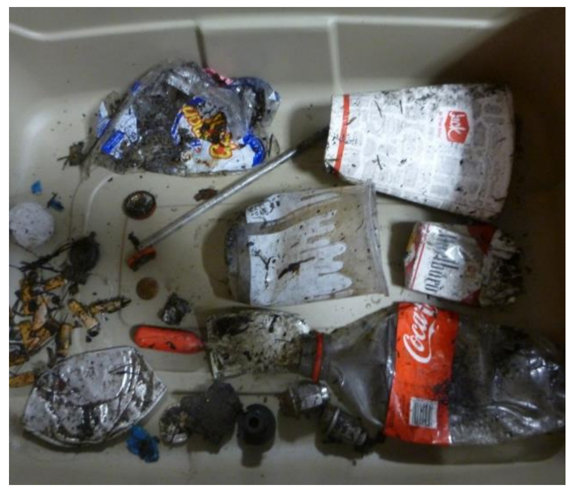
Regional Trash Generation Rates for Priority Land Uses in San Diego County

Task Order 13

Technical Report



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Prepared for:

San Diego County Trash Generation Rate Special Study Participants

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INTRODUCTION

Trash Amendments: The State Water Resources Control Board (State Water Board) recognizes trash as a widespread impairment to California's receiving waters. Due to the administrative burden of developing and implementing Total Maximum Daily Loads (TMDLs), the State Water Board has developed Amendments to the Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California and the Water Quality Control Plan for Ocean Waters (Trash Amendments) to procedurally streamline trash elimination efforts from Municipal Separate Storm Sewer System (MS4) discharges. The San Diego Regional Water Quality Control Board (San Diego Water Board) issued Order No. R9-2017-0077 on June 2, 2017, which directs San Diego Region Copermittees to begin the planning process for trash elimination from MS4s required by the Trash Amendments. In pursuing compliance, Copermittees may select one of two tracks outlined in the Trash Amendments: Track 1 or Track 2. Track 1 requires that Copermittees install, operate, and maintain full capture devices at MS4 outfalls or in MS4 systems that convey runoff from priority land uses (i.e., high-density residential, transportation, industrial, commercial, and mixed-urban land uses). Track 2 requires that Copermittees implement a plan with a combination of full capture systems, multi-benefit projects, institutional controls, and/or other treatment controls to achieve full capture system equivalence.

METHOD

Regional Special Study: The Regional Trash Generation Rate Special Study (Special Study) was conducted by Special Study participants[1] to quantify trash generation rates for priority land uses in the San Diego region. The trash generation rates combined with a jurisdiction's breakdown of priority land uses is one methodology that can be used to calculate the full capture equivalency for a jurisdiction implementing Track 2.

The objectives of the Special Study are:

- Quantify baseline trash generation rates from the priority land uses to calculate full capture equivalency, which is the amount of trash that must be eliminated from the MS4 to achieve compliance through a Track 2 approach,
- Evaluate the use of visual monitoring protocols, to demonstrate program progress during the 10-year trash reduction period, and
- Monitor the performance of full capture systems including ease of maintenance, durability, and susceptibility to flooding to inform future capital improvement, operations and maintenance efforts.

The methodology used in the Special Study is consistent with previous trash generation studies conducted and approved in other regions in California, such as the Los Angeles region, San Francisco Bay Area and other parts of the country (County of Los Angeles Department of Public Works 2004; EOA, Inc. 2014; Maryland Department of the Environment 2014a, 2014b; Metropolitan Washington Council of Governments 2009). Similar or the same full capture devices were used, the length of time between cleanouts and the data collection methods were consistent. A work plan and quality assurance project

[1] County of San Diego, San Diego Unified Port District, San Diego County Regional Airport Authority, and the Cities of Carlsbad, Chula Vista, Coronado, Del Mar, El Cajon, Escondido, Imperial Beach, La Mesa, National City, Poway, San Diego, Solana Beach, and Vista

plan for the Special Study was previously prepared by the Special Study participants and submitted to the San Diego Water Board in 2016 (County of San Diego et al. 2016[2]).

Full capture devices[3] were installed in 36 drain inlets[4] throughout the County among priority land use areas designated in the Trash Amendments: high-density residential, industrial, and commercial. These locations served as monitoring sites to establish a baseline trash generation rate for each of the three most common priority land uses of high-density residential, industrial and commercial. The two remaining priority land uses are transportation and mixed urban. Literature values may be used for transportation, which is commonly part of another priority land use. Mixed urban is a mixture of the other land uses and full capture equivalency can be calculated using the trash generation rates from the other four land uses.

Quantitative and Visual Monitoring: During the one-year monitoring period of the Special Study, a two-pronged approach was taken to evaluate trash. Quantitative trash measurements were done quarterly and drive-by visual assessments were done monthly. Trash measurements were conducted by collecting trash present at drain inlets, removing debris or vegetation, and characterizing the remaining material by weight and volume. Visual assessments were conducted by driving through the entire drainage area of each monitoring site and observing the amounts of trash using a prescribed protocol. These results were used to develop trash generation rates and visual assessment scores.

RESULTS

Trash Generation Rates: Results from the quantitative monitoring indicate that commercial priority land use had the highest generation rate followed by industrial and high density residential priority land uses.[5] These findings are consistent with other studies where retail/commercial and industrial areas generally produced higher trash generation rates than residential areas (Michael Baker International 2015[6]). The trash generation rates measured in the San Diego region are lower than rates reported in studies from the Los Angeles and San Francisco areas for all land uses studied (Table ES-2).

TABLE ES- 1. MEAN VOLUME- AND WEIGHT-BASED TRASH GENERATION RATES[A]

Priority Land Use	No. Sites	Mean Volume-Based Trash Generation Rates (gallons/acre/year)	Mean Weight-Based Trash Generation Rates (pounds/acre/year)
High-Density Residential	10	2.50	0.48
Industrial	14	2.60	0.66
Commercial	11	6.00	0.95

[A.] Mean trash generation values are presented here for the purpose of comparison. See text for additional details.

[2] Available at http://www.projectcleanwater.org/download/regional-trash-study-monitoring-plan-2016/
[3] StormTek Connector Pipe Screens; see Figure 1 in the main report and Section 2.1.2 for further details.
[4] See Table A-1 and Figures A-1 through A-5 of Appendix A.
[5] See Table 3 and 4 in the main report for further details.
[6] Available at http://www.projectcleanwater.org/download/literature-review-for-trash-amendment-compliance-strategy-7-31-2015/

TABLE ES- 2. MEAN TRASH GENERATION RATES (GALLONS/ACRE/YEAR) FROM OTHER STUDIES

Land Use	Trash Generation Rate (gallons/acre/year) Per Land Use						
	San Diego Special Study	Bay Area Study[7]	Los Angeles Trash TMDL Study[8]	Anacostia Baseline Monitoring [9]	Patapsco River Study: City of Baltimore [10]	Patapsco River Study: County of Baltimore[11]	Revolon Slough/ Malibu Creek[12]
Residential	2.50	5.35	4.3[13]	0.6	3.15	0.98[14]	1.0
Transportation	N/A	N/A	N/A	N/A	N/A	0.82	N/A
Industrial	2.60	8.4	15.33	1.22	3.15	N/A	N/A
Commercial	6.00	6.2	14.77	0.21	3.15	3.16	N/A
Retail	N/A	46.8	N/A	0.21	3.15	N/A	N/A
Schools/ Institutional	N/A	6.2	N/A	N/A	N/A	0.80	N/A
Park	N/A	5.0	5.81	N/A	N/A	0.86	1.0

Visual Monitoring: Results from the visual monitoring indicate that low to medium trash conditions were dominant (> 80%). This finding is consistent with the findings of the quantitative measurements taken as part of the Special Study, further supporting that trash generation rates are lower in San Diego than in the Los Angeles Region and San Francisco Bay Area. A statistical relationship was not found when the visual monitoring results were compared to the measured trash generation rates. The dominant low to medium trash conditions observed perhaps obscures any correlation that might have existed in other regions with higher trash conditions. Therefore, the Special Study results should not preclude the use of visual monitoring as a method to be considered to demonstrate compliance with the Trash Amendments.

Full Capture System Device Performance: Based on qualitative performance observations, the selected full capture device generally performed as it was intended. However, due to high stormwater flow and debris during storm events, damage at four of the 36 monitoring sites resulted in repair or replacement.

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[7] All values are "Best," which in the study refers to the mean generation rate for each priority land use. Where applicable, values taken are for "moderate" income level of $50,000 to $100,000 per year (EOA, Inc. 2014).
[8] All values are mean generation rates (County of Los Angeles Department of Public Works 2004).
[9] All values are mean generation rates adjusted from nine-month monitoring period to annual basis (Metropolitan Washington Council of Governments 2009). Values reported in pounds converted at an assumed 2.5 pounds per gallon based on an approximation of mean pounds per gallon from the Los Angeles study (County of Los Angeles Department of Public Works 2004). All values represent means from various monitoring programs (outfall monitoring, parking lots, in stream, etc.)
[10] Taken from a single all-purpose mean "urban" land use value (Maryland Department of the Environment 2014b) and converted from values reported as weight at 2.5 pounds per gallon based on an approximation of mean pounds per gallon from the Los Angeles Trash TMDL Study (County of Los Angeles Department of Public Works 2004).
[11] All values converted from mean weight-based trash generation rate (Maryland Department of the Environment 2014b) at 2.5 pounds per gallon based on an approximation of mean pounds per gallon from the Los Angeles Trash TMDL study (County of Los Angeles Department of Public Works 2004).
[12] All values are mean trash generation rates. Priority land uses only correlated to those observed applicable in Las Virgenes Creek watershed (Los Angeles Water Board 2007).
[13] A mean of high- and low-density residential rates.
[14] A mean of high-, medium-, and low-density residential rates.

Similar damages as a result of storm events were reported in other studies. To reduce damages to full capture devices, peak flow rate data should be considered in device selection and installation.

The results of the Special Study presented in this document provide scientifically defensible information on the baseline trash generation rates for priority land uses in San Diego County, which is one methodology that can be used to calculate the full capture equivalency value needed to implement a Track 2 program.

1.0 Introduction

The State Water Resources Control Board (State Water Board) has recognized trash as a widespread impairment to California's waterways. To streamline the regulatory approach and provide state-wide consistency, the State Water Board developed Trash Amendments to the Water Quality Control Plan for Inland Surface Waters, Enclosed Bays, and Estuaries of California and the Water Quality Control Plan for Ocean Waters (Trash Amendments) to address trash from Municipal Separate Storm Sewer System (MS4) discharges (State Water Board 2015a). The Trash Amendments, approved in 2015, consist of six primary elements:

- A Water Quality Objective
- Applicability
- Prohibition of Discharge
- Implementation Provisions
- Time Schedule
- Monitoring and Reporting Requirements

Public agencies that are regulated together under an MS4 National Pollutant Discharge Elimination System (NPDES) permit for discharge of runoff from their drainage systems are referred to as Copermittees. The San Diego Regional Water Quality Control Board (San Diego Water Board) issued Order No. R9-2017-0077 on June 2, 2017, which directs Copermittees to begin the planning process required by the Trash Amendments. In pursuing compliance, Copermittees may select one of two tracks outlined in the Trash Amendments. These tracks are further discussed below.

1.1 Track One Compliance

Track 1 requires that Copermittees install, operate, and maintain full capture devices for all MS4 facilities that capture runoff from priority land uses (i.e., high-density residential, transportation, industrial, commercial, and mixed-urban land uses). A full capture system is defined by the State Water Board as "treatment controls (either a single device or a series of devices) that traps all particles that are 5 mm or greater, and has a design treatment capacity that is either: a) of not less than the peak flow rate, Q, resulting from a one-year, one-hour, storm in the subdrainage area, or b) appropriately sized to, and designed to carry at least the same flows as, the corresponding storm drain" (State Water Board 2015b). Track 1 compliance is achieved when the Copermittee can "demonstrate installation, operation, and maintenance of full capture systems and provide mapped locations and drainage areas served by these full capture systems" (State Water Board 2015b).

Under Order No. R9-2017-0077, by December 3, 2018, Copermittees pursuing Track 1 must submit a time schedule for achieving full compliance along with a jurisdictional map showing the priority land uses, storm drain network, and proposed full capture system installation locations. Full compliance under Track 1 is required 10 years after the effective date of the implementing permit, but no later than December 2, 2030.

1.2 Track Two Compliance

Under Track 2, Copermittees may, "implement a plan with a combination of full capture systems, multi-benefit projects, institutional controls, and/or other treatment controls to achieve full capture system equivalence" (State Water Board 2015b). Track 2 compliance is achieved when Copermittees have developed and implemented monitoring objectives that demonstrate mandated performance results, effectiveness of the selected combination of treatment and institutional controls, and compliance with full capture system equivalency (State Water Board 2015b).

The Trash Amendments define full capture system equivalency as "the trash load that would be reduced if full capture systems were installed, operated, and maintained for all storm drains that capture runoff from the relevant areas of land… The full capture system equivalency is a trash load reduction target that the [Co]permittee quantifies by using an approach, and technically acceptable and defensible assumptions and methods for applying the approach, subject to the approval of permitting authority" (State Water Board 2015b). The Trash Amendments describe how full capture system equivalency can be demonstrated using either a Trash Capture Rate Approach or a Reference Approach.

The Trash Amendments note, "Copermittees that pursue the Track 2 compliance pathway must submit implementation plans to their permitting authority... The implementation plans must: (a) describe the combination of controls selected by each MS4 Permittee, and the rationale for the selection, (b) describe how the combination of selected controls is designed to achieve full capture system equivalency, and (c) how the full capture system equivalency will be demonstrated. The implementation plans are subject to the approval by the permitting authority" (State Water Board 2015a). The implementation plans, as required by Order No. R9-2017-0077, must be submitted by December 3, 2018. Full compliance under Track 2 is required 10 years after the effective date of the implementation permit, but no later than December 2, 2030.

According to Order No. R9-2017-0077 8.(1), one methodology to measure full capture system equivalency can be conducted as follows:

- "Directly measure or otherwise determine the amount of trash captured by full capture systems for representative samples of all similar types of land uses, facilities, or areas within the relevant areas of land over time to identify specific trash capture rates,"
- "Apply each specific trash capture rate across all similar types of land uses, facilities, or areas to determine full capture system equivalency," and
- Sum "the products of each type of land use, facility, or area multiplied by trash capture rates for that type of land use, facility, or area" as full capture system equivalency (p. 4 of Order No. R9-2017-0077).

1.3 Regional Trash Generation Rate Special Study

To support the development of a Trash Amendments compliance strategy, the County of San Diego conducted a literature review (Michael Baker International 2015[15]). The review summarized relevant studies in California and across the United States and showed that trash generation rates are correlated to land use, income level, and population density. Demographic and climatic conditions in San Diego County were used to prioritize literature studies that were most relevant to this region. Because of the wide range of literature values identified during the review, a local Special Study was proposed focusing

[15] http://www.projectcleanwater.org/download/literature-review-for-trash-amendment-compliance-strategy-7-31-2015/

on the primary priority land uses: high-density residential, transportation, industrial, and commercial land uses.

The resulting Regional Trash Generation Rate Special Study (Special Study) was conducted by the County of San Diego, San Diego Unified Port District, San Diego County Regional Airport Authority, and the Cities of Carlsbad, Chula Vista, Coronado, Del Mar, El Cajon, Escondido, Imperial Beach, La Mesa, National City, Poway, San Diego, Solana Beach, and Vista (Special Study Participants). The Special Study was conducted from July 2016 to November 2017 with the following objectives:

- Quantify baseline trash generation rates from the priority land uses to calculate full capture equivalency, which is the amount of trash that must be eliminated from the MS4 to achieve compliance through a Track 2 approach,
- Evaluate uses of visual monitoring protocols, which will be used to demonstrate program progress during the 10-year trash reduction period, and
- Monitor the performance of full capture systems including ease of maintenance, durability, and susceptibility to flooding to inform future operations and maintenance efforts.

Note that participation in the Special Study does not indicate a Copermittee's decision to pursue Track 2. The Special Study was designed in 2016, prior to the September 5, 2017 submittal requirement for jurisdictions to declare their track selection. Copermittees have the option to change tracks through adaptive management during the compliance timeline, even though the San Diego Water Board has already been notified of which track each jurisdiction plans to follow.

2.0 Methods

A work plan and quality assurance project plan for the Special Study was prepared by the Special Study Participants and submitted to the San Diego Water Board in 2016 (County of San Diego et al. 2016[16]). The Special Study is consistent with the methodologies used by previous trash generation studies in California, such as the Los Angeles region and San Francisco Bay Area, and other regions in the country (County of Los Angeles Department of Public Works 2004; EOA, Inc. 2014; Maryland Department of the Environment 2014a and 2014b; Metropolitan Washington Council of Governments 2009).

2.1 Monitoring Methods

2.1.1 Monitoring Site Selection

The site selection process is critical to accurately quantify trash generation rates specific to the San Diego region and the priority land uses. The primary selection criteria for monitoring sites was related to the distribution of priority land uses, but also considered the following factors where information was available:

- Feasibility of full capture system installation (due to infrastructure constraints),
- Drainage area preferably greater than 1 acre,
- Homogenous priority land use (90 percent or greater) within the drainage area,
- Consistent trash management actions in place within the drainage area, and

[16] Available at http://www.projectcleanwater.org/download/regional-trash-study-monitoring-plan-2016/

- Transportation areas within participating agencies' jurisdictions that are not bus stops, if available/appropriate (e.g., Park-and-Ride).

During the execution of the work plan additional considerations that influenced the selection of monitoring sites were considered. Originally, the work plan for the Special Study did not plan to alter frequency of street sweeping or organized litter removal. However, during execution and site selection it became clear that very frequent street sweepings were a concern. Weekly street sweeping was deemed not representative for the region, thus sites where weekly street sweeping was expected were excluded. In addition, several original monitoring sites were replaced due to unforeseen logistical and accessibility issues. For all remaining selected monitoring sites, regular street sweeping and organized litter pickup operations were not altered during the study period. Routine catch basin cleanouts were suspended at the monitoring sites for the duration of the study unless public safety was at risk from flooding.

The 36 sites include 24 of the 25 sites originally proposed in the work plan and quality assurance project plan (County of San Diego et al. 2016). One of these sites was removed due to potential flooding risks. An additional twelve sites meeting the selection criteria were added from the County's independent trash study. An additional twelve sites meeting the selection criteria were added from sites that were evaluated for the County's independent trash studies. Sites selected for this study are listed in Table A- 1 and Figures A-1 through A-5 in Appendix A. Maps depicting individual locations and drainage areas can be found in Appendix B.

2.1.2 Full Capture Device Selection and Installation

The full capture device selection process for the Special Study occurred prior to the release of the State Water Board's list of certified full capture devices. Therefore, the Special Study selected a device from a list of approved devices for the Los Angeles Trash TMDL (Los Angeles Water Board 2007). The StormTek Connector Pipe Screen (CPS; see Figure 1) was selected based on recommendations from municipalities, who have been successfully using the device including: the City of Los Angeles, the County of Los Angeles, and the City of Ventura. Particular benefits of the CPS device that drove this decision were that the device can be custom fitted to the large variety of inlet configurations, and the catch basin itself can be used to store accumulated trash allowing for less frequent cleanouts. Note that the CPS has since been certified by the State Water Board as a full capture device.

