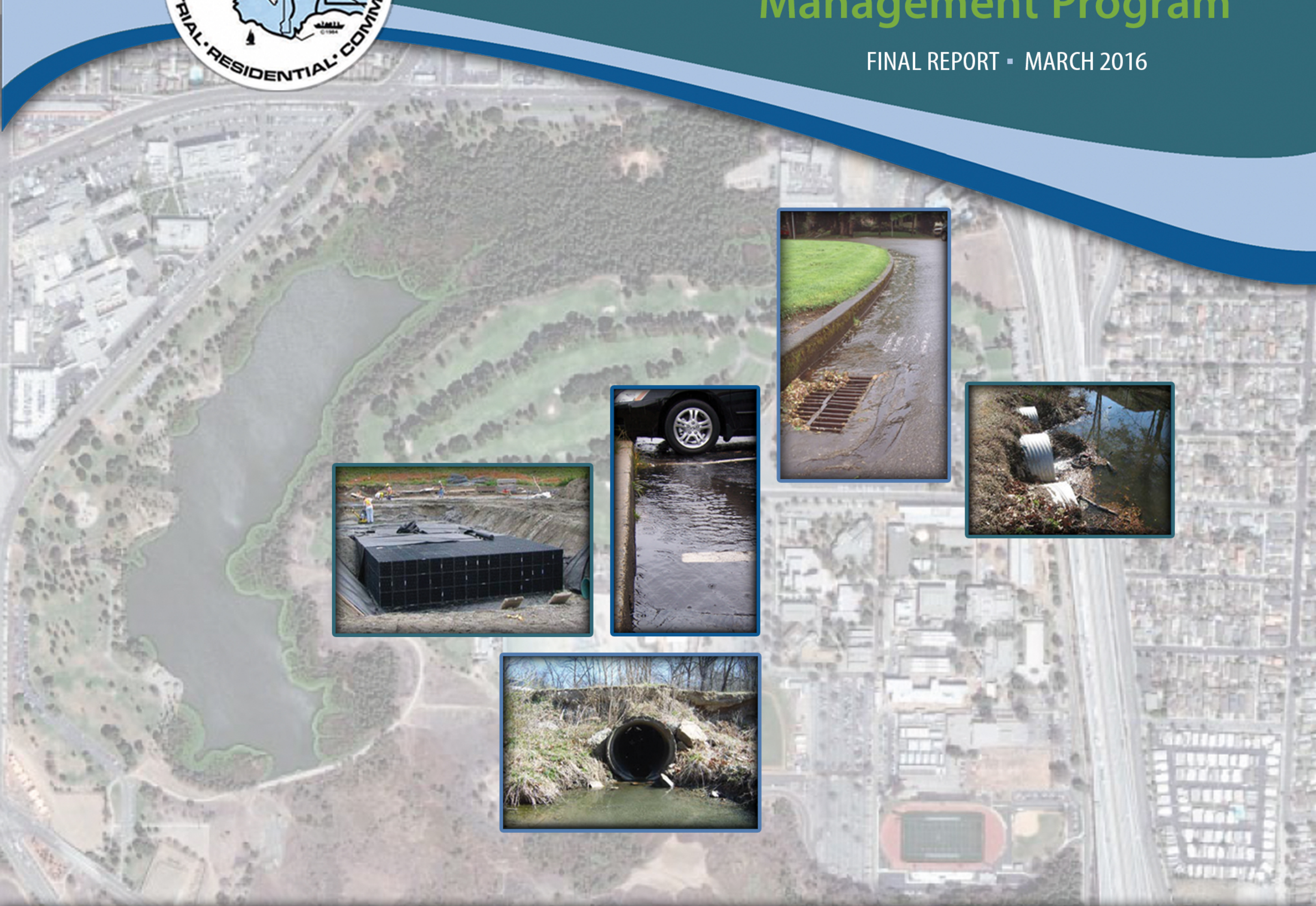
Machado Lake

Enhanced Watershed Management Program

FINAL REPORT ▪ MARCH 2016



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City of Torrance, California

ENHANCED WATERSHED MANAGEMENT PROGRAM FOR THE MACHADO LAKE WATERSHED

March 2016

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CITY OF TORRANCE, CALIFORNIA

MACHADO LAKE WATERSHED
ENHANCED WATERSHED MANAGEMENT PROGRAM

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LIST OF ABBREVIATIONS

ac-ft	acre-feet
ARS	Automated Retractable Screens
BMP	Best Management Practice
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CGP	Construction General Permit
City	City of Torrance
County	Los Angeles County
CPS	Connector Pipe Screens
CWA	Clean Water Act
DEM	Digital Elevation Model
EMC	Event Mean Concentration
EMWP	Enhanced Watershed Management Program
ET	Evapotranspiration
GIS	geographic information systems
GPS	Global Positioning System
HDSF	high-density single family
hm^3/yr	cubic hectometers or million cubic meters/year
HSG	Hydrologic Soil Group
HSPF	Hydrologic Simluation Program Fortran
ISA	Impervious Surface Area
kg	kilograms
kg/yr	kilogram per year
KMHRP	Ken Malloy Harbor Regional Park
LA	Los Angeles
LACFCD	LA County Flood Control District
lb/ac/yr	pounds per acre per year
LID	Low Impact Development
LARWQCB	Los Angeles Regional Water Quality Control Board
µg/kg	micrograms per kilogram
MCMs	minimum control measures
MFR	multi-family residential
mg/L	milligram per liter
MRP	Monitoring and Reporting Plan
MS4	Municipal Separate Storm Sewer Systems
MTA	Metroplitan Transportation Authority
MUN	municipal supply
MWDSC	Metropolitan Water District Southern California

NPDES	National Pollutant Discharge Elimination System
N-SPECT	Nonpoint Source Pollution and Erosion
OC	organochlorine
O&M	Operation and Maintenance
PCBs	polychlorinated biphenyls
PIPP	Public Information and Participation Program
PLAT	Pollutant Load and Analysis Tool
PRD	Permit Registration Documents
RAA	Reasonable Assurance Analysis
RARE	A Basin Plan designation for the aquatic life support category
REC 1	A Basin Plan designation for water contact recreational
REC 2	A Basin Plan designation for water non-contact recreational
RWLs	Recurring Water Limitations
SCAQMD	South Coast Air Quality Management District
SCCWRP	Sourthern California Control Water Research Project
SQMP	Stormwater Quality Master Plan
SWPPP	Stormwater Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TMDL	Total Maximum Daily Load
TMRP	trash monitoring and reporting plan
TN	Total Nitrogen
TP	Total Phosphorus
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WBPCs	Water Body Pollutant Classifications
WDRs	waste discharge requirements
WLA	Waste Load Allocation
WMMS	Watershed Management Model System
WMPs	Matershed Management Program
WQBELs	Water Quality-Based Effluent Limitations
WTM	Watershed Treatment Model

ENHANCED WATERSHED MANAGEMENT PROGRAM

1.0 INTRODUCTION

In order to satisfy the Los Angeles Municipal Separate Storm Sewer System (MS4) Permit (Permit) requirements, the City Torrance has developed this Enhanced Watershed Management Program (EWMP) for the Machado Lake Watershed area within the jurisdiction of Torrance.

This EWMP documents the results of an effort to address impairments in the Machado Lake watershed with a comprehensive, phased approach of best management practice (BMP) implementation for the City of Torrance (City). To develop this plan, BMPs to treat stormwater and dry weather flows to reduce nutrients, sediment, and other pollutants such as metals, bacteria, and toxics were identified and selected. As part of that process, benefits of management activities were estimated, in terms of pollutant load reductions or improvement in water quality, to meet waste load allocations (WLAs) defined by approved total maximum daily loads (TMDLs) established for waters within the Machado Lake watershed.

1.1 Regulatory Framework

The Los Angeles Regional Water Quality Control Board (LARWQCB or Regional Board) adopted Waste Discharge Requirements (WDRs) for MS4 discharges within the Coastal Watersheds of Los Angeles County on June 18, 1990, (Order No. 90-079; NPDES Permit No. CA0061654). The WDRs were later amended on December 13, 2001 (Order No. 01-182; NPDES Permit No. CAS004001 [as amended]). The current MS4 Permit (Order No. R4-2012-0175; NPDES Permit No. CAS004001) was adopted on November 8, 2012 and became effective on December 28, 2012.

The MS4 Permit contains effluent limitations, receiving water limitations (RWLs), Minimum Control Measures (MCMs), TMDL provisions, and outlines the process for developing watershed management programs (WMPs), including the EWMP. The MS4 Permit incorporates the TMDL WLAs applicable to dry- and wet-weather as Water Quality-Based Effluent Limitations (WQBELs) and/or Receiving Water Limitations (RWLs). Part V.A (pages 38-39) of the MS4 Permit requires compliance with the WQBELs and/or RWLs as outlined in the respective TMDLs.

1.1.1 <u>Relevant TMDLs</u>

A TMDL is a regulatory term used to describe a value of the maximum amount of a pollutant that a water body can receive while still meeting water quality standards. Attachment N of the MS4 Permit, titled "TMDLs in Dominguez Channel and Greater Harbor

Waters Watershed Management Area" lists information on TMDLs and incorporates WQBELs and RWLs relevant to the DC WMG including the TMDLs identified in Table 1.1.

Table 1.1 provides a summary of the various existing and pending TMDLs associated with each body of water the City discharges into.

Table 1.1 Summary of TMDLs for City of Torrance

Body of Water	TMDL Name	Pollutant(1)	Resolution Number	Effective Date
Machado Lake	Nutrient	Nitrogen, Phosphorus	R08-006	11 March 2009
	Trash	Trash	2007-006	6 March 2008
	Toxics	Pesticides, PCBs	R10-008	2 September 2010

Notes:
(1) Interim, final, and phased WLA are listed in Chapter 3 where applicable.
(2) The Resolution Name for what is referred to here as the Dominguez Channel Toxics TMDL is “Los Angeles and Long Beach Harbors Toxic and Metals TMDLs.” Dominguez Channel discharges into the Los Angeles and Long Beach Harbors.

1.2 EWMP Overview

The Machado Lake trash TMDL is being addressed this year (2016) with the Machado Lake TMDL Project. The process of BMP selection considered cost-effectiveness to promote a practical and implementable plan. This report also includes integrated approaches that consider BMPs that can address multiple pollutants cost-effectively, while considering parallel water resources planning strategies for the watershed.

The report is organized into nine sections that in summary provide the following information:

- Section 1 provides background information on the Machado Lake watershed and its impairments and associated TMDLs.
- Section 2 provides more detailed descriptions of the TMDL implementation area, including the geologic setting, land uses, hydrology, and hydraulics.
- Section 3 characterizes, evaluates, and prioritizes pollutants and their sources within the City’s TMDL implementation area.
- Section 4 details an evaluation of existing programs, mainly nonstructural in nature, to address the pollutants of concern.
- Section 5 presents candidate sites for structural BMP implementation and describes the regulatory and permit requirements that might apply to the proposed BMPs and that might affect the timing, feasibility, and cost of management alternatives.

- Section 6 presents an alternatives evaluation of different structural and nonstructural BMP management options.
- Section 7 includes a discussion of the integrated nature of the plan and its relation to other water resources efforts in the region.
- Section 8 documents schedules for implementing BMPs to meet phased WLA schedule.
- Section 9 presents cost estimates for the BMP alternatives.

1.3 Machado Lake Watershed

1.3.1 Geographic Setting

Machado Lake has a total drainage area of approximately 23 square miles and is located within the Dominguez Channel Watershed Management Area, although it is not tributary to the Dominguez Channel. Machado Lake overflows into Wilmington Drain during peak storm events. The lake itself is under the jurisdiction of the City of Los Angeles, while the drainage area is within the jurisdiction of several cities and unincorporated portions of Los Angeles County (County). The lake is located in the Ken Malloy Harbor Regional Park (KMHRP), which is a 231-acre Los Angeles City Park serving the Wilmington and Harbor City areas. The lake was originally created for inclusion into Harbor Regional Park in 1971, and intended for boating and fishing.

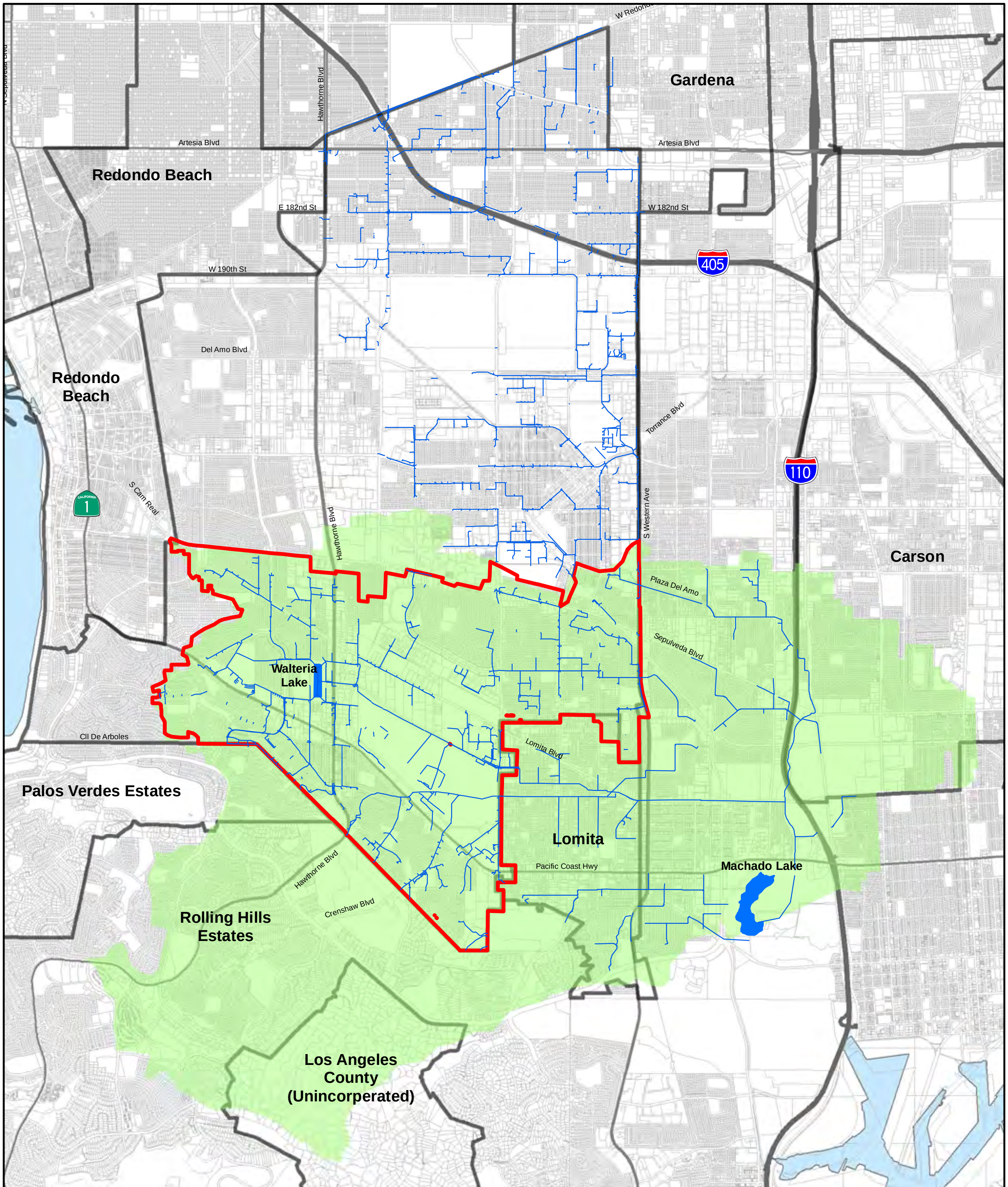
A map of the Machado Lake watershed and the different jurisdictions located within the drainage area is shown on Figure 1.1. The figure includes the boundary of the Machado Lake watershed and major storm drains.

1.3.2 Machado Lake Responsible Agencies

The responsible parties located within the Machado Lake Watershed include the cities of Los Angeles, Torrance, Carson, Lomita, Rolling Hills, Rolling Hills Estates, Rancho Palos Verdes, Redondo Beach, and Palos Verdes Estates, and unincorporated Los Angeles County.

1.3.3 TMDL Implementation Area

The area of Torrance located in the watershed accounts for 30 percent of the total drainage area. The portion of City Redondo Beach is about 0.2 percent of the entire watershed and flows to a City of Torrance catch basin. However, the City of Redondo Beach has requested this portion draining to Torrance be removed from the Machado Lake Implementation Plan since it is being covered in the Beach Cities Group EWMP. For the purposes of this report, this area of Torrance located within the watershed is called the TMDL Implementation Area.



Legend

- Storm Drain
- Project Area
- Lakes
- Machado Watershed
- <all other values>
- Freeway
- Major Roads
- Parcels

0 0.5 1 Miles

Figure 1.1
Machado Lake Watershed
BMP Implementation Plan
City of Torrance

The Madrona Marsh and Sump watershed discharges stormwater into Walteria Lake watershed. Madrona Marsh Restoration and Enhancement Project installed passive wetland treatment system to treat water in the sump for nutrients. Madrona Sump Dredging Project will remove nutrient and toxic rich sediments, therefore not part of this plan.

1.3.3.1 Walteria Lake

The Walteria Flood Control Basin (Walteria Basin) is a man-made basin located in the City of Torrance. The basin was built in 1962 by the Los Angeles County Flood Control District (LACFCD). Walteria Basin has a perimeter of approximately one mile and extends to an approximate depth of 100 feet. Walteria Basin's watershed is approximately 2,287 acres.

By jurisdictional area, the basin's watershed is 92.61 percent Torrance, 7.35 percent Palos Verdes Estates, and 0.04 percent Redondo Beach. The primary function of Walteria Basin is to provide flood protection. During storm and dry weather conditions Walteria Basin receives runoff from the surrounding watershed. Water in the basin is discharged during the dry season to pump out accumulated dry weather flows and after storm events to maintain flood protection for the adjacent communities. The discharge is pumped through the Project No. 584 storm drain and flows through the drainage network where it eventually discharges to Wilmington Drain. Wilmington Drain is a soft-bottom open channel maintained by LACFCD. Surface water in Wilmington Drain can flow via gravity or an unmanned pump station into Machado Lake. To ensure the downstream capacity is available for other storm flows, the Walteria basin is only pumped down after runoff in the watershed subsides.

In October 2014, a Special Study Monitoring Program was commenced analyzing Walteria Basin (Special Study). The objective of the Special Study is to:

- Compare the mass of pollutants entering Walteria Basin and the mass of pollutants discharged.
- Assess inflow and outflow compared to TMDL waste load allocations.

As part of the Special Study, LACFCD is monitoring the 4 inlets to Walteria Basin. The City of Torrance is monitoring the discharges from Walteria Basin during pumping events. The Special Study spans 2 years, and preliminary results have been available since late 2015.

Pending the final results of the Special Study, an appropriate Regional BMP will be identified. A variety of BMPs are currently being investigated including:

- Application of aluminum sulfate to Walteria Basin.
- A diversion of the outflows from Walteria Basin to the Torrance airport for infiltration to groundwater.
- Use of water collected in Walteria to irrigate a nearby park or open space.

As the Special Study is completed in late 2016, funding and selection of appropriate BMPs will be determined. A BMP implementation strategy for Walteria Basin will be refined and reported through adaptive management.

1.3.3.2 Del Amo

Stormwater discharge from the Del Amo basin is directed to retention basin where it percolates into the groundwater basin. The Del Amo Retention Basin also has no outlet, and is sized to capture runoff from at least the 85th percentile, 24 hour storm event. Since this basin is designated as 85th percentile basin, stormwater improvements are not proposed.

1.4 Water Quality Impairments

1.4.1 Designated Beneficial Uses

The existing beneficial uses of Machado Lake, as defined by the Los Angeles Regional Water Quality Control Board (LARWQCB) in the Basin Plan, include recreation (REC 1 and REC 2) and aquatic life support (WARM, WILD, RARE, and WET). The Basin Plan applies the municipal supply (MUN) beneficial use designation to Machado Lake, qualified by an asterisk, as a potential future use. Conditional designations are not recognized under federal law and are not water quality standards requiring TMDL development at this time. The Basin Plan designates beneficial uses to "all other inner areas." These beneficial uses for TMDL Implementation Area are shown in Table 1.2.

Table 1.2 Summary of TMDL Implementation Area Water Bodies

Water Body		Existing Beneficial Uses	Potential Beneficial Uses
Machado Lake	Machado Lake	WARM, WILD, WET, REC-1, REC-2	None
	Wilmington Drain[1]	WARM, WILD, WET, REC-1, REC-2	None

Note:
(1) Beneficial uses based on the tributary rule (LARWQCB, 1994).

1.4.2 2010 Section 303(d) List

Section 303(d) of the Clean Water Act (CWA) requires that "Each State shall identify those waters within its boundaries for which the effluent limitations are not stringent enough to implement any water quality standard applicable to such waters." The CWA also requires states to establish a priority ranking for 303(d) listed impaired waters and establish TMDLs for such waters. A TMDL is defined as the "sum of the individual waste load allocations for point sources and load allocations for nonpoint sources and natural background" (40 CFR 130.2) such that the capacity of the water body to assimilate pollutant loadings (the Loading Capacity) is not exceeded. TMDLs are required to account for seasonal variations and include a margin of safety to address uncertainty in the analysis.

Nutrient enrichment to Machado Lake has resulted in high algal productivity; algal blooms have been observed in the lake during summer months. High nutrient concentrations also contribute to excessive and nuisance macrophyte growth. Algae respiration and decay remove oxygen from the water column, leaving insufficient oxygen for fish and other organisms to breathe. The decay of algal blooms and other eutrophic related impairments can also create offensive odors. This nutrient enrichment, or eutrification of the ecosystem, causes impaired Warm Freshwater Habitat (WARM), Water Contact Recreation (REC 1), and Non-contact Water Recreation (REC 2) beneficial uses in Machado Lake. Because of the high nutrient concentrations, algal blooms, odors and eutrophic conditions, Machado Lake was placed on the Clean Water Act 303(d) list of impaired waterbodies in 1998, 2002, and 2006. A schedule for developing TMDLs in the Los Angeles Region was established in a consent decree (Heal the Bay Inc., et al. v. Browner C 98-4825 SBA) approved on March 22, 1999.

The consent decree combined waterbody-pollutant combinations in the Los Angeles Region into ninety-two (92) TMDL analytical units. In accordance with the consent decree, the Nutrient TMDL addresses nitrogen and phosphorus compounds and related effects for Machado Lake (analytical unit #76).

1.4.2.1 Waterbody Pollutant Combinations

Machado Lake is listed in the 1998, 2002, 2006, and 2008 Clean Water Act 303(d) lists of impaired water bodies as impaired due to chlordane, DDT, Dieldrin, Chem A, and PCBs in tissue. In addition to these approved 303(d) listings, there are sufficient data to document chlordane, DDT, and PCB impairments in sediment. The impairments were addressed in the Toxics TMDL. Chem A chemicals are bioaccumulative pesticides, which include chlordane and Dieldrin, and were addressed specifically through chlordane and Dieldrin. Clean Water Act 303(d) listing for Machado Lake and Wilmington Drain are presented in Table 1.3. TMDLs have been completed for nutrients, toxics, and trash.

Identification of the water quality priorities is a key component of the EWMP process. Part VI.C.5.a (page 58-60) of the MS4 Permit outlines the pertinent elements of the prioritization process as follows:

1. Water quality characterization (VI.C.5.a.i, page 58) based on available monitoring data, TMDLs, 303(d) lists, storm water annual reports, etc.;

2. Water body-pollutant classification (VI.C.5.a.ii, page 59) to identify water body-pollutant combinations that fall into three MS4 Permit-defined categories;

3. Source assessment (VI.C.5.a.iii, page 59) for the water body-pollutant combinations in the three categories; and

4. Prioritization of the water body-pollutant combinations (VI.C.5.a.iv, page 60).

The three MS4 Permit defined categories are:

- Category 1 (Highest Priority): Water body-pollutant combinations for which water quality based effluent limitations and/or receiving water limitations are established in Part VI.E, TMDL Provisions, and Attachments L through R of the Municipal Separate Stormwater Sewer System (MS4) Permit.

- Category 2 (High Priority): Pollutants for which data indicate water quality impairment in the receiving water according to the State Water Resources Control Board's Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (State's Listing Policy) and for which MS4 discharges may be causing or contributing to the impairment.

- Category 3 (Medium Priority): Pollutants for which there is insufficient data to indicate water quality impairment in the receiving water according to the State's Listing Policy, but which exceed applicable water limitations contained in Order R4-2012-0175 and for which MS4 discharges may be causing or contributing to the exceedance.

The water body pollutant classifications (WBPCs) were classified into one of the three MS4 Permit categories (Category 1-3). Those WBPCs with a TMDL were classified as Category 1, those WBPCs listed on the State's 303(d) list as impairing a particular water body segment were classified as Category 2, and those remaining WBPCs without an associated TMDL or on the State's 303(d) list, but showing exceedances of water quality criteria were classified as Category 3. A summary of these categorizations is presented in Table 1.3.

Table 1.3 Water Body Pollutant Combinations for Machado Lake Watershed

Water Body	Category 1 (TMDL)	Category 2 (303(d) List)	Category 3 (Other)
Machado Lake	Trash, Total Phosphorous, Total Nitrogen, Ammonia, Chlorophyll-a, PCB (sed.), Chlordane (sed.), Dieldrin (sed.), Dissolved Oxygen	None	*E. coli*, pH
Wilmington Drain	None	Coliform Bacteria, Copper (diss.), Lead (diss.)	Total Nitrogen, DDT (sed.), PCB (sed.), Chlordane, Dieldrin (sed.)

The Machado Lake Trash TMDL states that agencies can comply *with* the WLAs by installing full capture trash screens on catch basin filters that discharge to Machado Lake through a progressive eight-year implementation schedule. Full capture trash screen must be installed on 20 percent of a city's catch basin filters by March 6, 2012 with 20 percent more each year until 100 percent of catch basin filters have trash screens by March 6, 2016.

The City is complying with the TMDL requirements through a joint project with the Cities of Lomita, Carson, Rolling Hills Estates, Palos Verdes Estates, and Rancho Palos Verdes to install Automatic Retractable Screens and/or Connector Pipe Screens onto catch basin filters that are tributary to the Machado Lake. Work within the City of Torrance also includes the installation of No Parking signs for Street Sweeping within the portion of Torrance tributary to Machado Lake.

1.5 Objectives of the EWMP and Approach

This EWMP outlines the management actions that may be necessary to ultimately attain compliance with the Machado Lake Nutrient and Toxics TMDLs (LARWQCB, 2009), within the Torrance TMDL Implementation Area of the Machado Lake watershed. The BMP Implementation Plan calls for an integrated, adaptive management approach to utilize available resources effectively and efficiently. As new information becomes accessible through monitoring, the continued study of drainage patterns, diagnosis of problem sources, and new technologies for dry and wet weather treatment, and the plan may be modified as necessary. Implementation of the management actions described by the plan depends on feasibility, available funding, site-specific conditions, and various other factors.

1.5.1 Focus of the Plan

The Machado Lake EWMP must include implementation methods, a schedule, and proposed milestones to achieve compliance of the TMDL WLAs. The EWMP development requires identifying and selecting BMPs to treat stormwater or reduce pollutant loads, as well as developing estimates of benefits in terms of load reductions to meet WLAs. However, the BMP selection process must consider the cost-effectiveness to provide assurance that plans are practical and implementable.

The goal of the EWMP is to address current TMDLs except trash, with consideration of future potential TMDLs. The nutrient TMDLs is considered the primary focus of this implementation plan. A secondary focus is placed on toxics through removal of suspended sediments that toxics are associated with. The third focus is placed on trash because reporting on progress toward the trash TMDL implementation occurs annually and through a separate process. However, proposed BMPs that address trash have the potential to provide added benefit in addressing other pollutants, which is assessed in this implementation plan. Total nitrogen (TN) and total phosphorus (TP) source characterizations are provided in the plan.

This EWMP includes integrated approaches that consider BMPs that can address multiple pollutants cost-effectively. Additional benefits of BMPs, such as water storage/recharge and reuse, providing recreation space, improved natural habitat, source control, and public education, are considered in this implementation plan.

This EWMP also describes management options that are limited to area of the City of Torrance located within the Machado Lake watershed. This area is termed the *TMDL Implementation Area* in this report and is represented in red on Figure 1.1. Some of the proposed nonstructural or programmatic BMPs, such as staff training or education programs, could apply citywide. Rolling Hills Estates watershed is a tributary of Torrance TMDL Implementation Area, and flows directly to Walteria Lake, therefore not addressed in this plan.

1.5.2 TMDL Target

Key factors influencing the level of BMP implementation are the stormwater management targets expected to be achieved. For this project, multiple TMDLs and associated WLAs for stormwater runoff have been established for Machado Lake, which must be considered as a priority for developing the BMP implementation plan. The following provides a summary of applicable wet weather TMDL WLAs and implementation requirements, and methods for translating the requirements into management targets to address wet weather pollution.

1.5.2.1 Nutrients

The Machado Lake Nutrient TMDL was developed by the LARWQCB on May 1, 2008. The U.S. Environmental Protection Agency (USEPA) approved the Nutrient TMDL on March 11, 2009, and the approval letter was posted on April 8, 2009. The Nutrient TMDL was developed to address nutrient-related beneficial use impairments including the following Section 303(d) listings: eutrophication, algae, ammonia, and odor.

The City is subject to the requirements of the Machado Lake Eutrophic, Algae, Ammonia, and Odors (Nutrient) TMDL per the LARWQCB's Resolution R08-006. Under the Regional Board's resolution, the City shall submit to the Regional Board's Executive Officer a Monitoring and Reporting Plan (MRP) within 1 year of the effective date of the resolution or propose a Special Study Work Plan following the requirements of one of three optional studies. The Special Study Work Plan details the approach proposed by the City to perform Optional Study No. 3, to assess compliance with the WLA on a mass basis for total nitrogen and total phosphorus originating from the City's TMDL Implementation Area. The Special Study Work Plan is complete and turned in to the Regional Board.

