarding ease of installation, required maintenance, any nuisance issues, and overall usefulness for landscape watering.

Identify **Data** to be collected using the Assessment Methods already identified, as well as whether the data will be collected pre-implementation or post-implementation and whether it is quantitative or qualitative in nature. The following are examples of data collected based on the Assessment Methods described above:

Pre- and post-implementation wet weather runoff volume from residential rooftops (quantitative)

Pre- and post-implementation residential water use (quantitative)

Post-implementation homeowner opinion survey results, specifically ease of rain barrel installation (easy, moderate, difficult), required annual maintenance (number of hours), nuisance issues (number of issues), and overall usefulness for landscape watering (frequency of use over a one-year period) – (qualitative)

Consideration of appropriate assessment methodology will improve the planning and modeling conclusions that can be drawn from the pilot activity.

PROJECT SIZE

Additional project or activity information that will assist in project assessment includes the actual or anticipated area or volume of the practice (if known), and the drainage area that the practice will treat (if known). An example of the area or volume of a structural practice might include the reporting of the expected surface area and average depth of a proposed (or built) bioretention system. This information could be used to calculate the treatment volume. The area of a non-structural practice or activity should also be recorded (if known). For instance, if a project was assessing the reduction in pet waste contributions of bacteria by providing pet owners with pet waste bags in common walking areas, the area subject to bag participant use, such as the park area, would be recorded. In a similar manner, for structural management practices, the area contributing to a structural management practice would also be determined to document the drainage area that would contribute to the practice. It may be more difficult to determine the drainage area for non-structural practices. If this is possible, this information should be recorded.

ENVIRONMENTAL BENEFITS

Estimate anticipated environmental benefits, including **Pollutant Concentration or Load Change**, with the completion of the project or activity. Only primary targeted pollutants that will be measured should be considered at this point. Targeted pollutants may be selected because the receiving water is listed as impaired for the constituents, it is a pollutant of concern (existing high concentrations or loading), or because the pilot activity is intended to reduce one or more specific constituents (e.g., deployment of pet waste bag stations is intended to reduce bacteria loading to receiving waters). Assess expected runoff **Flow and Volume Changes**. Describe these either as an anticipated percent change or anticipated unit change (e.g., cubic feet per second, gallons per minute, cubic feet, or gallons, or other appropriate unit of measure).

To address additional benefits, qualitatively assess the extent to which **Multi-Pollutant, Regulatory, and Ecosystem Benefits** are expected to be realized through this project with a rating of Excellent (4 points), Good (3 points), Fair (2 points), or Poor (1 point). Projects or activities with no benefit or negative effects should be scored as Poor.

Guidelines for Scoring

Additional Benefits	Excellent	Good	Fair	Poor
Multi-Pollutant Benefits The ability of the project or activity to meet multiple objectives by addressing multiple pollutants or affecting several behaviors that contribute pollutants	Provides benefits for three or more pollutants or behaviors (especially targeted pollutants)	Provides benefits for two or more pollutants or behaviors	Provides benefits for only two pollutants or behaviors	Provides benefits for only one pollutant or behavior
Regulatory Benefits If the project or activity will assist the City in meeting MS4 NPDES requirements	Significantly contributes to meeting MS4 NPDES requirements	Moderately contributes to meeting MS4 NPDES requirements	Minimally contributes to meeting MS4 NPDES requirements	Does not contribute to meeting MS4 NPDES requirements
Ecosystem Benefits Creating or enhancing wildlife habitat, reducing flow impacts to receiving waters (improving instream habitat), removing invasive species, or planting native vegetation	Provides significant opportunities for ecosystem benefits	Provides moderate opportunities for ecosystem benefits	Provides only a few opportunities for ecosystem benefits	Provides no opportunities for ecosystem benefits or negatively impacts ecosystems

Economic Considerations

Document estimated project/activity costs, including **Planning**, **Construction**, annualized long-term **Operation and Maintenance**, and **Education and Outreach** costs. Describe and document costs not categorized above in the space provided (e.g., staff time, land costs). Also, qualitatively assess economic considerations, including **Planning**, **Construction**, annualized long-term **Operation and Maintenance**, and **Education and Outreach**, **Leveraging with Other CIPs**, and **Other Costs, such as** staff time or land costs, with a rating of Low (3 points), Medium (2 points), and High (1 point).