The manufacturer began installing the CPS devices in July 2016 at the selected Special Study monitoring sites. Regular inspections were performed to identify any malfunctions or device clogging under scenarios of unusually intense, frequent, or prolonged rainfall events.

FIGURE 1. EXAMPLE OF INSTALLED STORMTEK CONNECTOR PIPE SCREEN FULL CAPTURE DEVICE

The photograph on the left was taken at one of the monitoring sites and the photograph on the right is from http://www.stormtekcps.com/

2.1.3 Quantitative Monitoring

Quantitative monitoring was performed quarterly for one year at each monitoring site. The quantitative monitoring methodology used is based on trash generation studies conducted in other regions of the state and accepted by the Los Angeles and San Francisco Bay Regional Water Quality Control Boards (County of Los Angeles Department of Public Works 2004; EOA, Inc. 2014). The full study methodology is presented in the work plan and quality assurance project plan (County of San Diego et al. 2016), and is also outlined below:

- Selection and installation of full capture devices that meet the requirements of the Trash Amendments.
- Quarterly removal of trash and debris and subsequent transport to a facility for temporary storage and characterization.
- Supplemental inspection to ensure that full capture structures were not subject to bypass, failure, or overflow.
- Material characterization[17] performed at a warehouse, where trash was photographed, separated from debris and vegetation[18], dried, and measured. Data were recorded on chain of custody and material characterization forms. Then the data were reviewed by the consultant project manager for data entry and analysis on a quarterly basis.
- Post-monitoring data analysis and final documentation involved review of the results for scientific validity and finalization of the baseline trash generation rates.

Photographs of trash captured at one of the monitoring sites are presented in Figure 2.

[17] General trash types were documented in a material characterization form. Note that storm event volumes and durations were not recorded as a component of this study.

[18] "Trash means all improperly discarded solid material from any production, manufacturing, or processing operation including, but not limited to, products, product packaging, or containers constructed of plastic, steel, aluminum, glass, paper, or other synthetic or natural materials" (State Water Board 2015b). This excludes vegetative debris, street dirt, sand, and sediment that is often intermingled with trash. The San Francisco Bay Area study defined urban trash as all human-made materials that cannot pass through a 5-mm mesh screen, excluding sand, sediment, vegetation, and oil and grease (EOA, Inc. 2014). Thus, debris and vegetative materials were excluded prior to measurements.

FIGURE 2. EXAMPLE OF TRASH CAPTURED

Examples of a monitoring site prior to trash removal (left) and in-warehouse quantification of removed and dried trash separated from debris and vegetation (right).

2.1.4 Visual Monitoring

The visual monitoring program was developed to supplement the quantitative monitoring program and was implemented monthly for a year. The visual monitoring program will be used as deemed appropriate by individual jurisdictions to evaluate whether trash reduction targets are achieved during the 10-year compliance period.

The visual monitoring methodology used in the Special Study was based on the Visual On-land Trash Assessment Protocol for Stormwater Version 1.0 (EOA, Inc. 2013[19]) and is widely accepted and applied throughout the San Francisco Bay Area (EOA, Inc. 2014). Visual monitoring programs have been successfully implemented in the City of Ventura as components of trash reduction monitoring. The visual monitoring in the San Francisco Bay Area is being implemented as a method to estimate baseline trash generation rates for priority land uses and quantify trash removal effectiveness. The visual monitoring employed qualitative scoring with specifically defined criteria. A condition category (visual assessment score) on a scale from A to D (low to very high amounts of visible trash) was assigned, based on the observed accumulation of trash in the area near the monitored inlet. The categories, their descriptions, and example photographs are presented in Table C- 1 of Appendix C.

Two field observers performed visual monitoring at each location by driving in public right of ways through the entire drainage area and carefully examining trash deposited in the assessment area[20] (see Appendix B for a map of each site's drainage area). Each field observer recorded an independent visual assessment score based on the assessment protocol. Discrepancies between independent visual assessments were recorded as mixed numbers (A/B, B/C, or C/D) on the visual monitoring form. These categories were also identified as A = Low Trash, B = Medium Trash, C = High Trash, and D = Very High Trash. Field observers

[19] A version 1.3 of the protocol is currently available at http://www.scvurppp-w2k.com/pdfs/1617/wshop_trash_assess_072616/Updated_Visual_Trash_Assessment_Methodology_4_15_2015.pdf

[20] The assessment area extends from the center line of the road (or middle of the median) to back of the sidewalk including all portions of the public rights-of-way that could reach the stormwater drainage system (e.g., median, street, gutter, curb, sidewalk, back of sidewalk, and vegetated areas). The assessment area also includes any trash in parcels that could theoretically reach the stormwater drainage system, if there are no obstructions such as a building or fence that would prevent trash from moving to the stormwater drainage system.

photographed trash and noted apparent sources of trash when known. See Appendix D for the Visual Field Monitoring Data Sheets.

2.1.5 Full Capture Device Performance Monitoring

Performance of the full capture devices was evaluated qualitatively based on observations during the monitoring events for ease of maintenance, durability, and susceptibility to flooding. These evaluations were recorded on a material characterization form and a template is available in Attachment 4 of the work plan (County et al. 2016).

2.2 Data Analysis Methods

2.2.1 Trash Generation Rates

Quantitative monitoring results were analyzed to estimate annual trash generation rates as gallons per acre per year (volume-based) and pounds per acre per year (weight-based). A site-specific annual rate was calculated by dividing the site mean trash volume or weight by site-specific drainage area.

$$Site\ Specific\ Annual\ Rate\ = \frac{Site\ Mean\ Trash\ Volume\ or\ Weight\ \ per\ Year\ (gallons\ or\ pounds/year)}{Site\ Specific\ Drainage\ Area\ (acre)}$$

The drainage area is the area that drains to a catch basin. The drainage area was delineated using GIS aerial photographic data for each catch basin with a full capture device. Field surveys were conducted by Michael Baker International to verify the delineated drainage area. Maps depicting the drainage area of each site can be found in Appendix B.

Volume and weight measurements of trash were obtained from the quarterly monitoring events. During each monitoring event, measurements were taken separately by at least two personnel to ensure accuracy. Mean volume and weight measurements were calculated per site using the event means obtained for the four quarters during the one-year monitoring period. The annual generation rate per unit area was then obtained by multiplying the site mean volume or weight measurement by four to obtain yearly values (annualization), and then dividing by the site drainage area. An example calculation is presented in Table 1. These trash generation rates for individual locations were grouped by priority land use. Then, the summary statistics of median, arithmetic mean, standard deviation, standard error, minimum, and maximum of trash generation rates per priority land use were calculated (see Section 3).

TABLE 1. EXAMPLE OF PER-SITE VOLUME-BASED ANNUAL TRASH GENERATION RATE CALCULATION

Site ID	Sampling Date	Volume Measurement (gallons)	Event Mean Volume (gallons)	Site Mean Volume (gallons)	Drainage Area (acre)	Per Site Trash Generation Rate (gallons/acre/year)
37B-68	11/16/2016	3.55	3.66	1.97	23.30	0.34
		3.77				
		3.66				
	2/14/2017	2.80	2.75			
		2.69				
	5/3/2017	0.81	0.84			
		0.86				
	10/13/2017	0.59	0.62			
		0.65				

2.2.2 Visual Monitoring Assessment and Comparison

Trash condition assessment scores from the visual monitoring were compared to the measured trash generation rates. Each site's calculated mean volume- and weight-based trash generation rates were compared to the mean visual assessment score. This comparison did not consider priority land use, as land use type does not affect the relationship between the visual monitoring assessment scores and measured trash generation rates. BASMAA[21] compared visual monitoring assessment scores to measured trash generation rates in the same manner (EOA, Inc. 2013).

3.0 Results

3.1 Quantitative Monitoring Results

3.1.1 Quantitative Monitoring Event Summary

Trash volume and weight measurements were obtained from quarterly monitoring events at each of the 36 sites. A summary of the number of monitoring events and notes regarding the validation of data are presented in Table E-1 of Appendix E.

Rainfall in southern California typically occurs from October through April, with a dry season observed from May through September. During the Special Study, several storm events were recorded during the typically dry months, and average annual precipitation was about 25% higher than normal. Outside of these unusual storm events, the dry season observed average to below average total precipitation, when compared to historical rain analysis collected at Lindbergh Field.[22]

3.1.2 Annual Trash Generation Rates

Site specific annual trash generation rates (gallons/acre/year and pounds/acre/year) were calculated (summarized in Table E-2 of Appendix E) and categorized by priority land use. Descriptive statistics of these volume- and weight-based trash generation rates for each priority land use are presented in Table 2 and Table 3, respectively. Visual comparisons of trash generation rates among the priority land uses are presented in Appendix F.

[21] Bay Area Stormwater Management Agencies Association

[22] Precipitation data are available from https://www.sdcwa.org/annual-rainfall-lindbergh-field and https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca7740.

TABLE 2. DESCRIPTIVE STATISTICS OF VOLUME-BASED TRASH GENERATION RATES

Priority Land Use	No. Sites	No. Sampling Event[a]	Volume-Based Trash Generation Rates (gallons/acre/year)							
			Median	Mean	Std Dev	Std Error	Min.	Max.	25th	75th
High-Density Residential	10	36	1.00	2.50	3.49	1.10	0.05	10.76	0.52	3.49
Industrial	14	49	1.48	2.60	2.91	0.78	0.24	9.71	0.68	4.17
Commercial	11	36	2.20	6.00	9.40	2.83	0.28	29.27	0.57	4.85

No. sites is equal to sample size (n) for descriptive statistics above.
Std Dev- standard deviation; Std Error- standard error; Min.-minimum; Max.-maximum; 25th- 25th percentile; 75th- 75th percentile
[a] While quarterly monitoring events occurred, some data points were deemed invalid and not included in the analysis because of missing or malfunctioning full capture devices. A summary of monitoring events deemed invalid is presented in Table E-1 of Appendix E.

TABLE 3. DESCRIPTIVE STATISTICS OF WEIGHT-BASED TRASH GENERATION RATES

Priority Land Use	No. Sites	No. Sampling Event[a]	Weight-Based Trash Generation Rates (pounds/acre/year)							
			Median	Mean	Std Dev	Std Error	Min.	Max.	25th	75th
High-Density Residential	10	36	0.35	0.48	0.70	0.22	0.00	2.38	0.06	0.50
Industrial	14	49	0.21	0.66	1.31	0.35	0.04	4.48	0.07	0.28
Commercial	11	36	0.33	0.95	1.27	0.38	0.02	3.81	0.11	1.65

No. sites is equal to a sample size (n) for descriptive statistics above.
Std Dev- standard deviation; Std Error- standard error; Min.-minimum; Max.-maximum; 25th- 25th percentile; 75th- 75th percentile
[a] While quarterly monitoring events occurred, some data points were deemed invalid and not included in the analysis because of missing or malfunctioning full capture devices. A summary of monitoring events deemed invalid is presented in Table E-1 of Appendix E.

The highest mean trash generation rates by volume (40.58 gallons/acre/year) and weight (5.54 pounds/acre/year) were observed at the single park and ride location included in the Special Study. This single park and ride is not representative of all transportation land uses. Transportation land use constitutes only 1% of the total area of the County. Furthermore, bus stops and other transportation land uses often are located within other priority land uses. Nonetheless, jurisdictions will have the ability to use literature values or other reliable data sources as is deemed appropriate for the transportation land uses that are found in their jurisdiction. This value measured for a single park and ride lot is not further evaluated in this Special Study.

The land uses exhibited relatively similar trash generation rates with mean rates ranging from 2.50 to 6.00 (gallons/acre/year) and 0.48 to 0.95 (pounds/acre/year) for high-density residential and commercial priority land uses respectively. Standard deviations with values higher than the mean generation rates demonstrate the wide range of trash generation rates observed within priority land uses, reflecting the episodic nature and various other factors reported to affect trash generation at the local scale.

It should be noted that mean generation values are all larger than medians reported (Table 2 and Table 3) for both volume- and weight-based trash generation rates. This is a result of the data not being normally distributed (bell-shaped) but rather clustered toward lower trash generation rates as demonstrated in histograms (Figure G-1 through Figure G-6 of Appendix G).

3.2 Comparison of Visual and Quantitative Monitoring Data

3.2.1 Visual Monitoring Event Summary

Monthly visual monitoring was conducted from July 2016 through October 2017[23]. Twenty four of the sites had 12 monitoring events each and 12 sites[24] had nine events each (summarized in Appendix H). Low to medium trash conditions were observed during more than 80% of monitoring events. Observations recorded during visual field monitoring identified potential litter sources including: litter thrown or blown from vehicles, illegal dumping, and pedestrian litter. Visual monitoring assessment results for each site are included in an accompanying Access database.[25]

3.2.2 Visual Monitoring Assessment and Comparison

The visual monitoring results were compared to volume- and weight-based trash generation rates from the quantitative monitoring to examine how closely visual monitoring trash condition categories correspond to measured trash generation rates. As discussed in Section 2.2.2 and Appendix I, each site's overall mean annual volume- and weight-based trash generation rates were compared with the mean visual assessment scores, which is consistent with the method used in the BASMAA study (EOA, Inc. 2013). A statistical relationship was not found between the visual scores and the trash generation rates. Further details on the comparisons are provided in Appendix I.

3.3 Full Capture Device Performance Monitoring

Qualitative performance observations indicate that in general the selected full capture device performed as it was intended. However, due to several high-intensity storm events, several devices were damaged by high flow rate and debris. Full capture devices were replaced at four of 36 sites monitored and the grate was found missing or improperly functioning during seven of 137 sampling events. It is not believed that this was a design flaw of the chosen device, as similar observations have been made after high-intensity rain events in other studies (e.g., Metropolitan Washington Council of Governments 2009). According to communications with StormTek, almost all of the damage to full capture devices was due to unusually high flow rates. Thus, it is recommended to account for peak stormwater flow at a site when considering CPS installation and then consider if customized reinforcement may be necessary to reduce and avoid damage to the device.

Due to the small mesh size required[26], the screens on these devices can clog with sediment or organic materials, which can cause flooding. However, this would be a common issue among similar full capture devices and not specific to the selected device. Example photographs of a clogged screen on a full capture device and the resulting flooding into the roadway are presented in Figure J- 1 through Figure J-3 of Appendix J.

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[23] Due to the large number of sites and other monitoring logistical constraints, the monthly monitoring events occurred on different days and sometimes different months among the sites, which resulted in the actual study period spanning over more than 12 months.

[24] SDR1A-38, SDR1A-72, SDR1B-34, SDR1B-37, SDR1C-30, SDR2-39, SDR3-2, SDR4-11, SDR4-16, SDR4-8A, SDR6-13, and SDR6-26

[25] The Access database is presented in Appendix L.

[26] Full capture systems are defined in the Trash Amendments as treatment controls that traps all particles that are 5 mm or greater.

In summary, the selected full capture device performed as it was intended; the operational issues experienced do not appear specific to the device, but are likely common among most fabricated full capture devices that are inserted inside a catch basin.

4.0 Discussion

4.1 San Diego Regional Trash Generation Rates Compared to Other Studies

There are a number of studies that quantify the trash generation rates in urban and suburban areas in California as well as other areas in the United States; including the San Francisco Bay Area, the Los Angeles region, and the Chesapeake Bay region (Michael Baker International 2015). Below is a brief summary of these trash generation studies.

- San Francisco Bay Municipal Regional Stormwater NPDES Permit (MRP) Study (Bay Area Study; EOA, Inc. 2014): Beginning in 2010, the BASMAA installed full capture trash devices and monitored the generation of trash to help comply with numeric trash reduction requirements in the MRP. This study evaluated the significance of several variables that were deemed to potentially influence the amount of trash found in stormwater conveyance systems[27]. The significance of these variables was tested through the selection and completion of a monitoring program of 159 sites, which were sampled four times. Trash generation rates were estimated by land use and household income level.
- Los Angeles Trash TMDL Study (County of Los Angeles Department of Public Works 2004): As the result of 303(d) Clean Water Act for trash, baseline trash generation monitoring was conducted in the Los Angeles River and Ballona Creek watersheds to determine the amount of trash discharged from stormwater conveyance systems to the water bodies and assist with development of subsequent TMDLs. Trash monitoring was conducted at 175 sites in five land uses[28]. Annual trash generation rates were estimated for each land use by volume and by weight.
- Anacostia Baseline Monitoring (Metropolitan Washington Council of Governments 2009): For a total of nine months, the Metropolitan Washington Council of Governments collected baseline trash condition data from the Anacostia River for use in developing a trash TMDL. The monitoring was conducted at sites in streams, roads and parking lots, and outfalls[29].
- Patapsco River Study (Maryland Department of the Environment 2014b): A 2014 study developed waste load allocations for trash and debris in portions of the Patapsco River. Baseline load in this TMDL is defined as the annual trash load calculated from monitoring data collected at six storm drain outfalls in the City of Baltimore and at 20 in-stream sites and 17 stormwater management facilities randomly selected in the County of Baltimore. Because of high seasonal and annual variability, mean quantities are used from point and non-point sources. Annual trash loading rates

[27] The variables include 1) type of land use and businesses, 2) population density, 3) income level of the community, 4) rainfall/runoff patterns, 5) street sweeping effectiveness, 6) level of vehicular traffic, and 7) level of environmental concern in the community.

[28] Commercial, industrial, high-density single-family residential, low-density single-family residential, and open space/urban parks

[29] 1) seasonal in-stream baseline monitoring at 30 randomly selected sites; 2) baseline road and parking lot monitoring to characterize six land use types, including a low-density (1-acre single-family) site, a predominantly medium-density (1/8-acre single-family) site, a medium- density townhouse development, a high-density apartment complex, a commercial shopping center anchored by a grocery store, and the Beltsville Industrial Park (57% commercial/industrial); 3) outfall monitoring for the same six land use areas; and 4) monitoring for two Fresh Creek netting trash trap sites in Prince George's County to characterize loading rates from upland land use areas

were normalized for precipitation because the study 'assumed' a strong correlation between trash and rainfall.

- Revolon Slough/Malibu Creek Study (Los Angeles Water Board 2007): To establish a baseline trash generation rate for trash TMDL in Revolon Slough and Malibu Creek, the Los Angeles Water Board analyzed research from other watersheds (trash collection summaries from Long Beach and records of trash removed from a Continuous Deflective Separation [CDS] unit installed in the City of Calabasas[30]) to establish baseline trash generation rates for the TMDL.
- Caltrans Litter Management Pilot Study (Caltrans 2000): The California Department of Transportation (Caltrans) has conducted significant research into the efficacy of sweeping for trash reduction. The Caltrans study assessed the impact of increased street sweeping by measuring reductions at storm drain outfalls. Sweeping was conducted every week in the study area versus once per month in the control area. Annual air-dried litter loads during the two-year study period ranged from 3.1 kg/acre to 7.5 kg/acre. Note that trash data were normalized by area, assuming a uniform trash generation rate throughout the area of the catchment.