Resource agencies, local governments, project implementers, the scientific community, environmental groups, decision-makers at the city, county, state, and federal levels, and many others have continued to take meaningful steps towards the restoration of Machado Lake and its basin. Among these efforts, restoration activities are expanding through continued implementation of erosion control, stormwater management, and riparian restoration projects, development of the Machado Lake Nutrient TMDL that is providing a quantitative, science-based approach for pollutant reduction, and a strong research/monitoring effort to evaluate key ecological processes and response to water quality improvement projects. The Machado Lake Nutrient TMDL allows for the establishment of annual mass-based WLAs for TP and TN equivalent to monthly average concentrations of 0.1 milligram per liter (mg/L) TP and 1.0 mg/L TN, based on approved flow conditions. When the concentration based WLAs are met under the approved flow condition of 8.45 hm^3/yr (cubic hectometers or million cubic meters/year), the annual mass of the TP discharged to the lake will be 845 kilogram (kg) and the annual mass of TN discharged to the lake will be 8,450 kg. The City accounts for 35.6 percent of the Machado Lake Watershed. Table 1.4 lists the interim and final WLAs based on this area. The interim WLAs for both total phosphorus and total nitrogen have been met as shown in Appendix B.

Table 1.4 Interim and Final WQBELS for Machado Lake Nutrient TMDL

	Dry Weather		Wet Weather	
Nutrient TMDL	**Interim WLA**	**Deadline**	**Final WLA**	**Deadline**
Total Phosphorus	1.25 mg/L	May 2014	0.1 mg/L	September, 2018
Total Nitrogen	2.45 mg/L	May, 2014	1.0 mg/L	September, 2018

1.5.2.2 Toxics

Machado Lake is listed as impaired for chlordane, Chem-A, DDT, Dieldrin, and PCBs. The LAWQCB adopted the Machado Lake Toxics Total TMDL on September 2, 2010 (LARWQCB, 2010) and was approved by the State Water Quality Control Board and the USEPA. The pollutants listed within the Toxics TMDL include organochlorine (OC) pesticides and polychlorinated biphenyls (PCBs). These pollutants are associated with suspended sediments; therefore, the WLAs were calculated based on the fraction of suspended solids loading produced by each stormwater discharger, and assigned for both dry and wet weather. Compliance is measured either at the storm drain outfall of the permittee's drainage area, at representative storm drain outfalls representing the combined discharge of cooperating parties (if a coordinated compliance option is chosen by multiple permittees), or at an alternative compliance point approved by the Regional Board Executive Officer.

The WLAs assigned to Municipal Separate Storm Sewer Systems (MS4) permittees in the Toxicity TMDL BPA are concentration-based allocations (equal to the sediment numeric targets), and are listed in Table 1.5. The Toxics TMDL requires compliance with these WLAs by September 30, 2019.

Table 1.5 MS4 Permittees Toxics TMDL Waste Load Allocations

Parameter of Concern	Numeric Target for Sediment Concentration (µg/kg dry weight)	Waste Load Allocation for Suspended Sediment-Associated Contaminants(1) Concentration (µg/kg dry weight) Period	Compliance Averaging Period
Total PCBs	59.8	59.8	3-year average
DDT (all congeners)	4.16	4.16	3-year average
DDE (all congeners)	3.16	3.16	3-year average
DDD (all congeners)	4.88	4.88	3-year average
Total DDT	5.28	5.28	3-year average
Chlordane	3.24	3.24	3-year average
Dieldrin	1.9	1.9	3-year average

Note:
(1) The WLA applies to all MS4 Permittees including the County, Caltrans, General Construction and, industrial Stormwater Permittees, and other non-stormwater NPDES Permittees.

Suspended solids serve as carriers of toxics such as pesticides, dioxins and PCBs. Removal of suspended solids therefore, will also lead to toxics removal. This EWMP addresses toxics through the removal of sediments. Removal of toxics is calculated as a fraction of suspended sediments removed by proposed stormwater treatment devices. This EWMP relied on toxics data developed from the Domingues Channel Flow Monitoring Program.

Estimated baseline load for toxics is presented in Section 3 of this report.

1.5.2.3 Trash

The Machado Lake Trash TMDL requires that trash be eliminated in Machado Lake and on its shoreline either through assessment and collection or installation of full capture systems on discharges to the lake. The City is identified as a point source for trash based on being a permittee under the Los Angeles County Municipal Separate Storm Sewer System (MS4) NPDES permit. Based on the Machado Lake TMDL, the City's WLA is zero trash, meaning no trash may be discharged to the lake through the City's storm drains which discharge stormwater to the lake.

Figure 1.2 Automated Retractable Screens

The Machado Lake Trash TMDL became effective in March 2008. The trash monitoring and reporting plan (TMRP) was submitted to the LARWQCB in September 2008, and conditionally approved in December 2008. The City has implemented trash controls in the drainage areas to comply with March 6, 2016 final deadline. Therefore no further trash controls are proposed in this EWMP. The trash control project installed Automated Retractable Screens (ARS) and Connector Pipe Screen (CPS) systems as shown on Figure 1.2 that capture debris and prevent it from entering the Storm Drain System.

1.5.3 <u>Scheduled Total Maximum Daily Load</u>

Wilmington Drain, to which all of the County areas drain shown on Figure 1.1, is listed in the 303(d) list as impaired for metals (copper and lead) and bacteria. The additional pollutants of concern listed in Machado Lake are scheduled for TMDL development in 2014 or 2019. This EWMP also addresses metals or bacteria impairments in Wilmington Drain.

2.0 MACHADO LAKE WATERSHED

The Machado Lake watershed is situated within the Dominguez Channel Watershed Management Area. Machado Lake is separate from Dominguez Channel and discharges, under storm conditions, to the Los Angeles Harbor.

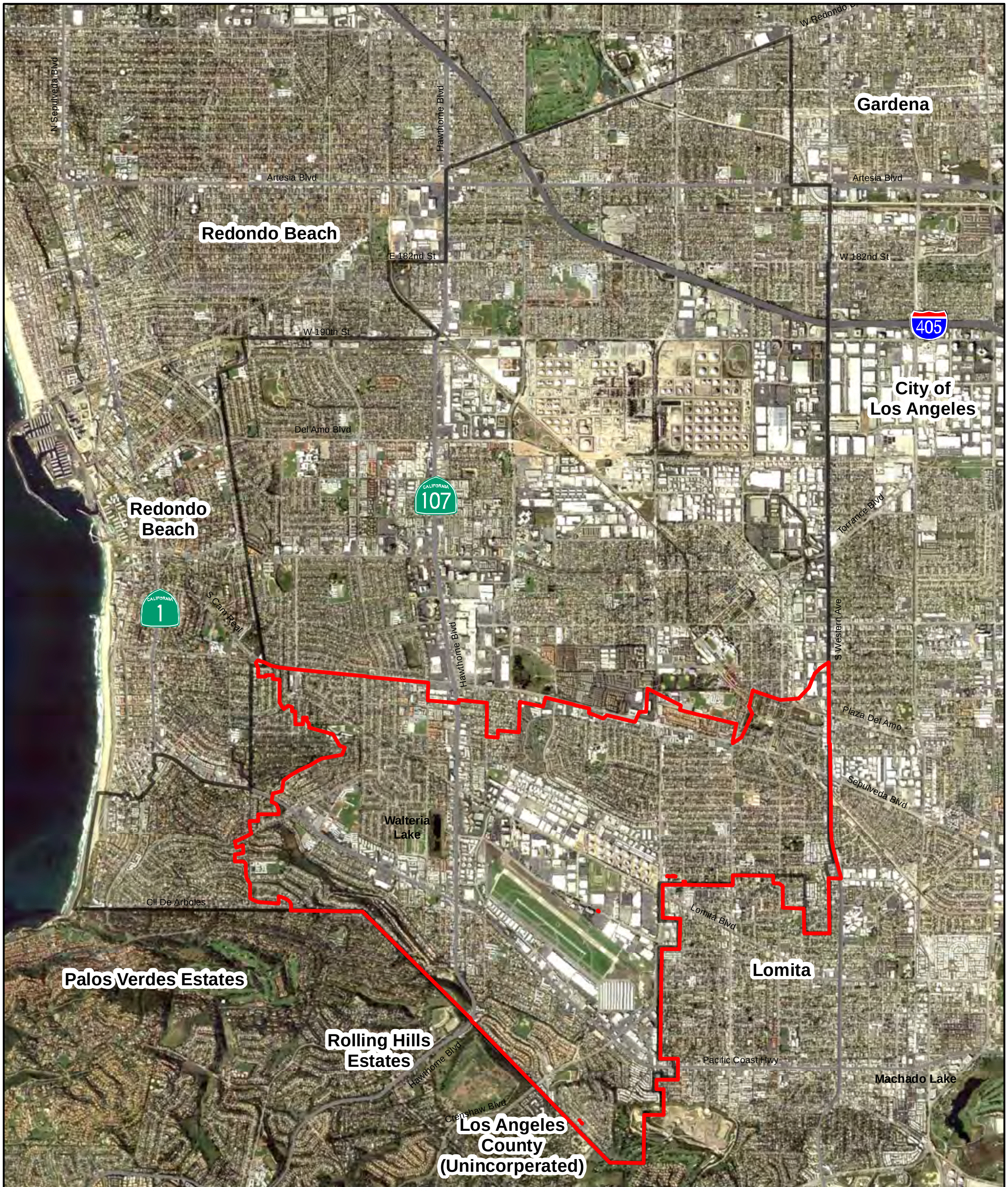
2.1 City of Torrance TMDL Implementation Area

The City is located about 15 miles south of Downtown Los Angeles (LA), in southern LA County, just north of the Palos Verdes Hills. The City was incorporated on May 12, 1921, and is just over 20.5 square miles in area. The City is bounded by Redondo Beach on the west and north, Lawndale and Gardena on the north, LA on the east, Lomita to the southeast, and Rolling Hills Estates and Palos Verdes Estates on the south. The City is also bounded by approximately 4,000 feet of Santa Monica Bay coastline. The City's storm conveyance systems are interconnected with neighboring city systems. Neighboring cities located at generally higher elevation such as Rolling Hills Estate and Palos Verde Estate discharge stormwater into the City's and/or LA County's storm conveyance systems located within the City's boundaries. Figure 2.1 shows an aerial view of the watershed and Figure 2.2 gives an overview of land uses in TMDL Implementation Area.

The TMDL Implementation Area is about 4,241 acres, which equals approximately 23 percent of the City of Torrance. The TMDL Implementation Area also includes a very small area of Redondo Beach that drains directly to a Torrance catch basin filter. The land use category with the largest fraction within the TMDL implementation area is residential (43 percent), while open space accounts for about 18 percent. Residential land uses include high-density single family (HDSF), multi-family residential (MFR), and mobile homes. The land uses in the Implementation Area are listed in Table 2.1.

Table 2.1 Land Use in TMDL Implementation Area

Land Use	Acreage	% TMDL Implementation Area
Residential	1,810	43
Commercial	419	10
Industrial	256	6
Transportation	996	23
Open Space	758	18
Total	**4,239**	**100**



Legend

- Project Area
- City Boundary
- Freeway
- Major Roads

0 0.5 1 Miles

Figure 2.1
Overview of TMDL Implementation Area
BMP Implementation Plan
City of Torrance

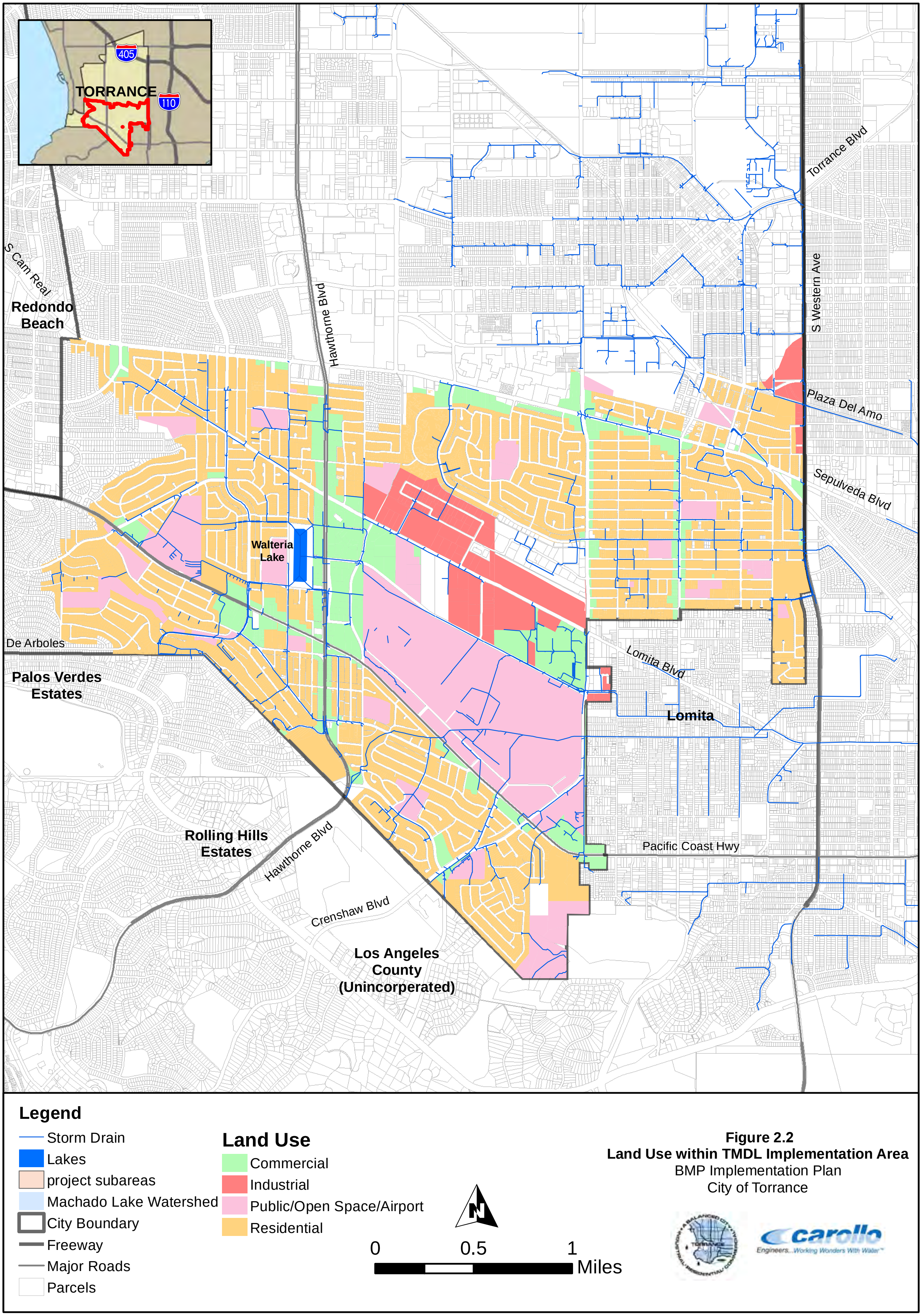


Figure 2.2
Land Use within TMDL Implementation Area
BMP Implementation Plan
City of Torrance

2.2 Geologic Setting and Soil

The soils found within the Machado Lake watershed are predominantly loam and clay. The most common soil type is Ramona Loam, which is observed in the TMDL Implementation Area. Ramona Loam is a compact soil with a large runoff coefficient at high rates of precipitation. Areas such as the Rolling Hills Estates and the lands along Highway 1 are composed of several different classifications of clay and loam. Diablo Clay Loam and Montezuma Clay.

The predominant soil types found in the TMDL Implementation Area are listed by their percentage in Table 2.2. The soil types found across the TMDL Implementation Area are displayed in Figure 2.3.

Table 2.2 Soil Types Distribution

Soil Classification(1)	Percentage of Soil within TMDL Implementation Area
Ramona Loam	21.4%
Yolo Sandy Loam	8.0%
Dublin Clay Adobe	35.3%
Oakley Fine Sand	35.4%
Total	**100.0%**

Note:
(1) LACDPW 2006 Hydrology Manual

2.3 Watershed Hydrology

As shown on Figure 1.1, the Machado Lake watershed is located in the southwestern area of the Dominguez Channel watershed and includes portions of the Cities of Los Angeles, Torrance, Lomita, Rolling Hills, Rolling Hills Estates, Carson, Palos Verdes Estates, Rancho Palos Verdes, Redondo Beach, and the communities of unincorporated Los Angeles County, including Wilmington and Harbor City. As shown, a large portion of the Machado Lake watershed consists of the hilly regions of Rolling Hills Estates and Rolling Hills. This portion of the watershed is unique, as it consists of relatively steep hills with drainage into the canyons.

Machado Lake is about 40 acres in area, while the Machado Lake wetlands cover an anear of approximately 64 acres. The lake and wetlands are located within the Ken Malloy Harbor Regional Park in the southeastern corner of the Machado Lake Watershed. Both Machado Lake and the Machado Lake wetlands serve as flood retention basins for the Machado Lake Watershed.

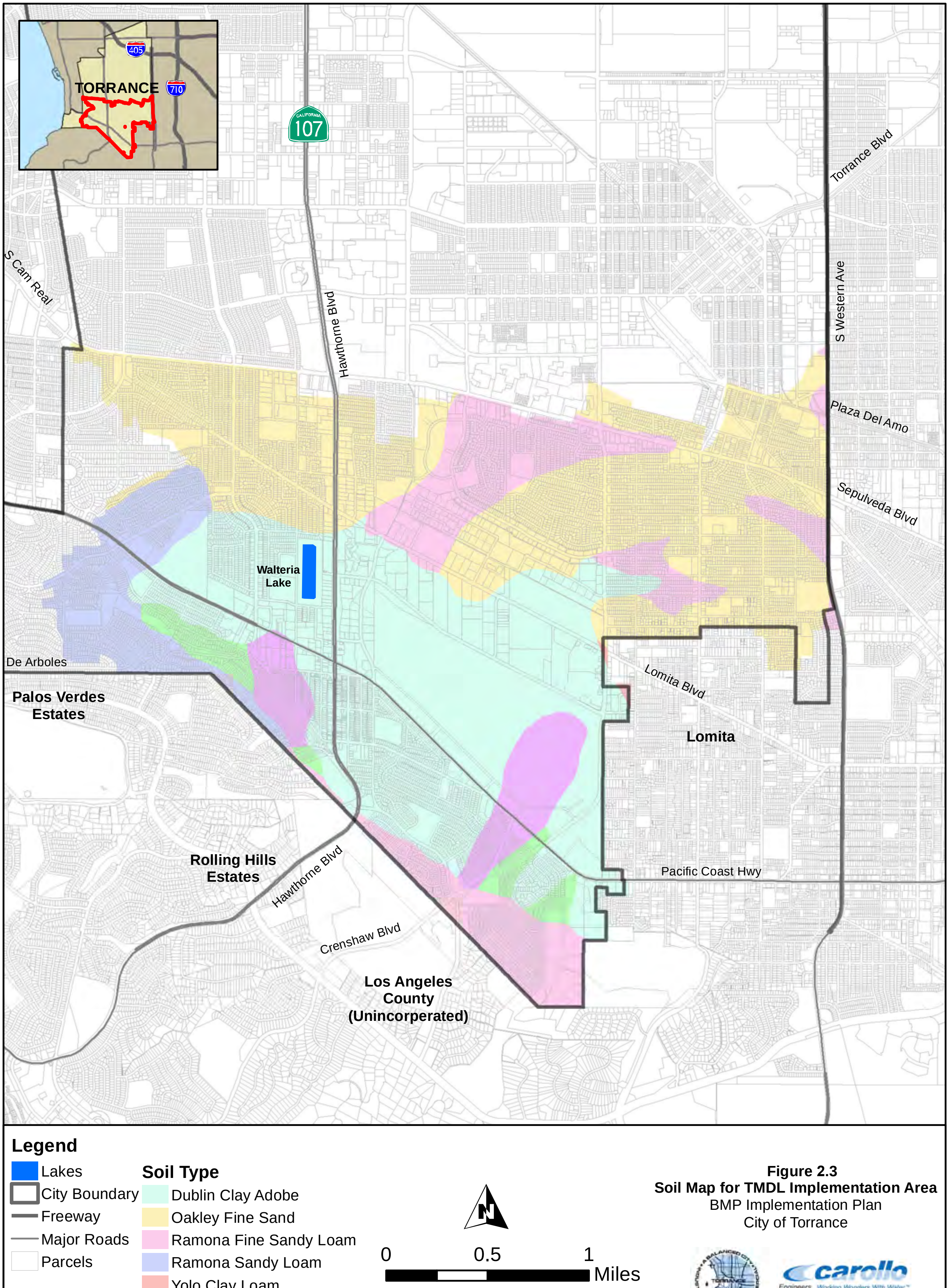


Figure 2.3
Soil Map for TMDL Implementation Area
BMP Implementation Plan
City of Torrance

The Machado Lake watershed can be divided into six primary subdrainage areas. These subdrainages are:

- The Walteria Lake
- Project 77/510
- Wilmington Drain
- Project 643 (72-inch Storm Drain)
- Project 643 (Figueroa Drain)
- Private Drain 553.

2.4 Watershed Hydraulics

As the TMLD implementation area is highly urbanized, stormwater drainage is primarily conducted through an extensive network of underground storm drain facilities. The Los Angeles County Department of Public Works maintains the system of storm drains in the City of Rolling Hills Estates. The primary use of the Dominguez Channel and all other open channels in the Dominguez Channel watershed (including Wilmington Drain, Machado Lake, and Madrona Marsh) is flood protection.

Machado Lake receives urban and storm water runoff from a complex network of storm drain systems. The first of three primary storm drain channels that flow into Machado Lake is the Wilmington Drain. Approximately 65 percent of the runoff from the Machado Lake Watershed flows through the Wilmington Drain into Machado Lake. The other two primary storm drain channels are the Project No. 77 Drain and the Harbor City Relief Drain. Several smaller storm drains also discharges into Machado Lake, including Project No. 643's Figueroa Street Outlet and a 72-inch diameter storm drain outlet. Machado Lake discharges at the southern end by overflowing a concrete dam into the Machado Lake wetland. Water discharges from the wetland through the Harbor Outflow structure and into the West Basin of the Los Angeles Harbor.

The Walteria Lake, located within the City's boundaries, is owned and operated by LA County Flood Control District. It is approximately 1,005 acre-feet in capacity and receives raw stormwater mainly from Rolling Hills Estates, Palos Verdes Estates, and the City of Torrance. Effluent from the lake is pumped at a maximum rate of 57 cubic feet per second (cfs) through a force main system into a 54-inch diameter drain line that lies under Skypark Drive. The discharge eventually leaves the City near the intersection of Crenshaw Boulevard and Amsler Street.

3.0 POLLUTANT SOURCE CHARACTERIZATION AND PRIORITIZATION

This section identifies the potential sources of the pollutants of concern derived from both point and nonpoint sources. The discussion is provided in several parts: modeling results, specific pollutant sources, and a source prioritization. Watershed monitoring results are summarized for reference in Appendix B. The focus of this characterization and prioritization is primarily within the City TMDL Implementation Area. Both wet and dry conditions are discussed. The City's Pollutant Load and Analysis Tool (PLAT) was used to quantify the average annual pollutant loading of nutrients and other pollutants from the TMDL Implementation Area.

3.1 Special Study

To meet the Nutrient TMDL's Optional Study #3 requirements and the aforementioned objectives, the Work Plan outlined an approach that utilized previously existing information to develop mass-based WLAs, and used a combination of water quality sampling and hydrologic modeling to characterize current wet and dry weather loading from the TMDL Implementation Area. Water quality samples were collected monthly at each monitoring location. During the wet season, dry weather sampling events were scheduled seven days after measurable precipitation, or after flow rates had returned to base levels typical of the season, whichever period was shorter.

A total of eight monitoring sites were selected for the Special Study. The characteristics of the monitoring sites are presented in Tables 3.1 and 3.2. Figure 3.1 shows the monitoring sites and associated drainage areas. Drainage areas were determined using GIS layers, provided by the City, of storm drains and the flow paths of Wilmington Drain. Land use calculations were determined using a GIS layer obtained from the City.

Monitoring for nitrogen and phosphorus constituents was performed during the Special Study. The monitoring results for total nitrogen, total phosphorus, and flow rate are displayed on Figure 3.2 and summarized in Table 3.3. The amount of pollutants entering the City from neighboring cities are represented by monitoring locations Tor-S6, Tor-S7 and Tor-S9. Monitoring sites Tor-S1, Tor-S2, Tor-S4 and Tor-S5 measure pollutants and flow leaving the city boundary. The locations of monitoring sites Tor-S1 through Tor-S9 are indicated on Figure 3.1 as S1 through S9.

Table 3.1 Monitoring Sites for the Special Study

Sampling Location Name	Map ID	Description	Primary Land Use	Lat-/ Long-itude	Upstream Storm Drain Name	Diameter (in) and Material
Tor-S1	S1	Located 40 ft north and 80 ft east of the intersection of Plaza Del Amo and Western Avenue. Basin name.	RES	33.82/ 118.31	City	36 RCP
Tor-S2	S2	Approximately 50 ft west of 246th Place and Pennsylvania Avenue intersection.	RES	33.80/ 118.33	City	33 RCP
Tor-S3	S3	Effluent of Walteria Lake, approximately 300 ft west of Hospital Drive and Skypark Drive intersection.	RES	33.81/ 118.35	Walteria Lake	54
Tor-S4	S4	Approximately 210 ft north and 85 ft east of 236th Street and Western Avenue intersection.	RES	33.81/ 118.31	City	9’-2”Wx11’H RCB
Tor-S5	S5	About 25 ft west of intersection of Bani Avenue and 250th Street (two pipes intersect from south and west).	RES	33.80/ 118.33	City	8’-9”Wx9’-7”H RCB
Tor-S6	S6	Approximately 600 ft east of Estates Lane and Crenshaw Boulevard.	RES	33.79/ 118.34	Rolling Hills E.	36 RCP
Tor-S7	S7	About 730 ft south of Rolling Hills Road and Madison Street intersection. Will monitor dry weather flow originating from Rolling Hills Estates.	RES	33.79/ 118.35	Rolling Hills E.	10’x10’ RCB
Tor-S8	S8	About 1,000 ft south of 244th Street and Ocean Avenue intersection. Will monitor dry weather flow originating from Rolling Hills Estates.	RES	33.80/ 118.36	Rolling Hills E.	24 RCP
Tor-S9	S9	About 830 ft east and 120 ft south of Paseo de las Tortugas and Vista Montana intersection. Will monitor dry weather flow originating from Palos Verdes Estates.	RES	33.80/ 118.36	Palos Verdes Estates	42 RCP

Legend

- Sampling Location
- Storm Drain
- Project Area
- City Boundary
- Freeway
- Major Roads

0 0.5 1 Miles

Figure 3.1
Special Study Sampling Locations
BMP Implementation Plan
City of Torrance

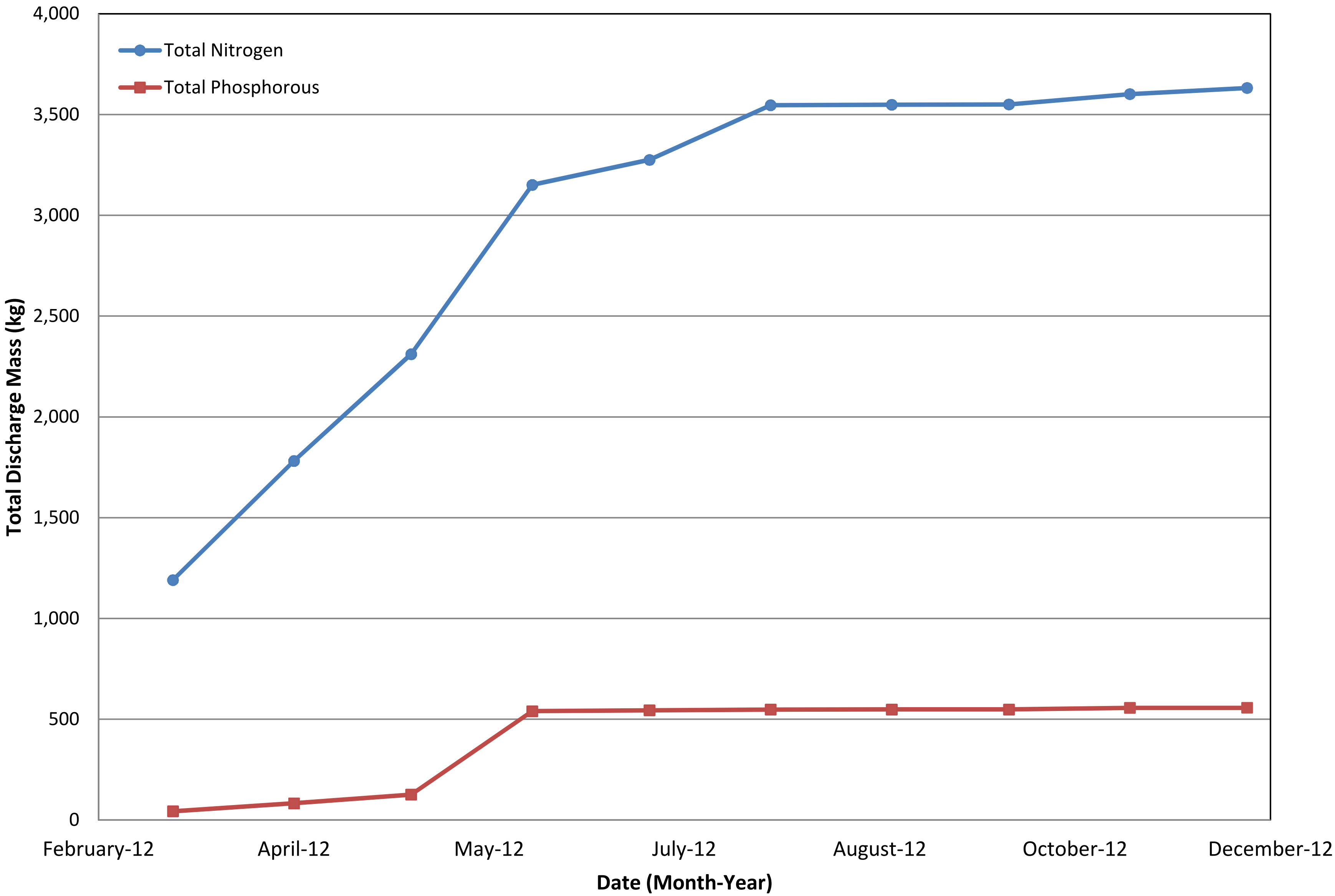
Table 3.2 Monitoring Site Drainage Areas and Majority Land Use

Monitoring Site	Map ID (on Figure 4)	Drainage Area (ac)	Predominant Land Use
Tor-S1	S1	154	Residential
Tor-S2	S2	248	Residential
Tor-S3	S3	2,115	Residential
Tor-S4	S4	852	Residential
Tor-S5	S5	797	Residential
Tor-S6, Tor-S7 and Tor-S9 drainage basin outside City of Torrance			

Table 3.3 Total Flow (gallons) and Total Mass (kg) of Nitrogen and Phosphorous

Monitoring Site	Total Annual Flow (Gallons)(1)	Total Nitrogen (kg)	Total Phosphorous (kg)
Walteria Lake Pumping Event (May 29 through June 5, 2012)			
Tor-S3[3]	5,557,715	30.5	4
Total Flow Leaving the City			
Tor-S1	114,947	0.6	0.1
Tor-S2	1,530,700	8.3	1.8
Tor-S4	2,079,514	13	1.5
Tor-S5	79,603,481	3,610	553
TOTAL	**83,328,643**	**3,632**	**557**
Total Flow Entering the City			
Tor-S6	134,162	0.7	0.1
Tor-S7	7,480,023	57	4.8
Tor-S9	1,337,848	6.5	1.6
TOTAL	**8,952,033**	**63.99**	**6.5**
Flow Generated from TMDL Area	**68,818,895**	**3,533**	**546**

Note:
(1) Discharge from Walteria Lake During Pumping (March 7 and December 31, 2012).