Guidelines for Scoring

Economic Considerations	Low	Medium	High
Planning			
Construction			
Operation and Maintenance			
Education and Outreach			
Leveraging with Other CIPs			
Other (staff time, land costs)			

Social Benefits

Qualitatively assess the extent to which social or community benefits, including **Aesthetic, Public Education, Community Engagement, Public Support, Partnership and Leveraging, and Interdepartmental Support Benefits**, are expected to be realized through this project with a rating of Excellent (4 points), Good (3 points), Fair (2 points), or Poor (1 point). Projects with no benefit or negative effects should be scored as Poor.

Guidelines for Scoring

Category	Excellent = 4	Good = 3	Fair = 2	Poor = 1
Aesthetic Benefits Neighborhood enhancement, blight removal, or creation of open space or recreational areas	Expect significant neighborhood enhancement	Expect moderate neighborhood enhancement	Expect minimal or slight neighborhood enhancement	Expect no neighborhood enhancement; open space/recreational areas reduced
Public Education Benefits Opportunities for signage about stormwater management, critical habitat, stream health, etc., or opportunities for workshops or training	Highly visible; excellent opportunities for public education	Moderate-visibility; some opportunities for public education	Limited-visibility; few opportunities for public education	No opportunities for public education
Community Engagement Benefits Involving the public in building or maintaining a stormwater feature, implementing pollution prevention measures, participating in stream or beach clean-ups, or other participation activities that foster public involvement in stormwater management	Public participation expected to be high	Public participation expected to be good	Public participation expected to be minimal	No public participation expected
Public Support Public support or opposition to the project/activity, the extent to which public services (e.g., parking, recreation, maintenance) are enhanced or diminished by the project/activity	Expect strong public support; no or minimal disruption to affected customers/citizens	Expect moderate public support; minor disruption to affected customers/citizens	Expect minimal public support; some disruption to affected customers/citizens	Expect public opposition; causes significant disruption to affected customers/citizens
Partnership and Leveraging Benefits Affect on interactions and relationships with stakeholders, environmental groups, business partners, or other departments, and within the Stormwater Department to share resources and engage them in stormwater management	Expected to build support for City Departments, including the Stormwater Department	Expected to provide some support for City Departments, including the Stormwater Department	Expected to have little effect on support for City Departments, including the Stormwater Department	Not expected to provide support for City Departments, including the Stormwater Department, or expected to diminish support
Interdepartmental Support Affect on City operations, efficiency, and costs, both within and outside the Stormwater Department	Expected to provide greatly improved operation or efficiency of City operations	Expected to provide some improved operation or efficiency of City operations	Expected to work effectively with current operations and neither improve nor diminish efficiency of City operations	Expected to diminish the efficiency of City operations

POST-IMPLEMENTATION

This section should be completed by the Consultant after the project or activity is complete to document measured or estimated outcomes.

ENVIRONMENTAL BENEFITS

For each target pollutant under consideration, report measured changes in **Pollutant Concentration or Load**, **Flow**, and **Volume**. If the pollutant was not measured quantitatively, provide a reasonable assessment of the estimated change in concentration or load by selecting the appropriate percent reduction. If the pollutant concentration or load has increased as a result of the project or activity, select < 0%. Indicate whether the pollutant is a targeted pollutant (see targeted pollutants in the Pre-Implementation section above). Estimated values will receive a score based on the checkbox ticked (100%–75% = 8, 75%–50% = 6, 50%–25% = 4, 25%–5% = 2, 5%–0%= 0, < 0% = -2). Enter measured or estimated flow and volume of runoff change in the space provided.