Consistent with the findings from the Special Study (Table 4), a review of other studies indicates that overall, commercial land use generates the most trash followed by industrial land use. Mean trash generation rates for priority land uses from the Special Study are lower than mean rates estimated in the Los Angeles region and the Bay Area. Note that household income levels are comparable among the Los Angeles region, the Bay Area, and the San Diego region, for all land uses (Table 4) [31]. Lower trash generation rates may be explained in part due to lower population density in the San Diego region than in the Los Angeles region and the Bay Area.[32]

However, even if the study sites accurately represent the urban areas of the County as a whole, the sites may not represent individual jurisdictions if the jurisdiction's characteristics do not align well with the County's as a whole. Therefore, jurisdictions have the flexibility to determine their own rates, e.g., by incorporating data from other published studies or their own studies, as appropriate based on their own jurisdiction's unique characteristics, as long as the jurisdiction can show a reasonable basis.

[30] A land use of the contributing area to the CDS was primarily moderate-density single-family residential, with some high-density residential apartment complexes, and a sports complex.

[31] Although median household incomes for Anacostia Baseline Monitoring and Patapsco River Study areas are also comparable to the San Diego region, the trash generation rates from these studies are less directly comparable than those from the Los Angeles and the Bay Area studies because the rates are an average of in-stream, road and parking lot, and outfall sites (Anacostia Baseline Monitoring) or normalized for rainfall (Patapsco River Study).

[32] Population densities are 680/mi^2, 7,660/mi^2, and 4,204/mi^2 in 2010 for San Diego County, Los Angeles area (as Los Angeles River and Ballona Creek watersheds combined), and San Francisco Bay Area, respectively (US Census Data; Michael Baker International 2015).

TABLE 4. TRASH GENERATION RATES COMPARISON TO OTHER STUDIES

Land Use	Mean Trash Generation Rate (gallons/acre/year) Per Land Use						
	San Diego Special Study[33]	Bay Area Study[34]	Los Angeles Trash TMDL Study[35]	Anacostia Baseline Monitoring[36]	Patapsco River Study: City of Baltimore[37]	Patapsco River Study: County of Baltimore[38]	Revolon Slough/ Malibu Creek[39]
Residential	2.50[40]	5.35	4.3[41]	0.6	3.15	0.98[42]	1.0
Transportation	N/A	N/A	N/A	N/A	N/A	0.82	N/A
Industrial	2.60	8.4	15.33	1.22	3.15	N/A	N/A
Commercial	6.00	6.2	14.77	0.21	3.15	3.16	N/A
Retail	N/A	46.8	N/A	0.21	3.15	N/A	N/A
Schools/ Institutional	N/A	6.2	N/A	N/A	N/A	0.80	N/A
Park	N/A	5.0	5.81	N/A	N/A	0.86	1.0

4.2 Factors Affecting Trash Generation Rates

The Special Study considers land use as the key factor affecting trash generation rates. This assumption is consistent with the basis of the statewide Trash Amendments. Other factors have also been reported or suggested to affect trash generation rates including population density, income level of the community, rainfall/runoff patterns, street sweeping effectiveness, level of vehicular traffic, and level of environmental concern in the community (EOA, Inc. 2014; Michael Baker International 2015). Income variability, rainfall/runoff patterns, and population density have been discussed as potentially important variables for certain jurisdictional areas in San Diego County and are thus reviewed in additional detail below.

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[33] According to the US Census Bureau, San Diego County's median household income was $66,529 per year in 2012-2016.

[34] All values are "Best," which in the study refers to the mean generation rate for each priority land use. Where applicable, values taken are for "moderate" income level of $50,000 to $100,000 per year (EOA, Inc. 2014).

[35] All values are mean generation rates (County of Los Angeles Department of Public Works 2004). According to the US Census Bureau, the median household income in Los Angeles County is $57,952 per year in 2012-2016.

[36] All values are mean generation rates adjusted from nine-month monitoring period to annual basis (Metropolitan Washington Council of Governments 2009). Values reported in pounds converted at and assumed 2.5 pounds per gallon based on an approximate of mean of the pounds per gallon from the Los Angeles study (County of Los Angeles Department of Public Works 2004). All values represent means from various monitoring programs (outfall monitoring, parking lots, in stream, etc.)

[37] Taken from a single all-purpose mean "urban" land use value (Maryland Department of the Environment 2014b) and converted from values reported as weight at 2.5 pounds per gallon based on an approximation of mean pounds per gallon from the Los Angeles Trash TMDL Study (County of Los Angeles Department of Public Works 2004).

[38] All values converted from mean weight-based trash generation rate (Maryland Department of the Environment 2014b) at 2.5 pounds per gallon based on an approximation of mean pounds per gallon from the Los Angeles Trash TMDL study (County of Los Angeles Department of Public Works 2004).

[39] All values are mean trash generation rates. Priority land uses only correlated to those observed applicable in Las Virgenes Creek watershed (Los Angeles Water Board 2007).

[40] > 10 dwellings per acre

[41] A mean of high- and low-density residential rates.

[42] A mean of high-, medium-, and low-density residential rates.

4.2.1 Income level

The Bay Area Study explicitly addressed trash generation rates by different income levels (EOA, Inc. 2014). In that study, areas where median household income was less than \$50,000 per year recorded trash generation rates as high as two orders of magnitude above the trash generation rates documented in areas with an income greater than \$100,000. The Special Study was conducted in a wide range of urban and suburban communities, including disadvantaged communities, and thus results should be considered valid to apply to the entire study area. However, jurisdictions have the ability to further refine the data to improve the applicability of the trash generation results to their jurisdiction.

4.2.2 Rainfall/Runoff Patterns

No clear literature correlation exists between rainfall and trash generation (Michael Baker International 2015). The Bay Area Study compared historical rainfall records to results from the Los Angeles Trash TMDL Study and found no correlation between the two (EOA, Inc. 2014). While the Patapsco River Study for the City of Baltimore assumed a strong correlation and normalized trash generation rates by rainfall, no proof was given for this assumption (Maryland Department of the Environment 2014).

When the trash generation rates from the Special Study were calculated separately for the wet and dry seasons, no correlation was observed, which is consistent with the Bay Area Study (Table K-1 of Appendix K). Antecedent dry conditions may affect trash generation rates. With longer antecedent dry conditions, more trash may accumulate and be washed off via runoff during a subsequent storm event. However, the resulting amounts of trash in storm drains would also be affected by how frequently cleanups and street sweeping are conducted, as well as other variables such as the amount of wind-blown trash deposited. Therefore, the impact of the length of antecedent dry periods between storm events is unclear.

4.2.3 Population Density

High densities of people living in areas generally implies more human activity, which would consequently lead to higher trash generation rates (Marias, et al. 2004). It has been shown that a higher density of people will produce more trash, even if the per capita generation rate is lower (Marias, et al. 2004). Also, as income level increases, population density in residential areas typically decreases. This could result in a possibility that the two factors of income level and population density of residential areas are inversely correlated. However, these factors were not evaluated in the Special Study.

4.3 Trash Characterization

Although trash was not sorted and quantitatively categorized in the Special Study, photographic documentation suggests that much of the trash collected was categorized as plastic bags, cigarette butts, bottles, aluminum cans, styrofoam cups, and plastic wrappers. Based on photo documentation, the types of trash observed appeared similar across the different priority land uses. The types of trash observed in the Special Study appear consistent with those reported in other studies.[43]

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[43] The Bay Area Study reported food and beverage containers, packaging, cigarette butts, food waste, construction and landscaping materials, furniture, electronics, tires, and hazardous material as typical items (EOA, Inc. 2014). The Maryland study's findings are also similar. In the Maryland study, the six most commonly observed trash items at 30 randomly selected sites—plastic bags, food packaging, construction debris, Styrofoam, plastic bottles, and aluminum cans—accounted for 79 percent of counted items; the most commonly observed items in the parking lot and roadway areas were paper, food packaging, aluminum cans, and plastic bottles and cans; and the most commonly reported trash items in trash ended up in outfalls were plastic bags, food packaging, Styrofoam, and plastic bottles (Maryland Department of the Environment 2014b). The Caltrans Litter Management Pilot Study indicates that smoking and food-related litter account for 20 percent to 30 percent of the litter by

4.4 Visual Monitoring

The Special Study measured lower trash generation rates compared to other studies (Table 4). Because of the generally low trash generation rates measured, demonstrating a correlation between visual assessment scores and measured generation rates is more challenging. Figure I-3 of Appendix I demonstrates how most rates from the Special Study would fall within the visual assessment score of A and B for the BASMAA study (0 - 5 gallons/acre/year for score A, and 5 - 10 gallons/acre/year for score B). Further details to support this assessment are presented in Appendix I.

The majority of visually monitored trash conditions were in the low to medium range (visual assessment scores of A and B) and were not normally distributed. If a larger number of data for each trash condition from low to very high had been observed, then the nature of the correlations between the visual monitoring and quantitative monitoring results might have been identified. Additionally, more frequent quantification of trash in the catch basin (monthly instead of the quarterly monitoring done in the Special Study), may have resulted in identifying a correlation with the visual monitoring that was conducted monthly. However, cost constraints prevented consideration of such an expanded design. Therefore, the findings of the Special Study should not rule out the use of visual monitoring to demonstrate compliance with Track 2.

weight and volume. Approximately 79 percent of items by weight and 71 percent by volume were assigned to the "other" category. The study also indicates that approximately 80 percent of the litter collected at the outfall is floatable (Caltrans 2000).

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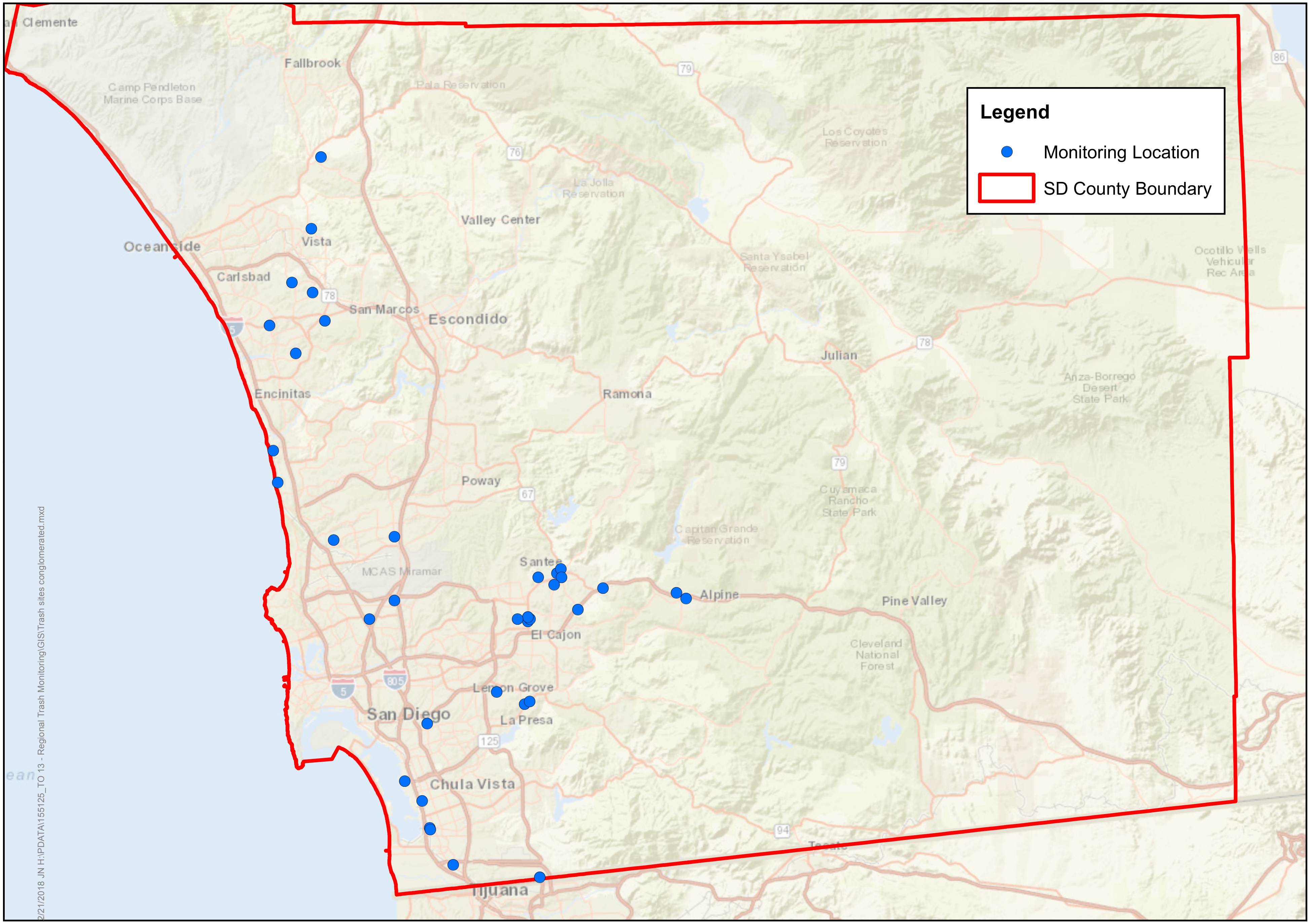
APPENDIX A. MONITORING SITES

TABLE A- 1. MONITORING SITES

Priority Land Use	Site Name	Jurisdiction/Agency	Latitude	Longitude	Drainage Area (acres)
High-Density Residential **(10 Sites)**	SDR1A-72	Lakeside	32.85177	-116.92990	6.7
	SDR4-16	Bostonia	32.81670	-116.95980	1.9
	Res-CiSD-1	City of San Diego	32.56461	-117.05582	3.9
	Res-CiSD-6	City of San Diego	32.90269	-117.12376	14.7
	55A-205	City of Carlsbad	33.09152	-117.24246	34.3
	CAR2-37	County of San Diego	33.12532	-117.20626	16.5
	HDR-CV-1757	City of Chula Vista	32.63070	-117.09277	3.4
	HDR-VI-1	City of Vista	33.22039	-117.22177	13.6
	SLR1-32	County of San Diego	33.29411	-117.20941	8.2
	SWT2-125	Spring Valley	32.73178	-116.96148	7.1
Park & Ride Lot **(1 Site)**	Tran-CiSD-2	City of San Diego	32.71036	-117.08608	1.1
Industrial **(14 Sites)**	SDR1A-38	Lakeside	32.86339	-116.92656	2.9
	SDR1B-34	Lakeside	32.86775	-116.92155	8.4
	SDR1C-30	Lakeside	32.85956	-116.94928	2.7
	SDR3-2	Lakeside (Los Coches - Upper)	32.84758	-116.87061	1.8
	SDR4-11	Bostonia	32.81439	-116.96223	2.1
	SDR6-26	Alpine	32.84207	-116.78145	5.2
	Ind-CiSD-2	City of San Diego	32.55098	-116.95156	6.9
	37B-68	City of Carlsbad	33.12098	-117.27378	24.5
	BRA-EC-2	City of El Cajon	32.81674	-116.97513	10.6
	IND-CV-2015	City of Chula Vista	32.60083	-117.08326	26.9
	IND-SDUPD-2554	San Diego Unified Port District	32.65301	-117.11260	19.1
	IND-VI-1	City of Vista	33.15459	-117.22098	37.3
	SWT2-112	Spring Valley	32.72914	-116.96794	5.6
	SWT5-101	Spring Valley	32.74211	-117.00126	9.8
Commercial **(11 Sites)**	SDR6-13	Alpine	32.83606	-116.76959	7.4
	SDR1B-37	Lakeside	32.85927	-116.92083	9.2
	SDR2-39	Lakeside (Los Coches)	32.82606	-116.90146	0.80
	SDR4-8A	Bostonia	32.81892	-116.96224	8.50
	Com-CiSD-1	City of San Diego	32.89975	-117.19758	6.5
	Com-CiSD-3	City of San Diego	32.83713	-117.12444	14.6
	Com-CiSD-6	City of San Diego	32.81811	-117.15505	16.8

	COM-CV-2009	City of Chula Vista	32.60284	-117.08389	1.3
	COM-DM-1	City of Del Mar	32.95953	-117.26517	1.4
	COM-SB-2	City of Solana Beach	32.99221	-117.27051	9.5
	COM-VI-1	City of Vista	33.16486	-117.24594	17.2



2/21/2018 JN H:\PDATA\155125_TO 13 - Regional Trash Monitoring\GIS\Trash sites conglomerated.mxd

Michael Baker INTERNATIONAL

0 1 2 4 Miles

Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community, MBI

Figure A-1
San Diego Region Monitoring Locations

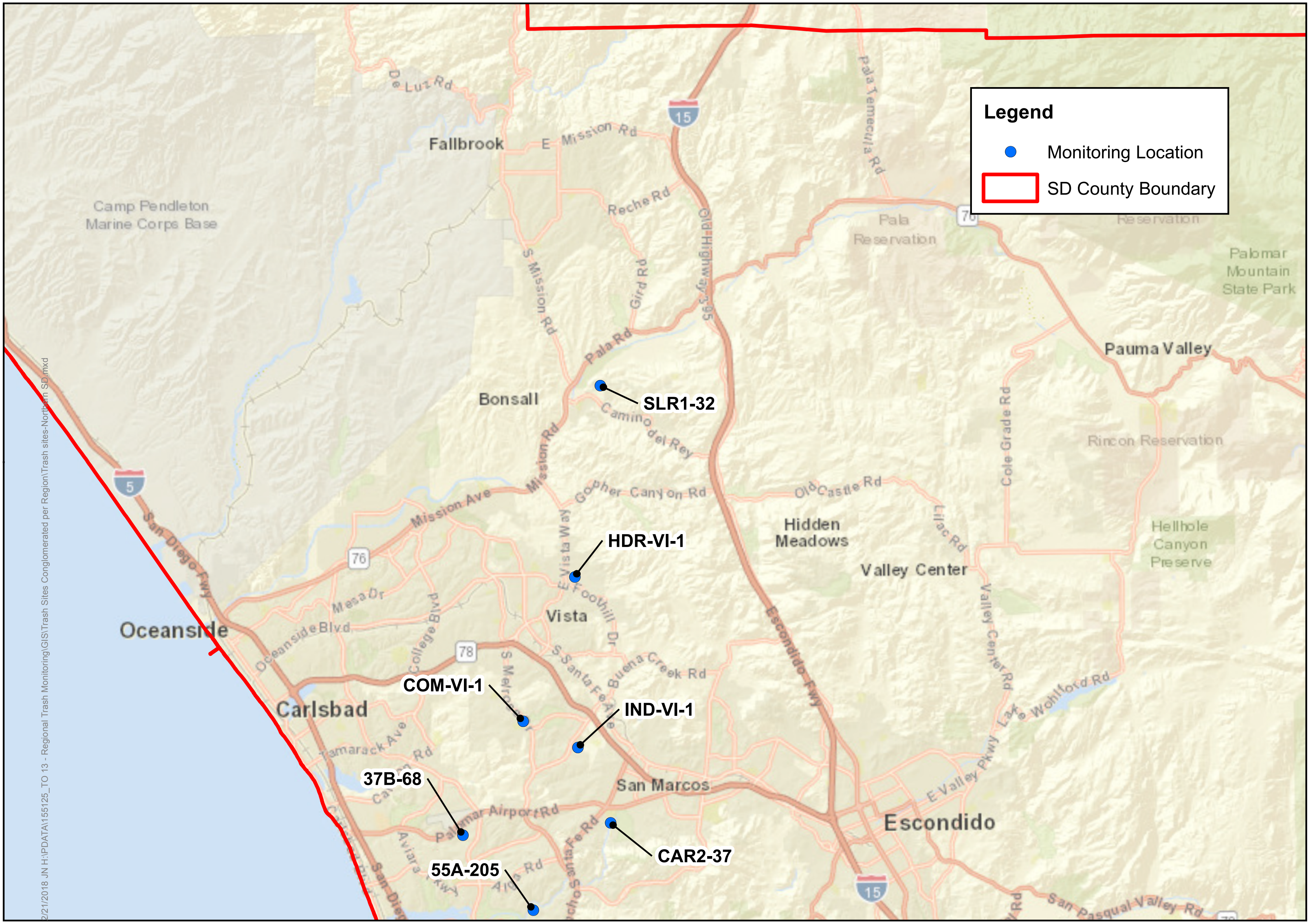


Figure A-2
Northern San Diego Region
Monitoring Locations

Michael Baker INTERNATIONAL

Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community, MBI

1/18/2018 JN H:\PDATA\155125_TO 13 - Regional Trash Monitoring\GIS\Trash Sites Conglomerated per Region\Trash sites-Central SD.mxd