Total Nitrogen
Total Phosphorous
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Total Discharge Mass (kg)
February-12
April-12
May-12
July-12
August-12
October-12
December-12
Date (Month-Year)

The water quality sampling data were reviewed to identify whether site location or the timing of events affected the concentrations observed. The data set was reviewed in this way by constituent group, constituent, and, as necessary, constituent fraction (e.g. total and dissolved phosphorus). An analysis of sample variance showed that neither the site location nor event timing had any significant affect on the concentrations of the constituents measured during the study.

3.2 Potential Sources of Pollutants of Concern

In order to characterize existing water quality conditions in the EWMP area, and to identify pollutants of concern for prioritization per section VI.C.5.a.ii of the MS4 Permit, available data from TMDLs, the 303(d) list, and available monitoring data collected during the previous ten years were analyzed. The following source documents were utilized during the water quality characterization:

- Basin Plan Amendments
  - Machado Lake Trash TMDL
  - Machado Lake Pesticides and PCBs TMDL
  - Machado Lake Nutrient TMDL
- Monitoring Reports and Data
  - Machado Lake Special Study
  - Port of Los Angeles Ambient Water Quality Monitoring Data (2005-2008)
  - City of Los Angeles Machado Lake Nutrient TMDL Monitoring Data (2011-2012)
  - County of Los Angeles Machado Lake Nutrient TMDL Monitoring Data (2012)
  - Los Angeles County 1994-2000 Integrated Receiving Water Impacts Report

The pollutants addressed in this section are toxics, metals, nutrients, bacteria, and trash. To generally describe the potential sources in the watershed, pollutant sources have been divided into the following categories: NPDES sources, road infrastructure, atmospheric deposition, and wastewater from sanitary sewer and SSOs. Typical sources of these pollutants are summarized in Table 3.4.

Table 3.4 Typical Sources of Pollutans*

Pollutant Source	Pollutants: Bacteria	Pollutants: Nutrients	Pollutants: Metals	Pollutants: TSS	Pollutants: Trash	Key Reference (Appendix A 1-12)
NPDES Sources						
Residential land areas	●	●		●	●	1, 2, 3, 4, 5, 6
Agricultural activities (i.e., animal operations)	●	●		●		7, 8, 8
Construction activities			●			7, 9
Industrial/municipal activities	●		●	●	●	6, 10
POTW discharges			●			11
Landscaping, fertilizers		●				7, 9
Pet waste	●	●				9
Wildlife	●					7, 1
Native geology		●				7, 1
Land surface erosion				●		7
Detergents		●				9
Car washing				●		7, 9
Road Infrastructure						
Transportation sources (i.e., tire wear)						7, 9, 12, 13
Pavement erosion				●		7, 14
Atmospheric Deposition						
Construction activities			●			7, 9
Roofing			●			7
Resuspension of historic emissions in road dusts and soil particles			●			15
Land surface erosion		●				16
Sanitary Sewers SSOs						
Sewer leaks, sanitary sewer overflows (SSOs), illicit discharges, septic systems	●	●		●		7, 5, 17
POTW discharges		●	●			12

* City of San Diego and Caltrans 2012. Tecolote Watershed Comprehensive Load Reduction Plan. Final Report. San Diego, CA.

3.2.1 Lead and Zinc

While the available Annual Reports do not indicate a clear source of lead in this subwatershed, the Regional Board Final Staff Report for the TMDL for Metals in Ballona Creek 3 states that urban runoff, or the wash-off of pollutant loads accumulated on the land surface, is likely a substantial source of metals during both wet and dry weather (Regional Board, 2005). Indirect atmospheric deposition was estimated to account for 19 percent of the typical annual load for lead in the Ballona Creek Watershed (LARWQCB, 2005). Wet weather EMCs for lead, based on the Los Angeles County EMC dataset, show that the highest concentrations are expected from agricultural land uses, followed in order by industrial, commercial, high density single family residential, and transportation, multi-family residential, educational, and open space land uses (Geosyntec Consultants Wright Water Engineers, 2012). Other Los Angeles region land use studies have found that high density single family residential has the highest EMCs, followed by industrial and commercial land uses (Stein et al 2007). These potential sources will be evaluated for BMP implementation as part of the RAA.

3.3 Dry Weather Loading

Dry weather can also be a significant source of pollutant loading. However, results of the stormwater sampling indicate that dry weather flows are insignificant and therefore no further modeling was performed.

3.4 Wet Weather Loading

The City developed a Stormwater Quality Master Plan (SQMP) in 2011 to address increasingly stringent regulatory requirements and stormwater related issues caused by continued development pressure. As part of the SQMP, the portion of the Machado Lake Watershed within the City was modeled utilizing a tool referred to as the PLAT, a module linking a number of publicly available models including: USEPA's PLOAD, the Program for Predicting Pollution Particle Passage thru Pits, Puddles, & Ponds (P8),USEPA's SWMM 5.0, and USEPA's SUSTAIN. WMMS and N-SPECT model (Nonpoint Source Pollution and Erosion Comparison Tool) were used to validate PLAT model results. The PLAT was initially calibrated to WMMS model output obtained from the Los Angeles County. PLAT is based mainly on spatially distributed inputs derived from high-resolution satellite imagery.

There are many models that might be suitable for use in conducting the evaluation for Implementation Area. Because Torrance has previously used PLAT as a watershed modeling and basin planning tool, the modeling efforts in the Implementation Area utilized PLAT methodology. In addition, the PLAT modules were selected based on the following model capabilities:

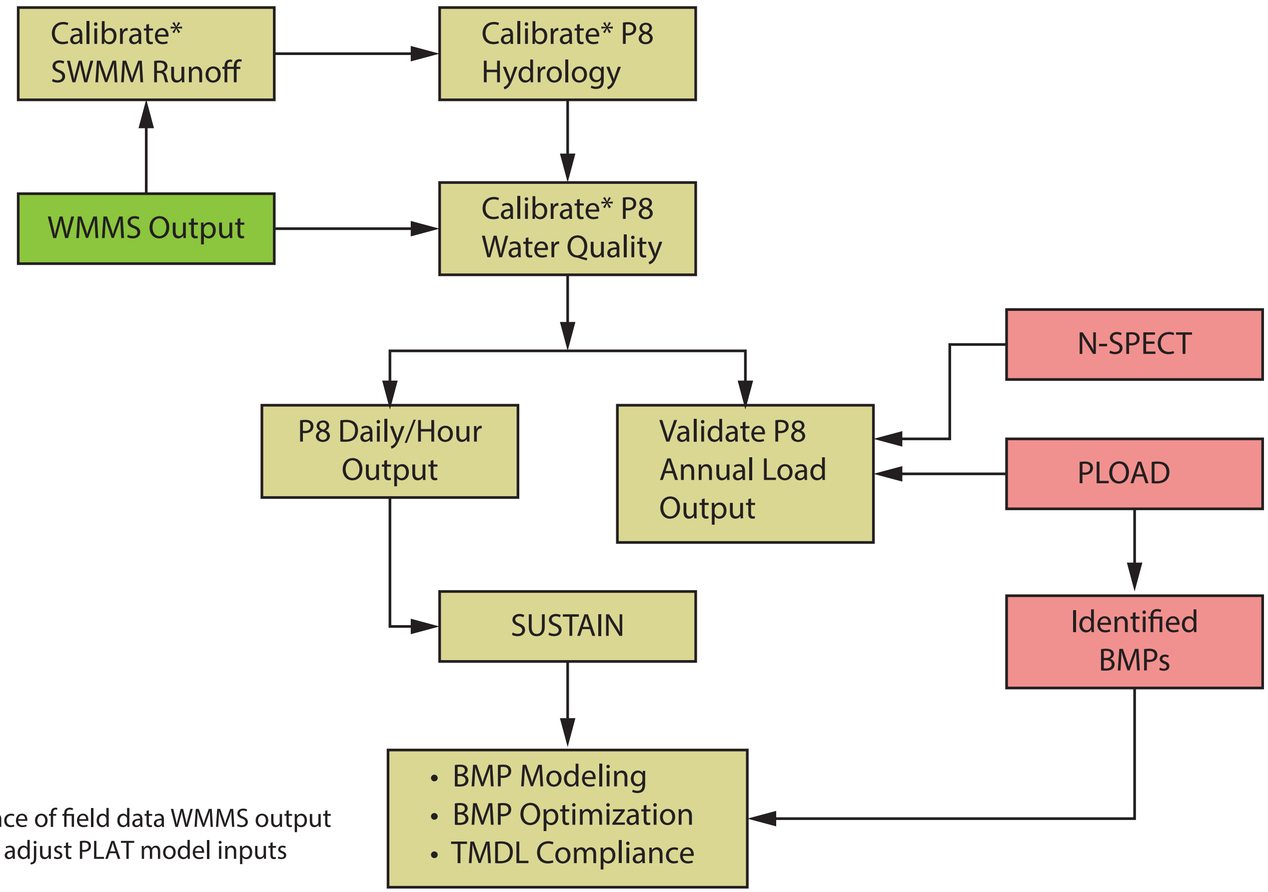
- Dynamic continuous long-term simulation for modeling runoff and pollutant loadings and concentrations in discharges and receiving waters from lands in a watershed system
- Can represent rainfall, runoff , and groundwater processes of urban and natural watershed systems
- Can represent variability in pollutant loadings, based on land use, soil hydrologic group, and slope among other parameters
- Employs a BMP process based approach or empirically based BMP approach
- Includes decision support to evaluate cumulative BMP performance on a watershed scale

3.4.1 Pollutant Loading and Analysis Tool (PLAT)

Even though PLAT was developed before the guidelines (RWQCB, 2014) for developing a Reasonale Assurance Analysis (RAA) was published, only few enhancements were made to meet RAA modeling requirements. The enhancements include converting the original XP-SWMM model (a proprietry software) to EPA SWMM 5.0 model. The general concept of PLAT methodology is presented on Figure 3.3. PLAT methodology is comprised of three main evaluations:

1. Model Calibration/verification – In the absence of field data specific to Torrance, LA County WMMS and N-SPECT models were used to calibrate/validate some modules of PLAT.
2. Annual load estimation and initial BMP Screening. – impervious cover information derived from satellite imagery, EMC and PLOAD model were used to compute annual pollutant load, characterize pollutant hotspots, and perform initial BMP screening analysis to select BMPs for detailed aevaluation.
3. Detailed Load and BMP Evaluation – Uses EPA SWMM 5, P8 and SUSTAIN models for comprehensive water quality modeling to identify priority subbasins based on BMP need, BMP sizing and optimization, and evaluation of management alternatives.

The following paragraphs summarize the modules used in PLAT.



* In the absence of field data WMMS output was used to adjust PLAT model inputs

3.4.1.1 Annual Load Estimation and Initial BMP Screening Analysis

Satellite remote sensing imagery is the primary source of data used in this analysis. PLOAD, a spreadsheet model, is among one of the models that is most commonly used to estimate pollutant loadings on an annual average basis for any user-specified pollutant. Impervious cover and land cover information extracted from satellite imagery is used in conjunction with PLOAD to compute annual pollutant load for the TMDL Implementation Area.

3.4.1.1.1 PLOAD

The PLOAD model was originally developed to calculate pollutant loads for urban and suburban watersheds, which was subsequently adopted by the USEPA for watershed management planning and was integrated into the BASINS model (USEPA 2001). PLOAD determines pollutant load from a watershed based on watershed land-use data, percent imperviousness, and pollutant export coefficients or EMC values based on either observed data or available literature. It is commonly used to estimate pollutant loadings on an annual average basis for any user-specified pollutant.

However, PLOAD does not have the ability to estimate conveyance, e.g., it cannot evaluate changes in peak flow or water quality due to transport. The model also cannot accurately be applied to assess loading for short time intervals. Unlike other models such as P8, it also cannot be used to locate and size BMPs.

3.4.1.1.2 Satellite Remote Sensing

Satellite remote sensing information provides an effective way for monitoring land use/land cover changes in urban areas through mapping variations in anthropogenic impervious surfaces. Impervious surface area (ISA) is considered a key indicator of environmental quality and is also used to identify extent of urban land use because it is highly related to urban land use categories and development density (Xian and Crane, 2005). In addition, ISA can be measured fast and economically by using multi-temporal satellite remotely sensed information. The longtime records available from land remote sensing data makes it possible to quantitatively estimate spatial and temporal variations of land use/cover conditions.

Ground surveys are expensive and generally not practical for mapping impervious surfaces of large areas such as the City’s service area. While Global Positioning System (GPS) is useful for assisting in collecting field data, it is not easily implemented for mapping large areas either. Remote sensing, in the form of aerial photography, has been an important source of land use-land cover information for many years and impervious surface area can be readily interpreted from aerial photographs (Draper and Rao, 1986). However, the cost of aerial photography acquisition and interpretation of cover types is prohibitively expensive for large geographic areas. An alternative is to acquire the needed information from digital satellite imagery such as the Landsat Thematic Mapper or Enhanced Thematic Mapper Plus, WorldView, IKONOS, and QuickBird. This approach has several advantages:

1. The synoptic view of the sensor provides large area coverage,
2. The digital form of the data lends itself to efficient analysis,
3. The classified data are compatible with geographic information systems (GIS), eliminating the need to digitize interpreted information, and
4. Land cover maps can be generated at considerable less cost than by other methods.

A number of studies have demonstrated the feasibility of using multispectral satellite data to classify impervious surface area in urban environments. In this study, a high-resolution WorldView satellite imagery acquired on July 10, 2010 was used for ISA mapping.

DigitalGlobe's WorldView-2, the world’s newest high-resolution commercial color imaging satellite, was launched on October 8, 2009 from Vandenburg Air Force Base in California. WorldView-2 is the first high-resolution satellite with 8-multispectral imaging bands. It can simultaneously collect panchromatic imagery (black and white) at 0.46 m grid resolution and multispectral imagery at 1.84 m grid resolution. The satellite provides full-color images for enhanced spectral analysis, mapping and monitoring applications, land-use planning, disaster relief, exploration, defense and intelligence, and visualization and simulation environments. The combination of WorldView-2’s increased agility and high altitude enables it to typically revisit any place on earth in 1.1 days.

3.4.1.1.3 Impervious Surface Area Mapping

Impervious area was determined based on satellite imagery. As part of this project, the City purchased high-resolution satellite data from WorldView captured on July 10, 2010. The imagery was selected to minimize the impact of cloud cover and atmospheric effects. The imagery was geometrically and radiometrically corrected using standard methods. Terrain correction using the USGS 1-arc second National Elevation Dataset was performed to improve geolocation accuracy. The geo-rectified satellite imagery is shown in Appendix C.

An image processing model was developed whereby impervious surfaces were extracted from the imagery based on user-defined variables. Within the study area, five image samples, distributed throughout the watershed and encompassing all general land uses were input to the model. Each of the sample images were classified as either pervious or impervious cover. The output was put into GIS for further analysis.

A ground-truth dataset was created by generating a stratified random sample of points across the study area and classifying the points as either pervious or impervious. This step was accomplished via photo interpretation of current high-resolution vertical and oblique color aerial photography.

The completed impervious cover map after image classification and statistical analysis is shown on Figure 3.4. The percentage of impervious surface area is depicted as a continuous variable, ranging from 0 to 100 percent imperviousness based on redness. Areas shaded in deep red have the highest percentage of imperviousness, while areas shaded in light pink have the lowest percentage of imperviousness. Figure 3.5 shows the average percent subbasin imperviousness derived from Figure 3.4.

To confirm that satellite imagery can be used to accurately classify the percent impervious surface area, the satellite estimates were compared to measurements made from aerial photographs provided by the City. The location where the comparison was made is shown on Figure 3.4. Figure 3.6 shows the correlation between the percent imperviousness between these two sources. The results indicate that there is a strong relationship between aerial photograph measurements and satellite-derived estimates. Based on the comparison, an impervious cover map was created using satellite imagery for the entire study area.

3.4.1.2 PLAT Detailed Load and BMP Evaluation Modules

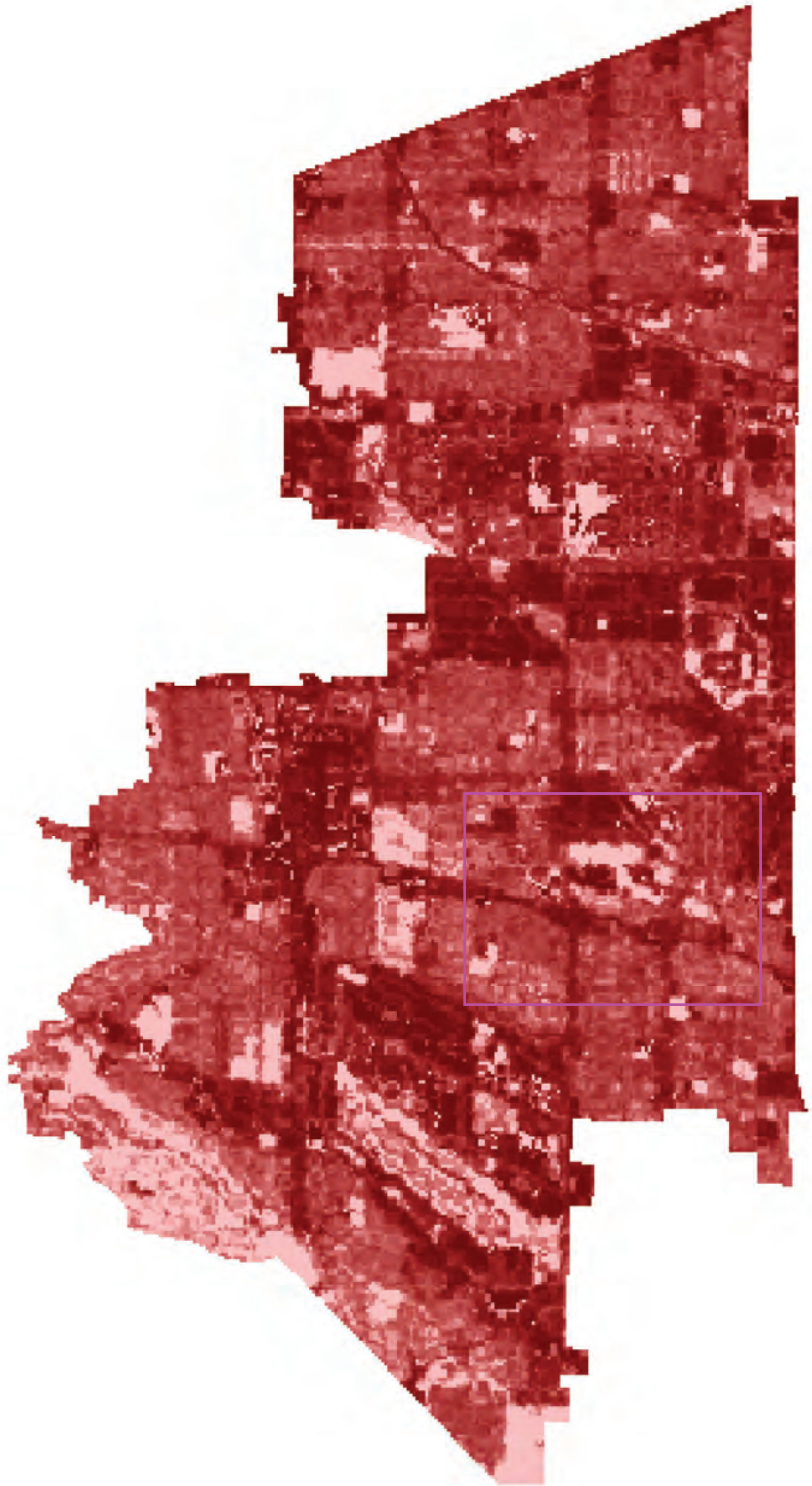
The main objective of the Detailed BMP Evaluation is to overcome the limitations of PLOAD. The Detailed BMP Evaluation modules use the results of the initial BMP Screening by PLOAD to limit computational time by avoiding modeling BMPs that may not work.

Under the current PLAT structure, subcatchment hydrology must be simulated externally. For this project, an external surface water management model (SWMM 5.0) was developed to simulate hydrographs for the study basins, and these hydrographs were subsequently imported into the P8 and SUSTAIN models. The City's original XP-SWMM model was exported to SWMM 5.0 for use in this analysis to meet RAA modeling requirement. This section describes the linkages between the SWMM, P8 and SUSTAIN models, and provides a step-by-step process of the modeling methodology.

The general steps for model development and calibration are listed below and illustrated on Figure 3.7.

1. Converted XP-SWMM model EPA SWMM 5.0 model to simulate runoff and routing for study basins.

2. Calibrated SWMM model runoff volume and timing to flow data extracted LA County WMMS model .



Imperviousness (%)

High : 100

Low : 0

% Impervious Comparison Area

Figure 3.4
Percent Impervious Cover Map Derived from Satellite Imagery

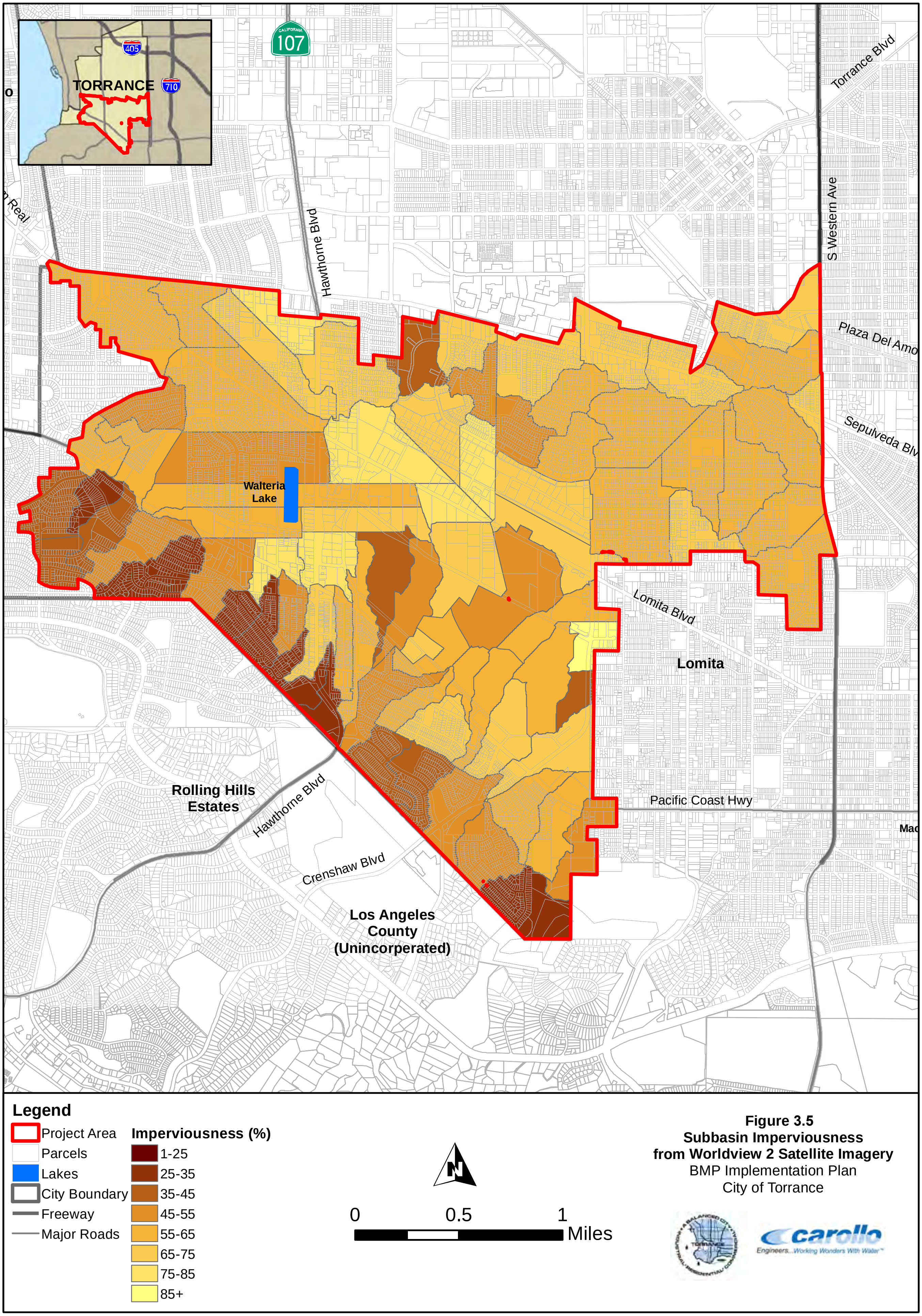
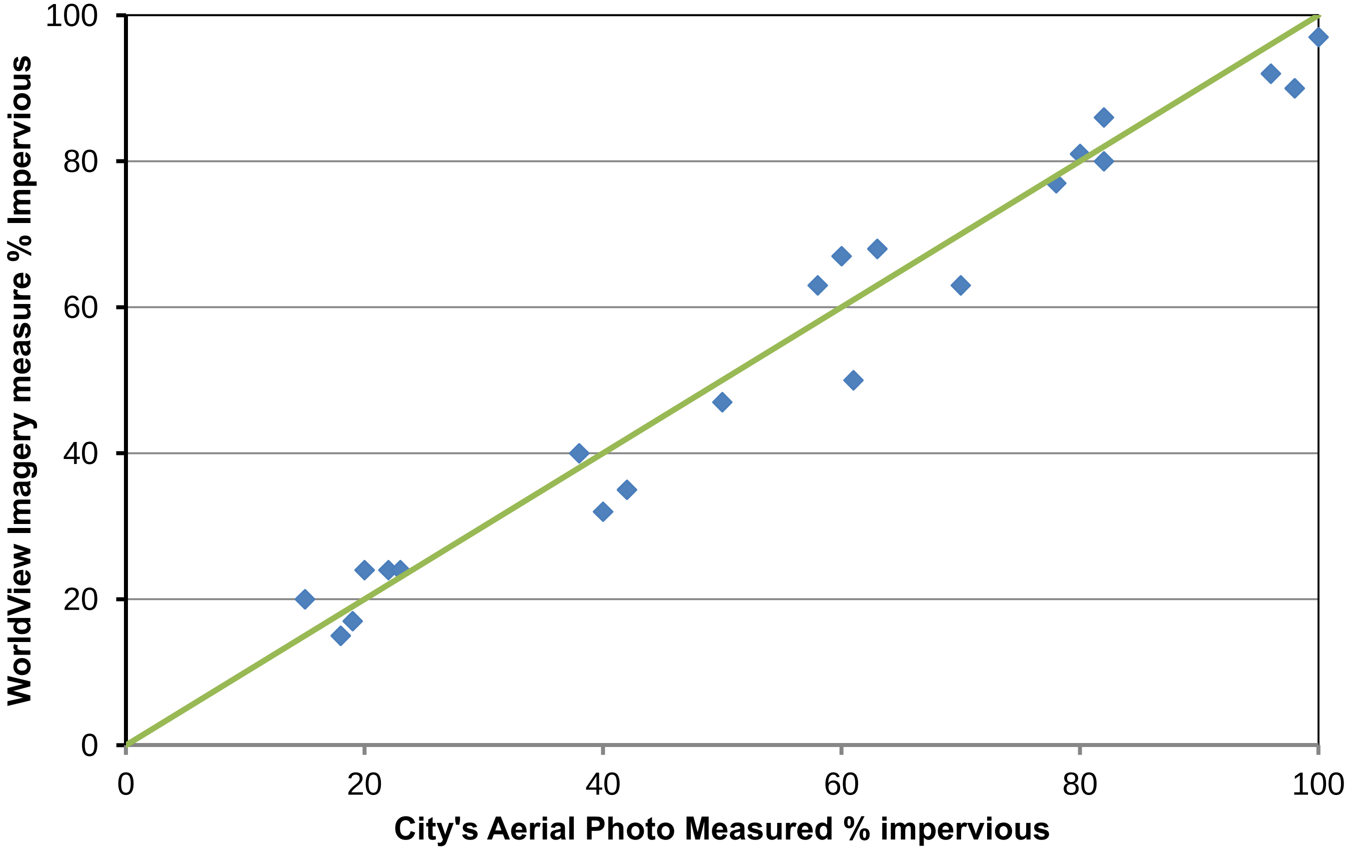


Figure 3.5
Subbasin Imperviousness
from Worldview 2 Satellite Imagery
BMP Implementation Plan
City of Torrance



WorldView Imagery measure % Impervious
100
80
60
40
20
0
0
20
40
60
80
100
City's Aerial Photo Measured % impervious

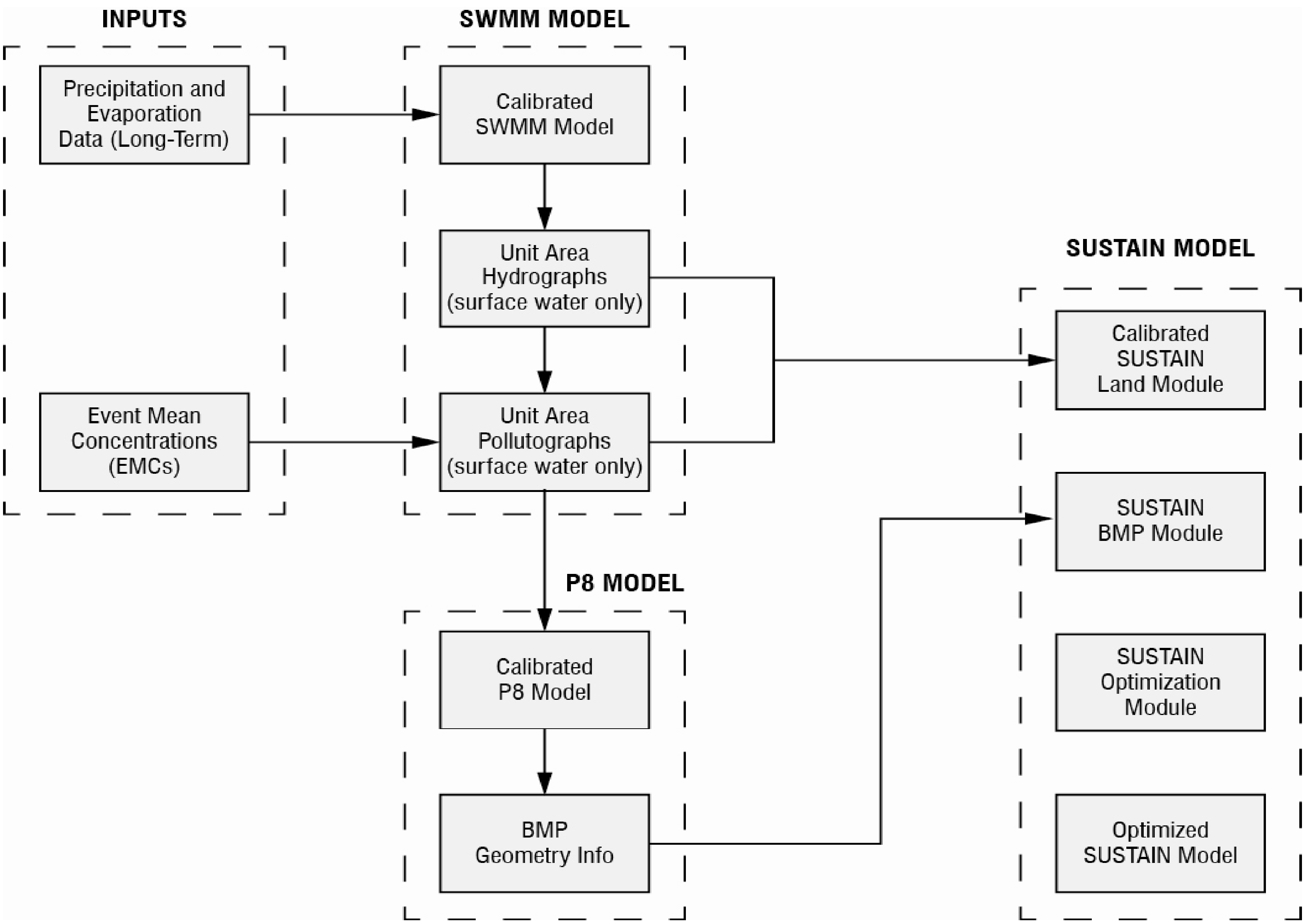


Figure 3.7 SWMM, P8 and SUSTAIN Model Development and Calibration/Verification

3. Using the calibrated SWMM model, developed unit-area surface water hydrographs (not including stream baseflow) to characterize runoff from each subcatchment by land use (commercial, residential, or forest) and land cover (pervious or impervious) for the 1-year calibration period.