Assess additional benefits, including **Multi-Pollutant, Regulatory, and Ecosystem Benefits**, with a rating of Excellent (4 points), Good (3 points), Fair (2 points), or Poor (1 point). Projects or activities with no benefit or negative effects should be scored as Poor.

Guidelines for Scoring

Additional Benefits	Excellent	Good	Fair	Poor
Multi-Pollutant Benefits The ability of the project or activity to meet multiple objectives by addressing multiple pollutants or affecting several behaviors that contribute pollutants	Provides benefits for three or more pollutants or behaviors (especially targeted pollutants)	Provides benefits for two or more pollutants or behaviors	Provides benefits for only two pollutants or behaviors	Provides benefits for only one pollutant or behavior
Regulatory Benefits If the project or activity will assist the City in meeting MS4 NPDES requirements	Significantly contributes to meeting MS4 NPDES requirements	Moderately contributes to meeting MS4 NPDES requirements	Minimally contributes to meeting MS4 NPDES requirements	Does not contribute to meeting MS4 NPDES requirements
Ecosystem Benefits Creating or enhancing wildlife habitat, reducing flow impacts to receiving waters (improving instream habitat), removing invasive species, or planting native vegetation	Provides significant opportunities for ecosystem benefits	Provides moderate opportunities for ecosystem benefits	Provides only a few opportunities for ecosystem benefits	Provides no opportunities for ecosystem benefits or negatively impacts ecosystems

Weighting Factor

The weighting factor for each of the qualitative measures provides a means to emphasize those parameters in which the measured or estimated benefits of the parameter are substantial. The use of a weighting factor other than one should be discussed with City of San Diego staff to determine if a higher weighting is appropriate for the project or activity. Justification should be documented under “Additional Documentation” on page 3 of the scorecard if a higher weighting factor is used.

ECONOMIC CONSIDERATIONS

Document actual costs for this project or activity, detailing separately the **Planning**, **Construction**, annualized long-term **Operation and Maintenance**, and **Education and Outreach** costs incurred. Indicate cost-savings realized by leveraging funds for related capital improvement projects in the **Leveraging with Other CIPs** category. Describe and document costs not categorized above in the space provided (e.g., staff time, land costs).

SOCIAL BENEFITS

Qualitatively assess the extent to which social or community benefits were realized as a result of project/activity implementation with a rating of Excellent (4 points), Good (3 points), Fair (2 points), or Poor (1 point). Projects with no benefit or negative effects should be scored as Poor.

Guidelines for Scoring

Category	Excellent = 4	Good = 3	Fair = 2	Poor = 1
Aesthetic Benefits Neighborhood enhancement, blight removal, or creation of open space or recreational areas	Significant neighborhood enhancement	Moderate neighborhood enhancement	Minimal or slight neighborhood enhancement	No neighborhood enhancement; open space/recreational areas reduced
Public Education Benefits Opportunities for signage about stormwater management, critical habitat, stream health, etc., or opportunities for workshops or training	Highly visible; excellent opportunities for public education	Moderate-visibility; some opportunities for public education	Limited-visibility; few opportunities for public education	No opportunities for public education
Community Engagement Benefits Involving the public in building or maintaining a stormwater feature, implementing pollution prevention measures, participating in stream or beach clean-ups, or other participation activities that foster public involvement in stormwater management	Public participation excellent or much better than expected	Public participation good or better than expected	Public participation minimal or less than expected	No public participation