Figure A-3
Central San Diego Region
Monitoring Locations

Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community, MBI

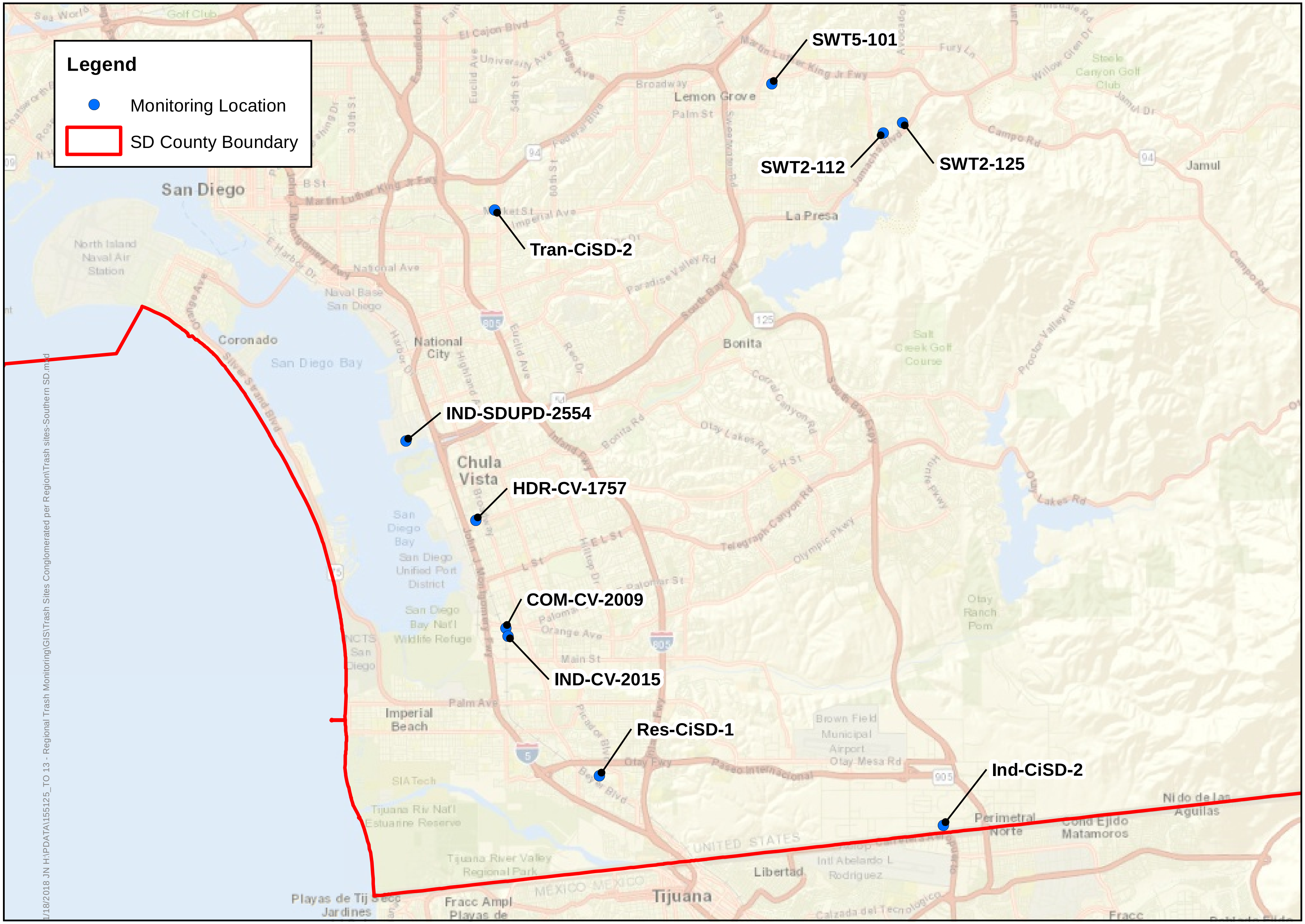


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Figure A-4
Southern San Diego Region
Monitoring Locations

Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community, MBI

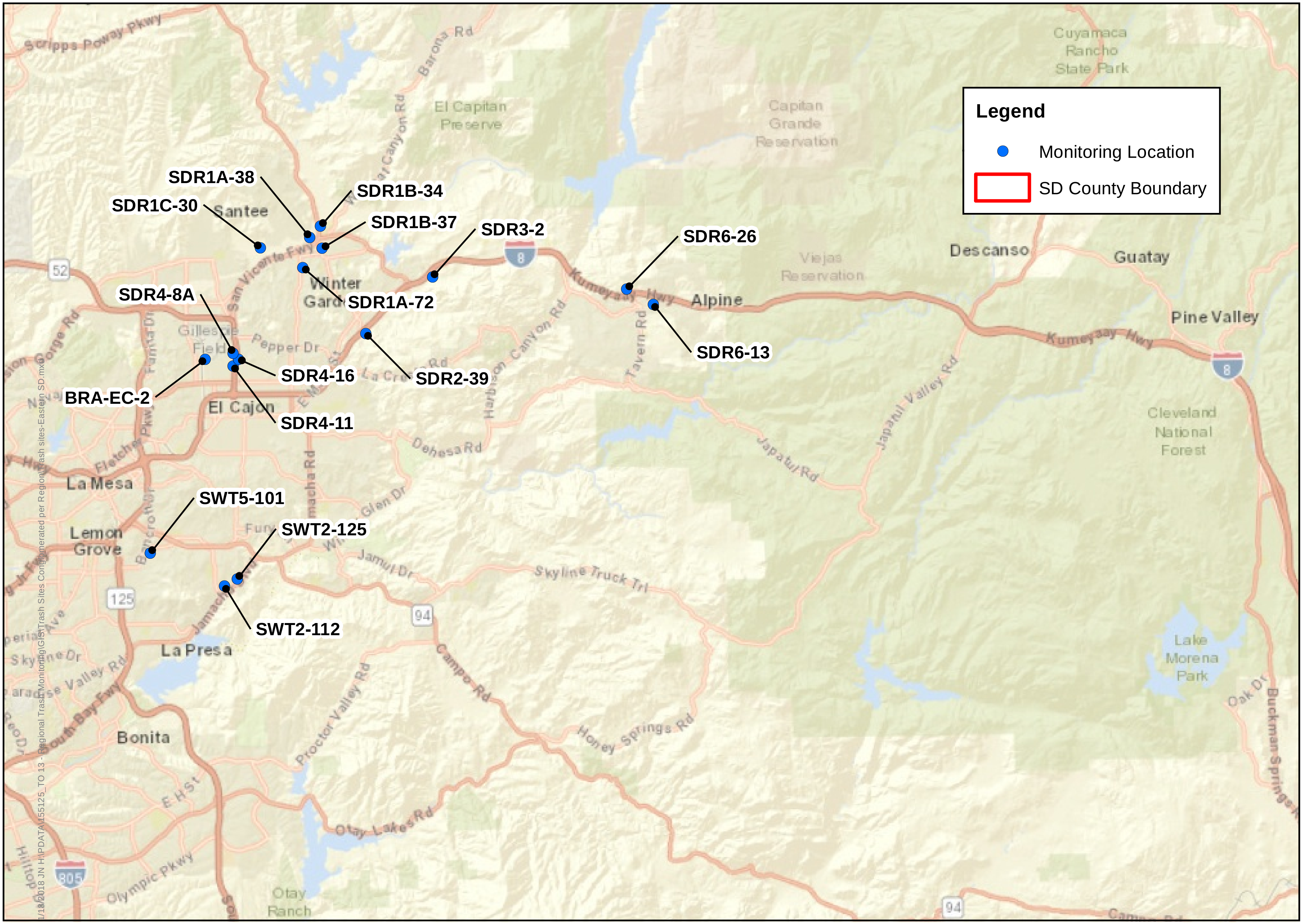

Figure A-5
Eastern San Diego Region
Monitoring Locations

Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community, MBI

APPENDIX B. MONITORING SITE LOCATION MAPS

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0 100 200 400 Feet

Monitoring Locations

Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, MBI

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Monitoring Locations

Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, MBI

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Michael Baker INTERNATIONAL

0 100 200 400 Feet

Monitoring Locations

Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, MBI

Site Number: COM-CV-2009
Jurisdiction: City of Chula Vista
Land Use Type: Commercial

Legend

Land Use Category Inlet Location

Commercial

Drainage Area

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0 100 200 400 Feet

Monitoring Locations

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0 100 200 400 Feet

Monitoring Locations

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Site Number: COM-SB-2
Jurisdiction: City of Solana Beach
Land Use Type: Commercial

Legend

Land Use Category Inlet Location

- Commercial
- Drainage Area

0 100 200 400 Feet

Monitoring Locations

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0 100 200 400
Feet

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0 100 200 400 Feet

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0 100 200 400 Feet

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Monitoring Locations

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0 100 200 400 Feet

Monitoring Locations

Site Number: 55A-205
Jurisdiction: City of Carlsbad
Land Use Type: HD Residential

Legend

Land Use Category Inlet Location

HD Residential

Drainage Area

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0 100 200 400 Feet

Monitoring Locations

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0 100 200 400 Feet

Monitoring Locations

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Site Number: HDR-VI-1
Jurisdiction: City of Vista
Land Use Type: HD Residential

Legend

Land Use Category Inlet Location

HD Residential

Drainage Area

0 100 200 400 Feet

Monitoring Locations

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Michael Baker INTERNATIONAL

0 100 200 400 Feet

Monitoring Locations

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Site Number: Res-CiSD-6
Jurisdiction: City of San Diego
Land Use Type: HD Residential

Legend

Land Use Category Inlet Location

HD Residential

Drainage Area

0 100 200 400 Feet

Monitoring Locations

Site Number: SDR1A-72
Jurisdiction: Lakeside
Land Use Type: HD Residential

Legend

Land Use Category Inlet Location

HD Residential

Drainage Area

Michael Baker INTERNATIONAL

0 100 200 400 Feet

Monitoring Locations

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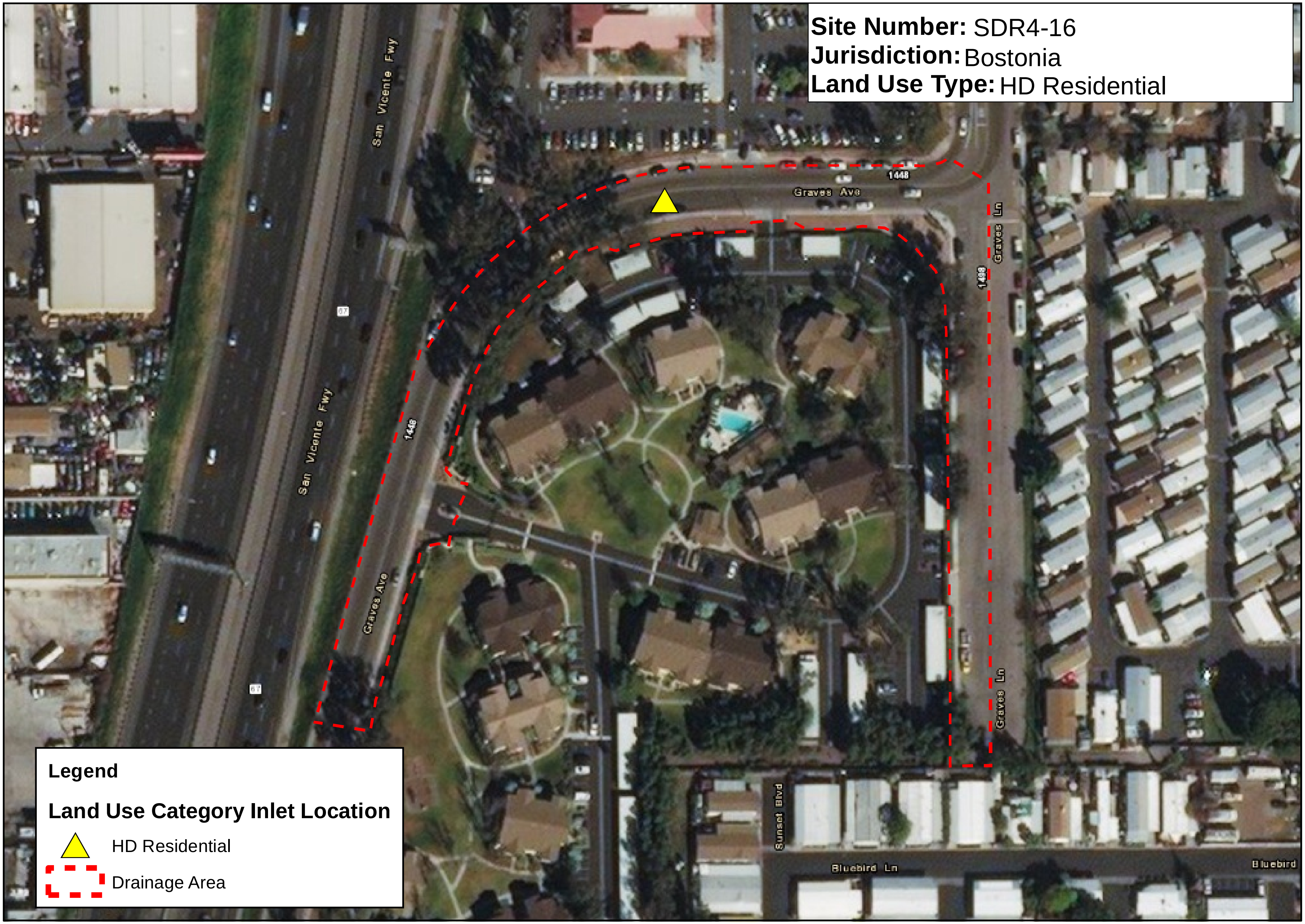

Site Number: SDR4-16
Jurisdiction: Bostonia
Land Use Type: HD Residential

Legend

Land Use Category Inlet Location

HD Residential

Drainage Area

0 100 200 400 Feet

Michael Baker INTERNATIONAL

Monitoring Locations

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Site Number: SLR1-32
Jurisdiction: County of SD
Land Use Type: HD Residential

Legend

Land Use Category Inlet Location

HD Residential

Drainage Area

0 100 200 400 Feet

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Monitoring Locations

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0 100 200 400 Feet

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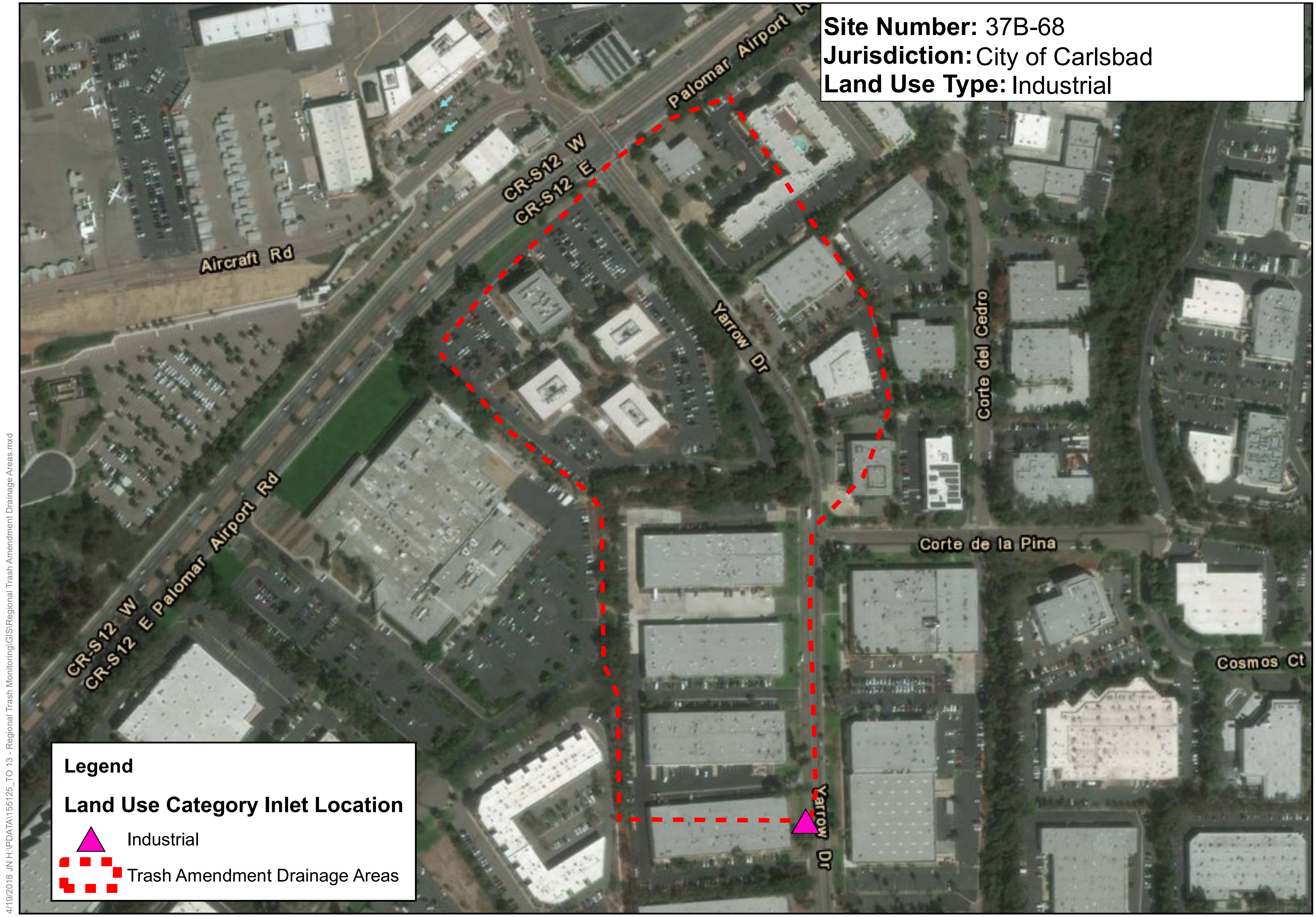

Michael Baker INTERNATIONAL

0 100 200 400 Feet

Monitoring Locations

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0 100 200 400 Feet

Monitoring Locations

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Site Number: Ind-CiSD-2
Jurisdiction: City of San Diego
Land Use Type: Industrial