4. Developed unit-area pollutographs for the calibration period by applying EMCs from each land use to the unit-area hydrographs (not including stream baseflow).

5. Built P8 and SUSTAIN land and conveyance module using unit-area hydrographs, pollutographs, and calibrated routing parameters from the SWMM model for the 1-year calibration period.

6. Confirmed flow calibration was maintained by comparing runoff files from calibrated SWMM model to those from P8 and SUSTAIN.

3.4.1.2.1 EPA SWMM 5.0

The original XP-SWMM model runoff volume and timing was calibrated to one year flow data extracted from WMMS. XP-SWMM is not a public domain software and therefore the model will be converted to EPA SWMM 5.0. The conversion will not result in any significant loss of accuracy since they computationally use similar engines. EPA SWMM 5.0 (SWMM) is a dynamic rainfall-runoff simulation model used for single event or long-term (continuous) simulation of runoff quantity and quality from user-prescribed land uses. SWMM has been widely used, since its initial development in 1971. GIS is used for the spatial component of the analysis in addition to visualization.

Infiltration was simulated in the SWMM 5.0 model using the Horton Infiltration equation. This equation is used to represent the exponential decay of infiltration capacity of the soil that occurs during rainfall or snowmelt events. The soil infiltration capacity is a function of the following variables: Fo (maximum or initial value of infiltration capacity), Fc (minimum or ultimate value of infiltration capacity), k (decay coefficient), and time. These infiltration parameters are used for the generation of runoff from the individual sub-drainage basins.

The actual values of Fo, Fc, and k are dependent upon soil, vegetation, and initial moisture conditions prior to a rainfall or snowmelt event. Because it was not feasible to obtain this detailed information for each sub-drainage basin through field samples, infiltration assumptions were made based on the soil types throughout the study area. Composite infiltration parameters (Fo and Fc) were calculated for each sub-drainage basin based on the fraction of each soil type within each individual sub drainage basin. Global databases containing the infiltration parameters for each sub-drainage basin were developed and imported into the SWMM 5.0 model.

The values of Fo, Fc, and k applied for each Hydrologic Soil Group are summarized in Table 3.5. The values shown in the table are based on suggested values in the *Storm Water Management Model, Version 4: User's Manual*, U.S. EPA, 1988. The Fo and Fc values were determined for each sub-drainage basin by calculating a weighted average based on the given soil groups within each basin.

Table 3.5 Horton Infiltration Parameters

Hydrologic Soil Group	F_o (in/hr)	F_c (in/hr)	k (1/sec)
A	5.0	0.38	0.00115
B	3.0	0.23	0.00115
C	2.0	0.10	0.00115
D	1.0	0.03	0.00115

3.4.1.2.2 P8 - Urban Catchment Model

The P8 model is designed to predict the generation and transport of runoff pollutants in urban watersheds. It consists mainly of methods derived from other tested urban runoff models, including SWMM, HSPF, D3RM, and TR-20.

The P8 model was developed to design and evaluate development runoff treatment control combinations for pollutant removal efficiency. Although, due to its simplicity, the P8 model has inherent limitations, this model is highly suitable for planning level studies and scenario testing. Model components include stormwater runoff assessment, surface water quality analysis, and routing through structural controls. The model applications include development and comparison of stormwater management plans, watershed-scale land-use planning, site planning, and evaluation for compliance, effectiveness of BMPs, and selection and sizing of management practices.

In P8, continuous water balance and mass balance calculations are performed on a user-defined system consisting of watersheds, devices (runoff storage/treatment areas, BMPs), particle classes, and water quality components. Simulations are driven by continuous hourly rainfall and daily air temperature time series data. The model simulates pollutant transport and removal in a variety of BMPs, including swales, buffer strips, detention ponds (dry, wet, and extended), flow splitters, and infiltration basins (offline and online), pipes, and aquifers.

3.4.1.2.3 SUSTAIN

To overcome the limitations of P8, the SUSTAIN model is employed to comprehensively size and place BMPs, perform optimization analysis, and assess TMDL compliance. Input for SUSTAIN is derived by P8 and SWMM.

The SUSTAIN model is public domain software developed by USEPA. SUSTAIN includes algorithms for simulating urban hydrology, pollutant loading, and treatment processes packaged from multiple models that individually address such processes. Users have the option to import time series data from external watershed models (e.g., Hydrologic Simulation Program Fortran (HSPF) or SWMM instead of performing new land simulations in SUSTAIN.

3.4.1.3 Model Calibration/Verification

In the absence of field data specific to Torrance, LA County WMMS and N-SPECT models were first used to calibrate and validate some modules of PLAT. Annual load computed by PLOAD and P8 modules were compared to WMMS and N-SPECT output.

The Nonpoint Source Pollution and Erosion Comparison Tool (N-SPECT) is a complex yet user-friendly GIS extension that helps coastal managers and local decision makers predict potential water-quality impacts from nonpoint source pollution and erosion. Input data includes land cover, elevation, precipitation, and soil characteristics to create the baseline information.

3.4.2 Average Annual Wet Weather Load

The annual average loadings generated by PLAT for each sub area in the TMDL Implementation Area between 2005 and 2006 are presented in Table 3.6. The data used in the model represent general observations in the Los Angeles Harbor/Dominguez Channel Watershed, which includes the Machado Lake subwatershed, and specific monitoring data from the TMDL Implementation Areas. Monitoring conducted as per the TMDL requirements was used to refine the PLAT modeling results in the Machado Lake watershed, as appropriate.

Table 3.6a PLAT Annual Average Loads by Sub Area

Sub Area	Area(1) (ac)	TSS (kg/yr)	TN (kg/yr)	TP (kg/yr)	Lead (kg/yr)	Zinc (kg/yr)
Baseball Field	155	15,650	28	4	1.93	23.21
Walnut Sump	923	71,451	127	22	11.45	146.97
Walteria Lake	2,118	2,989(2)	38	7	27.36(5)	371.34(5)
Airport	975	72,305	4,168	619	10.74	144.55
Airport Southeast	70	2,897	4	0.9	0.86	9.78
Total	**4,241**	**165,292**	**4,365**	**653**	**52.34**	**695.85**

Table 3.6b PLAT Annual Average Loads by Sub Area

Sub Area	Area[(1)] (ac)	Total PCB[(3)] (g/yr)	Total DDT[(3)] (g/yr)	Dieldrin (g/yr)[(3)]	Chlordane (g/yr) [(3)]	Fecal Coliform (MPN/ 100 ml/yr) x10^7 (g/yr)
Baseball Field	155	1.54	1.05	0.30	0.90	1.21
Walnut Sump	923	7.03	4.79	1.37	4.11	1.49
Walteria Lake[(2)]	2,118	0.29	0.20	0.06	0.17	22.40
Airport	975	7.11	4.84	1.39	4.16	10.3
Airport Southeast	70	0.29	0.19	0.06	0.17	0.80

Notes:

(1) Area from PLAT.
(2) Load entering Airport Sub Area.
(3) Annual load for toxics is the concentration of each constituent multiplied by TSS load.
(4) Average toxic constituent concentrations in µg/kg used are: total PCB = 98.38, Chlordane - 57.54, Dieldrin - 19.2 and total DDT - 66.99. Source: Regional Board Machado Lake Pesticides and PCBs TMDL.
(5) Load entering Walteria Lake.

3.5 Summary of Sources

The information about pollutant loading from the TMDL Implementation Area in the Machado Lake watershed can be compared with the TMDL allocations. A summary of the pollutant loading from the TMDL Implementation Area, the Final TMDL allocations and ultimate required reductions are presented in Table 3.7.

The annual loading from the TMDL Implementation Area currently complies with the interim limit of total nitrogen, 7,370 kg/yr and total phosphorus of 3,760 kg/yr as listed in Table 3 of this report. Final nutrient WLAs are supposed to be attained by September 11, 2018.

According to Table 3.7, 54 percent of total phosphorus load and 31 percent of total nitrogen load must be removed by the City to meet the final nutrient WLAs. The base loads in table are based on 2005 and 2006 conditions. The base loads for lead, zinc, and bacteria were derived from LA County WMMS model.

Table 3.7 Calculated Annual Loading Rates to Machado Lake

Constituent	Annual Loading(1) (kg/yr)	Final Allocation (kg/yr)	Required Reduction (kg/yr)	Required Reduction(2) (%)
Total Nitrogen	4,365	3,008	1,357	31
Total Phosphorus	653	301	352	54
	Toxic Constituent (g/yr)			
Total PCBs	16.26	9.88	6.38	39.24
Total DDT	11.07	0.87	10.20	92.14
Dieldrin	3.17	0.54	2.63	82.98
Chlordane	9.51	0.31	9.20	96.74

Notes:
(1) The annual loading from the TMDL Implementation Area complies with the interim limit of total nitrogen, 7,370 kg/yr and total phosphorus of 3,760 kg/yr as listed in Table 3.
(2) Percent of pollutant amount that is required to be removed.

3.6 Pollutant Source Characterization

The locations and density of pollutant sources in the TMDL Implementation Area are keys to understanding where BMPs and other implementation components should be focused. Typical sources for the pollutants of concern (nutrients) are fertilizers (residential and agricultural), atmospheric deposition, wastewater, leaking sewers, septic systems, animal operations, pets, native geology. The following sections provide a description of these sources.

3.6.1 Sanitary Sewer and SSOs

When sanitary sewers overflow or leak, they can release raw sewage into the environment. Many sanitary sewer networks in the United States were installed decades ago and are in need of replacement. Aging systems are a major source of sanitary sewer leakage. Severe weather, improper system operation and maintenance (O&M), clogs, and root growth can contribute to sanitary sewer leaks and overflows. Overflows can affect nearby waters and also back up into streets and basements (USEPA 2009). Raw sewage contains high concentrations of bacteria and nutrients from human and kitchen waste, as well as organic chemicals and metals.

Chemicals are present in sewage water from household use of cleaners, disinfectants, personal care products, treated swimming pools, and pharmaceuticals. Personal care products and pharmaceuticals have recently been scrutinized for their potential to be harmful endocrine disrupting chemicals (Boyd et al. 2004). Chemicals from laboratory sinks are also present in raw sewage (USEPA 2009).

3.6.2 Agricultural Operations

Agricultural land use is limited in the TMDL Implementation Area and therefore are not a significant source of nutrients.

3.6.3 Atmospheric Deposition

Atmospheric deposition of pollutants—either directly to a waterbody surface or indirectly to the watershed land surface—can be a large source of contamination to surface waters near urban centers. While this atmospheric source ultimately becomes a part of stormwater, it is important to understand the pathways from initial source (e.g., industrial facility emitting metals into the air) and transport (from air to land to water) processes. Direct dry deposition to waterbodies in the TMDL Implementation Area is not a significant factor because of the small water surface on which to receive direct deposition. Pollutants also exist in wet deposition, which occurs during rain and snowfall. In California, wet deposition is not a significant source of pollutants in comparison to dry depositions because there are so few rain events (Lu et al. 2003).

3.7 Pollutant Source Prioritization

To help develop implementation strategies, a prioritization of pollutant loading by sub area and potential sources was developed. The effort is concentrated on wet weather loading, with the assumption that BMPs targeted for the watershed would be designed to treat both wet and dry weather flows that drain to the BMP.

Wet weather loads generated from the TMDL Implementation Area were converted to area loads (e.g., pounds per acre per year [lb/ac/yr]) for use in the pollutant source prioritization. This provides a normalized view for targeting management in that it shows where the rates are highest. Area loads for each constituent were then ranked with a score 1 through 4 by sub area. Values were assigned quartiles as follows:

- A score of 1 for the lowest 25th quartile[1],
- A score of 2 for values between the 25th and 50th quartile,
- A score of 3 for values between the 50th and 75th quartile, and

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[1] A quartile is one of the 4 subdivisions that have been grouped into four equal sized sets based on their statistical rank.

- A score of 4 for the highest quartile.

The final rankings for wet weather area-based loads in Table 3.8.

Table 3.8 Wet Weather Load Ranking by TMDL Implementation Area (Area Loads)

TMDL Implementation Area	Parameter Score			Total Score	Priority Rank
	TSS	TN	TP		
Airport	4	4	4	12	1
Walnut Sump	4	2	3	9	2
Baseball Field	3	3	3	9	2
Airport Southeast	1	2	2	5	3
Walteria Lake	2	1	1	4	4

Rank: 1 – Highest Priority 4 – Lowest Priority

4.0 DEVELOPMENT OF NONSTRUCTURAL SOLUTIONS

The Implementation Plan uses an integrated approach to address multiple pollutants, using both structural and nonstructural solutions. The following are the proposed nonstructural BMP opportunities to control the contribution of pollutants to the maximum extent practicable.

A comprehensive program has been developed and ready to be implemented to reduce or eliminate the amount of pollutants in stormwater and urban runoff. This program meets a variety of regulatory requirements, including those of the LARWQCB adopted Order R4-2007-0042 for municipal stormwater and urban runoff discharges within the County (LARWQCB 2007b). An evaluation was conducted to identify opportunities for improvements to existing programs and new programs that would help meet TMDL WLAs and to determine the level of success in implementing these programs. Existing nonstructural BMPs are described in Section 4.1.1 and new nonstructural BMPs are proposed in Section 4.1.2. Considered holistically, these existing, improved, and new programs are expected to contribute to the reduction of TMDL pollutant loads and contribute to meeting WLAs.

4.1 Nonstructural Solutions

In general, nonstructural solutions include pollution prevention actions and source control activities that prevent or minimize the amount of pollution entering urban runoff. Pollution prevention actions seek to control constituents of concern before their release to the environment. Typical pollution prevention actions include conservation and reuse activities. Source control activities target pollutants from specific sources to reduce or eliminate the concentrations of those pollutants entering the municipal separate storm sewer systems (MS4). Typical source control activities include, but are not limited to:

- Issuance of local ordinances
- Street sweeping
- Product bans by either the State or Federal government

For pollution prevention and source control measures to be effective, the parties involved need to be educated about the measures, incentives should be provided to use the measures, and enforcement should be available to ensure the measures are implemented. Both pollution prevention and source control measures are proposed as complementary components of nonstructural solutions, which may provide more effective treatment at a lower cost than many structural solutions.

4.1.1 Existing Nonstructural BMPs

The following provides a summary of existing nonstructural BMPs that were evaluated to determine if enhancements could be made to specifically support TMDL implementation. A summary of the City's existing nonstructural BMPs relevant to nutrients and sediment reduction and flow reductions are presented in Table 4.1. The description provides an overview of relevant programs that could directly support stormwater pollution control.

Table 4.1 Ongoing Nonstructural Solutions Conducted by City of Torrance

Non-Structural Solution	BMP Type	Description
Public Information and Participation Program	Education	Encompasses several outreach campaigns. Those that most directly address nutrients are the Smart Gardening Program, pet waste outreach, and fats, oils and grease outreach.
Industrial/ Commercial Facilities Control Program	Enforcement	Tracks, inspects, and ensures compliance with permits for industrial and commercial facilities. Controls pollutant transport.
Development Planning	Source Control	Focuses on mitigating the long-term hydrologic and pollutant effects of the built environment and changes in land use. Includes establishing requirements for post-construction BMPs, reviewing plans to ensure that proposed drainage plans meet water quality and hydrologic performance standards, and ensuring long-term operation and maintenance of post-construction BMPs.
Development Construction Program	Enforcement	Addresses runoff from public and private construction projects through the use of stormwater pollution prevention plans (SWPPPs), training of staff engaged in construction activities, and compliance inspections. Through runoff prevention, controls the transport of nutrients and toxics.
Public Agency Activities Program	Source Control	Applies BMPs to infrastructure and facility operation and maintenance activities of Public Agencies to reduce pollutant sources. This includes sewer system maintenance, corporation yard, and recreational facility management.
Illicit Connections/Illicit Discharge Program	Enforcement	IC/ID removal prevents the discharge of a variety of pollutants including nutrients and toxics from entering the storm drain system.

Table 4.1 Ongoing Nonstructural Solutions Conducted by City of Torrance

Non-Structural Solution	BMP Type	Description
Catch basin filter Clean Out	Source Control	Catch basin filters are cleaned at least annually, with higher priority catch basin filters cleaned semi-annually or quarterly. For industrial catch basin filters, the optimal cleaning frequency appears to be between quarterly and semiannual; for residential catch basin filters, the optimal frequency appears to be annual. For commercial catch basin filters, the optimal frequency is semiannual.
Catch basin filter[1]	Source Control	In an effort to reduce trash as part of the Machado Lake Trash TMDL, catch basin filter could be installed in portions of watershed. Catch basin filter proposed with Machado Lake Trash TMDL Project.
Street Sweeping	Source Control	Curbed streets are swept weekly with vacuum sweepers in the city. Much of Torrance is not signed for street sweeping. This will be corrected with Machado Lake Trash TMDL Project.
Impervious Cover Disconnection	Source Control	Employ rooftop disconnection techniques.
County Ordinance No. 2008-000S2U	Enforcement	Prohibits wash down of paved surfaces, irrigation runoff, and requires car washing BMPs.
Restaurant Training	Education	An education program that includes restaurant BMP guidelines, a watershed model showing the potential for oil and grease to affect the watershed, a PowerPoint presentation, and collateral material for restaurant owners, including posters, buckets with BMPs printed on them, and brochures. Torrance does this as part of Clean Bay Certification Program.
County Ordinance Title 10 Animals, Chapter 10.40.060, B.	Enforcement	Requires pet owners to pick up and properly dispose of their pet's waste.

Notes:
(1) Although normally considered structural BMPs, for the purposes of the model, catch basin filter were accounted for as a nonstructural BMP.
(2) Torrance has ban on smoking in Public Parks and Torrance Beach.

Enhancements to the existing nonstructural BMPs and additional nonstructural BMPs can be considered and are discussed in the following section.

4.1.2 Potential Nonstructural BMPs

Potential nonstructural BMPs may include new nonstructural solutions and enhancements of existing nonstructural solutions. Specific sources of nutrients and toxics and their associated nonstructural solutions are listed in Table 4.2. The nonstructural solutions listed in Table 4.2 are detailed in Table 4.3. Sanitary sewer maintenance is covered in other areas of the Implementation Plan. Note that the costs presented in Table 4.3 are per year, and total implementation costs include an estimated rate of inflation of 3 percent over the life of the program.

Table 4.2 Potential Nonstructural Solutions by Pollutant Source

Pollutant Source	Associated Potential Nonstructural Solution(s)
Irrigation overflow	• Smart Gardening Program, with evapotranspiration controller irrigation enhancement • Public Agency Activities Program – landscape and recreational facilities management focus
Landscape fertilizer	• Smart Gardening Program • Public Agency Activities Program – landscape and recreational facilities • management focus • Development Planning – post construction BMPs
Catch basin filters[(1)]	• Development Planning – post construction BMPs • Catch basin filters[(1)] • Catch basin filter clean outs – increased frequency • Catch basin filter – install inserts where other structural BMP retrofits options are infeasible due to ownership/space constraints. Inserts should be selected that are capable of removing nutrients.
Streets and parking lots	• Street and parking lot sweeping – more efficient sweepers and increased frequency
IC/ID	• More aggressive identification and removal of illicit connections • Add stencils and re-stencil storm drains, as needed
Sewage	• Public Agency Activities Program – sewer systems maintenance, overflow, and spill prevention focus • Public Information and Participation Program – fats, oils, and grease outreach • Recreation Vehicle Sewage Disposal Sites – Public Information
Horse manure	• Public outreach
Pet waste	• Public outreach, providing bags and receptacles at parks, etc.
Green waste	• Public outreach
Sediment	• Industrial/Commercial Facilities Control Program • Development Planning • Public Agency Activities Program – materials storage facilities/corporation yards management focus

Note:
(1) Although normally considered structural BMPs, for the purposes of the model, catch basin filter were accounted for as a nonstructural BMP

Table 4.3 Proposed New and Enhanced Non-Structural BMP Descriptions

Non-Structural Solution	Description	New/Enhanced Program	Targeted Pollutant	Annual Cost
Add stencils and re-stencil storm drains, as needed	Audit storm drains to determine where stencils are not present or are faded. Efforts should initially be focused in Island 1 where field investigations noted faded or missing storm drain labels	Enhanced: Public Agency Activities Program	Nutrients and toxics	$5K per year
Catch basin filter clean outs	Modify program to use more aggressive techniques and increase frequency to clean 60% of catch basin filters monthly and 40% of catch basin filters semi-annually.	Enhanced: Public Agency Activities Program	Nutrients and toxics	$100K per year
Catch basin filter[1]	Expand installation of trash catch basin filter to cover more areas in the city; catch basin filter should be capable of removing trash, nutrients, and toxics. As an example, Kristar's FloGard Perk Filter has been approved by Washington Dept of Ecology's TAPE program 5 as "basic treatment" meaning that third party monitoring data has validated its ability to remove at least 80% TSS and 50% TP. Regular maintenance is necessary to retain pollutant removal performance	Enhanced: TMDL Implementation	Nutrients and toxics	$20K (includes yearly O&M)
Downspout disconnection program	Establish a downspout disconnection program to incentivize the disconnection of residential rooftop downspouts. See Section on Integrated Water Resource Considerations for additional information, page 36	New	Nutrients and toxics	$50K/ year
Fats, oils, and grease outreach	Target restaurants and residents in the TMDL Implementation Area for additional FOG outreach to educate them about the potential of sewage overflows caused by FOG blockages	Enhanced: PIPP	Nutrients	$5K/ year
Green waste outreach	Target residents and institutional land uses in TMDL Implementation Area for additional proper management of green waste.	New	Nutrients	$5K/ year
Horse manure outreach	Target residents for outreach about horse manure management.	New	Nutrients	$5K/ year
Illicit connection removal	Enhance program so that 40% of the system is surveyed and 20% of identified IC is removed	Enhanced: ID/IC Program	Nutrients and toxics	$75K $2,500/illicit connection removal[2]

Table 4.3 Proposed New and Enhanced Non-Structural BMP Descriptions

Non-Structural Solution	Description	New/Enhanced Program	Targeted Pollutant	Annual Cost
Industrial/ Commercial Facilities Control Program	Enhancement may include more in-depth training for inspectors and staff that addresses nutrient and toxics specific BMPs. Strengthening partnerships with enforcing agencies may also improve enforcement escalation procedures	Enhanced: Industrial Commercial Facilities Program	Nutrients and toxics	$5K/ year
Landscape and recreational facilities management	Enhancements are similar to the Smart Gardening Program, with application to landscape and recreational facilities managed by the City. The enhancements include switching to non-phosphorus organic fertilizers or using no fertilizer, adding soil amendments to lawns, converting a goal of 25% of lawn to native vegetation and using ET controllers. Outreach may include trainings for City staff that manage or maintain landscape and recreational facilities	Enhanced: Public Agency Activities Program	Nutrients and toxics	$10K/ year
Materials storage facilities/ corporation yards management	Training for City staff in charge of materials storage facilities and corporation yards with focus on activities and materials that may contribute to nutrient and toxic pollution to storm drain	Enhanced: Public Agency Activities Program	Nutrients and toxics	$5K/ year
Oil pump ESC outreach	Work with oil pump parcels located throughout the TMDL Implementation Area to ensure that sediment does not leave the site during the wet season.	New	Nutrients and toxics	$10K/ year
Pet waste outreach	Target residents, pet stores, and animal shelters in TMDL Implementation Area for additional pet waste outreach	Enhanced: PIPP	Nutrients	$50K/ year
Post construction requirements for new development and redevelopment	This program may be enhanced with additional training for Development Planning Staff. The focus would be education in planning for and maintaining post-construction BMPs that are effective in reducing nutrients toxics, and runoff	Existing: Development Planning Program	Nutrients and toxics	$25K
Sewer system maintenance, overflow, and spill prevention	Enhance sewer system maintenance and target staff working in the TMDL Implementation Area for SSO response and spill prevention training.	Enhanced: Public Agency Activities Program	Nutrients	$20K • $1,700/mi to clean sewer pipe

Table 4.3 Proposed New and Enhanced Non-Structural BMP Descriptions

Non-Structural Solution	Description	New/Enhanced Program	Targeted Pollutant	Annual Cost
Smart Gardening Program	This program includes outreach to reduce inputs (fertilizers, pesticides, water, etc.) to landscape, controlling nutrient sources and irrigation runoff. Field investigations showed evidence of lawn irrigation runoff in the majority of residential neighborhoods in all three Islands. This program should aggressively target the population within the TMDL Implementation areas. This program may be additionally enhanced to include evapotranspiration (ET) controllers to further reduce irrigation runoff. It may also encourage residents to change to non-phosphorus organic fertilizers or use no fertilizer, add soil amendments to lawns, and convert lawn to natural vegetation.	Enhanced: Public Agency Activities Program	Nutrients and toxics	$60K/ year
Street and parking lot sweeping	Increase frequency of sweeping to 2x/weekly	Enhanced: Public Agency Activities Program	Nutrients and toxics	$80K/ year4

Notes:
(1) Although normally considered structural BMPs, for the purposes of the model, catch basin filter were accounted for as a nonstructural BMP.
(2) Source: Marcoux, 2004 and Brown et al., 2004
(3) Source: WERF, 1997
(4) Source: Modified from Ramsey-Washington Metro Watershed District, 2005.
(5) Source: Washington State Department of Ecology's Technology Assessment Protocol - Ecology (TAPE) program reviews performance evaluation reports on new stormwater treatment technologies and determines whether or not the technologies meet Ecology's performance standards. http://www.ecy.wa.gov/programs/wq/stormwater/newtech/

4.2 Public Information and Participation Program

The County of Los Angeles Department of Public Works' Countywide Stormwater/Urban Runoff Public Education, Used Motor Oil and Used Oil Filter Recycling, Household Hazardous Waste/Electronic Waste Collection, and Smart Gardening programs help achieve the Public Information and Participation Program (PIPP) public outreach mandates and address nutrients and toxics pollution. Public community events, paid media campaigns, media relations efforts, and distribution of collateral materials are part of the standard public outreach practices for the above-mentioned environmental education programs. Visit www.CleanLA.com for information about these programs.

The Smart Gardening Program consists of learning centers and workshops that educate homeowners about conservation (of fertilizers, pesticides, water, etc.) when gardening and landscaping, which reduces the amount nutrients and toxics in the environment. The Smart Gardening Program could be enhanced to help facilitate TMDL implementation by identifying learning centers and/or holding workshops in TMDL Implementation Area.

Tip cards with Smart Gardening Program information could be tailored to address specific concerns (discontinuing irrigation overspray as a pollutant transport mechanism, controlling excess nutrients from fertilizer, pesticide alternatives, etc.) and sent to residences within TMDL Implementation Area.

4.3 Nonstructural Solutions Recommendations

As a result of the review of the existing programs that address the TMDL pollutants, the following are recommended enhancements and additional BMPs that would offer additional water quality benefits and contribute to TMDL implementation:

- **Enhancing the Smart Gardening Program** so it would extend the reach of the water conservation and pollution-prevention messages to the Machado Lake watershed.
- **Conducting TMDL-specific stormwater training** that emphasizes activities and BMPs that can cause or mitigate the TMDL pollutants of concern.
- **Enhancing commercial and industrial facility inspections** to avoid that activities associated with these businesses become new sources of pollutants.
- **Improving enforcement escalation procedures** to more effectively address known sources of pollution.
- **Improving street sweeping technology** to more effectively reduce sediment-bound pollutants from road surfaces.
- **Reducing irrigation return flow** through a variety of water conservation initiatives.

The remainder of the discussion and analysis pertaining to nonstructural solutions focuses on those seven recommended BMPs, which are expected to contribute substantially to reductions in pollutant loads. Table 4.4 shows the extent to which each BMP enhancement or new BMP addresses the TMDLs. All the proposed BMPs address nutrients and toxics; TMDL-Specific Stormwater Training addresses trash.