Public Support Public support or opposition to the project/activity, the extent to which public services (e.g., parking, recreation, maintenance) are enhanced or diminished by the project/activity	Strong public support; no or minimal disruption to affected customers/citizens	Moderate public support; minor disruption to affected customers/citizens	Minimal public support; some disruption to affected customers/citizens	Public opposition; causes significant disruption to affected customers/citizens
Partnership and Leveraging Benefits Affect on interactions and relationships with stakeholders, environmental groups, business partners, or other departments, and within the Stormwater Department to share resources and engage them in stormwater management	Builds support for City Departments, including the Stormwater Department	Provides some support for City Departments, including the Stormwater Department	Has little effect on support for City Departments, including the Stormwater Department	Provides no support for City Departments, including the Stormwater Department, or diminishes support
Interdepartmental Support Affect on City operations, efficiency, and costs, both within and outside the Stormwater Department	Provides greatly improved operation or efficiency of City operations	Provides some improved operation or efficiency of City operations	Works effectively with current operations and neither improves nor diminishes efficiency of City operations	Diminishes the efficiency of City operations

Weighting Factor

A weighting factor greater than one should be used if the described benefit was a primary goal or outcome of the project. For example, a BMP installation project with limited environmental benefits (i.e., small treatment area) that was designed to educate and engage the public about the purpose and function of stormwater BMPs would be weighted higher for the public education and community engagement benefit. The use of the weighting factors should be discussed with City of San Diego staff to determine if weighting is appropriate for the project or activity. Justification should be documented under "Additional Documentation" in the lower, open-ended part of the scorecard if a higher weighting factor is used.

TECHNICAL FEASIBILITY AND SCALABILITY

Technical feasibility of a project or activity is an important consideration of the assessment. This score describes ways in which the project or activity can be scaled up based on ease of implementation, level of effort for large-scale implementation, and site-specificity. This category allows documentation of issues discovered during the activity or at its completion that limit the possibility of larger application of the activity because of technical reasons. To qualitatively assess the extent to which the technical feasibility and scalability impact the project a rating scale has been developed. Similar ratings of Excellent (4 points), Good (3 points), Fair (2 points), or Poor (1 point) have been determined to maintain consistency.

Guidelines for Scoring

Category	Excellent = 4	Good = 3	Fair = 2	Poor = 1
Technical Feasibility and Scalability Ease of implementation, level of effort for large-scale implementation, and site-specificity	Easily scalable to a larger area of implementation; minimal extra effort and resources will be required to develop and implement at a larger scale; very few or no site-specific issues	Somewhat scalable to a larger area of implementation; some extra effort and resources required to develop and implement at a larger scale; several site-specific issues	Somewhat scalable but will be challenging with a larger implementation area; moderate effort and resources required to develop and implement at a larger scale; many site-specific issues	Very difficult to scale to a larger implementation area; significant effort and resources required to develop and implement at a larger scale; significant site-specific issues

Weighting Factor

By applying a weighting factor greater than one, those projects or activities that have significant technical limitations can be scored such that these limitations will result in lower (negative) scoring and thereby decrease the overall project or activity rating due to these limitations. The use of the weighting factors should be discussed with City of San Diego staff to determine if weighting is appropriate for the project or activity. Justification should be documented under "Additional Documentation" in the lower, open-ended part of the scorecard if a higher weighting factor is used.

OVERALL PROJECT RATING AND FEASIBILITY

The Overall project or activity rating will provide individual scores for the Environmental, Social, and economic benefits, as well as the impacts of the project. These scores will be summed to provide the overall project rating. It is important however that each activity or project be considered based on all these categories and not just the overall project rating to give a complete "at a glance" project/activity assessment.

ADDITIONAL DOCUMENTATION

Justification for the use of a higher weighting factor (if applicable): document assumptions for the use of a weighting factor greater than one, if applicable, for environmental and social benefits and project impacts.

Description of project impacts: describe negative impacts of the project or activity on city operations and the community as rated above in "Project Impacts."

OTHER ISSUES TO BE CONSIDERED

Assumptions and notes pertinent to full-scale implementation: provide a list of assumptions and other notes detailing project- or activity-specific information, needs, and considerations that should be taken into account for project implementation on a broader scale.

Other benefits from full-scale implementation: provide a list of anticipated economic, social, and environmental benefits, not already recorded above, resulting from full-scale implementation of the project or activity.