Legend

Land Use Category Inlet Location

Industrial

Drainage Area

0 100 200 400 Feet

Monitoring Locations

Michael Baker INTERNATIONAL

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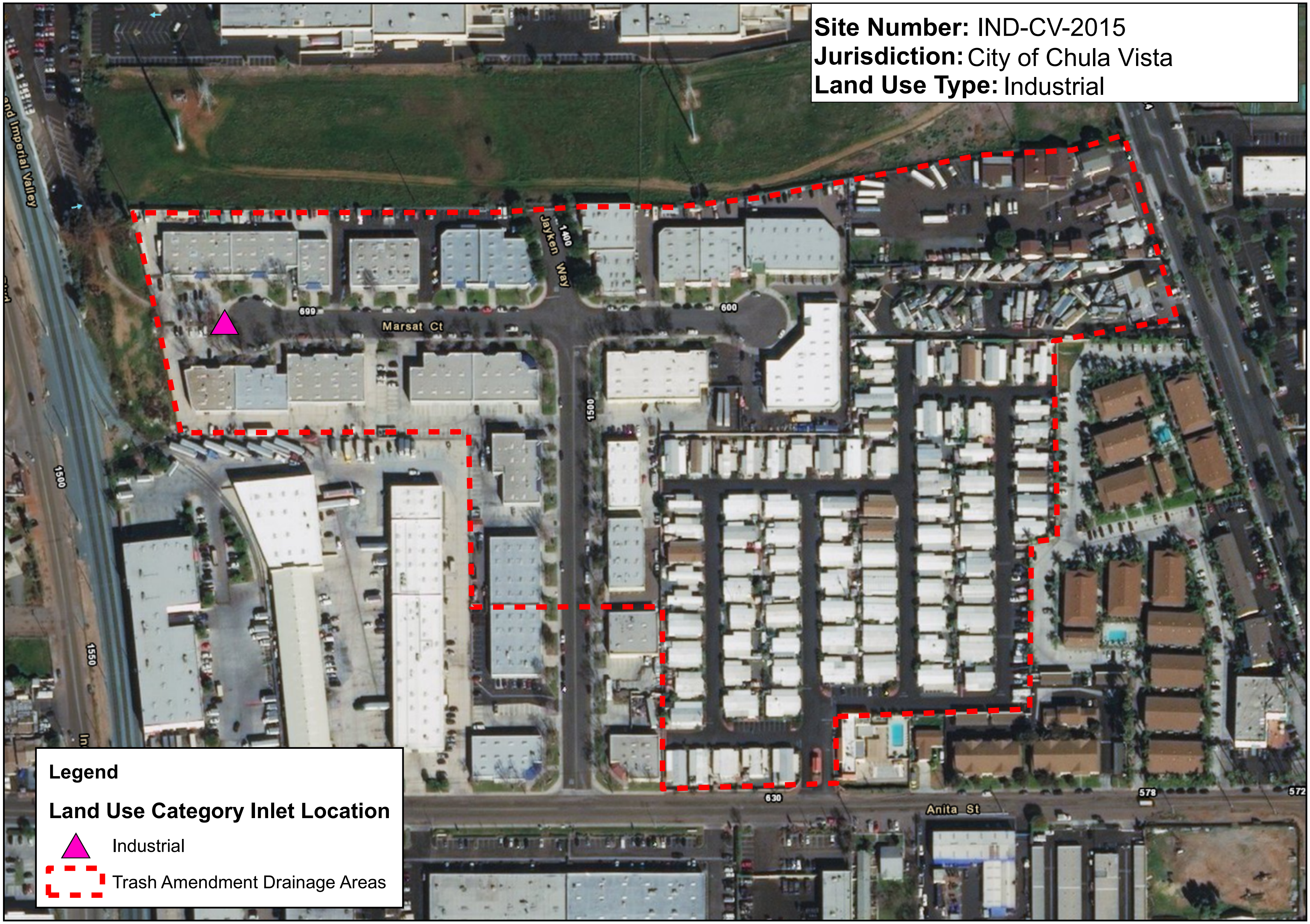
Site Number: IND-CV-2015
Jurisdiction: City of Chula Vista
Land Use Type: Industrial



Legend

Land Use Category Inlet Location

Industrial

Trash Amendment Drainage Areas

0 100 200 400 Feet

Michael Baker INTERNATIONAL

Monitoring Locations

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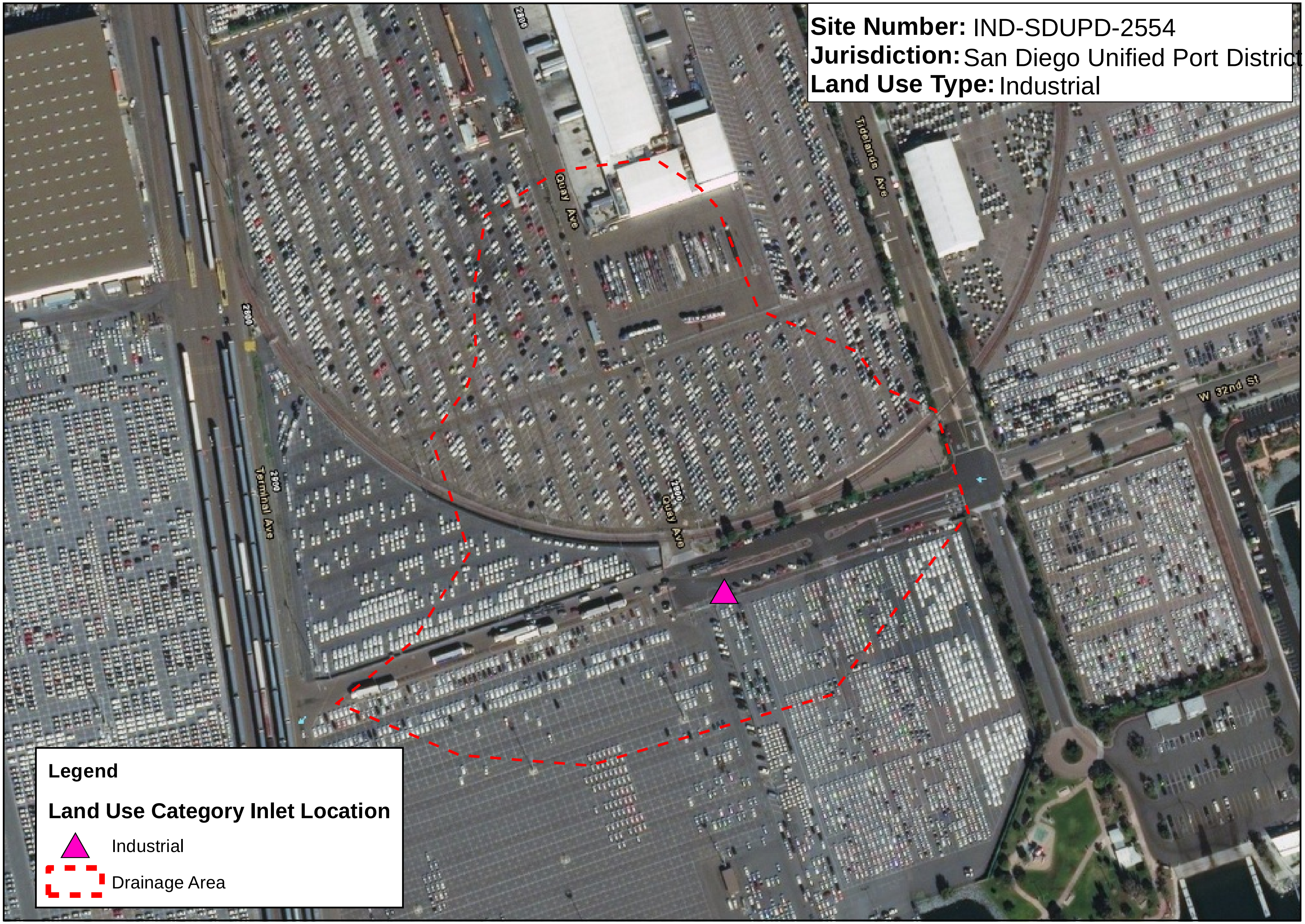

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Michael Baker INTERNATIONAL

0 100 200 400 Feet

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Site Number: IND-VI-1
Jurisdiction: City of Vista
Land Use Type: Industrial

Legend

Land Use Category Inlet Location

Industrial

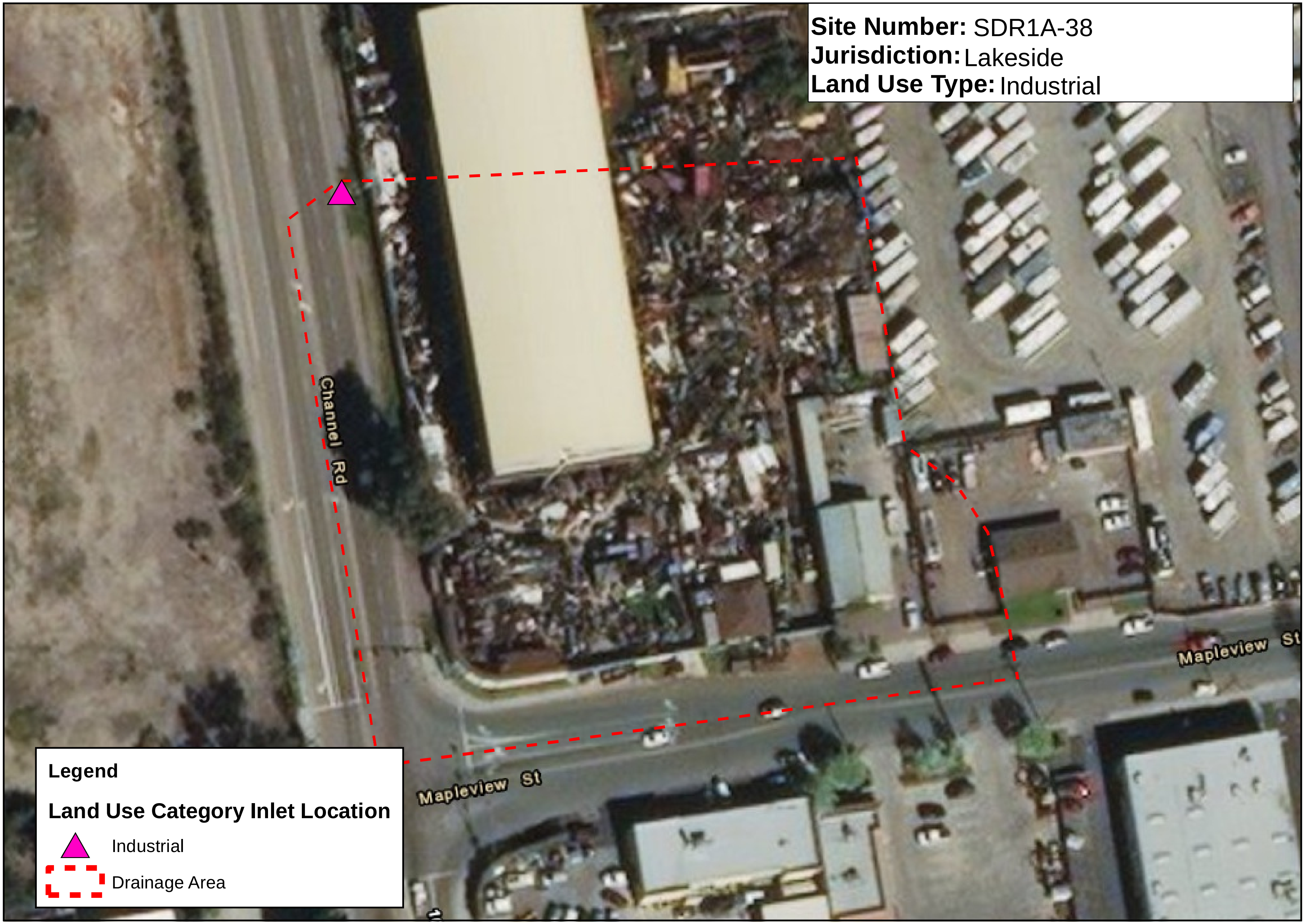
Drainage Area

Michael Baker INTERNATIONAL

0 100 200 400 Feet

Monitoring Locations

Site Number: SDR1A-38
Jurisdiction: Lakeside
Land Use Type: Industrial



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Michael Baker INTERNATIONAL

0 100 200 400 Feet

Monitoring Locations

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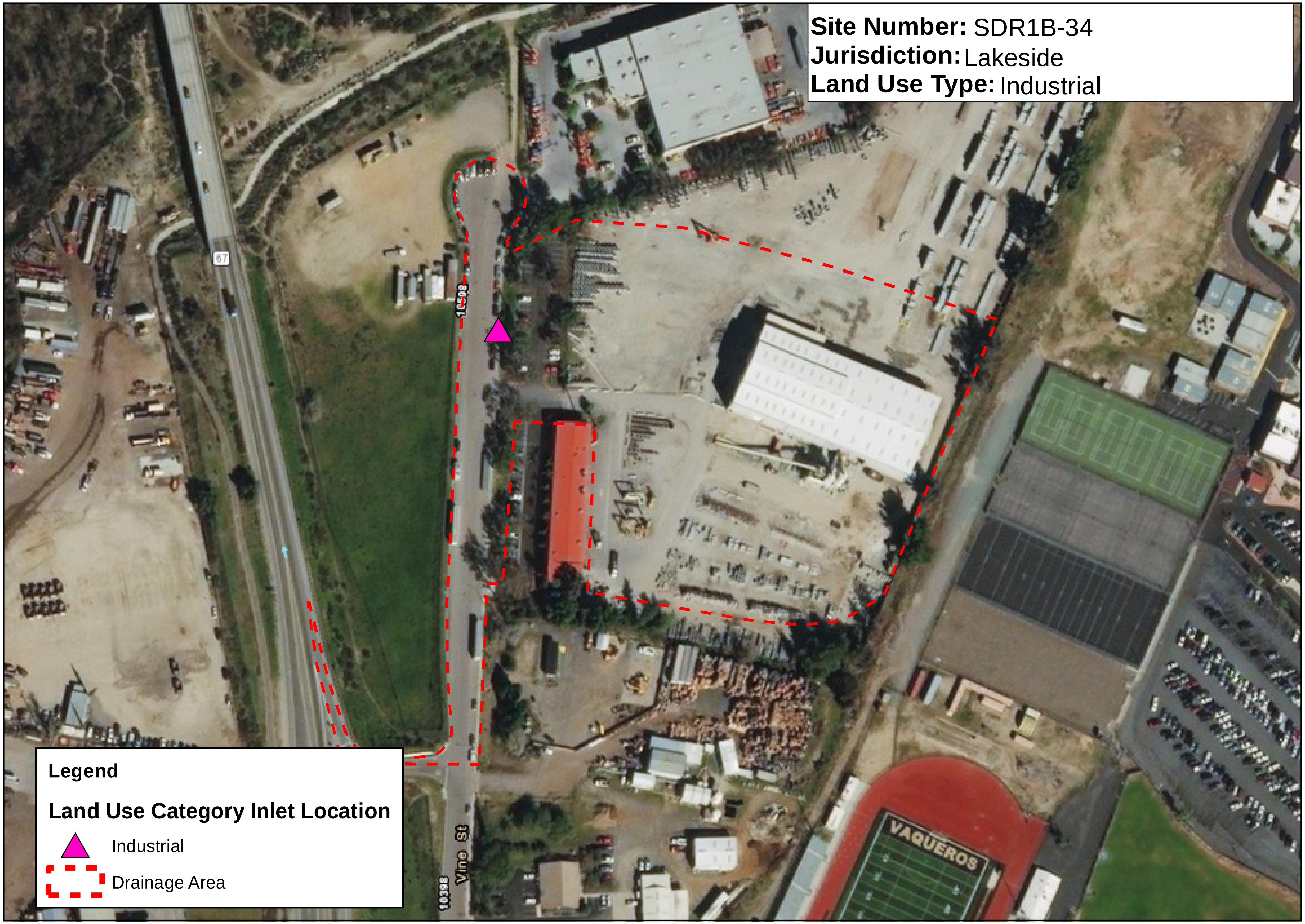
Site Number: SDR1B-34
Jurisdiction: Lakeside
Land Use Type: Industrial



Legend

Land Use Category Inlet Location

Industrial

Drainage Area

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Michael Baker INTERNATIONAL

0 100 200 400 Feet

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Michael Baker INTERNATIONAL

0 100 200 400 Feet

Monitoring Locations

Site Number: SDR3-2
Jurisdiction: Lakeside-Los Coches Upper
Land Use Type: Industrial

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Michael Baker INTERNATIONAL

0 100 200 400 Feet

Monitoring Locations

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Site Number: SDR4-11
Jurisdiction: Bostonia
Land Use Type: Industrial

Legend

Land Use Category Inlet Location

Industrial

Drainage Area

Michael Baker INTERNATIONAL

0 100 200 400 Feet

Monitoring Locations

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0 100 200 400 Feet

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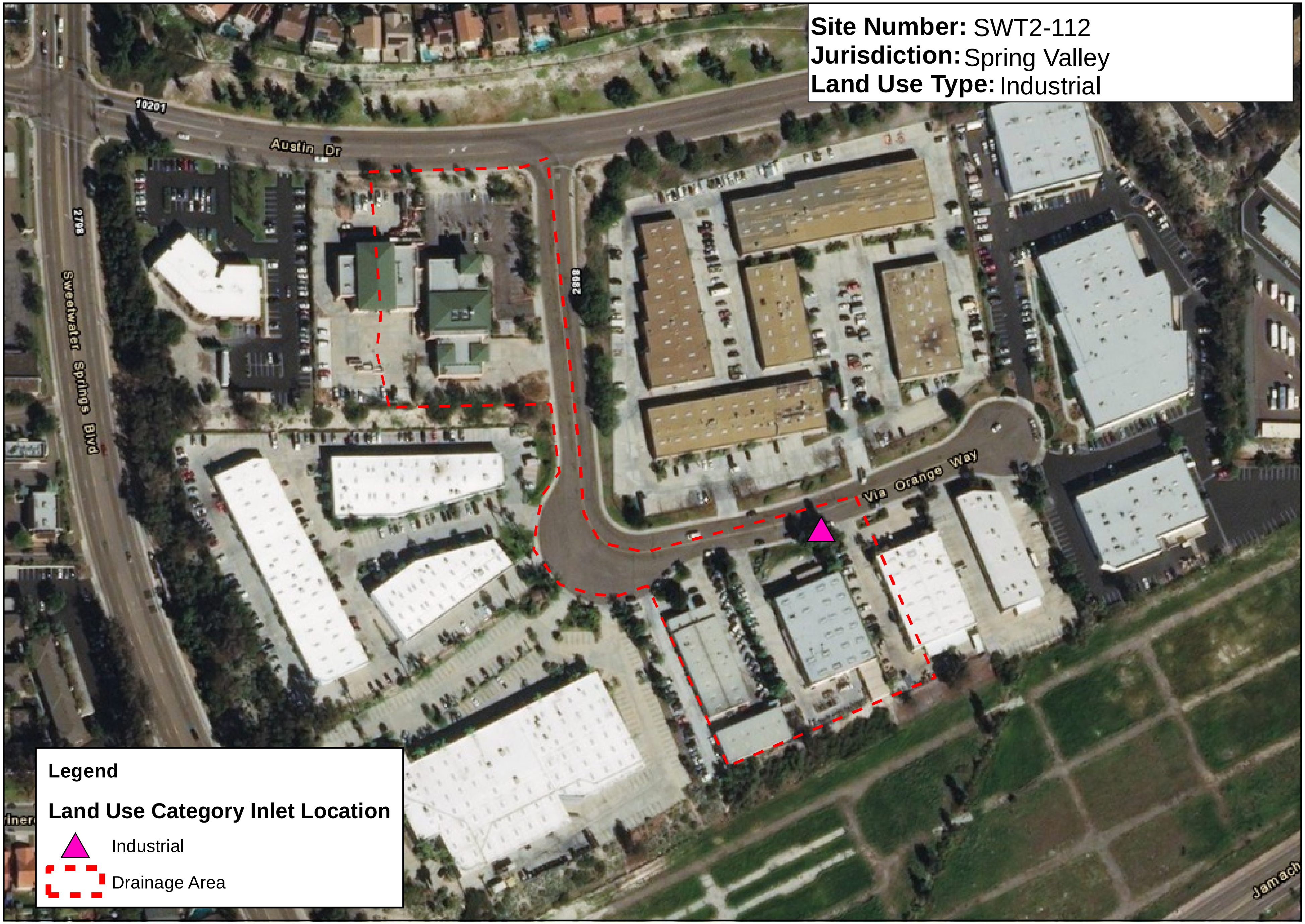
Site Number: SWT2-112
Jurisdiction: Spring Valley
Land Use Type: Industrial