Table 4.4 Summary of Recommended Nonstructural Solutions

Nonstructural BMP	Condition: Wet Weather	Condition: Dry Weather	TMDL Pollutant Addressed: Nutrient	TMDL Pollutant Addressed: Trash	TMDL Pollutant Addressed: Toxics
Enhancements to Existing BMPs					
Smart Gardening Program Enhancements	√	√	◗	○	◗
TMDL-Specific Stormwater Training	√	√	◗	◗	◗
Enhancement of Commercial and Industrial Facility Inspections	√	√	◗	○	◗
Enforcement Escalation Procedures	√	√	◗	○	◗
Improved Street Sweeping Technology	√	√	◗	○	◗
New BMP					
Reduction of Irrigation Return Flow	√	√	●	○	◗
√ - applicable; ◗ - about half as effective, ○ - effective					

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5.0 DEVELOPMENT OF STRUCTURAL SOLUTIONS

Meeting WLAs for the nutrient and toxics TMDLs, and categories 2 and 3 pollutants targets in Implementation Area will take advantage of the nonstructural BMPs, but structural solutions will provide the majority of the necessary load reductions required. However, structural BMPs are also the most costly, so careful consideration was made in identifying opportunities for structural BMPs and collecting appropriate information to make cost-effective decisions regarding implementation.

Identification and assessment of opportunities for structural BMPs were focused on publicly owned land in the TMDL Implementation Area. Both distributed and centralized structural BMPs were considered. Distributed structural BMPs refer to those practices that provide the control and/or treatment of stormwater runoff at the site level. Typical BMPs in this category include, but are not limited to the following:

- Porous pavement
- Grassed swales
- Bioretention
- Water-harvesting systems
- Catch basin filter filters
- Practices that can be implemented on individual parcels or in the parkway to store, infiltrate, and treat runoff from that parcel.

Centralized BMPs refer to stormwater treatment, storage, or infiltration facilities that provide benefits on a larger scale (e.g., regional). Such projects can include neighborhood-scale or larger-scale facilities such as:

- Spreading grounds
- Flood control facilities
- Park space that provides treatment/infiltration of runoff from nearby areas.

The BMPs presented above are all not equally suitable to all site conditions and performance goals across watersheds. Consequently, several important site specific factors were considered when identifying those BMPs to include in the project analysis.

The following sections describe the process used to assess opportunities for implementing structural BMPs; both distributed and centralized. Section 6 describes the evaluation of BMP alternatives using an optimization process.

5.1 Summary of Structural Solutions

A phased approach is necessary for implementing structural solutions. The first priority was given to approaches that do not require obtaining land tenure, which may be projects within publicly owned right-of-ways or programs that encourage private owners to implement structural BMPs within their own properties. The next phase will involve public acquisition of property on which structural solutions can be implemented. The creation of public-private partnerships to implement structural solutions will also be considered. A summary of the pollutant removal mechanisms and capabilities of structural BMPs is provided in Table 5.1.

Table 5.1 Pollutant Removal Mechanisms and Capabilities of Structural BMPs

Structural BMP	Pollutant Removal Mechanism	Total Nitrogen	Total Phosphorus	Toxics(1)
Infiltration Basin	Infiltration	H	H	H
Detention Basin	Settling	M	M	M
Constructed Wetland	Biological Uptake, Settling	M	H	H
Catch basin filter	Settling, Filtration	L	M	M
Bioretention	Adsorption, Settling, Biological Uptake, Infiltration	M	H	H
Porous Pavement	Infiltration	M	H	H

Notes:
H: high; M: medium; L: low
Scoring modified from International BMP Database, 2010.
(1) Performance data is not widely available for this pollutant class; assumed that removal efficiency would be similar to sediments since these pollutants are largely associated particulates.
(2) Phosphorus index of fill soils in bioretention areas will cause a high total phosphorus outflow; high TP removal efficiency is dependent on the fill soils having a low P-index.
(3) Nitrogen removal by bioretention areas can be increased using a design variation that creates an anaerobic zone below the drainpipe.

5.2 Assessment of Opportunities for Distributed Structural BMPs

It was not feasible within the TMDL Implementation Plan to identify and size each distributed structural BMP in the TMDL Implementation Area. Rather, within specific classifications of land characteristics (e.g., impervious roads, land use, soil type), general assumptions were established that provide insight regarding the types and benefits of distributed BMPs that can be implemented at a larger scale. That resulted in identifying key distributed structural BMP projects that could be considered for TMDL implementation planning.

Two major categories of distributed structural BMPs were identified, which were based on site characteristics and the types of BMPs determined feasible: 1) catch basin filter distributed BMPs and 2) other distributed BMPs on public land. The following provides detailed discussions for these categories and the proposed projects for TMDL implementation.

5.2.1 Catch Basin Filter Distributed BMPs

Storm drain systems in developed areas typically begin with inlets at the street level. Stormwater inlets have a variety of names, and there are regional differences in terminology. In California, storm drain inlets are routinely called catch basin filters.

As discussed in Section 3, roads represent a major source of TMDL pollutant loads, and therefore treating road runoff is considered a key strategy for multi-pollutant TMDL implementation. Because of the number and spatial distribution of catch basin filters in the TMDL Implementation Area, they represent an excellent opportunity for treating pollutants in addition to trash. Appendix G provides performance data for the catch basin filters proposed for the BMP Implementation Area.

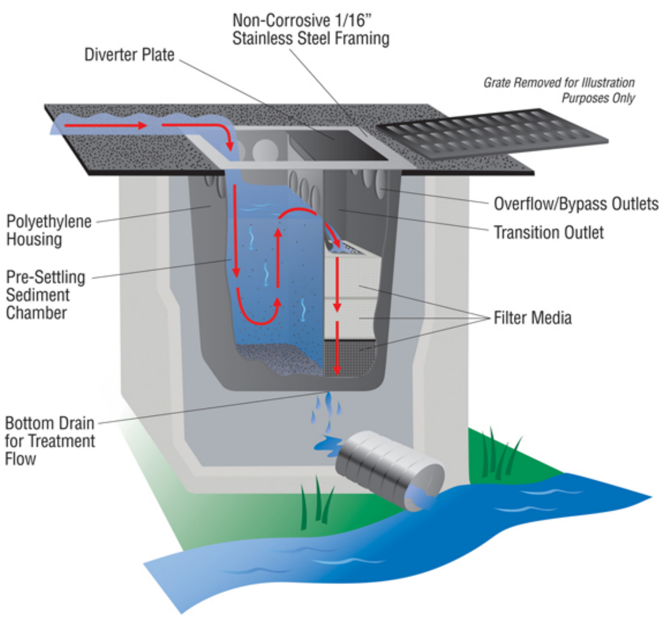

Figure 5.1 Example of Catch Basin Filter

5.2.1.1 Catch Basin Filter

Catch basin filters, as illustrated on Figure 5.1, are devices designed specifically to capture trash, oil/grease, other floatables, sediment, organics, and other pollutants—can offer additional pollutant removal benefits. On the basis of a synthesis of available studies, catch basin filters are expected to treat and remove a significant fraction of sediment (and associated metals and toxics) with treatment focused on runoff from the transportation network. The treatment efficiency of catch basin filters for bacteria is poorly studied and unknown but is likely to be very low unless the insert has a design element targeting bacteria. Such devices tend to have a 1- to 3-year warranty and would need maintenance or replacement after that. Catch basin filter can replace full capture devices upon installation depending on whether the space they occupy is compatible with the full capture device. Some devices (such as the Abtech Smart Sponge™) can be installed in tandem with existing full capture devices.

Implementing catch basin filters throughout the TMDL Implementation Area is highly applicable because of the high density of catch basins. The TMDL Implementation Area includes almost 811 catch basins, which equates to approximately 1 catch basin filter every 200-300 lineal feet of stormdrain. The distribution of catch basins within the TMDL implementation area is summarized in Table 5.2.

Table 5.2 Summary of Catch Basin Filters by Subwatershed

Subwatershed	Storm Drain Length (mi)	Number of Catch basin filters	Catch basin filter Density (CB/mi)
Walteria Lake	25	373	15
Airport	14	173	12
Walnut Sump	9	242	27
Baseball Field	1.4	23	17
Total	**50**	**811**	**16**

Note:
(1) Based on count from City's storm drainage atlas maps

The City is currently in the process of installation of full capture devices for compliance with the trash TMDL. Implementing catch basin filters would require retrofitting or replacing the full capture devices that have been installed. For the TMDL Implementation Plan, implementing catch basin filters is assumed to focus on replacing existing full capture devices with catch basin filters, which is a more resource intensive, conservative approach. During actual implementation, other more cost-effective approaches for full capture device retrofit could be employed. The schedule for implementing catch basin filters in the TMDL Implementation Area considers maximizing the operational period of installed full capture devices, thus improving the return on the investment. Implementing catch basin filters would involve internal planning, conducting a pilot study to gain approval from the LARWQCB for attaining the trash TMDL requirements (for cases where full capture devices are being retrofitted or replaced), installing the devices, and maintaining the sediment-removal insert as part of the existing catch basin filter maintenance activities.

5.2.1.2 Other Distributed BMPs on Public Land

Before stormwater enters the storm drain systems, opportunities are available for the storage, infiltration, and treatment of runoff within publicly owned right-of-ways or parcels. Such areas include road right-of-ways or other properties owned by public agencies for various purposes (e.g., parks, schools, storage, and utilities). Figure 5.2 shows the publicly owned parcels within the TMDL Implementation Area. In combination with road right-of-ways, this area represents a significant opportunity for on-site stormwater treatment.

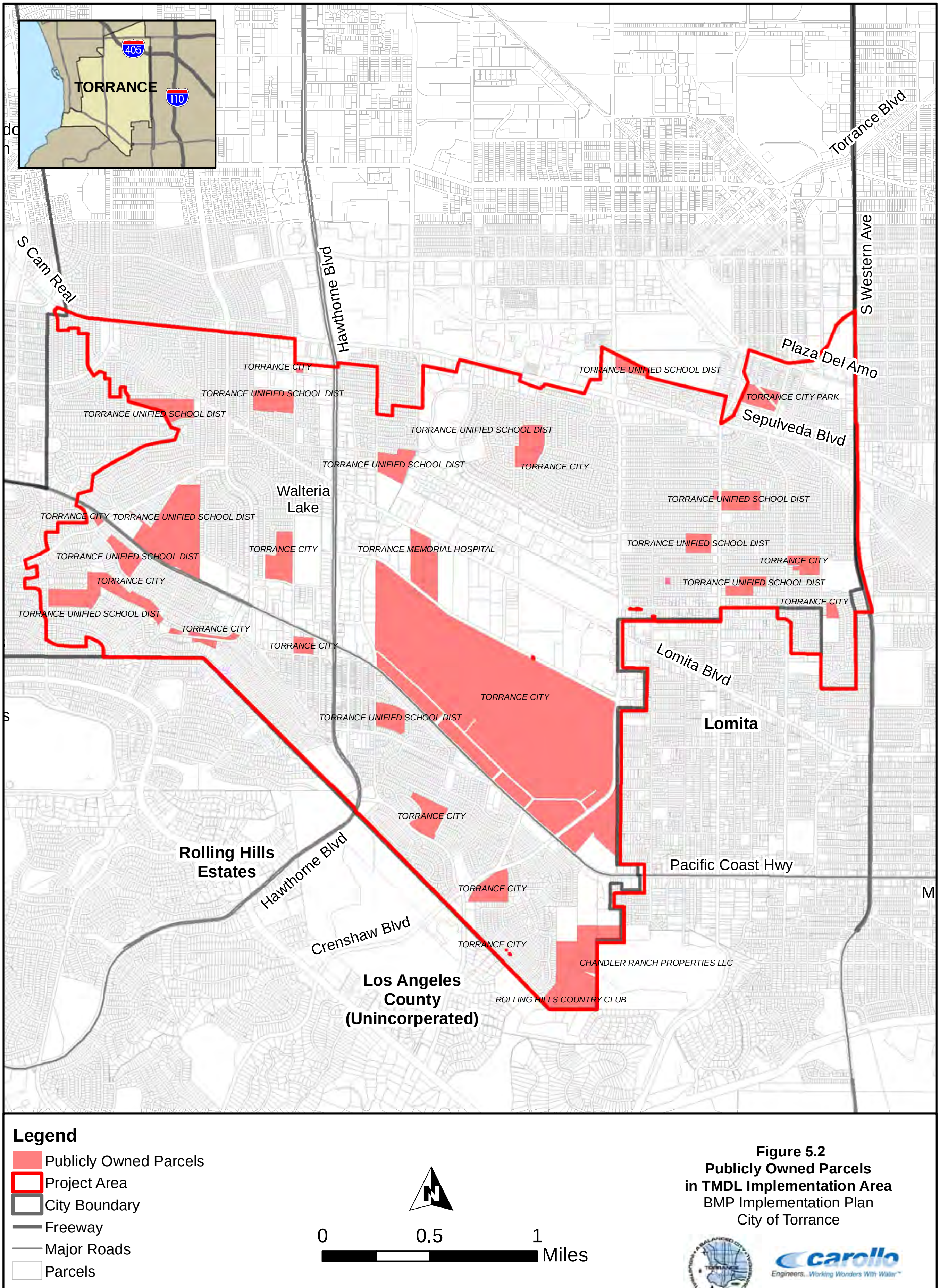

Figure 5.2
Publicly Owned Parcels
in TMDL Implementation Area
BMP Implementation Plan
City of Torrance

5.2.2 Low Impact Development

The County of Los Angeles adopted a low impact development (LID) ordinance on January 1, 2009, which directly influences the selection and use of structural BMPs. New development and future redevelopment within the City are subject to LID requirements. The requirements are intended to result in runoff quantities and quality that mimic the runoff from undeveloped areas, up to and including runoff from a 50-year design storm event.

Development projects with four or fewer residential units are required to implement two LID BMP alternatives as specified in the County LID Standards Manual. LID BMP alternatives include, but are not limited to the following measures:

- Disconnecting impervious areas
- Installing porous pavement
- Dry wells
- Conforming to landscaping and irrigation requirements
- Installing green roofs

Developments with five or more units or nonresidential developments are required to provide infiltration for excess runoff volume. Runoff from these developments that mimics the natural hydrograph must meet treatment requirements. Redevelopment projects where at least 50 percent of the impervious surfaces are altered must mitigate the entire project area. Redevelopment projects that alter less than 50 percent of the impervious area only need to mitigate the alteration.

Implementation of LID BMPs within the TMDL Implementation Area provides an opportunity to reduce the loading of pollutants by reducing concentrations of pollutants in runoff and reducing the volume of runoff.

Both development and redevelopment are largely driven by the strength of the economy. Currently, the rate of development is near a historic low and as a result, estimates for gains from LID and the schedule for those gains are difficult to quantify. As part of the adaptive management implementation, the effects of implementing LID BMPs through development and redevelopment will be tracked though the monitoring and reporting program. Increased levels of development or redevelopment should result in decreases in pollutant loading from the TMDL Implementation Area, reducing the need for additional structural controls. Stagnation of development in the TMDL Implementation Area may lead to an extended schedule or require additional structural controls to attain TMDL WLA levels.

5.3 Assessment of Opportunities for Centralized Structural BMPs

To identify, evaluate, and ultimately select the optimal combination of centralized structural BMPs to address pollutant load reductions for the TMDL Implementation Area, key information was required. Investigations were performed to identify and assess potential sites for placing centralized structural BMPs on public land. Priority locations of centralized structural BMPs were publicly owned properties to reduce the need for land acquisition. Additional consideration was made regarding the necessity for implementing centralized structural BMPs on private land. Results of this assessment provided information necessary to support TMDL implementation planning.

5.3.1 Site-Screening Methodology

An initial analysis was conducted to identify all publicly owned parcels in the TMDL Implementation Area. That initial screening resulted in approximately 24 parcel groups as shown on Figure 5.2. The 24 parcel groups included any publicly owned land with no analysis of the suitability for a centralized BMP. Most of the sites provide adequate space for a centralized BMP. They are not too steep, or are within a feasible distance of a stormwater drainage system.

Additional screening was performed to further narrow potential sites for additional investigation. Additional field investigations were performed for identified locations to assess site and drainage area characteristics and identify the ideal BMP that could be constructed at the site.

Subsequently, GIS analysis was performed of land ownership parcels and site characteristics to identify potential sites for centralized BMP placement on publicly owned parcels. Considerations in the analysis included the following:

- **Land cost**—Land costs were minimized by identifying publicly owned parcels.
- **Percent impervious**—Areas with higher percent imperviousness would produce more runoff during typical rain events. Higher impervious areas were targeted for greater potential volume reduction and water quality improvements.
- **Space requirements—**Sites were evaluated to determine if space is available to implement an appropriately sized BMP.
- **Watershed treatment area—**The size of the TMDL Implementation Area drainage area for each site was evaluated on the basis of available storm drain or Digital Elevation Model (DEM) data. Sites were identified that provide sufficient space for BMPs to adequately treat/store/infiltrate runoff from their respective drainage areas.

- **Soil type**—Soil type was evaluated as an initial estimate of the infiltration rate and capacity of the soils. Sites with infiltration rates suitable for infiltration BMPs were further investigated.

- **Slope**—Slopes of sites were considered on the basis of DEM or other available topography data sets. Sites with moderate slopes (less than 10 percent for GIS purposes) were considered for centralized BMPs. Slope was verified in the field investigation, and sites where the slope is inappropriate for a centralized BMP were eliminated.

- **Multi-benefit use**—Sites were identified that could serve multiple purposes. For instance, some stormwater practices, such as infiltration basins or grassed swales, could serve a dual purpose of stormwater management and community park space. Several parks could be altered to provided stormwater treatment and storage.

Those criteria were evaluated to identify sites where centralized BMPs would be feasible. Sites that could provide enough space to effectively treat the drainage area associated with the site, that have soils suitable for infiltration, and that are publicly owned (to reduce land acquisition costs) were preferred. Sites that could provide a multi-benefit use, such as parks or parking lots where belowground storage could be used, were considered ideal. From the GIS screening analysis, a list of potential locations for centralized BMPs was developed to address stormwater runoff from the TMDL Implementation Area.

This GIS screening and additional field investigations narrowed the potential sites to the following five sites (which are also depicted on Figure 5.3):

- Airport 1 – A1
- Airport 2 – A2
- Airport 3 - A3
- Walnut Sump
- Baseball Field

Details regarding the proposed structural BMP improvements are presented in subsequent subsections, while general observations and strategies used to develop these BMP concepts are described below.

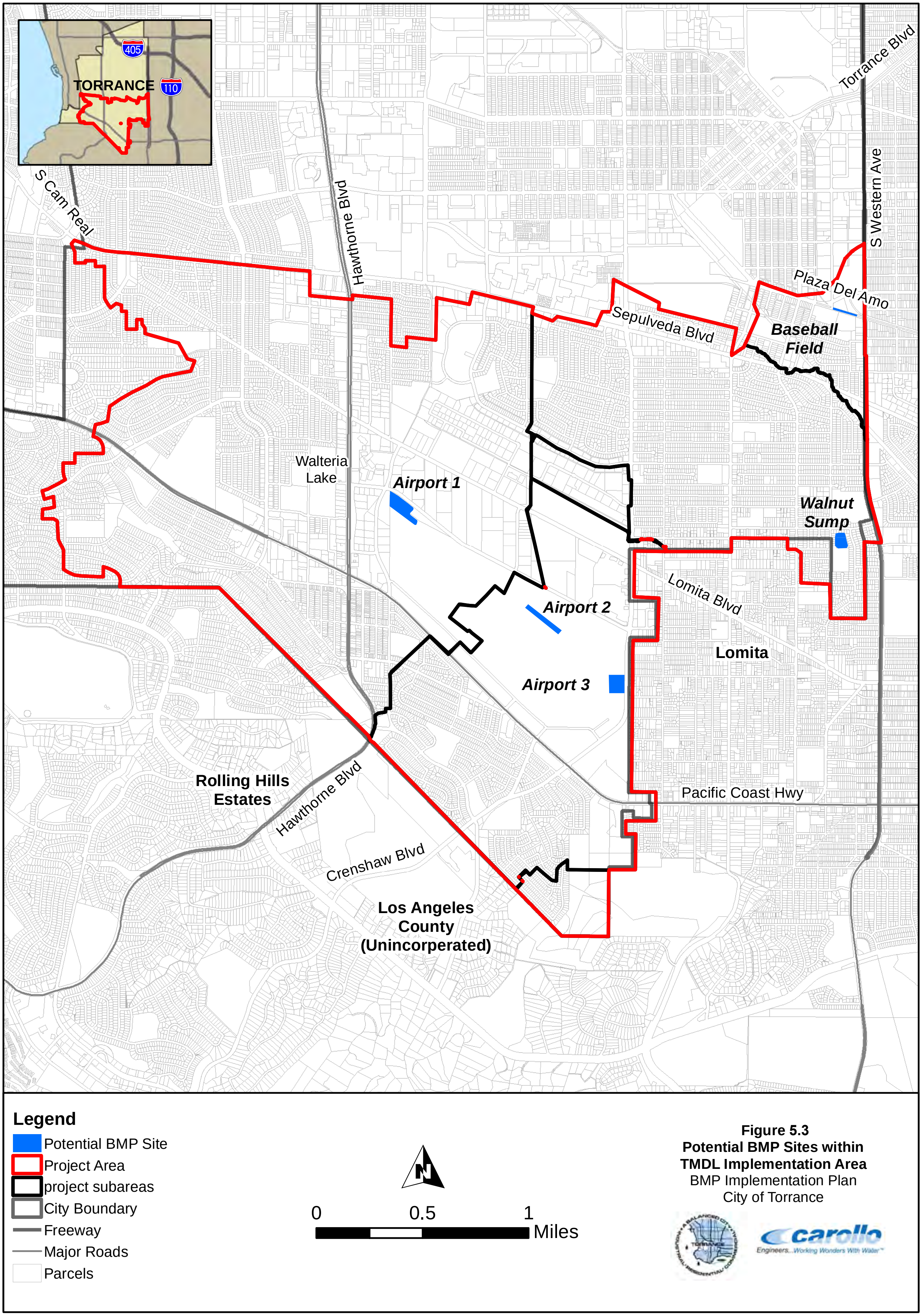

Figure 5.3
Potential BMP Sites within TMDL Implementation Area
BMP Implementation Plan
City of Torrance

Because existing site layouts and features can have an effect on where and what type of BMPs can be installed on a site, site layouts and on-site structures were photographed and documented to support evaluation of the site for centralized BMPs. The considerations included the following:

- **Effects on surrounding areas—**Any nearby structures, including storm drains and utilities, were documented. Any effects that could occur to surrounding structures because of settlement issues were noted.
- **Maintenance/accessibility—**Every BMP must be maintained at some level for the BMP to continue to function as it was designed. BMPs were considered that maximize access for maintenance purposes.
- **Research potential—**Research of stormwater BMPs is ongoing and necessary to fill existing data gaps and to continue to support the City in developing BMP standards. Monitoring protocol would be considered and incorporated into the design of each BMP that is implemented.

The individual site characteristics and summary of field investigations and BMP recommendations are described below. The description includes results of field tests to evaluate infiltration rate, water table depth and soil quality; more detailed maps of potential BMP sites; and photographs of the watershed treatment area and available BMP area for each site. Centralized structural BMP options for the sites were narrowed down to specific BMP types and sizes during the process of evaluating nonstructural and structural solutions.

The watershed treatment areas for each of the five identified sites, unless otherwise noted, are residential with concentrated or dispersed density configurations. Residential areas are known to generate high levels of nutrients, such as nitrogen and phosphorus, typically from over fertilization and excess irrigation. Detergents used to wash cars in residential areas can contain high levels of phosphorus. Residential areas are also a source for metals and bacteria. While the largest portion of the watershed treatment areas are residential, there are also institutional and commercial areas in many of the watersheds. Institutional and commercial areas are typically a source of metals, nutrients, and PAHs. Additional pollutant source discussion is included in each site discussion where additional detail is required.

On the basis of observed conditions at all the potential BMP sites, two types of centralized BMPs could be implemented in the open space at the five sites: underground storage/infiltration basins and extended dry detention/infiltration basin. Three of the potential BMP sites, A1, A2 and A3 are located at the Torrance Airport, one at Walnut Sump and the last site is located under the road near Torrance Baseball Field. The sites were also selected to eliminate or minimize the need for pump stations. Each centralized BMP is suitable for treating nutrients, toxics, metals, and other pollutants typically delivered with suspended sediment (e.g., organic pesticides, PAHs) in stormwater. Infiltration basins require high infiltration rates and are not designed to store water for extended periods. Underground storage/infiltration systems are suitable in areas with hydrologic soil group (HSG) C soils and soils in the lower range of HSG B where infiltration is possible but could take longer.

The five potential sites investigated do not have hard surface areas such as tennis courts, basketball courts, playgrounds, skateboard parks, and parking areas. These potential sites do not require a structural foundation and therefore could be used for belowground storage and treatment. Storm chambers installed below these surfaces would provide additional treatment while still allowing the areas to be used for recreation and parking.

The type and size of the BMP were determined through further optimization analysis and reported in Section 6. The BMPs are planned to infiltrate water within a few days, reducing possible public health risks from stagnant water such as mosquitoes and drowning. An infiltration basin could still be used for recreation and open space activities between storm events and during the dry season. Belowground BMPs could have overlying space available for recreation or parking regardless of the weather.

Each of the investigated potential centralized BMP sites has ample open space to provide access for maintenance. Observed maintenance at each potential site includes regular mowing similar to the required maintenance for an aboveground-centralized BMP. To maintain infiltration functionality, sediment would need to be removed when infiltration rates are reduced twenty-five to fifty percent from the design infiltration rate. Infiltration rates can be restored by removing accumulated sediment and disking or aerating the surface. Sediment from belowground BMPs would have to be removed annually or as needed.

Considering current usage, ample space would be available for construction activities at each investigated site. While the focus of each of the potential centralized BMPs is TMDL compliance, implementing such BMPs also aligns with several integrated water resources planning objectives. In addition to the intended BMP objective of water quality improvement, a centralized BMP at each of the proposed sites would contribute to flood protection, water conservation, groundwater replenishment, and improved aesthetics.

5.3.2 Utility Search

Prior to recommending a potential BMP site, a utility search was conducted. Known utilities companies contacted for utility information regarding the project area include:

- Sempra – Gas utility
- Southern California Edison – Electric utility
- Metropolitan Water District of Southern California (MWDSC)

Utility information obtained from the companies were included in the database created for this project. Analysis of the utility information indicates that there appears to no potential conflict with the proposed projects. The utility information is included in Appendix D.

5.3.3 Geotechnical Investigation

Accurately identifying the HSG of the existing soils is also an important first design step in computing BMP design treatment volume and appropriate runoff reduction credit. The initial screening of the on-site soils was conducted to identify basic soil characteristics related to stormwater management, such as the HSG and other features relevant to construction activities (e.g., erosion and sediment control). Also, through the initial screening areas where more detailed soil investigation and field determinations may be needed to refine the limits of the different HSGs as defined in the soil survey were identified. The initial screening also included the identification of locations deemed suitable for infiltration BMPs and therefore further detailed geotechnical investigations.

Due to concern regarding infiltration rates at the Torrance Airport, a geotechnical investigation of this site was conducted using three soil borings. Details of this subsurface investigations are summarized in Appendix E. In summary, it can be concluded that the boring logs indicate that the top layer below surface at the Airport consists of a thin layer of silty sand followed by sandy clay, alluvium, and clay deposits. At depths ranging from 25 to 45 feet below surface, a sand layer is present. This layer would be most suitable for infiltration of stormwater. Hence, substantial excavation would be required to install the underground infiltration galleries at this site, which results in higher cost and difficult access for maintenance. More details regarding this BMP site is provided in the next section.

5.3.4 Torrance Airport Basin

The Torrance Airport Basin is about 60 percent impervious with a concentrated impervious configuration and moderate road density. There are three proposed BMP sites all located at Torrance Airport (A1, A2, and A3). These are open areas and are well maintained, suggesting the use of fertilizers that have high levels of nutrients and some metals, such as copper, adding another source of nutrients and metals to the stormwater runoff from the area.

For the purposes of BMP implementation in this area, the drainage basin is subdivided into four treatment subcatchments, AS1, AS2, AS3, and Walteria Lake, shown on Figure 5.4. Stormwater runoff from these four subcatchments could be diverted to the three potential sites; A1, A2, and A3 for treatment. The subcatchments were delineated based on drainage characteristics and storm drain layout. Stormwater runoff from AS3 could be treated at A3, AS2 stormwater would be diverted to A2 and Walteria Lake discharge diverted to A1 for treatment. Based on the storm drain layout it is not costeffective to divert stormwater from AS1 to any of the three BMP sites. Therefore, distributed BMPs will be considered for this subcatchment.

The Walteria Lake subcatchment is served by Walteria Lake, which acts as an extended wet detention basin. Stormwater is pumped from the lake through a 54-inch diameter force main. During big storms and/or pumping conditions, there is a high potential for sediment resuspension. This may lead to high pollutant discharge into Machado Lake. To prevent pollutant discharge into Machado Lake and thereby meet WLAs, discharge from Walteria Lake could be diverted at two locations into potential BMP sites A1 and A2 as shown on Figure 5.5. However, A1 and A2 are designed based on Torrance watershed only. Additional capacity to treat flow volume pumped from Walteria Lake is not part of this report. A1 could be expanded with financial participation from the LACFCD.

5.3.4.1 Subcatchment Volume Associated with 85th Percentile, 24 Hour Storm

Wherever feasible, the City wants to capture and retain all non-stormwater runoff and all stormwater runoff from the 85th percentile, 24 hour storm event for the drainage area tributary to the BMP sites at Torrance airport, Walnut Sump and the Baseball Field. The applicability of the three BMP sites to capture and treat the 85th percentile runoff volume for each subcatchment was investigated. The total surface area and volume requirements for each potential BMP site is summarized in Table 5.3. As shown in the table, the potential BMP sites A1, A2 and A3 have adequate surface area to implement underground storage/infiltration system to treat stormwater generated from their respective subcatchments. The total depth of the proposed underground storage/infiltration system will range between 4 and 8 feet.

Table 5.3 Summary of BMP Requirements –Torrance Airport

BMP Site	Drainage Area Treated (ac)	Percent Imperviousness	Treatability (1)	24 hr 85th Percentile Volume (ac-ft)	BMP Capacity (ac-ft)
A1	NA[2]	NA	NA	NA	22.4
A2	86	45	6.7%	2.8	12.0
A3	640	59	66.1%	27.2	32.8

Notes:
(1) Treatability: Fraction of impervious surface in subcatchment treated by BMP
(2) Only effluent discharged from Walteria Lake subcatchment.
(3) The 85th percentile 24-hour storm depth = 0.85 in.

The three sites were also evaluated to determine if the soils at the sites meet infiltration requirements. Based on geotechnical evaluation, BMP site A3 is the least feasible site to implement underground storage/infiltration due to the presence of a thick clay layer. Infiltration system at the site will have to very deep and will be costly. Therefore, underground storage/infiltration system would be implemented at site A3 only when additional treatment is required after installation of BMPs at sites A1 and A2. Sites A1 and A2 have enough capacity to capture and infiltrate the 85th percentile runoff from subcatchments AS2 and AS3. The total capacity of sites A1 and A2 is approximately 34.4 ac-ft Therefore, AS2 and AS3 can be designated as 85th Percentile Basins. All the runoff captured at AS2 and AS3 will be discharged through infiltration.

5.3.4.2 Torrance Airport Basin Treatment Scenarios

Tables 5.4 shows a summary of the pollutant load generated from subcatchments AS1, AS2 and AS3. These three subcatchments represent approximately 23 percent of the Implementation Area. However, they generate about 95 percent of the total phosphorus load generated from the entire Implementation Area. Therefore, for the City to meet the TMDL requirements, stormwater generated from these subcatchments must be managed using watershed-based strategies that combine structural and institutional or non-structural BMPs.

Table 5.4 Torrance Airport Subcatchment Pollutant Load Summary

	Pollutant Load (kg/yr)		
Subcatchment	**TSS**	**TP**	**TN**
AS1	19,627	167.8	1,130.5
AS2	4,694	40.8	272.5
AS3	47,984	410.5	2,765

	Pollutant Load (g/yr)			
Subcatchment	**Total PCB**	**Total DDT**	**Dieldrin**	**Chlordane**
AS1	1.94	1.31	0.38	1.13
AS2	0.46	0.31	0.09	0.27
AS3	4.72	3.21	0.92	2.76

Subcatchment AS1

Stormwater generated from subcatchment AS1 will be treated soley with distributed and non-structural BMPs. The distributed and non-structural BMPs recommended for implementation in AS1 include:

- Street sweeping – toxics and other pollutants released to the urban environment during dry weather conditions are likely to adsorb on street sediments, which provide mechanism for metals to reach downstream waterbodies. Street sweeping removes sediment, debris, and other pollutants from road and parking lots surfaces. Street sweeping is also proposed in subcatchments AS2 and AS3.

- Catch Basin Filter/Cleanouts – continuation of catch basin filter cleaning programs will contribute to removal of sediments prior to entering the storm drains. The pollutant removal mechanisms of catch basin filter filter inserts are: screening, sedimentation, flotation, and absorption. Debris and large particles are removed by screening; smaller particles and sediment along with associated hydrocarbons, metals, nutrients, toxics and pathogens are removed by settling; and hydrocarbons that are not associated with sediment are removed by absorption.

This EWMP through modeling which is discussed in Section 6 proposes combined efficiencies of non-structural BMPs 30 percent for sediment, 10 percent for phosphorus and 23 percent for nitrogen. Toxics removal is assumed to be directly related to sediment removal efficiency. The assumptions underlying the modeling efforts are discussed in Section 6.

Subcatchment AS1 has a total drainage area of about 249 acres with average imperviousness of about 60 percent. All of the stormwater runoff from AS1 will be captured by a total of 57 catch basin filters. All the 57 catch basin filters will be retrofitted to allow the installation of full capture filters. Based on two years (2005-2006) of simulation, Table 5.5 presents the expected outcome after implementation of distributed and non-structural BMPs in subcatchment AS1. The load reductions listed in the table are based on volume reduction. The catch basin filters considered have bacteria removal capabilities as shown in Appendix G.

Table 5.5 Torrance Airport Basin - Summary of Load Reduction from Quantified BMPs for Subcatchment AS1

	Load (lb/yr)		
BMP Scenario	**TSS**	**TP**	**TN**
Before BMP	19,627.3	167.8	1,130.5
After BMP(1) (Load reduction)	13,739.1	151	870.5
% Load Reduction	30	10	23

	Pollutant Load (g/yr)			
Subcatchment	**Total PCB**	**Total DDT**	**Dieldrin**	**Chlordane**
Before BMP	1.94	1.31	0.38	1.13
After BMP1 (Load reduction)	1.36	0.92	0.27	0.79
% Load Reduction	30	30	30	30

Note:
(1) Load reduction by combined non-structural BMPs

Subcatchments AS2 and AS3

Both non-structural and structural BMPs are recommended for subcatchements AS2 and AS3. Street sweeping and storage/infiltration system will be implemented in these two subcatchments. The storage/infiltration system will be implemented in phases at BMP sites A1 and A2. The combined volume of the proposed BMPs at A1 and A2 is approximately 44.8 ac-ft. The total runoff volume generated from the 85th percentile 24 hour storm is about 30 ac-ft. Thus, the proposed BMPs have enough capacity to handle this storm. However, the BMPs will be implanted in two phases. In phase 1, an 8 feet deep underground storage/infiltration system will be implemented at Site A2. The implementation of underground storage/infiltration system in Phase 2 will depend on the effectiveness of the Phase 1 BMP. The EWMP calls for an integrated, adaptive management approach to utilize available resources effectively and efficiently. If through continued study of drainage patterns, diagnosis of problem sources, and new technologies for dry and wet weather treatment, it is realized that more treatment is needed in the Airport treatment area, BMP site A1 will be considered for implementation of additional storage/infiltration system in Phase 2.

In Phase 1, runoff generated from subcatchments AS2 and AS3 will be treated at Site A2 (12 acre-ft). Under this phase, two options have been identified and illustrated on Figures 5.6 and 5.7. In Option 1, stormwater runoff will be diverted from Crenshaw Blvd and Amsler Street, and pump through a 14-inch diameter forcemain to another diversion system at Crenshaw Blvd and 250th Street. From here, the stormwater will flow by gravity to the infiltration system at Site A2. To improve infiltration in this area, the infiltration system should be located at a depth not less than 40 feet from the ground surface.

Option 2, which is the preferred option, stormwater diverted from storm drains at Crenshaw Blvd and Amsler Street, and Crenshaw and 250th Street will flow by gravity into the infiltration system at Site A2. Stormwater from Crenshaw Blvd. and Amsler Street will be conveyed through a 21-inch to Crenshaw and 250th Street. From here, the stormwater will be conveyed through a 24-inch pipe to the infiltration system for treatment.

Based on one year (2005) simulation, Table 5.6 presents the expected outcome after implementation of non-structural and structural BMPs to treat stromwater runoff from subcatchments AS2 and AS3. The load reductions in the table are based on volume reduction.

Total sediment solids (TSS) was used as a surrogate pollutant for toxics. The calculation details can be found in Appendix I.

Table 5.6 Torrance Airport Basin - Summary of Load Reduction from Quantified BMPs for Subcatchments AS2 and AS3.

BMP Scenario	Load (kg/yr) TSS	TP	TN
Before BMP	52,677.8	451.3	3,037.5
After BMP[(1)] (Load reduction)	48,779.6	321.3	2,308.5
% Load Reduction	92.6	71.2	76.0

Subcatchment	Pollutant Load (kg/yr) Total PCB	Total DDT	Dieldrin	Chlordane
Before BMP	5.18	3.52	1.01	3.03
After BMP[(1)] (Load reduction)	4.80	3.26	0.94	2.81
% Load Reduction	92.6	92.6	92.6	92.6

Note:
(1) Load reduction by combined non-structural BMPs

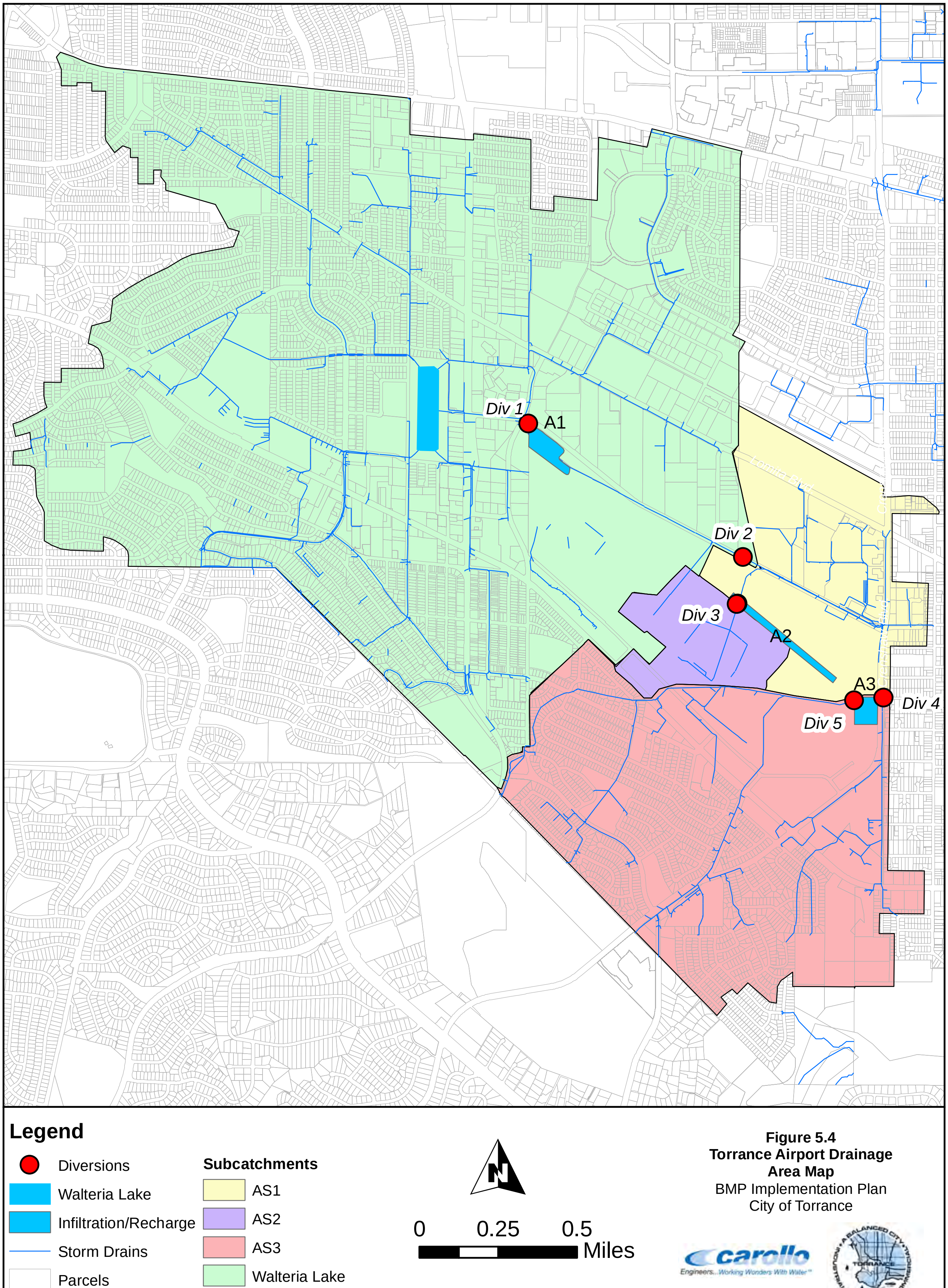

Figure 5.4
Torrance Airport Drainage Area Map
BMP Implementation Plan
City of Torrance

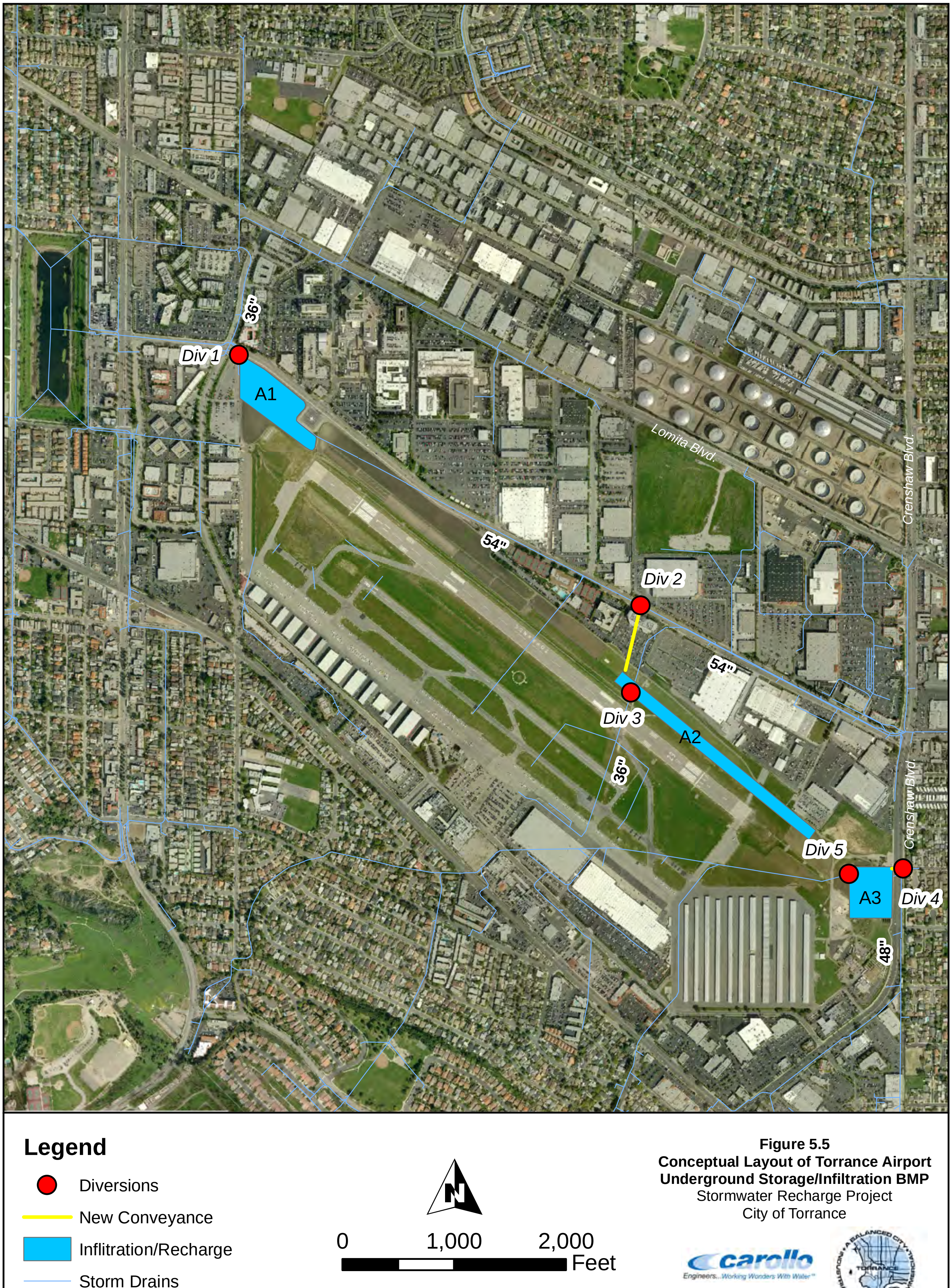

Figure 5.5
Conceptual Layout of Torrance Airport Underground Storage/Infiltration BMP
Stormwater Recharge Project
City of Torrance

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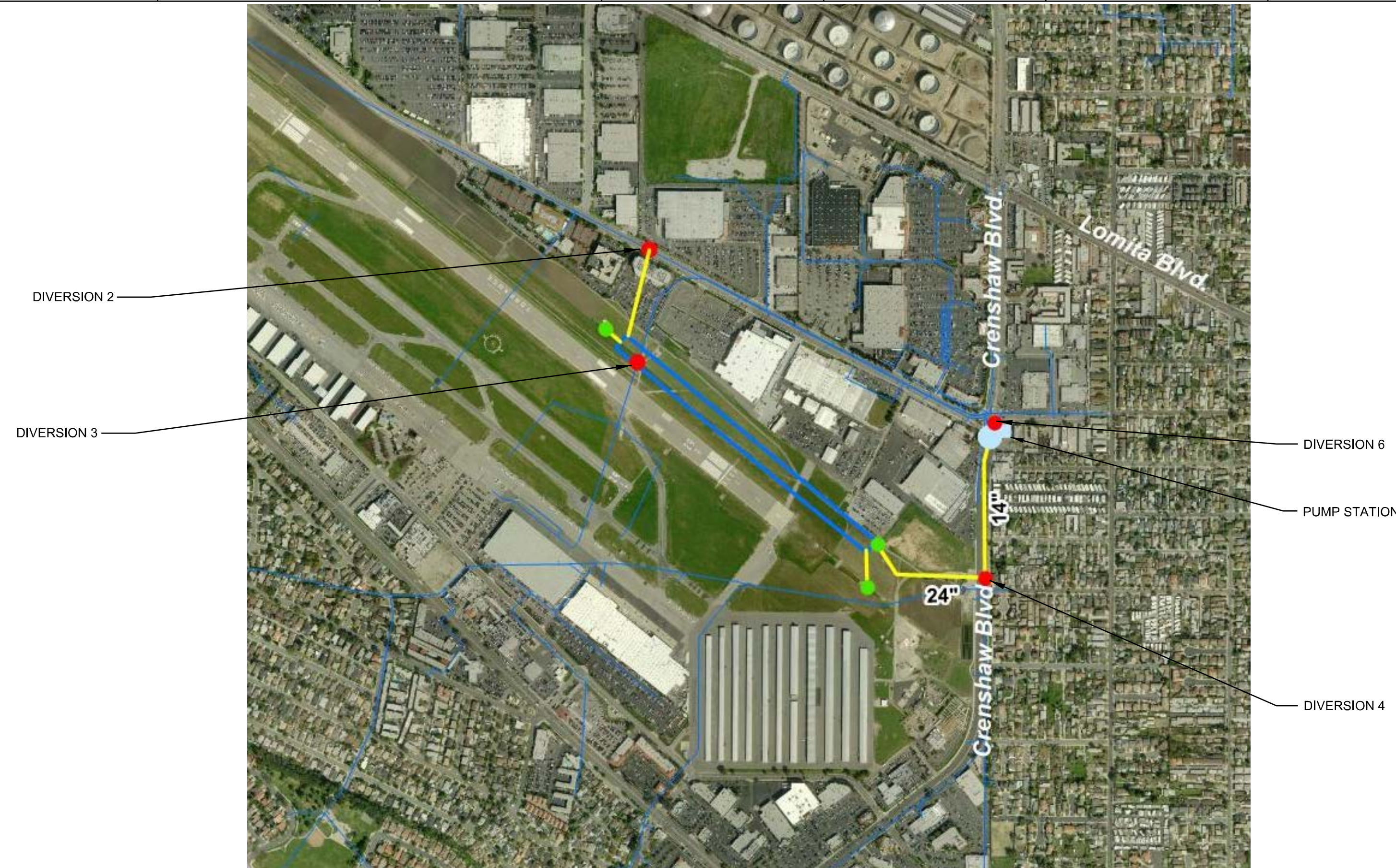

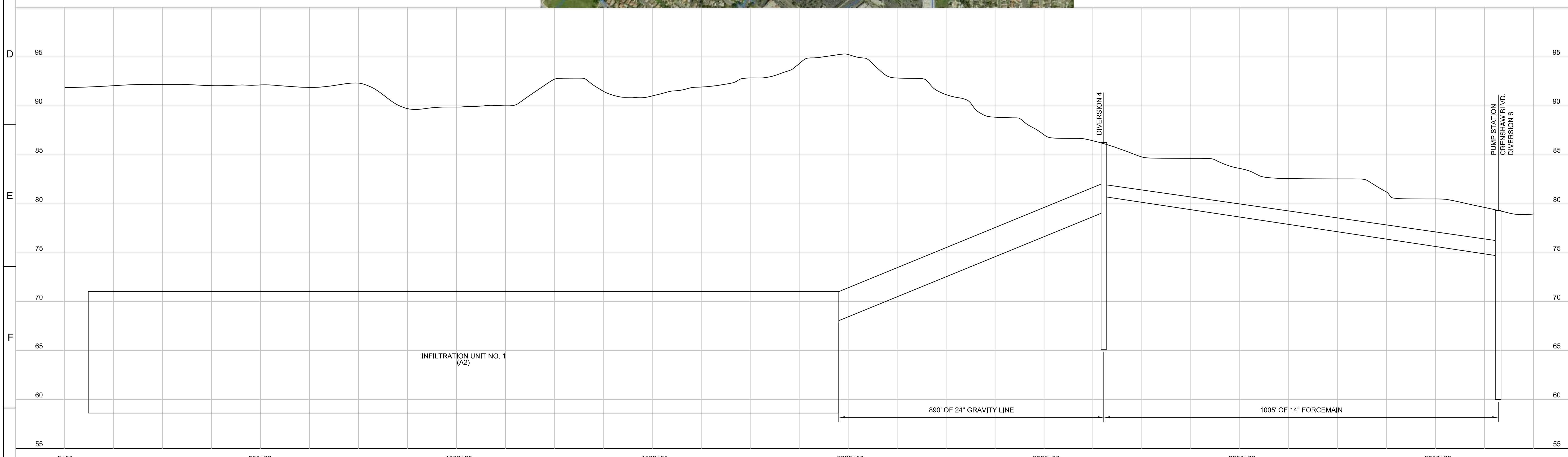

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DATE APRIL 2013
PROJECT ENGINEER
PROJECT MANAGER
PRINCIPAL

carollo®

CITY OF TORRANCE, CALIFORNIA

PLAN AND PROFILE OPTION 1

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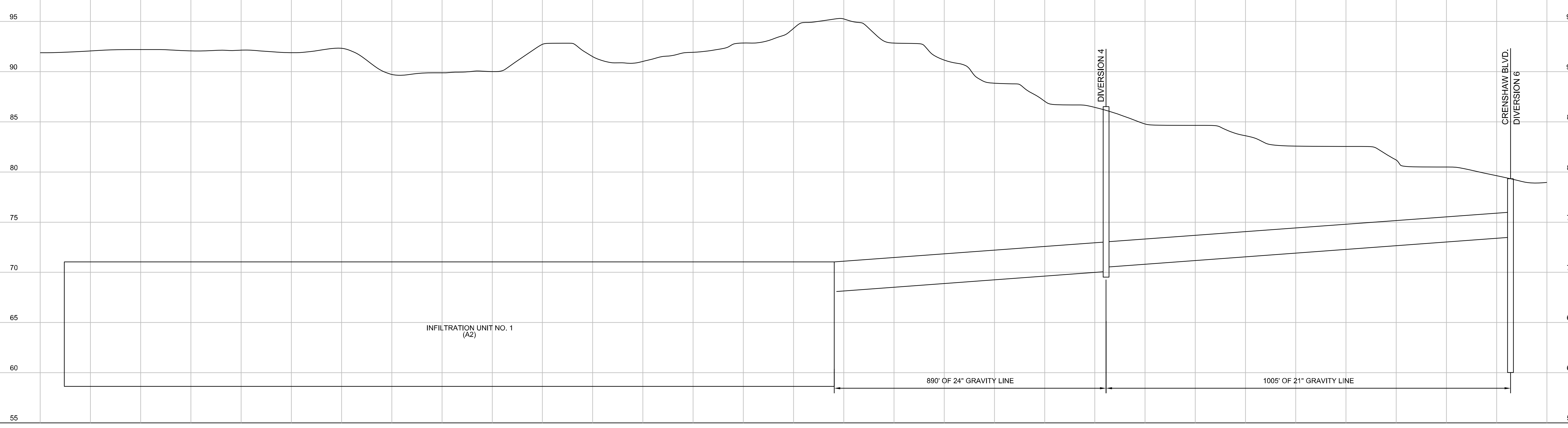

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PROJECT MANAGER
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CITY OF TORRANCE, CALIFORNIA

PLAN AND PROFILE OPTION 2

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Figure 5.7
Recommended BMP
at Torrance Airport
Stormwater Recharge Project
City of Torrance

The storage requirements summarized in Table 5.3 were incorporated into the water quality model to simulate the effectiveness of the BMPs. All assumptions used in the pre-BMP model scenario were retained. The simulations do not include non-structural BMPs such as street sweeping and catch basin filter. The nonstructural BMPs were evaluated separately.

5.3.4.3 Recommended BMP Implementation in Torrance Airport Basin

The Torrance Airport subcatchments, AS1, AS2, and AS3 represent approximately 23 percent of the Implementation Area. However, they generate about 95 percent of the total phosphorus and 44 percent of sediment load generated from the entire Implementation Area. The City has to implement BMPs to treat stormwater generated in this area in order to comply with the established TMDLs in the Machado Lake Watershed.

In addition to street sweeping, catch basin filter filter inserts and other non-structural BMPs discussed earlier, two potential sites, A1 and A2 are recommended for implementation of underground storage/infiltration system. The sites were selected based on space availability, soil conditions, and cost effectiveness. The implementation of the structural BMPs can be accomplished in two phases.

In Phase 1, an eight feet deep underground storage/infiltration system will be installed at Site A2 to receive stormwater runoff through 21- and 24-inch diameter gravity pipes. Since this Plan calls for an adaptive management approach to utilize available resources effectively and efficiently, if through continued study of drainage patterns, diagnosis of problem sources, and new technologies for dry and wet weather treatment, it is realized that more treatment is needed in the Airport treatment area, BMP site A1 (22 acre-ft) will be considered for implementation of additional storage/infiltration system in Phase 2. Phase 3 will consist of installing 57 catch basin filter inserts in subcatchment AS1.

In addition to contributing to meeting the TMDL reduction requirement of improving water quality, a centralized BMP at Torrance Airport would provide other water resources benefits. A centralized BMP at Torrance Airport would be designed to increase infiltration providing additional groundwater replenishment to the groundwater basin. Storage provided by the BMP would reduce potential flooding in the watershed treatment area. Further benefits could be determined during implementation.

5.3.4.3.1 <u>Potential Partnership with Peninsula Cities</u>

There is an opportunity for the Peninsula Cities to "financially partner" with the City of Torrance on the proposed Airport Project. The cities include Rolling Hills Estate, Rancho Palos Verdes, Palos Verdes Estates, and Los Angeles County unincorporated. Table 5.7 shows the drainage areas that airport project will treat.

As a result of the potential partnership, the capacity of the BMP at Site A3 will increase by about 100 percent and the total construction cost is estimated to increase from about $7,000,000 to about $14,000,000.

Table 5.7 Summary of Drainage Areas of Airport Project Partners

Partner	Drainage Area Acre	Drainage Area Square Miles	Share (%)
Torrance	726	1.13	24.34
Palos Verdes Estates	93	0.15	3.12
Rancho Palos Verdes	625	0.98	20.95
Rolling Hills Estates	1098	1.72	36.81
LA County Unincorporated	441	0.69	14.78
Total	**2983**	**4.66**	**100.00**

5.3.5 Walnut Sump Basin

The watershed treatment area that could be treated by the Walnut Sump is about 62 percent impervious with a concentrated impervious configuration and moderate road density. For treatment purposes, this area is divided into two subcatments, WS-1 and WS-2 as shown on Figure 5.8. WS-2 includes subarea SD 1040 shown on Figure 5.8. Two treatment options have been identified for this treatment area. Both options include street sweeping. Option No. 1 will use the existing Walnut Sump to treat about 100 percent of the stormwater generated from subcatchment WS-2 including subarea SD 1040 shown on Figure 5.8. If more treatment is needed in this area in order to achieve TMDL compliance Option No.1 could be expanded to include 50 catch basin filter in WS-1. The catch basin filters will be retrofitted to allow the installation of full capture filter to capture fine sediments and other pollutants. Walnut Sump, which will receive stormwater from this treatment basin, has adequate capacity to store and infiltrate the 85th percentile 24 hour runoff as shown in Table 5.8.

Table 5.8 Summary of BMP Requirements – Walnut Sump

Option	Drainage Area Treated (ac)	Percent Imperviousness	24 hr 85th Percentile Volume (ac-ft)(1)	Walnut Sump Capacity (ac-ft)	No. of Catch Basin Filter
Option No. 1	742	61	39.1	50	50
Option No. 2	922	62	-	-	150

Treatability
Option No.1 - 79%; Option No.2 - 100%
(1) The 85th percentile 24-hour storm depth = 0.85 in.

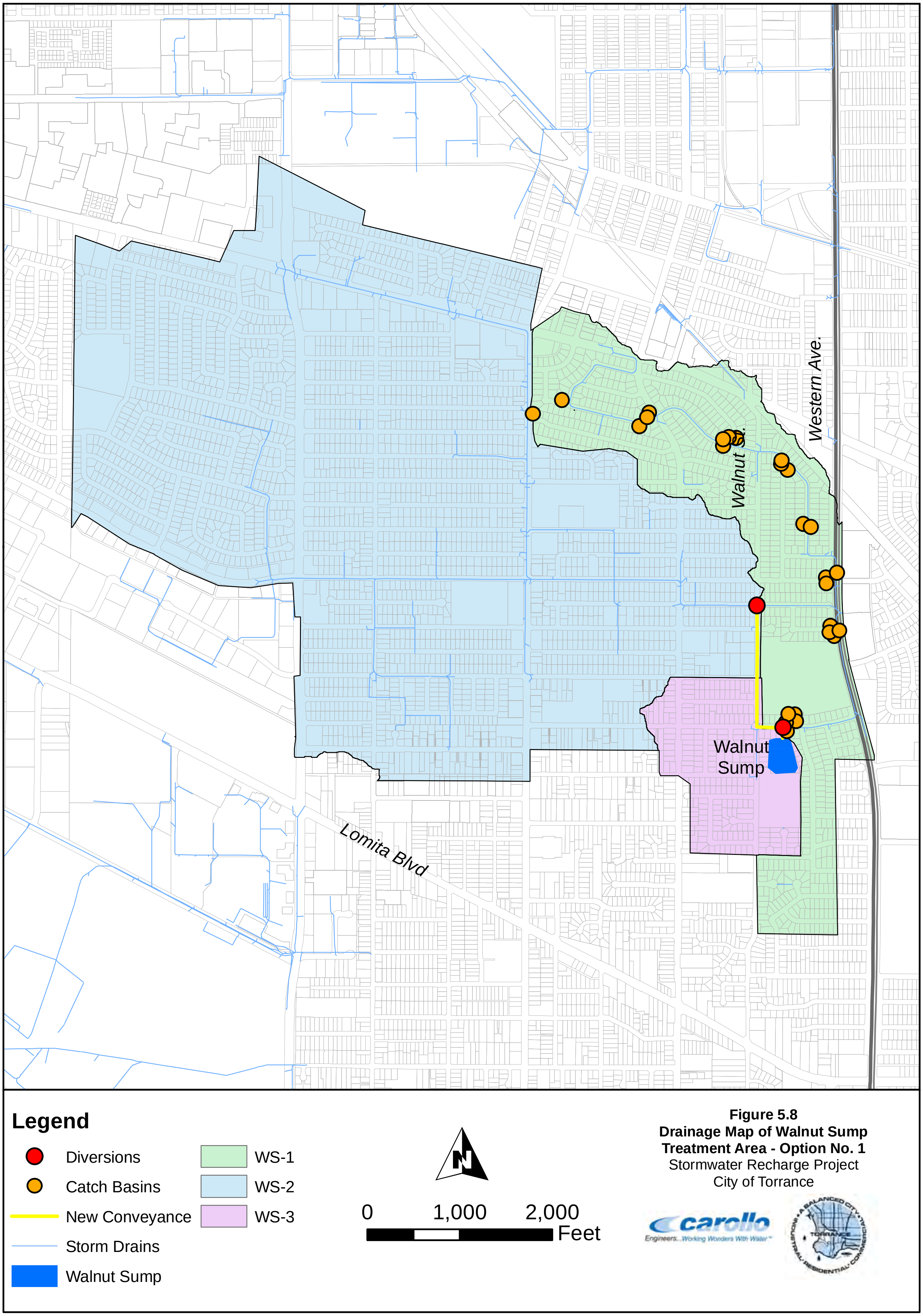

Figure 5.8
Drainage Map of Walnut Sump
Treatment Area - Option No. 1
Stormwater Recharge Project
City of Torrance

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In Option No. 1, stormwater runoff from subarea SD 1040 will be diverted to Walnut Sump in Phase I. In Phase II, stormwater from remaining areas of WS-2 will be diverted from the existing 9.2’ x 11’ RCB” storm drainpipe at 235th St. and Walnut St. through a new 60-inch diameter gravity pipe to a stormwater lift station to be located at 236th Street and Walnut Street. From the lift station, stormwater will be pumped through an 18-inch forcemain to Walnut Sump pre-treatment area for further removal of heavy sediments, oil, grease, and floatable wastes. Hydrodynamic Separator unit will be used for the pre-treatment. The pretreated stormwater runoff will then be conveyed to the Walnut Sump main storage area for storage and infiltration. If needed, 50 catch basin filter filters will be installed in WS-1 in Phase III.