Legend

Land Use Category Inlet Location

Industrial

Drainage Area

0 100 200 400 Feet

Michael Baker INTERNATIONAL

Monitoring Locations

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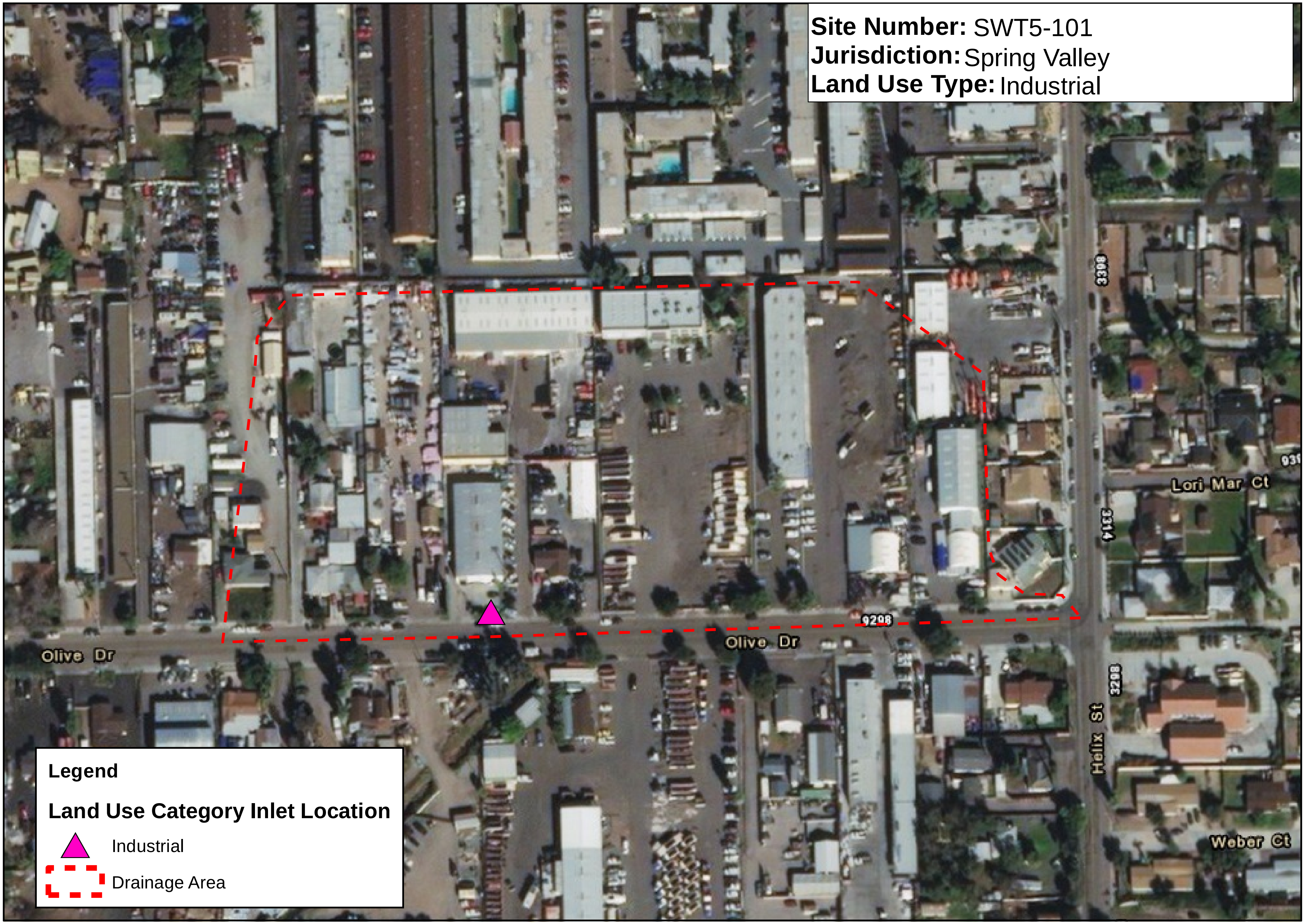
Site Number: SWT5-101
Jurisdiction: Spring Valley
Land Use Type: Industrial



Legend

Land Use Category Inlet Location

Industrial

Drainage Area

0 100 200 400 Feet

Michael Baker INTERNATIONAL

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Site Number: HDR-CV-1757
Jurisdiction: City Chula Vista
Land Use Type: HD Residential

Legend

Land Use Category Inlet Location

HD Residential

Drainage Area

0 100 200 400 Feet

Monitoring Locations

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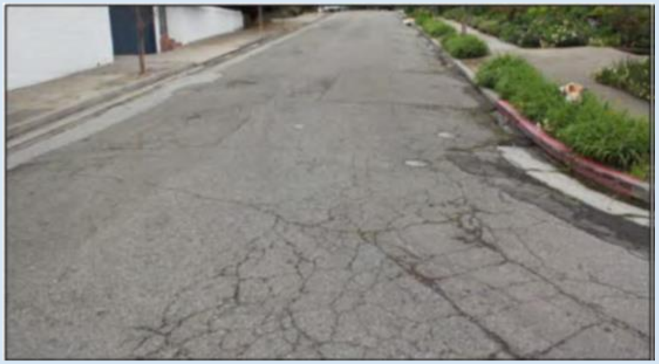
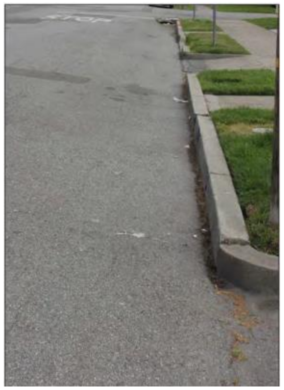
APPENDIX C. VISUAL MONITORING METHOD

TABLE C- 1. VISUAL MONITORING ASSESSMENT CONDITION CATEGORIES AND DESCRIPTIONS

Condition Category (Visual Assessment Score)	Definition	Example of Photographs
Low (A)	Effectively, no trash is observed in the assessment area. There may be some small pieces, but they are not obvious at first glance. One individual could easily clean up all trash observed in a very short time frame.	 
Medium (B)	Predominantly free of trash except for a few pieces that are easily observed in the assessment area. The trash could be collected by one or two individuals in a short period of time.	 

Condition Category (Visual Assessment Score)	Definition	Example of Photographs
High (C)	Trash is widely/evenly distributed and/or small accumulations are visible on the street, sidewalks, or inlets. It would take a more organized effort to remove all trash from the area.	 
Very High (D)	Trash is seen throughout the assessment area, with large piles and a strong impression of lack of concern for litter in the area. There is often significant litter along gutters. It would take an organized effort and likely many people to remove all trash from the area.	 

APPENDIX D. FIELD MONITORING DATA SHEETS

A template of Visual Monitoring Data Sheet is presented here; see Attachments 3 through 5 of the work plan (County et al. 2016) for all other field monitoring data sheet templates.

Visual Monitoring Form

Site ID:______________

Location:____ **Date:**______________ **Time:**______________

Team Members:____ **Contact Email:**___________________________

Note: Fill out a separate Visual Monitoring Form for each assessment area.

I. Assessment Area

Assessment Area: Below, describe the location and boundaries of the assessment area. Include the street segment name, length of the street based on cross streets, and land area description (if applicable).

II. Condition Category Assignment

Trash Condition Category:

Conduct the assessment in accordance with the Monitoring Work Plan for Trash Amendment Compliance (Refer to Definitions below). Check one of the categories below based on the assessment.

☐ Low (**A**) ☐ Medium (**B**) ☐ High (**C**) ☐ Very High (**D**)

☐ Low/Medium (**A/B**) ☐ Medium/High (**B/C**) ☐ High/Very High (**C/D**)

Photograph Documentation:
Check the box below to indicate that photographs were taken and are maintained by your agency.

Photographs: ☐ Number of photographs taken:

Trash Condition Category	Definition
A	Effectively no trash is observed in the assessment area. There may be some small pieces in the area, but they are not obvious at first glance and one individual could easily clean up all trash observed in a very short timeframe.
B	Predominantly free of trash except for a few pieces that are easily observed in the assessment area. The trash could be collected by one or two individuals in a short period of time.
C	Trash is widely/evenly distributed and/or small accumulations are visible on the street, sidewalks, or inlets. It would take a more organized effort to remove all trash from area.
D	Trash is continuously seen throughout the assessment area, with large piles and a strong impression of lack of concern for litter in the area. There is often significant litter along gutters. It would take a large number of people during an organized effort to remove all trash from the area.

III. Preliminary Source Identification

Stormwater trash sources currently identified within the assessment area (CHECK ALL SOURCES THAT APPLY).

Vehicles

- ☐ Moving Vehicles
- ☐ Parked Cars
- ☐ Uncovered Loads
- ☐ Other:

Inadequate Waste Container Management

- ☐ Overflowing or uncovered receptacles/dumpsters
- ☐ Dispersal of household trash and recyclables before, during, and after collection
- ☐ Other:

Pedestrian Liter

- ☐ Restaurants
- ☐ Convenience Stores
- ☐ Liquor Stores
- ☐ Bus Stops
- ☐ Special Events
- ☐ Other:

Illegal Dumping

- ☐ Illegal dumping on-land
- ☐ Homeless encampments
- ☐ Other:

IV. Comments and Additional Information about the Assessment Area and Sources

APPENDIX E. QUANTITATIVE MONITORING

TABLE E- 1. QUANTITATIVE MONITORING-EVENT SUMMARY

Site ID	No. Monitoring Events	Data Deemed Invalid from Event[a]	Reason
Com-CiSD-1	2	6/30/2017, 11/9/2017	A grate of the full capture device was missing or malfunctioning and trash might have not been fully captured.
Com-CiSD-3	4	-	-
Com-CiSD-6	4	-	-
Ind-CiSD-2	4	-	-
Res-CiSD-1	4	-	-
Res-CiSD-6	4	-	-
Tran-CiSD-2	4	-	-
37B-68	4	-	-
55A-205	2	7/18/2017, 11/9/2017	A grate of the full capture device was missing or malfunctioning and trash might have not been fully captured.
BRA-EC-2	4	-	-
CAR2-37	4	-	-
COM-CV-2009	4	-	-
COM-DM-1	4	-	-
COM-SB-2	4	-	-
COM-VI-1	4	-	-
HDR-CV-1757	4	-	-
HDR-VI-1	4	-	-
IND-CV-2015	4	-	-
IND-SDUPD-2554	3	7/18/2017	A grate of the full capture device was missing or malfunctioning and trash might have not been fully captured.
IND-VI-1	4	-	-
SLR1-32	4	-	-
SWT2-112	4	-	-
SWT2-125	4	-	-
SWT5-101	4	-	-
SDR1A-38	3	-	3 Events were available from County's other special study sites.
SDR1A-72	3	-	
SDR1B-34	3	-	
SDR1B-37	3	-	
SDR1C-30	3	-	

Site ID	No. Monitoring Events	Data Deemed Invalid from Event[a]	Reason
SDR2-39	3	-	3 Events were available from County's other special study sites
SDR3-2	3	-	
SDR4-11	3	-	
SDR4-16	3	-	
SDR4-8A	3	-	
SDR6-13	1	7/12/2017, 11/9/2017	A grate of the full capture device was missing or malfunctioning and trash might have not been fully captured; 3 Events were available from County's other special study sites.
SDR6-26	3	-	3 Events were available from County's other special study sites

[a] For certain events, data were deemed invalid and excluded due to full capture device malfunctions as shown above.

Table E- 2. Quantitative Monitoring - Per Site Trash Generation Rate

Site ID	Priority Land Use	Jurisdiction/ Agency	Drainage Area (acres)	No. Event	Site Mean Volume Based Trash Generation Rate (gallon/acre/yr)	Site Mean Weight Based Trash Generation Rate (lb/acre/yr)
55A-205	High-Density Residential	City of Carlsbad	34.3	2	0.01	0.00
CAR2-37	High-Density Residential	County of SD	16.5	4	0.20	0.05
HDR-CV-1757	High-Density Residential	City of Chula Vista	3.4	4	2.42	0.72
HDR-VI-1	High-Density Residential	City of Vista	13.6	4	0.63	0.10
Res-CiSD-1	High-Density Residential	City of SD	3.85	4	6.69	0.39
Res-CiSD-6	High-Density Residential	City of SD	14.7	4	0.64	0.06
SDR1A-72	High-Density Residential	Lakeside	6.7	3	1.06	0.43
SDR4-16	High-Density Residential	Bostonia	1.9	3	10.76	2.38
SLR1-32	High-Density Residential	County of SD	8.2	4	0.93	0.31
SWT2-125	High-Density Residential	Spring Valley	7.1	4	1.64	0.39
Tran-CiSD-2	Park & Ride Lot	City of SD	1.1	4	40.58	5.54
37B-68	Industrial	City of Carlsbad	24.5	4	0.32	0.04
BRA-EC-2	Industrial	City of El Cajon	10.6	4	1.29	0.19

Site ID	Priority Land Use	Jurisdiction/ Agency	Drainage Area (acres)	No. Event	Site Mean Volume Based Trash Generation Rate (gallon/acre/yr)	Site Mean Weight Based Trash Generation Rate (lb/acre/yr)
Ind-CiSD-2	Industrial	City of SD	6.9	4	0.75	0.07
IND-CV-2015	Industrial	City of Chula Vista	26.9	4	0.47	0.12
IND-SDUPD-2554	Industrial	SD Unified Port District	19.1	3	0.84	0.07
IND-VI-1	Industrial	City of Vista	37.3	4	0.24	0.04
SDR1A-38	Industrial	Lakeside	2.9	3	4.08	0.32
SDR1B-34	Industrial	Lakeside	8.4	3	1.52	0.26
SDR1C-30	Industrial	Lakeside	2.7	3	4.43	0.26
SDR3-2	Industrial	Lakeside (Los Coches- Upper)	1.8	3	9.71	2.81
SDR4-11	Industrial	Bostonia	2.1	3	7.79	4.48
SDR6-26	Industrial	Alpine	5.2	3	1.58	0.21
SWT2-112	Industrial	Spring Valley	5.6	4	1.44	0.20
SWT5-101	Industrial	Spring Valley	9.8	4	2.04	0.23
Com-CiSD-1	Commercial	City of SD	6.5	2	0.82	0.02
Com-CiSD-3	Commercial	City of SD	14.6	4	0.28	0.14
Com-CiSD-6	Commercial	City of SD	16.8	4	2.26	0.35
COM-CV-2009	Commercial	City of Chula Vista	1.3	4	29.27	2.73
COM-DM-1	Commercial	City of Del Mar	1.4	4	4.85	1.65
COM-SB-2	Commercial	City of Solana Beach	9.5	4	0.56	0.11
COM-VI-1	Commercial	City of Vista	17.2	4	0.57	0.11
SDR1B-37	Commercial	Lakeside	9.2	3	1.73	1.04
SDR2-39	Commercial	Lakeside (Los Coches)	0.8	3	19.14	3.81
SDR4-8A	Commercial	Bostonia	8.5	3	2.20	0.33
SDR6-13	Commercial	Alpine	7.4	1	4.35	0.15

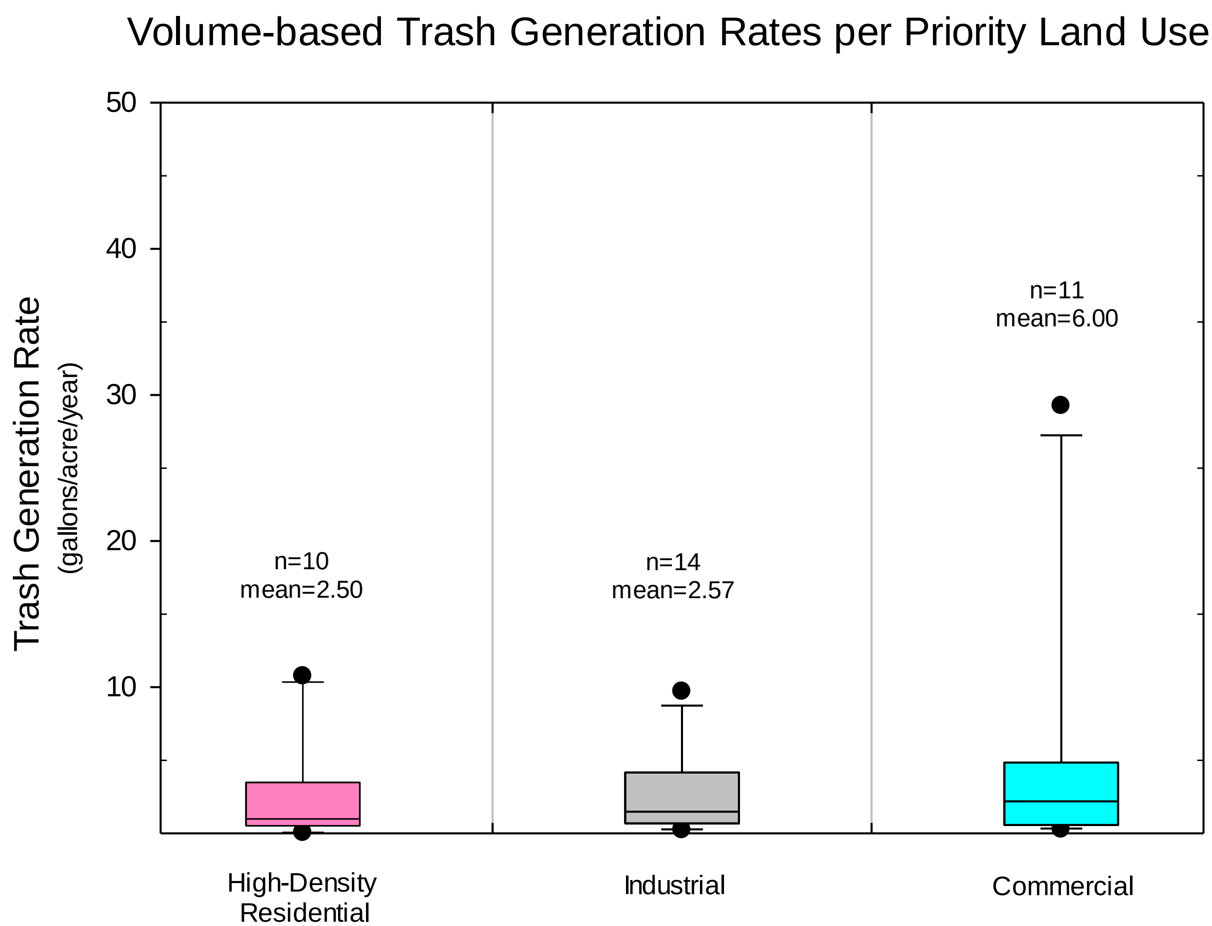


Figure F- 1. Volume-Based Trash Generation Rates Per Priority Land Use

The bottom and the top of the box are the 25th and 75th percentiles and the band inside the box is the median. The bottom and the top whiskers are the 10th and the 90th percentiles. The dots are data outside the 10th and 90th percentiles. 'n' is the sample size, which is equal to the number of sites per priority land use.