Option No. 2 which is the recommended option consists of catch basin filter only in WS-1 and WS-2 to capture fine sediments and other pollutants as shown on Figure 5.9. Under this option, stormwater from WS-1 and WS-2 will be treated by a total of 150 catch basin filters retrofitted to allow the installation of full capture screens.

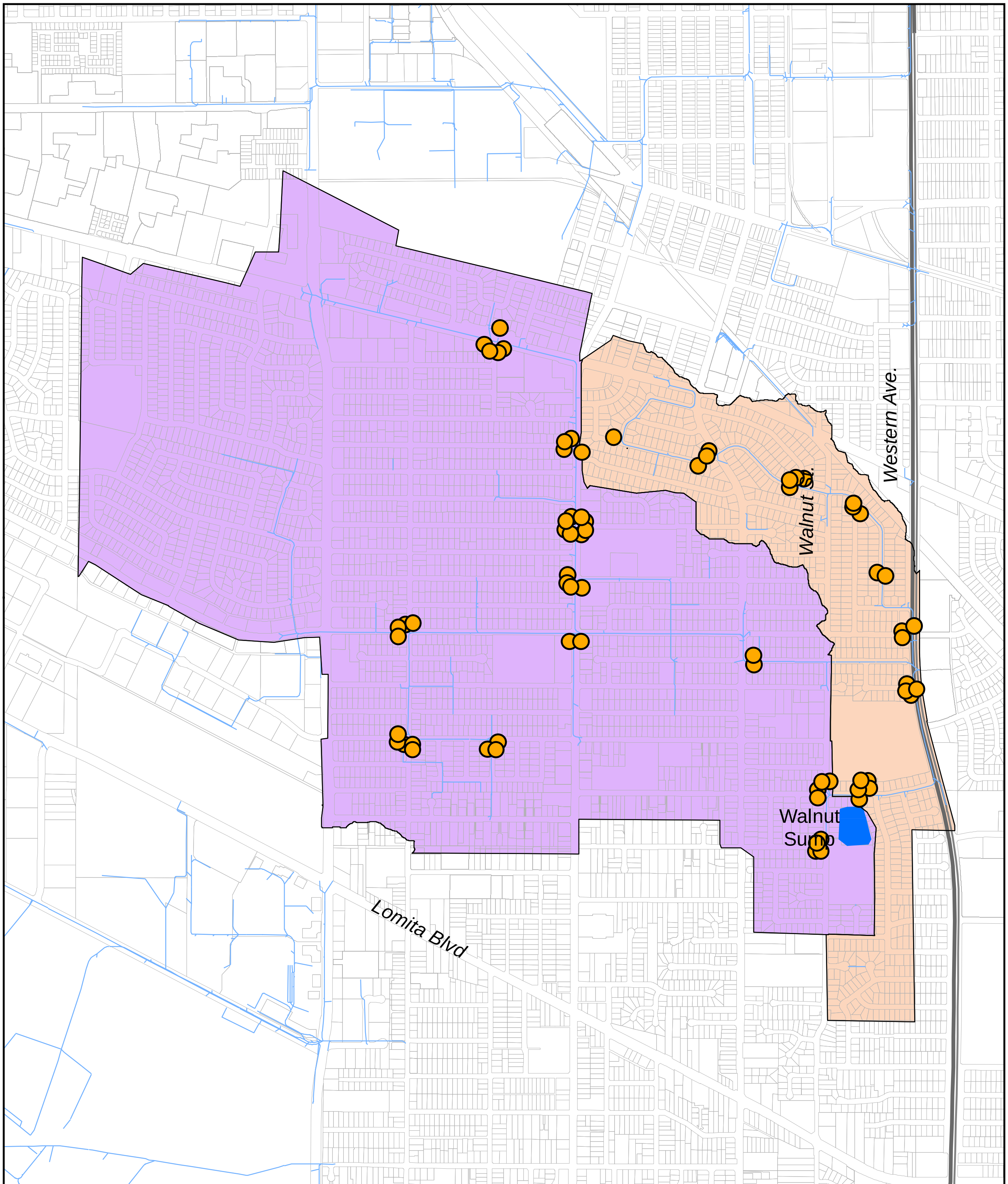
Figure 5.10 shows the conceptual layout of both options. Figure 5.11 shows detail design concept of both options. Table 5.6 summarizes the storage requirements for this treatment basin. Figure 5.13 shows the details of the proposed Walnut Sump storage/infiltration system.

The storage requirements summarized in Table 5.6 were incorporated into the water quality model, P8 to simulate the effectiveness of the BMPs. All assumptions used in the pre-BMP model scenario were retained. The simulations do not include non-structural BMPs such as street sweeping and catch basin filter. The results of one year (2005) simulation runs are summarized in Table 5.9. The load reductions in the table are based on volume reduction.

5.3.5.1 Recommended BMP Implementation at Walnut Sump

The overall objective of the Implementation Plan is compliance with the Machado Lake nutrients and toxics TMDLs. The primary objective for this project location, therefore, is to remove toxics and nutrients from the existing storm drain in subcatchment WS-2. These objectives may in general be met by implementing BMPs or a combination thereof. In addition to street sweeping and other non-structural BMPs, the structural BMP proposed for the Walnut Sump drainage area includes the following elements:

- Stormwater lift station
- 60-inch gravity main
- 18-inch force main
- Flow diversion facility
- Hydrodynamic separator.
- Above ground storage/infiltration area – Walnut Sump
- Overflow piping.



Legend

Catch Basins

Storm Drains

Walnut Sump

Subcatchments

WS-1

WS-2

0 1,000 2,000 Feet

Figure 5.9
Drainage Map of Walnut Sump Treatment Area - Option No. 2
Stormwater Recharge Project
City of Torrance

Legend

- Diversions
- Pump Station
- Conveyance
- Walnut Sump
- Storm Drains

0 200 400 Feet

Figure 5.10
Conceptual Layout of Walnut Sump
Aboveground Storage/Infiltration BMP
Stormwater Recharge Project
City of Torrance

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DRAWN BWS
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DATE APRIL 2013
PROJECT ENGINEER
PROJECT MANAGER
PRINCIPAL

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CITY OF TORRANCE, CALIFORNIA

PLAN AND PROFILE OF WALNUT SUMP TREATMENT SYSTEM

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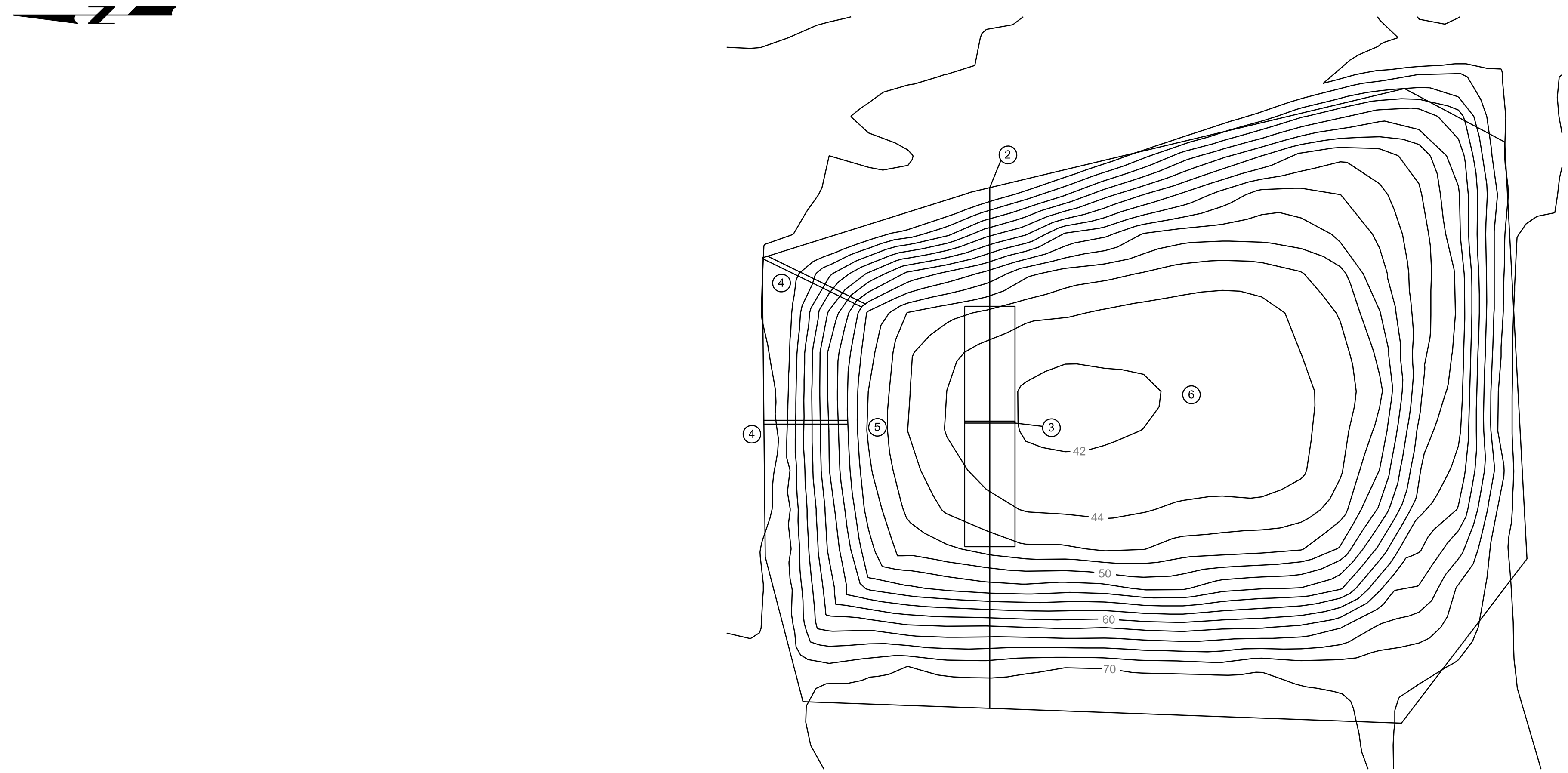
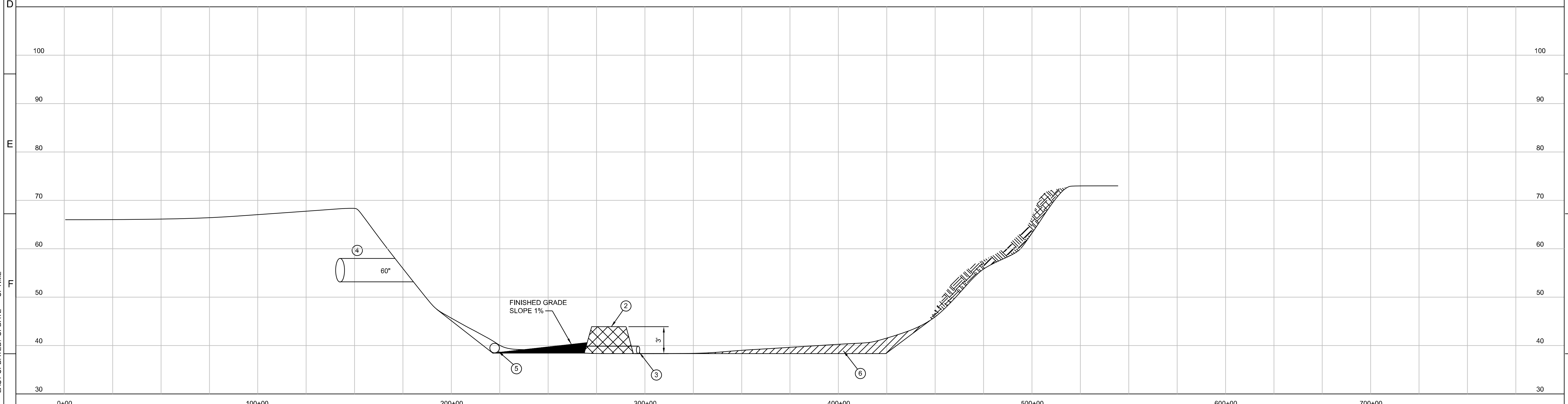


1 RIPRAP APRON
2 EARTH BERM ACROSS ENTIRE WIDTH OF INFILTRATION BASIN
3 6" GRAVITY MAIN
4 INLET PIPE
5 UPSTREAM PRETREATMENT (INSTALL ARS UNIT)
6 DROUGHT TOLERANT VEGETATION



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PROJECT MANAGER
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DETAILS OF WALNUT SUMP STORAGE/INFILTRATION BMP PLAN AND PROFILE

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Table 5.9 Walnut Sump - Summary of Load Reduction from Quantified BMPs

BMP Scenario	Load (kg/yr) TSS	TN	TP
Before BMP	71,451	22	127
After BMP(1)	66,164	15.9	97.7
% Load Reduction	92.6	72.1	76.9

Subcatchment	Pollutant Load (g/yr) Total PCB	Total DDT	Dieldrin	Chlordane
Before BMP	7.03	4.79	1.37	4.11
After BMP(1) (Load reduction)	6.51	4.43	1.27	3.81
% Load Reduction	92.6	92.6	92.6	92.6

Note:
(1) Load reduction by combined non-structural BMPs

The implementation will carried out in phases as listed below:

1. Phase I – Divert flow from storm drain 1040
2. Phase II – Install catch basin filter filters in WS-1
3. Phase III – Diversion and pump station for WS-2

In addition to contributing to meeting the TMDL reduction requirement of improving water quality, a centralized BMP at walnut Sump would provide other water resources benefits. A centralized BMP at this location would be designed to increase infiltration providing additional groundwater replenishment to the groundwater basin. Storage provided by the BMP would reduce potential flooding in the watershed treatment area. Further benefits could be determined during implementation. For example, the actual BMP design could include additional vegetation that would enhance habitat area in the area and Public Education.

5.3.6 Baseball Field Basin

The watershed treatment area that could be treated by the Baseball Field underground storage/infiltration system is about 60 percent impervious with a concentrated impervious configuration and moderate road density. This treatment area has adequate surface area, about 0.73 acres to treat the 85th percentile 24-hour storm water quality volume generated from this drainage basin. Two treatment options have been identified for this basin. Option No. 1 will treat about 25 percent of the stormwater generated from the Baseball Field Basin (155 ac). Thus, under this option, only stormwater runoff from sub area BB-S3 shown on Figure 5.13 will be treated. Stormwater generated from the remaining Sub areas; BB-S1, BB-S2, and BB-S4 will be captured by 19 catch basin filters retrofitted to allow full capture filters. These catch basin filters are of the same type as the the ones proposed for Airport and Walnut Basins. Option No. 2 will treat the 85th percentile 24-hour storm water quality volume generated from the entire Baseball Field Basin, BB-S1, BB-S2, BB-S3, and BB-S4. Figure 5.13 shows the drainage map of this treatment area and Figure 5.14 is the conceptual layout of this treatment system.

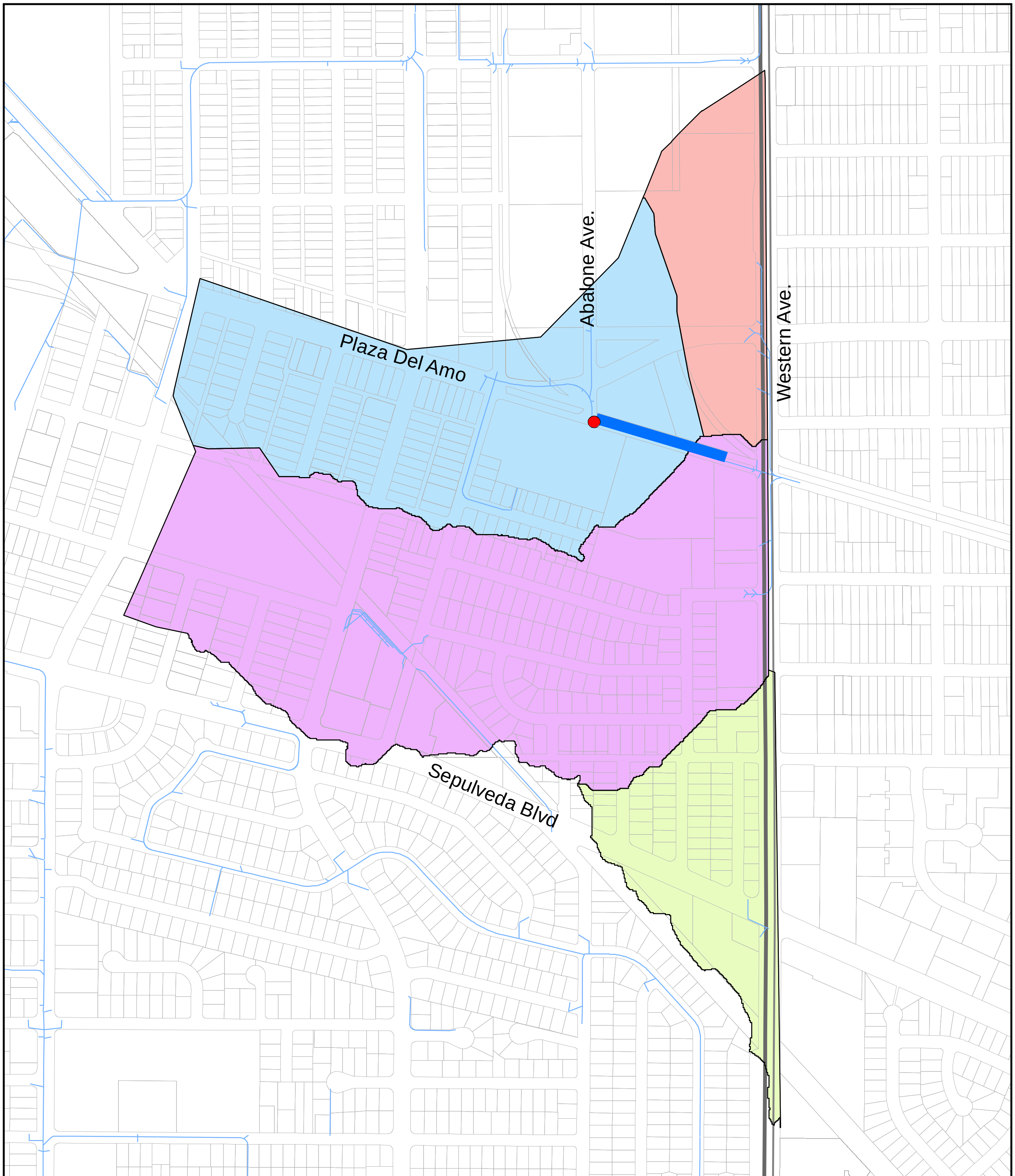
In Option No. 1 (recommended option), stormwater will be diverted from the existing 36-inch diameter pipe at Plaza Del Amo and Western Avenue through a short diversion pipe into the BMP system. Option No. 2 will be considered for implementation when through monitoring and modeling it is found out that more treatment is needed in this subarea. Option No. 2 will capture stormwater runoff generated from BB-S1, BB-S2, BB-S3, and BB-S4. Stormwater runoff will be diverted from existing drain at Plaza Del Amo and Western Ave. into Unit B2. This option also includes the installation of 23 full capture filter screens. Figure 5.14 shows conceptual layout and detail design concept of both options. Table 5.10 summarizes the storage requirements for this treatment basin. Based on two years (2005-2006) of simulation, Table 5.11 shows the load reduction associated with each option. The load reductions listed in the table are based on volume reduction. For bacteria removal, the same catch basin filters recommended for the Terrace Airport will be used.

Figure 5.15 shows the plan and profile of these two options.

Table 5.10 Summary of BMP Requirements – Baseball Field

Option	Area Treated (ac)	Percent Imperviousness	Treatability	24 hr 85th Percentile Volume (ac-ft)	BMP Capacity (ac-ft)
Option No. 1	39	63	26.3	2.6	2.9
Option No. 2	148	65	100	6.4	6.0

Note
(1) The 85th percentile 24-hour storm depth = 0.85 in.



Legend

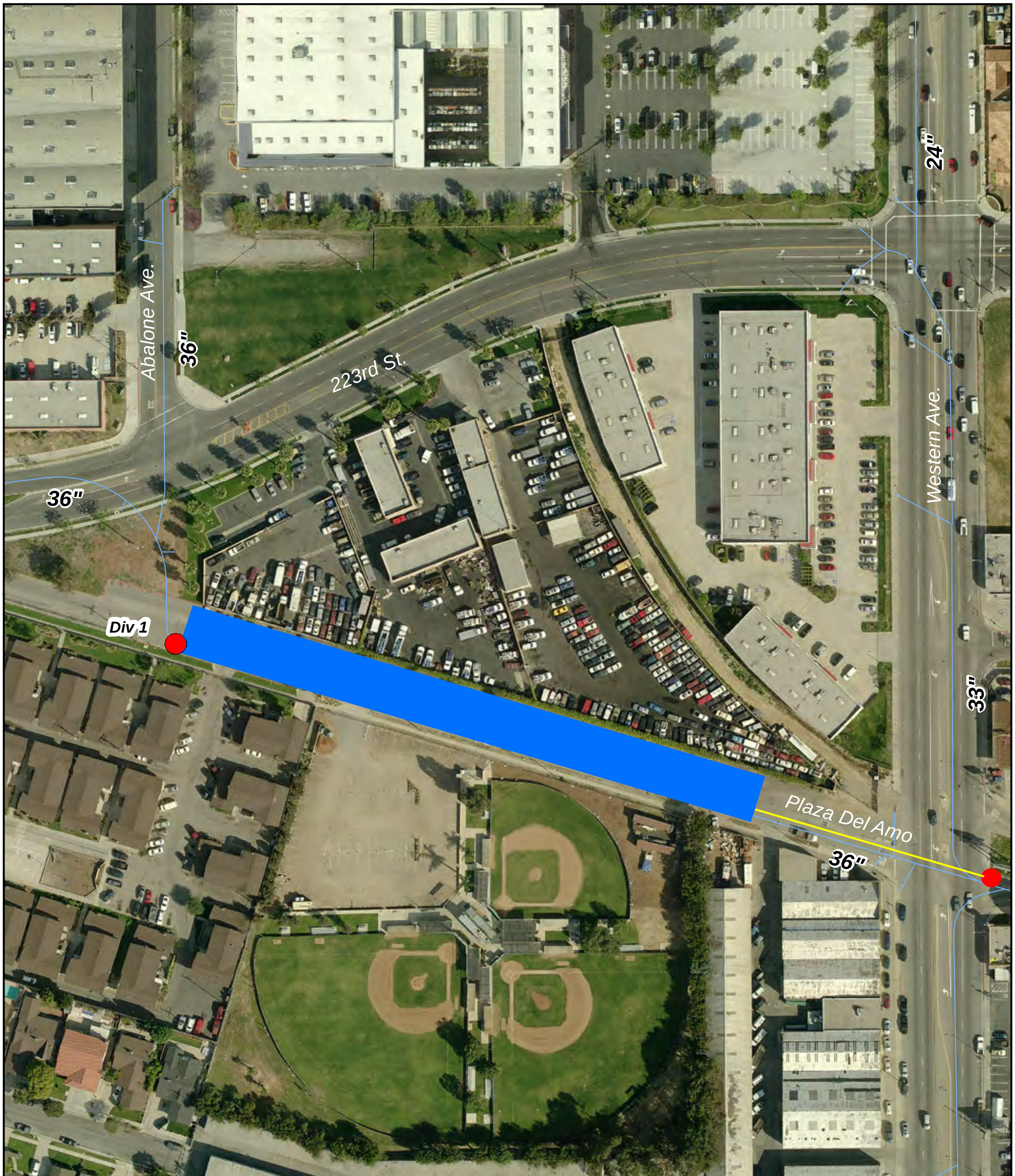
- Diversions
- Infiltration/Recharge
- Storm Drains

SUBCATCH

- BB-S1
- BB-S2
- BB-S3
- BB-S4

0 500 1,000 Feet

Figure 5.13
Drainage Map of Baseball Field Treatment Area
Stormwater Recharge Project
City of Torrance

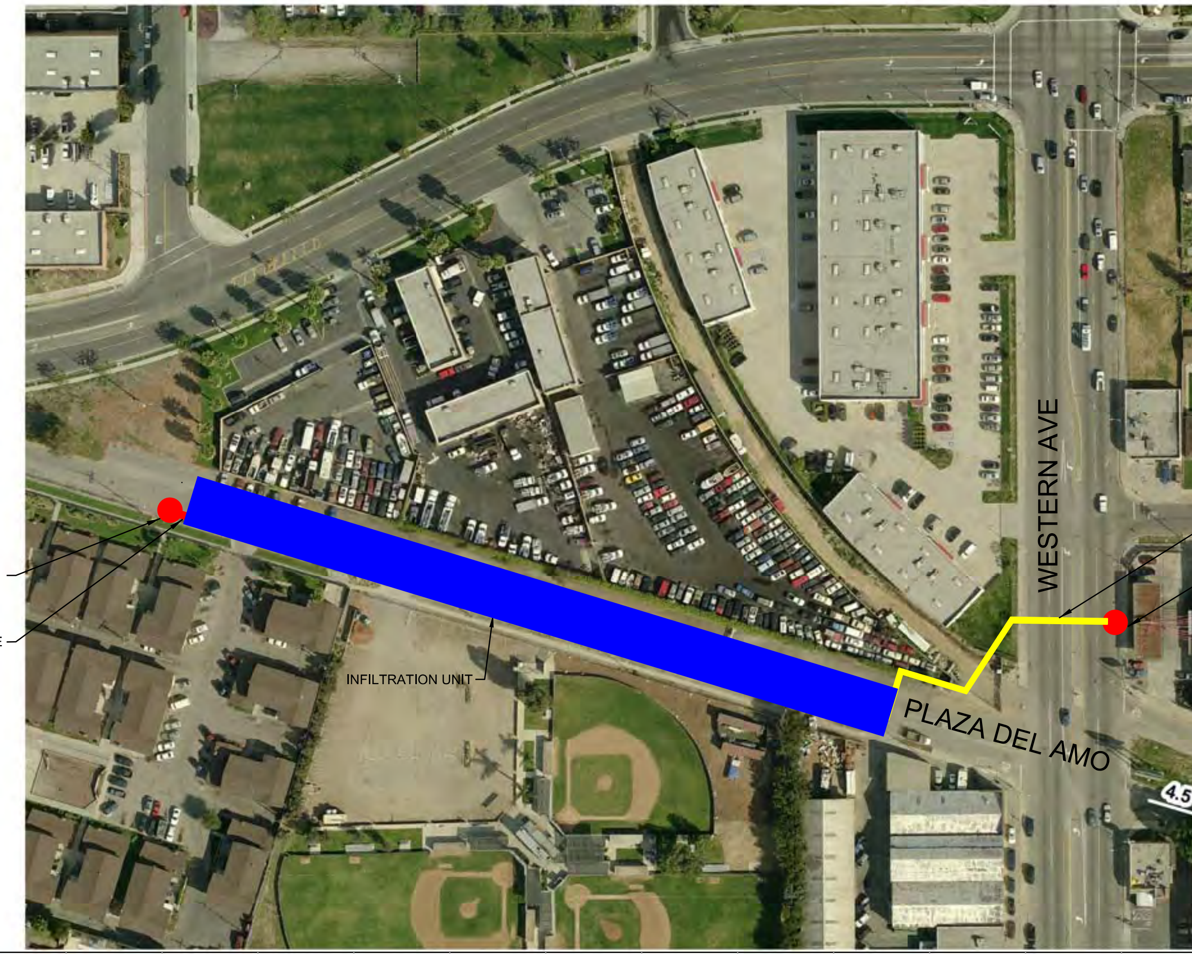


Legend

- Diversions
- Storm Drains
- Infiltration/Recharge
- New Conveyance

0 150 300 Feet

Figure 5.14
Conceptual Layout of Baseball Field Underground Storage/Infiltration BMP
Stormwater Recharge Project
City of Torrance



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DETAIL DESIGN CONCEPT OF BASEBALL FIELD
BMP TREATMENT SYSTEM

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Table 5.11 Baseball Field - Summary of Load Reduction from Quantified BMPs

BMP Scenario	Load (kg/yr) TSS	TP	TN	
		Option 1		
Before BMP	15,650	4	28	
After BMP(1)	1831.05	1.1.6	7.84	
% Load Reduction	88.3	71	72	
		Option 2		
Load Before BMP	15,650	4	28	
Load After BMP(1)	1236.35	1.12	7.28	
% Load Reduction	92.1	72	74	
		Load (g/yr)		
BMP Scenario	**Total PCB**	**Total DDT**	**Dieldrin**	**Chlordane**
		Option 1		
Load Before BMP	1.54	1.05	0.30	0.90
Load After BMP(1)	0.18	0.12	0.04	0.11
% Load Reduction	88.3	88.3	88.3	88.3
		Option 2		
Before BMP	1.54	1.05	0.30	0.90
After BMP(1)	0.12	0.08	0.02	0.07
% Load Reduction	92.1	92.1	92.1	92.1

Note:
(1) Load reduction by combined non-structural and structural BMPs

In addition to contributing to meeting the TMDL reduction requirement of improving water quality, a centralized BMP at Baseball Field would provide other water resources benefits. A centralized BMP at this location would be designed to increase infiltration providing additional groundwater replenishment to the groundwater basin. Storage provided by the BMP would reduce potential flooding in the watershed treatment area. Further benefits could be determined during implementation. This BMP could be constructed without interfering with baseball field.