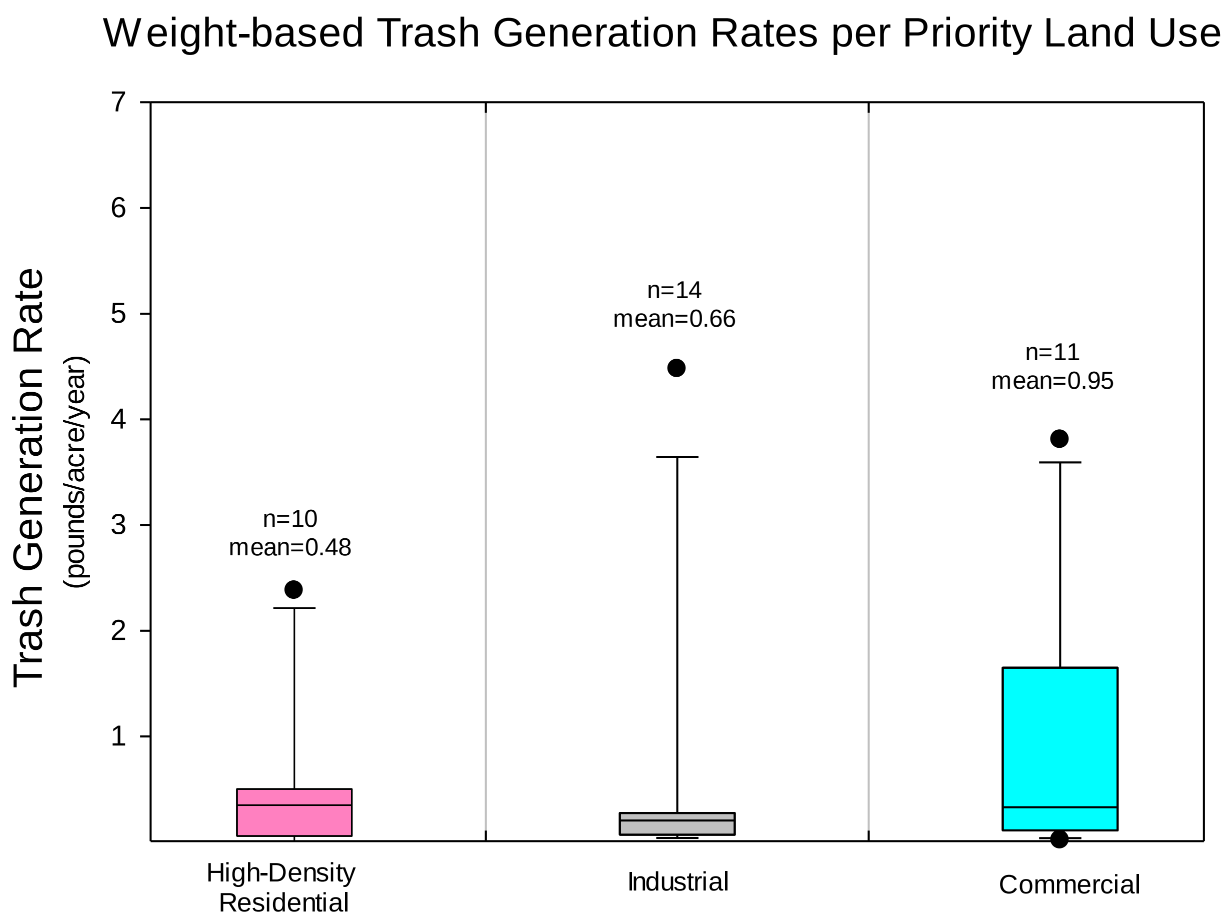


FIGURE F- 2. WEIGHT-BASED TRASH GENERATION RATES PER PRIORITY LAND USE

The bottom and the top of the box are the 25th and 75th percentiles and the band inside the box is the median. The bottom and the top whiskers are the 10th and the 90th percentiles. The dots are data outside the 10th and 90th percentiles. 'n' is the sample size, which is equal to the number of sites per priority land use.

APPENDIX G. HISTOGRAMS OF SITE MEAN TRASH GENERATION RATES

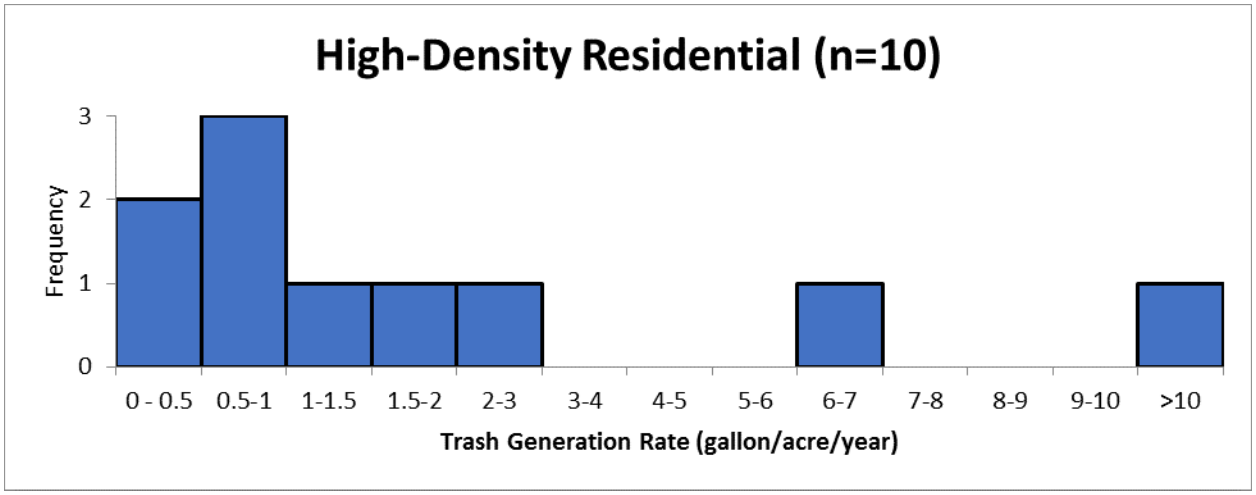


FIGURE G- 1. VOLUME-BASED TRASH GENERATION RATE FOR HIGH-DENSITY RESIDENTIAL PRIORITY LAND USE

Frequency along the y-axis indicates a number of data per a given range of trash generation rates on the x-axis.

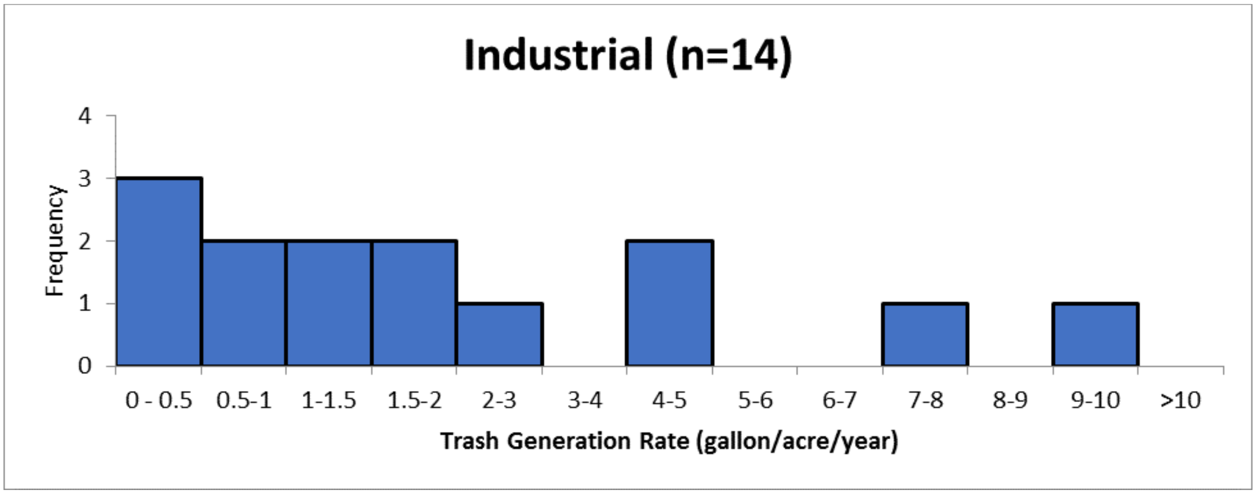


FIGURE G- 2. VOLUME-BASED TRASH GENERATION RATE FOR INDUSTRIAL PRIORITY LAND USE

Frequency along the y-axis indicates a number of data per a given range of trash generation rates on the x-axis.

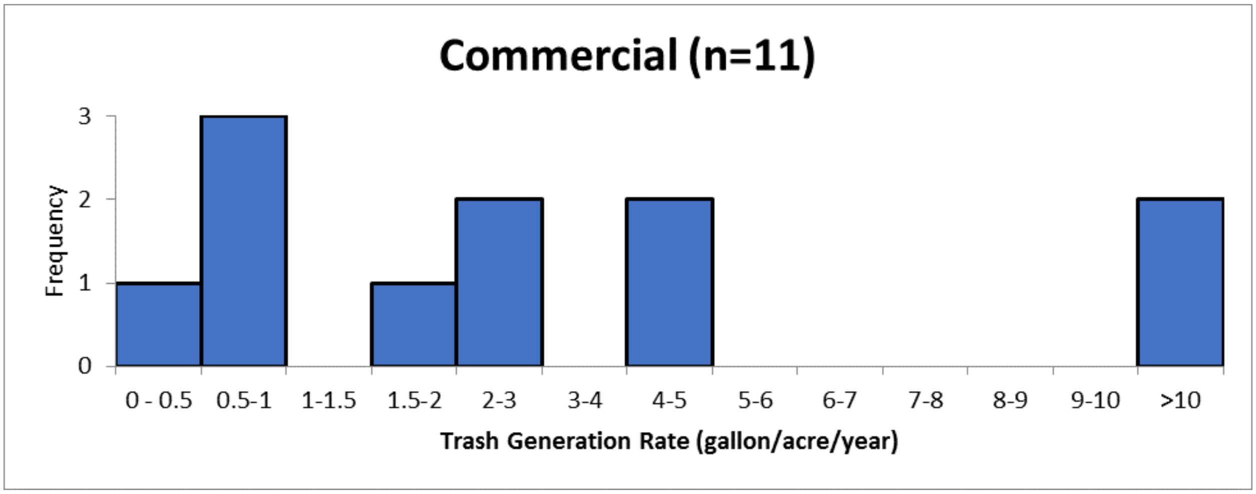


FIGURE G- 3. VOLUME-BASED TRASH GENERATION RATE FOR COMMERCIAL PRIORITY LAND USE

Frequency along the y-axis indicates a number of data per a given range of trash generation rates on the x-axis.

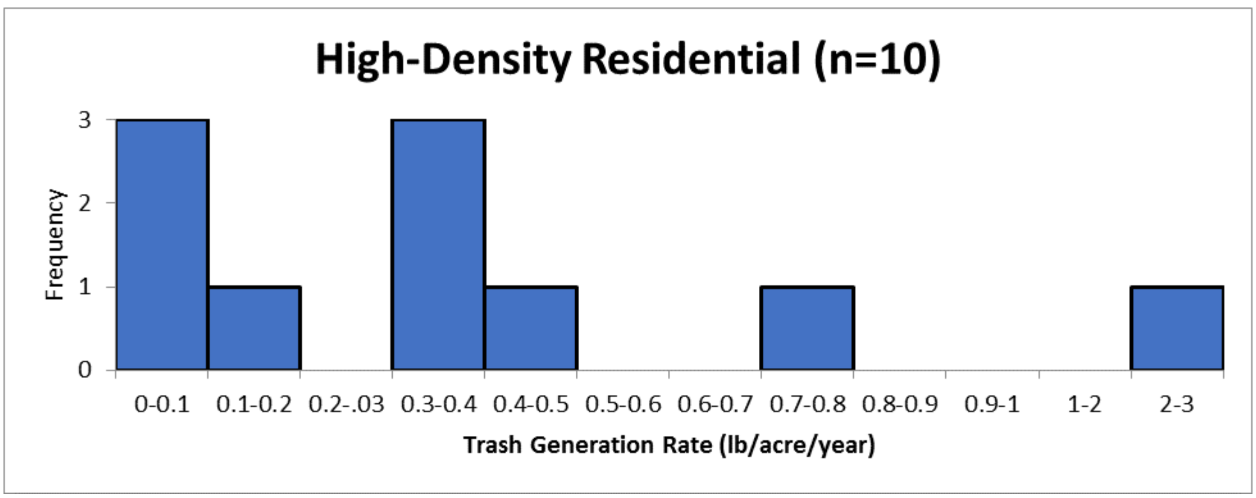


FIGURE G- 4. WEIGHT-BASED TRASH GENERATION RATE FOR HIGH-DENSITY RESIDENTIAL PRIORITY LAND USE

Frequency along the y-axis indicates a number of data per a given range of trash generation rates on the x-axis.

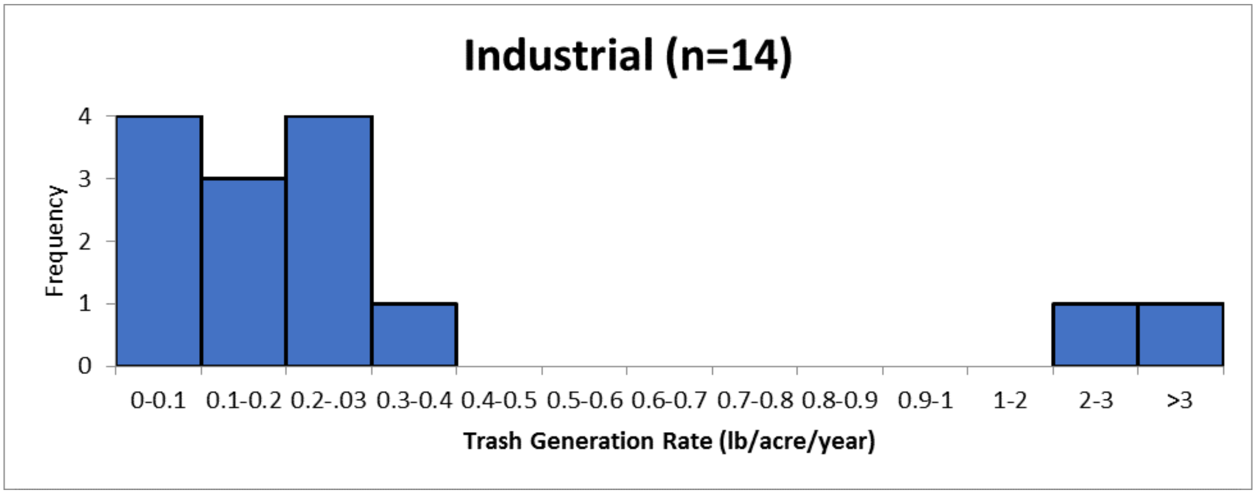


FIGURE G- 5. WEIGHT-BASED TRASH GENERATION RATE FOR INDUSTRIAL PRIORITY LAND USE

Frequency along the y-axis indicates a number of data per a given range of trash generation rates on the x-axis.

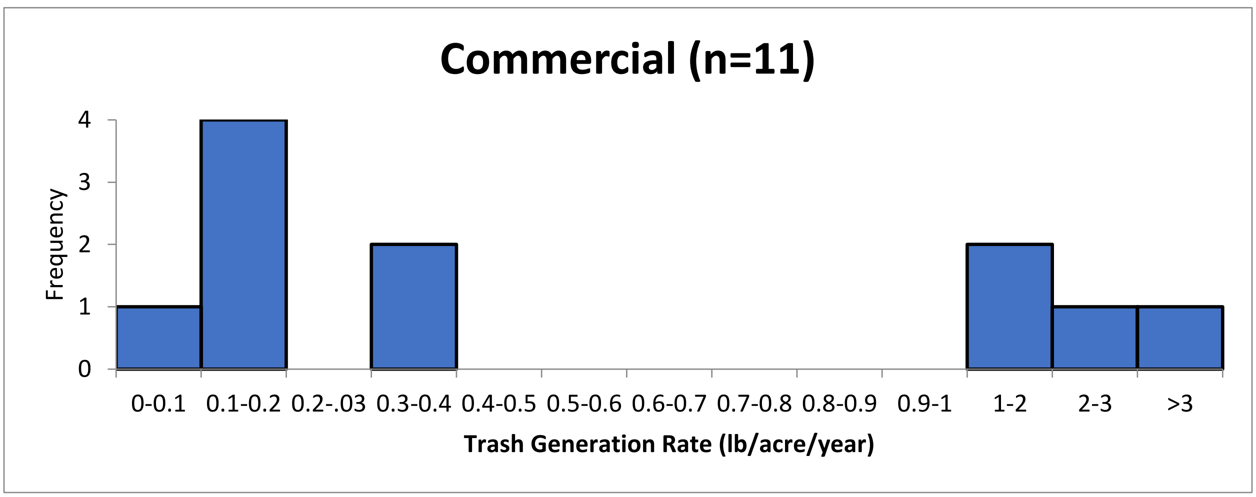


FIGURE G- 6. WEIGHT-BASED TRASH GENERATION RATE FOR COMMERCIAL PRIORITY LAND USE

Frequency along the y-axis indicates a number of data per a given range of trash generation rates on the x-axis.

APPENDIX H. VISUAL MONITORING EVENT SUMMARY TABLE

Visual monitoring occurred for 9 months at the 12 sites which were from the County's other special study and added to the Special Study (SDR1A-38, SDR1A-72, SDR1B-34, SDR1B-37, SDR1C-30, SDR2-39, SDR3-2, SDR4-11, SDR4-16, SDR4-8A, SDR6-13, and SDR6-26), resulting in 9 monitoring events per site. In the rest of the sites, visual monitoring was monthly, resulting in 12 events per site.

TABLE H- 1. VISUAL MONITORING EVENT SUMMARY

Site ID	Priority Land Use	Jurisdiction/ Agency	No. Samples
55A-205	High Density Residential	City of Carlsbad	12
CAR2-37	High Density Residential	County of San Diego	12
HDR-CV-1757	High Density Residential	City of Chula Vista	12
HDR-VI-1	High Density Residential	City of Vista	12
Res-CiSD-1	High Density Residential	City of San Diego	12
Res-CiSD-6	High Density Residential	City of San Diego	12
SLR1-32	High Density Residential	County of San Diego	12
SWT2-125	High Density Residential	Spring Valley	12
Tran-CiSD-2	Park and Ride Lot	City of San Diego	12
37B-68	Industrial	City of Carlsbad	12
BRA-EC-2	Industrial	El Cajon	12
Ind-CiSD-2	Industrial	City of San Diego	12
IND-CV-2015	Industrial	City of Chula Vista	12
IND-SDUPD-2554	Industrial	San Diego Unified Port District	12
IND-VI-1	Industrial	City of Vista	12
SWT2-112	Industrial	Spring Valley	12
SWT5-101	Industrial	Spring Valley	12
Com-CiSD-1	Commercial	City of San Diego	12
Com-CiSD-3	Commercial	City of San Diego	12
Com-CiSD-6	Commercial	City of San Diego	12
COM-CV-2009	Commercial	City of Chula Vista	12
COM-DM-1	Commercial	City of Del Mar	12
COM-VI-1	Commercial	City of Vista	12
COM-SB-2	Commercial	City of Solana Beach	12
SDR1A-72	High Density Residential	Lakeside	9
SDR4-16	High Density Residential	Bostonia	9
SDR1A-38	Industrial	Lakeside	9
SDR1B-34	Industrial	Lakeside	9
SDR1C-30	Industrial	Lakeside	9
SDR3-2	Industrial	Lakeside (Los Coches - Upper)	9
SDR4-11	Industrial	Bostonia	9
SDR6-26	Industrial	Alpine	9
SDR1B-37	Commercial	Lakeside	9
SDR2-39	Commercial	Lakeside (Los Coches)	9
SDR4-8A	Commercial	Bostonia	9
SDR6-13	Commercial	Alpine	9

APPENDIX I. SITE MEAN TRASH GENERATION RATES COMPARED TO VISUAL MONITORING RESULTS

Visual monitoring results were compared with qualitative trash generation rates to assess any correlation between measured generation rates and visual assessment scores. Figures I-1 and I-2 show boxplots of each site's average trash generation rates compared to the site average rounded visual assessment scores, as was done in the Bay Area Stormwater Management Agencies Association (BASMAA) study (EOA, Inc., 2013). Descriptive statistics for each visual assessment score can be found in Tables I-1 through I-2.

There was no strong correlation found between visual assessment scores and actual measured trash generation rates. This may be due to the overall low trash generation rates observed in this Special Study, with the highest value around 30 gallons per acre per year. The BASMAA study observed trash generation rates much higher, up to 250 gallons per acre per year, leading to clearer differences between visual assessment scores (EOA, Inc. 2013, EOA, Inc., 2014). Figure I-3 shows the Special Study visual comparison to volumetric trash generation rates alongside the BASMAA study visual comparison. This demonstrates how most rates from the Special Study would fall within the visual assessment score of A or B for the BASMAA study, which are very close in quantitative value for these assessment scores assigned by the BASMAA study (0-5 gallons/acre/year for score A, and 5-10 gallons/acre/year for score B). Descriptive statistics comparing the BASMAA results to those from the Special Study are presented in Table I-3.

TABLE I- 1. VOLUME-BASED DESCRIPTIVE STATISTICS FOR TRASH GENERATION RATES COMPARED TO VISUAL ASSESSMENT SCORE

Statistic	Visual Assessment Score "A"	Visual Assessment Score "B"	Visual Assessment Score "C"
Maximum	9.71	29.27	10.76
90th Percentile	6.31	4.08	10.76
75th Percentile	2.23	6.69	8.64
Median	0.79	1.3	2.2
Mean	1.85	5.46	4.02
25th Percentile	0.36	1.06	1.18
10th Percentile	0.14	0.05	0.84
Minimum	0.01	0.24	0.084
n (Sample Size)	16	15	4

No visual assessment score of D was observed.

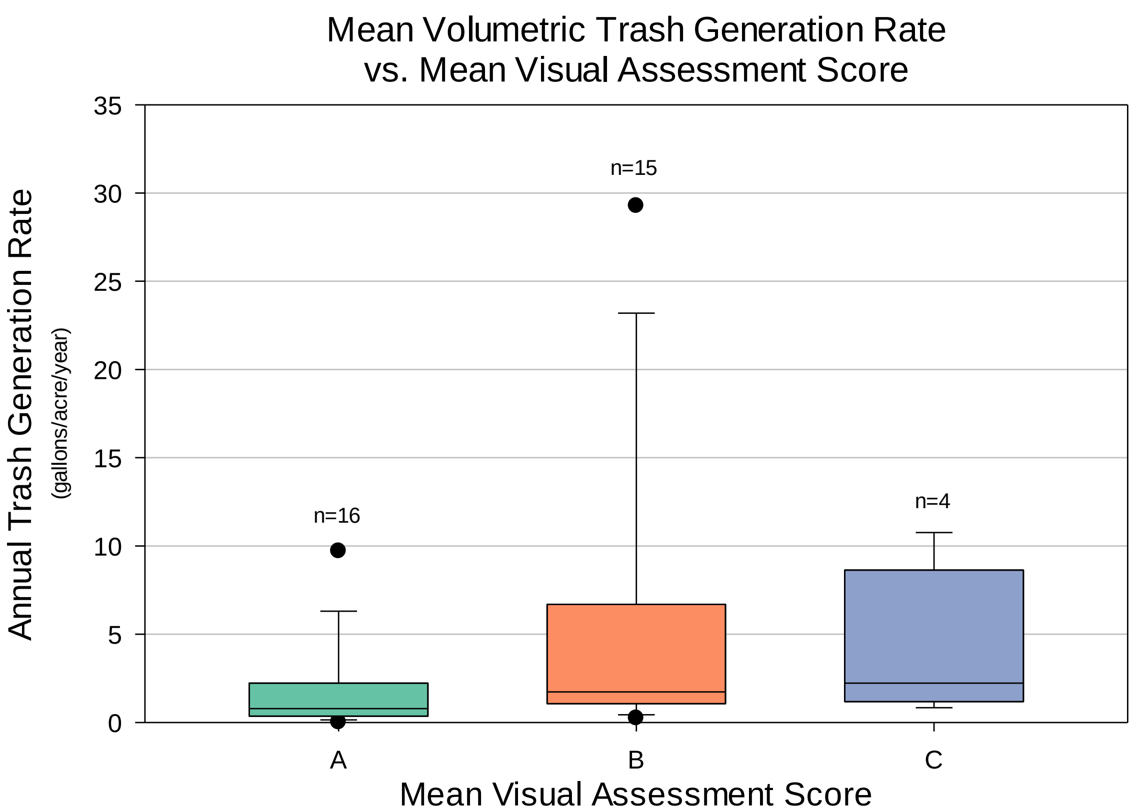


FIGURE I-1. SITE MEAN VOLUMETRIC TRASH GENERATION RATE COMPARED TO MEAN VISUAL ASSESSMENT SCORE

The bottom and the top of the box are the 25th and 75th percentiles and the band inside the box is the median. The bottom and the top whiskers are the 10th and the 90th percentiles. The dots are data outside the 10th and 90th percentiles. 'n' is the number of sites per visual assessment score (A, B, or C). No visual assessment score of D was observed in the Special Study.

Table I- 2. Weight-Based Descriptive Statistics for Trash Generation Rates Compared to Visual Assessment Score

Statistic	Visual Assessment Score "A"	Visual Assessment Score "B"	Visual Assessment Score "C"
Maximum	2.81	4.48	2.38
90th Percentile	2	23.19	2.38
75th Percentile	0.37	1.04	1.87
Median	0.13	0.26	0.34
Mean	0.43	1.46	0.78
25th Percentile	0.06	0.19	0.14
10th Percentile	0.01	0.43	0.07
Minimum	0	0.04	0.07
n (Sample Size)	16	15	4

No visual assessment score of D was observed.

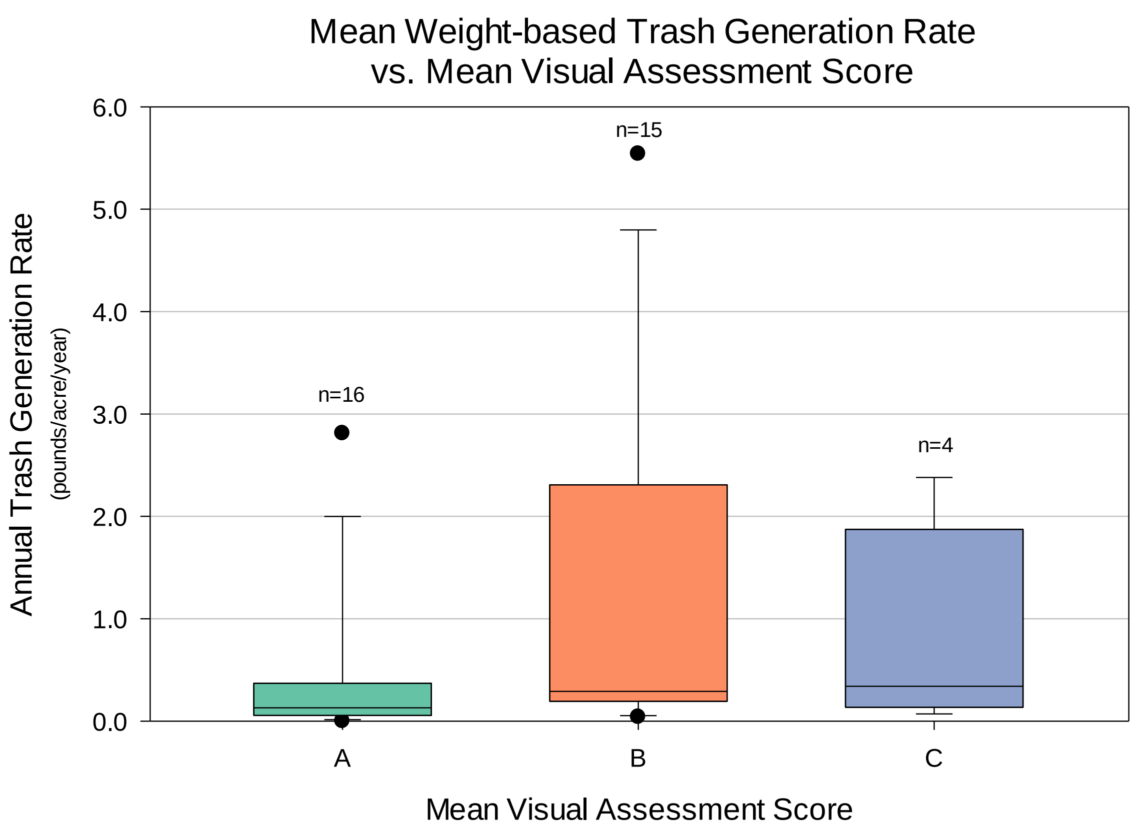


Figure I-2. Site Mean Weight-based Trash Generation Rate Compared to Mean Visual Assessment Score

The bottom and the top of the box are the 25th and 75th percentiles and the band inside the box is the median. The bottom and the top whiskers are the 10th and the 90th percentiles. The dots are data outside the 10th and 90th percentiles. 'n' is the number of sites per visual assessment score (A, B, or C). No visual assessment score of D was observed in the Special Study.

TABLE I-3. VOLUME-BASED DESCRIPTIVE STATISTICS FOR TRASH GENERATION RATES COMPARED TO VISUAL ASSESSMENT SCORE, FOR BOTH SAN DIEGO SPECIAL STUDY AND BASMAA STUDY (EOA, 2014)

Statistic	BASMAA Score "A"	Special Study Score "A"	BASMAA Score "B"	Special Study Score "B"	BASMAA Score "C"	Special Study Score "C"	BASMAA Score "D"
Maximum	8.3	9.71	24.4	29.27	94.7	10.76	252.8
90th Percentile	5.0	6.31	14.0	4.08	48.1	10.76	145.4
75th Percentile	2.9	2.23	9.7	6.69	38.6	8.64	129.0
Median	1.4	0.79	6.5	1.3	13.0	2.2	88.0
Mean	2.2	1.85	7.6	5.46	16.9	4.02	100.3
25th Percentile	0.8	0.36	4.2	1.06	15.3	1.18	69.8
10th Percentile	0.4	0.14	2.8	0.05	11.2	0.84	42.2
Minimum	0.2	0.01	2.0	0.24	6.3	0.084	27.1
n (Sample Size)	38	16	54	15	46	4	16

No visual assessment score of D was observed in the San Diego Special Study.

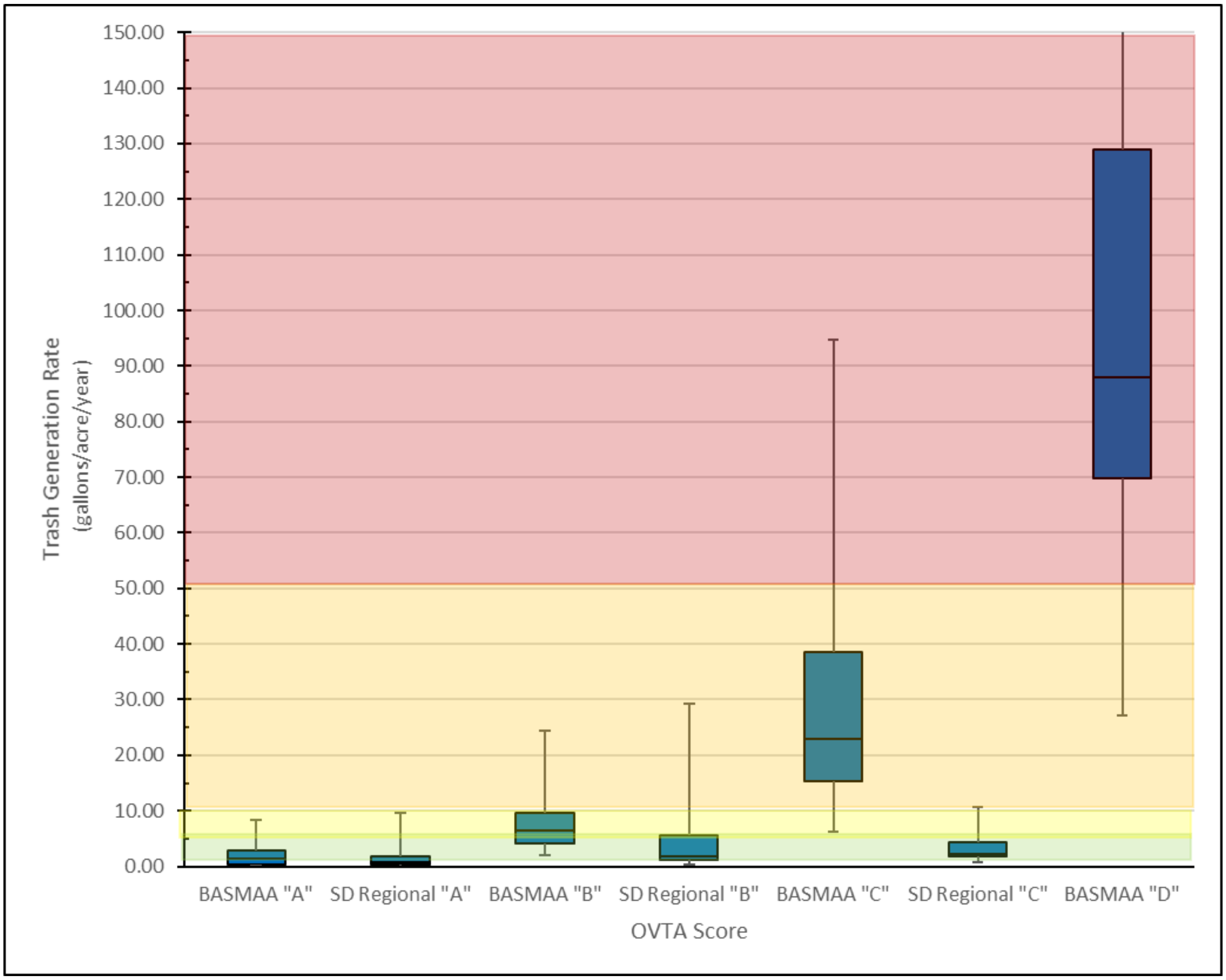


FIGURE I-3. COMPARISON OF VISUAL ASSESSMENT SCORES TO TRASH GENERATION RATES BETWEEN THE SAN DIEGO REGIONAL SPECIAL STUDY AND THE BASMAA (EOA, INC. 2013)

The bottom and the top of the box are the 25th and 75th percentiles and the band inside the box is the median. The green shade represents estimated generation rates for visual assessment score of A, the yellow shade represents estimated generation rates for visual assessment score of B, the orange shade represents estimated generation rates for visual assessment score of C, and the red shade represents estimated generation rates for visual assessment score of D. No visual assessment score of D was observed in the Special Study.

APPENDIX J. EXAMPLE PHOTOGRAPHS OF FULL CAPTURE DEVICE PERFORMANCE

FIGURE J- 1. EXAMPLE OF A FULL CAPTURE DEVICE WITH A CLOGGED SCREEN

FIGURE J- 2. EXAMPLE OF FLOODING DUE TO A CLOGGED SCREEN OF A FULL CAPTURE DEVICE

FIGURE J- 3. EXAMPLE OF A FULL CAPTURE DEVICE WITH A CLOGGED SCREEN

APPENDIX K. COMPARISON OF WET AND DRY SEASON TRASH RATES

TABLE K- 1. WET AND DRY SEASON TRASH GENERATION RATES

Priority Land Use	Wet-Season Mean (gallons/acre/year)	Dry-Season Mean (gallons/acre/year)	*p*-value from t-test
High-Density Residential	2.25	5.39	0.53
Industrial	5.71	9.85	0.46
Commercial	1.85	5.28	0.09

As presented in Table K-1, trash generation rates by priority land use were compared between the wet (October to May) and dry season (June to September). Mean generation rates were slightly different between the two seasons. A t-test evaluated if any of the differences were significant. All t-test *p*-values were higher than 0.05, indicating that there were no significant differences between wet and dry season trash generation rates. San Diego's average annual precipitation for water year 2017 (October 2016 through November 2017) is 12.73 inches. This is about 25 percent higher than 10.08 inches, which is the average of water years from 1965 through 2016.[44] In addition, the dry season in 2017 was actually drier than previous years: i.e., August monthly total precipitation was 0 inches in 2017 and 0.05 inches as a mean of 1936 through 2016. Therefore, the lack of the seasonal difference in trash generation rates is not likely attributed to the changes in rainfall patterns during the monitoring period of the Special Study.

[44] Precipitation data are available from https://www.sdcwa.org/annual-rainfall-lindbergh-field and https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca7740.

APPENDIX L. ACCESS DATABASE

An Access database containing site information and quantitative and visual monitoring data was provided to Copermittees with this report.