5.4 Additional Structural Options for TMDL Implementation

Through additional monitoring, pollutant source characterizations, and site investigations throughout the duration of the TMDL implementation schedule, additional options for structural BMPs could be identified that can enhance or replace those BMPs identified in this plan. This is especially true for dry weather, when flows are highly variable throughout the storm drain system, and specific areas could require special methods treating storm drain flows before they discharge to receiving waters. For storm drains with particularly high dry weather flows and associated pollutant loads where other nonstructural or structural BMPs are not providing a remedy, specific mechanical BMPs can be implemented. Such BMPs could include diversions to wastewater treatment plants or on-site treatment facilities that provide ultraviolet disinfection or other forms of treatment.

Likewise, for wet weather, certain mechanical BMPs can be installed in problem storm drains where other nonstructural and structural BMPs are not providing a solution. Several stormwater BMPs are available for this purpose, which are based on a range of technologies that continue to evolve through continued research and development. This TMDL Implementation Plan is intended to be iterative and adaptive to allow for modifications as additional studies of the drainage system and diagnoses of problem sources are achieved and as new technologies for dry and wet weather treatment continue to emerge.

5.5 Regulatory Requirements and Environmental Permits

Consultation with regulatory agencies and the acquisition of permits is required before project components can be constructed. The following sections summarize regulatory permits and approvals relevant to the implementation of the Water Quality Enhancement Projects in the Machado Lake watershed.

5.5.1 <u>Environmental Assessment</u>

In accordance with the California Environmental Quality Act (CEQA), local agencies are required to identify the significant environmental impacts of their actions and to avoid or mitigate those impacts, if feasible. Every development project that requires discretionary governmental approval will require at least some environmental review pursuant to CEQA, unless an exemption applies. The Water Quality Enhancement Projects discussed in the previous section will likely require the preparation of a Negative Declaration.

5.5.2 U.S. Army Corps of Engineers

Section 404 of the Federal Clean Water Act regulates the discharge of dredged, excavated, or fill material in wetlands, streams, rivers, and other waters of the United States. The U.S. Army Corps of Engineers (USACE) is the federal agency authorized to enforce Section 404 and issue permits for certain authorized activities conducted in these waters. Based on the proposed area for the projects, it is unlikely that a Section 404 permit will be required. If required and jurisdictional, Section 404 permitting could potentially be completed under the nationwide permit program. Coverage under the nationwide program can be authorized within three to four months from the time the permit application is deemed complete.

5.5.3 U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service (USFWS), Department of the Interior, is responsible for administering the Federal Endangered Species Act, which prohibits activities affecting threatened and endangered species unless authorized by a permit from the USFWS. The Endangered Species Program is charged with issuing permits for activities that could potentially affect native endangered or threatened species, including Incidental Take Permits associated with Habitat Conservation plans. The USACE will consult with USFWS regarding endangered species issues as part of the Section 404 process. A biological resources report for the project site may be required as part of the permit application package to the USACE.

5.5.4 California Department of Fish and Game

The regulatory functions of the California Department of Fish and Wildlife (CDFW) include the review of CEQA documents as a responsible agency. In addition, CDFW issues streambed or lakebed alteration agreements for projects with impacts to waters of the State, issues permits for take of threatened and endangered species for authorized activities, approves and permits the take of birds, mammals, reptiles, amphibians, non-game fish, and plants for scientific or educational purposes, and the take of threatened, endangered, or candidate species for management purposes. The Water Quality Enhancement Projects may require a CDFW Code Section 1602 Streambed Alteration Agreement.

5.5.5 State Water Resources Control Board

Construction activities disturbing one or more acres must obtain coverage under the National Pollutant Discharge Elimination System (NPDES) General Permit for Discharges of Stormwater Associated with Construction Activity Water Quality Order No. 2009-0009-DWQ (Construction General Permit, or CGP). Construction activity subject to this permit includes clearing, grading, and disturbances to the ground such as stockpiling or excavation. To obtain coverage under the CGP, the City will designate a Legally Responsible Person to electronically file Permit Registration Documents (PRDs) with the State Water Resources Control Board (SWRCB). PRDs include a Notice of Intent, Risk

Assessment, Site Map, Stormwater Pollution Prevention Plan (SWPPP), annual fee, and certification. A project-specific SWPPP will need to be developed and implemented to reduce polluted discharges from entering the storm drain system and local receiving waters during construction activities. The CGP requires all permitted dischargers to develop and implement a SWPPP that:

- Identifies all pollutant sources including sources of sediment that may affect the quality of stormwater discharges associated with construction activity from the construction site.
- Identifies and eliminates non-stormwater discharges.
- Specifies BMPs to reduce or eliminate pollutants in stormwater and authorized nonstormwater discharges from the site during construction.
- Incorporates BMP inspection and maintenance routines.
- Identifies a sampling and analysis strategy and sampling schedule for discharges that have been discovered through visual monitoring to be potentially contaminated by pollutants not visually detectable in runoff.

The City or construction contractor will need a Qualified SWPPP Developerto prepare the SWPPP, and then a Qualified SWPPP Practitioner will need to implement the plan during construction. The SWPPP must address the use of appropriately selected, correctly installed, and properly maintained pollution control BMPs.

5.5.6 Regional Water Quality Control Board, Los Angeles Region

Under Section 401 of the Clean Water Act, applicants for Section 404 Permits must first obtain a Water Quality Certification documenting that the proposed activity will comply with state water quality standards. If the project is determined to be under USACE jurisdiction, a Section 401 Water Quality Certification will be required for the project.

If the project is not under USACE jurisdiction, the LARWQCB may require coverage under Waste Discharge Requirements instead. Protection of beneficial uses during construction and operation are key issues. Construction dewatering may be necessary because of high groundwater. Dewatering activities will require coverage under the General NPDES Permit and Waste Discharge Requirements of Discharges from Construction and Project Dewatering to Surface Waters in Coastal Watersheds of Los Angeles and Ventura Counties. To obtain permit coverage, a Report of Waste Discharge and application must be filed with LARWCQB at least 30 days prior to discharge.

Even though the installation of Water Quality Enhancement Projects is generally encouraged by the LARWQCB, concerns may be raised with the potential of projects using on-site infiltration of stormwater to affect the water quality of the underlying groundwater. Prior to implementing projects such as infiltration basins/trenches, flow through planters, porous pavement, etc., the City would need to conduct a technical analysis evaluating the possibility of groundwater impacts. The analysis will determine the depth to groundwater, its designated beneficial uses, and the historical uses of the site. There are cases where projects may be infeasible – if the depth to groundwater is less than 5 feet from the surface, if drinking water wells are present within 100 feet of the proposed infiltration site, or if the site is a brown field with potential pollutant mobilization through the soil, etc. Consultation with LARWQCB staff is recommended.

5.5.7 South Coast Air Quality Management District

Construction activities in the South Coast Air Basin are subject to South Coast Air Quality Management District's (SCAQMD) Rule 403. Rule 403 sets requirements to reasonably regulate operations that periodically may cause fugitive dust emissions into the atmosphere by requiring actions to prevent, reduce, or mitigate fugitive dust emissions. The construction contractor will need to implement dust control measures during project construction.

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6.0 EVALUATION OF NONSTRUCTURAL AND STRUCTURAL SOLUTIONS

As shown in the previous sections, a number of nonstructural and structural BMP options were identified that can support TMDL implementation. An evaluation of those practices was performed, including optimizing the most cost-effective combination of BMPs to support meeting WLAs for the TMDL Implementation Area. The evaluation analysis for the Nutrient and Toxics TMDLs uses an integrated approach, considering reductions for both classes of pollutants. The evaluation analysis uses the identified suite of structural and nonstructural projects discussed in Sections 4 and 5 to determine the set of actions that will most likely be implemented in an effort to achieve the TMDL requirements. The analysis is a demonstration of how the identified projects may achieve compliance. As the implementation is an adaptive management process, the precise suite of actions and the timing may be changed to use resources more cost effectively. The adaptive management approach will allow changes in the type and quantity of structural and nonstructural BMPs to ensure cost effective measures are being implemented. Flexibility in the schedule and makeup of the Implementation Plan are key to adaptive management.

The quantification analysis is based on the reductions from both nonstructural and structural BMPs that work together to reduce the concentration and load of constituents. Generally nonstructural BMPs consist of pollution prevention activities and source control activities that reduce the amount of the constituent entering the MS4 system, ultimately reducing the concentration in stormwater. Nonstructural activities also encourage the effective use of water, aiming to reduce dry-weather flows. In this way, nonstructural activities reduce the constituent load entering structural BMPs located downstream of the sources.

Removal of suspended sediments by the proposed BMPs will be used a surrogate to assess compliance of Toxics. Toxics removal will be estimated as a fraction of suspended solids removed by the BMPs.

6.1 Evaluation of Structural Solutions

6.1.1 <u>Watershed Modeling and Optimized BMP Selection Approach</u>

Watershed modeling tools linked to a BMP simulation system were used to evaluate and optimize quantitative load reduction scenarios to address TMDL implementation efforts in the TMDL Implementation Area of the Machado Lake watershed. The watershed model is based on existing commonly used to simulate and evaluate BMPs Brief descriptions of the watershed model and BMP simulation model is provided below.

6.1.1.1 P8 - Hydrologic Modeling Using a Continuous Simulation Model

The P8 watershed modeling system utilizes a modeling approach that has been used to support numerous TMDL developments throughout the country. The P8 model is a continuous simulation model and generates runoff characteristics based on rainfall, soil characteristics and infiltration rates, evapo-transpiration, antecedent conditions, and land use specific pollutant loading characteristics. Meteorological data from 2005 to 2013 were used to calibrate the model. Existing meteorological data, hydraulic data, land use information, and monitoring data were used to calibrate each sub-watershed to most accurately simulate the runoff and pollutant load.

The P8 model simulates hydrology, sediment, and general water quality were combined with a stream fate and transport model. Wet-weather loading estimates are developed using the modeled constituents including TN, TP, TSS, and Toxics. Based on the model results from 2005 to 2013, a daily or average annual load was calculated for TSS, TN, TP and Toxics. Annual load results were compared with the WLAs to calculate the load reduction needed to meet those WLAs and presented in Table 3.5.

6.1.1.2 Optimization BMP Design Approach

The optimization BMP design approach uses GIS information and time-series data for watershed runoff flows and pollutant concentrations (generated by the watershed model), integrates a process-based BMP simulation, and applies optimization techniques for the most cost-effective BMP planning and selection.

Based on comprehensive site evaluation and financial analysis, the City selected five sites for centralized BMP Implementation. Optimization of BMP design approach was therefore not comprehensively performed.

6.1.1.3 BMP Simulation Process

The BMP simulation system uses process-based simulation for BMP function and removal efficiency and accepts flow and water quality time-series data generated internally by P8 as input data. Process-based simulation of BMPs provides a technique that is sensitive to local climate and rainfall patterns. BMP effectiveness can be evaluated and estimated over a wide range of storm conditions, site designs, and flow routing configurations.

The storage/infiltration BMPs used in the study included underground and aboveground storage/infiltration systems. The primary benefits of these BMPs are storage and infiltration, which enable runoff volume and rate reduction. These type BMPs also provide water quality benefits via filtration, settling of sediment, and pollutant decay.

The PLAT was used to estimate the average annual load of TN, TP, and TSS from the TMDL Implementation Area. The model-calculated annual loadings for these constituents are presented in Table 3.5. Additionally, the final WLA and the resulting required reduction for nutrients are included in Table 3.5. The model's estimate for current annual loading of nitrogen is less than the interim WLA, but would require a 30 percent reduction to meet the final WLA. The current loading of phosphorus estimated by the PLAT is also less the interim WLA, but would require a 54 percent reduction in average phosphorus loading by 2018. Load reductions of TSS are are used to estimate toxics removal.

6.2 Nonstructural Quantification Analysis

The Watershed Treatment Model (WTM) is used to assess the effectiveness of nonstructural BMPs on the dry weather and annual loading of nutrients and suspended solids from the TMDL Implementation Area. The WTM was developed by the Center for Watershed Protection with funding by the USEPA in June 2010. The WTM is a spreadsheet-based model that calculates annual pollutant loads and runoff volumes and accounts for the benefits of a full suite of stormwater treatment practices to determine reductions in pollutant loads. The WTM is used for the TMDL Implementation Area in the Machado Lake watershed to determine the accumulated effectiveness of implementing dry weather BMPs for the control of nutrients and suspended solids.

The WTM uses both environmental inputs (e.g., area of land use types, soil types, etc.) and inputs about BMPs. Environmental inputs are used to determine current loads and inputs about BMPs determine the percent reduction in loads.

6.2.1 Illicit Connection Removal

Illicit connections to storm drains are sources of a variety of pollutants including nutrients. This source control is applicable to residential and commercial areas in the TMDL Implementation Area. However, the load reduction impact of such program is dependent on the presence and extend of illicit connections in the TMDL Implementation Area. The costs of a field investigation, water sample analysis, and illicit connections trace or to confirm reconnection to the sewer system (via dye, video, or smoke testing) can be highly variable and depend on the extent and nature of the problem. Literature review indicates that the cost of removal of one illicit connection and its reconnection to the sewer system is roughly $2,500 (Marcoux, 2004 and Brown et al., 2004), which makes this is an expensive option. However, the City's NPDES Permit already requires inspection of the storm drain system for illicit connections and removal of the connections, and increased effort to identify illicit connections would enhance the City's illicit connection program. For the purposes of this evaluation, it was assumed that:

- 0 percent of residents have illicit connections. Previous audits by the Cityof all city storm drain found no illicit connections.
- 10 percent of businesses have illicit connections,

- 40 percent of the sanitary sewer is surveyed for illicit connections,
- 20 percent of illicit connections are corrected.

Assumptions were based on best professional judgment because the number of illicit connections varies depending on local habits, municipal outreach, and enforcement. The number of illicit connections identified and corrected would be dependent on the resources the City can allocate to this program.

6.2.2 Catch Basin Filter Cleanout

Regular catch basin filter cleanout prevents pollutants from flowing through and into the storm drain system. Sediment, debris, and gross particulate matter are the targeted pollutants with the cleanout of catch basin filters, but removal of particulate-bound pollutants, including nutrients and toxics, occurs through the physical removal of sediments. Catch basin filter cleanouts can be prioritized as follows:

- Priority A: These catch basin filters are cleaned quarterly.
- Priority B: These catch basin filters are cleaned semi-annually.
- Priority C: These catch basin filters are cleaned annually.

Review of the City's program showed that most catch basin filters were Priority C. However, the model only allows input of semi-annual or monthly cleanouts. Therefore, semi-annual cleanouts were selected. Other inputs were based on best professional judgment. The assumption of semiannual cleanouts may overestimate current load removal and therefore underestimate the percent reduction in loads that could be achieved from increased cleanout frequency.

For the purposes of this evaluation, it was assumed that:

- The impervious area drains to the catch basin filters,
- Catch basin filters are currently cleaned semi-annually,
- In the future, 60 percent of catch basin filters will be cleaned quartely,
- In the future, 40 percent of catch basin filters will be cleaned semi-annually,

6.2.3 Street Sweeping

Street sweeping uses mechanical pavement cleaning practices to minimize pollutant transport to receiving water bodies. Sediment, debris, and gross particulate matter are the targeted pollutants, but removal of other particulate-bound pollutants, such as nutrients and toxics, can be accomplished simultaneously.

The City's Permit requires that the City prioritize street sweeping as follows:

- Priority A: These streets and/or street segments shall be swept at least two times per month.
- Priority B: Each street and/or street segments is swept at least once per month.
- Priority C: These streets and/or street segments shall be swept as necessary but in no case less than once per year.

For the purposes of this evaluation, it was assumed that:

- Publicly owned roads and parking lots are currently swept weekly.
- All roads in TMDL Implementation Area are currently swept with vacuum sweepers.
- The future program will use vacuum sweepers.

City roads are currently being swept weekly. However, the majority of streets lack proper no-parking signage to allow street sweeping trucks to effectively sweep along the curbs. The City is implementing a signage program to allow enforcement on non-parking days and increase the effectiveness of the current street sweeping program. The City uses both mechanical and the more effective vacuum sweepers. The street sweeping cost (including O&M) of vacuum street sweepers is $360/curb mile based on a monthly sweeping frequency (in 2005 dollars) (Shilling, 2005).

6.2.4 Residential Irrigation and Fertilizer Reduction

Over irrigation leads to runoff, increasing flows within the stormwater system. Additionally, urban irrigation runoff can be high in TSS and nutrients. The nutrients in urban irrigation runoff are typically from fertilizers, which are often overused. Effective outreach can teach residents not to overwater and to test the soil to determine the appropriate amount of fertilizer to apply. In addition, evapotranspiration (ET) controllers have been successfully used to reduce irrigation runoff. The cost of this outreach is highly dependent on the approach, which could vary from internet outreach sites to homeowner incentives to educational displays at retail stores.

For the purposes of this evaluation, it was assumed that:

- Half of runoff from the TMDL Implementation Area is dry weather flow.
- An irrigation reduction program would reduce irrigation flows by 20 percent.
- Enhanced outreach of television and radio spots would be necessary to reach and convey the message of controlling irrigation and using proper amounts of fertilizer.

6.2.5 Results of Watershed Treatment Model

The results of the above combined inputs to the WTM are listed in Table 6.1. The reductions are based on percent of dry weather load and the percent of annual runoff load (e.g., street sweeping has benefits in both wet and dry weather). These reductions are considered approximate estimates due to the environmental characterization assumptions made for the model and the assumptions listed in the previous sections.

Table 6.1 Estimated Reductions in Nutrients and TSS from Non-Structural BMPs

Flow Condition	Percent Reduction(1)			
	Total Nitrogen	Total Phosphorus	Total Suspended Solids	Toxics
Dry Weather Runoff	21%	15%	33%	33%
Annual Runoff	23%	10%	26%	26%

Note:
(1) Load reductions as predicted by the Watershed Treatment Model with inputs discussed in Section 6.2.

WTM requires a number of inputs to assess current conditions and the effectiveness of specific source controls. The WTM is the best available tool for modeling and estimating reductions because there is very little reliable literature about load reduction in stormwater through implementation of nonstructural BMPs. WTM results will need to be compared with and used in conjunction with stormwater quality and quantity data to evaluate the effectiveness of the nonstructural BMPs.

As shown in Table 6.1, the use of nonstructural BMPs is estimated to reduce TP loading by 10 percent on an annual basis. Therefore, the remaining 44 percent of the required 54 percent reduction (see Table 11) will need to be through the use of structural BMPs. Similarly, structural BMPs need to remove the remaining 8 percent of the required 31 percent of TN removal as calculated with the models and assumptions stated in this report.

6.3 Structural Quantification Analysis

The PLAT calculates the distribution of structural BMPs to provide the required load reductions at the optimal cost. In setting the load reductions levels for structural BMPs in the PLAT, the anticipated reductions through implementation of non-structural BMPs are subtracted from the total load reductions necessary to achieve the TMDL WLAs. Structural BMPs considered in the PLAT include rainwater capture and reuse, bioretention, porous pavement, and centralized treatment. The initial recommendations for structural BMPs optimized by the PLAT are presented in Table 6.2.

Table 6.2 Optimized Sizing of Centralized BMPs from PLAT[1]

Sub Area	Total Area (ac)[(1)]	Impervious Area (%)	Centralized BMP Needed (ac-ft)		Total BMP Treatment Capacity (ac-ft)
			Aboveground	Underground	
Airport - AS2	86	45	N/A	1.5	12.0
Airport - AS3	640	59	N/A	28	38.0
Airport - Walteria	391	60	N/A	20.5	22.4
Walnut Sump	-	-	39.5	n/a	50
Baseball Field	-	-	N/A	1.0	2.9

Note:
(1) Overall removal load reduction percentages: TSS – 90%; TP – 68%, TN – 70%; Toxics – 90%.

The final mix of BMPs will depend on funding available for installation and the measured gains in nutrients and toxics reductions as projects are implemented. Refinements to the model based on Machado Lake watershed water quality and quantity monitoring may also change the amounts and relative distributions of BMPs in future reconsideration of the Nutrients TMDL.

6.3.1 Retrofit through Redevelopment

Additionally, the City will adopt an ordinance requiring LID components when greater than 50 percent of the impervious area is modified. Residential areas within the TMDL Implementation Area are generally established with low levels of redevelopment. The commercial and industrial areas may experience a moderate rate of redevelopment and would be subject to the City's LID ordinance.

For purposes of this evaluation, it is assumed that 15 percent of the 675 acres commercial, industrial, and institutional area in the area will experience redevelopment over the course of the Implementation Plan. In addition, the rate of redevelopment is assumed to be 2.5 percent per year between 2013 and 2018. This rate is based on the levels experienced in the TMDL Implementation Area of LA County over the past 20 years and is expected to be similar in the TMDL Implementation Area over the life of the Implementation Plan.

Future rate of redevelopment are largely a function of the economic health of the region as a whole and is outside the control of the City. In the future, if the levels of LID through redevelopment becomes more significant that assumed for this study, it could be possible, that less structural BMPs are required in the TMDL Implementation Area to meet the WLAs.

6.4 Quantification Analysis Results

A summary of the required BMP capacity volumes and identified volumes though City projects, redevelopment, and identified opportunities is presented in Table 6.2. The remaining BMP capacity (i.e., the BMP capacity not identified through retrofit of City lands, conceptual opportunities, or redevelopment) may be provided through private installation of BMPs or the installation of structural BMPs within leased properties or acquisition of land within the TMDL Implementation Area. Leasing land area will require negotiation with lessees on properties where leases will expire during the implementation period. Private installation of BMPs may occur through incentive programs, or ordinances. Stormwater fees may be developed to provide a funding mechanism for future BMPs and fund (not oversee) the programs discussed in the BMP Implementation Plan. To attain the WLAs, it may not be necessary for the City to acquire land outside the Implementation Area to implement BMPs. Successful implementation of the programs to attain WLAs will require the multi-departmental detailed planning which is beyond the scope of the BMP Implementation Plan. The BMP Implementation Plan is rooted in an adaptive management approach, allowing the City to assess the true effectiveness of non-structural BMPs, and monitoring to better refine the annual average load of the pollutants of concern. To attain WLA, City may need to work with LACFCD and Rolling Estates to expand Project A1 at the Torrance Airport.

6.5 Quantification Analysis Conclusions

Due to the reasonable amount of existing publicly owned land within the TMDL Implementation Area in the Machado Lake watershed, centralized structural BMPs can be implemented in areas currently owned by the City. This avoids lengthy negotiations between landowners and the City, incentive programs, City ordinances, and stormwater fees may need to be developed and instituted, and land acquisition may be necessary.

The monitoring program will provide stormwater sampling data to assess the site-specific level of nutrients associated with the sediment leaving TMDL Implementation Area. The measured pollutant levels from the monitoring program may provide more site-specific pollutant loading scenarios from the watershed, which would help reevaluate reductions required to meet the WLAs. Currently, TP is the limiting constituent driving the number of BMPs. Additionally, the Nutrients TMDL is due to be reevaluated by 2016, and the reevaluation will include the information from special studies and the results of monitoring programs. The Nutrients TMDL reevaluation may be used to refine the loading capacity of Machado Lake, ultimately changing the WLAs. If, through monitoring, the loadings from the TMDL Implementation Area reveal that nonstructural BMPs are more effective than assumed by the WTM, or the levels of constituents in the runoff from TMDL Implementation Area are lower than currently thought to exist, BMP implementation will need to be adjusted accordingly.

6.6 Reasonable Assurance

The main objective of this implementation plan is capture 85th percentile runoff and infiltrate it, wherever possible. This is in addition to non-structural BMPs including enhanced street sweeping, public education and catch basin filter filter inserts. The City is already performing street sweeping and public education. The proposed BMPs have sufficient capacity to capture and infiltrate the 85th percentile runoff. The expected pollutant removal is summarized in Table 6.3.

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Table 6.3 Summary of Expected Phosphorus Removal

Project Location	Subcatchment	Drainage Area (ac)	Total No. of Catchbasins	Proposed No. of Catchbasins	BASELINE LOAD AND LOAD REDUCTION Baseline Load for TP (kg/yr)	Load Reduction from Structural BMPs (kg/yr)	Load Reduction from Street Sweeping (kg/yr)	Load Reduction from Catch Basin Inserts (kg/yr)	Total Load Reduction (kg/yr)	COST ESTIMATES Strucutual BMPs Captial Cost	Street Sweeping Captial Cost	Catch Basin Inserts Captial Cost	Total Capital Cost	$/kg removed	30
	AS1	391	57	57	167.8	6.7	5.0	5.1	16.8	$ 128,500	$ 138,293	$ 125,400	$ 392,193	$ 766	
Airport	AS2	86	0	0	40.8	27.6	2.9	0.0	30.5	$ 7,031,000	$ 30,417	$ -	$ 7,061,417	172328.431	
	AS3	640	0	0	410.5	278.9	28.7	0.0	307.6		$ 226,362	$ -	$ 226,362	$ -	
	Subtotal	***1,045***	***173***	***57***	***619.1***	***313.2***	***36.6***	***5.1***	***354.9***	***$ 7,159,500***	***$ 369,606***	***$ 125,400***	***$ 7,679,972***	***$ 173,094***	***$ -***
Walnut Sump	WS-1	742	50	50	17.7	0	1.2	1.3	2.5	$ 125,000	$ 262,438	$ 110,000	$ 497,438		
	WS-2	181	192	0	4.3	12.9	0.3	0	13.2	$ 3,488,000	$ 64,018	$ -	$ 3,552,018		
	Subtotal	***923***	***242***	***50***	***22.0***	***12.9***	***1.5***	***1.3***	***15.7***	***$ 3,613,000***	***$ 326,456***	***$ 110,000***	***$ 4,049,456***	***$ -***	***$ -***
Baseball Field	BB-S1	16	5	5	0.4	0	0.03	0.1	0.13		$ 5,659	$ 11,000	$ 16,659	$ -	
	BB-S2	50	9	9	1.3	0	0.09	0.2	0.28		$ 17,685	$ 19,800	$ 37,485		
	BB-S3	39	4	0	1.0	2.1	0.07	0.0	2.19	$ 500,000	$ 13,794	$ -			
	BB-S4	50	5	5	1.3	0	0.09	0.1	0.20		$ 17,685	$ 11,000	$ 28,685		
	Subtotal	***155***	***23***	***19***	***4.0***	***2.1***	***0.3***	***0.4***	***2.8***	***$ 500,000***	***$ 54,822***	***$ 41,800***	***$ 82,828***	***$ -***	***$ -***
Walteria Lake	WL	***2,118***	***0***	***0***	***7.0***	***0***	***0.5***	***0***	***0.5***	***0***	***$ 749,116***	***$ -***	***$ 749,116***		
Totals		**4,241**	**438**	**126**	**652**	**328**	**39**	**6.8**	**374**	**11,272,500**	**1,500,000**	**277,200**	**12,561,372**	**173,094**	**0**

7.0 MULTI-BENEFITS ANALYSIS

This BMP Implementation Plan outlines the management actions that may be needed to ultimately attain the WLAs of the Machado Lake Nutrient TMDL (LARWQCB, 2009) in the City's TMDL Implementation Area of the Machado Lake watershed. Although the primary intention of the proposed structural and nonstructural BMPs is to reduce nutrients load to Machado Lake, the ancillary benefits include water supply improvement, community enhancement, and sediment reductions. This section describes the additional benefits that may be achieved as the management actions are implemented. It should be noted that they do not necessarily benefit the City directly.

7.1 Water Supply

7.1.1 Irrigation Reduction

Irrigation reduction is a proposed nonstructural BMP. Irrigation reduction has the direct water supply benefit of reducing the amount of potable water used for irrigation. Irrigation reductions could be achieved through outreach to residents and implementation of evapotranspiration controllers. Irrigation reductions will be aided by Ordinance No. 2008-0052U, which prohibits runoff from lawns and landscaping on to hardscape (streets, sidewalks). This ordinance also limits fertilizer running onto the street, thus reducing nutrient loads to stormwater. Field monitoring data show that irrigation runoff is insignificant and therefore the City may continue to monitor this in the future.

7.2 Community Enhancement Benefits

Water quality improvements benefit the community at large. These benefits include aesthetics, increases in property value, enhanced recreation opportunities, enhanced water supply, and lower costs for landscape maintenance. Ecosystem benefits are also realized from the improvements. Runoff reduction contributes to water conservation, provides habitat benefits through the reduction of the artificial dry weather flows, and reduces the cost of landscape maintenance. Improvements in Machado Lake water quality will provide the community with enhanced recreational opportunities. Water quality improvements are likely to improve wildlife viewing and fishing opportunities at the lake. Enhancements in habitat directly benefit the wildlife and provide habitat refuge in a highly urbanized area.

7.3 Toxics TMDL and Reduced Sediment to Machado Lake

Best management practices proposed to reduce nutrients in the Machado Lake BMP Implementation Plan include practices that will reduce sediment loads, especially as the WLAs for Toxics were assigned as a fraction of the suspended sediment loading to Machado Lake. Current sediment loading to the lake is estimated at 38,400 kg/yr. Reduction of sediment loading will provide for improved water quality in the lake, and will reduce future needs to dredge the lake.

Structural and nonstructural BMPs capture and remove sediment (TSS) from the watershed. Street sweeping and catch basin filter cleanouts are nonstructural practices that directly remove sediment loads from the watershed and manage them for proper disposal. Nonstructural practices also address the sources of sediment in the watershed, the public outreach, development construction, new development, and public works elements of the City's stormwater management program play a role in encouraging erosion control and reducing sediment inputs to the storm drainage system. Underground storage/infiltration systems are structural BMPs that prevent conversion of pervious areas to impervious cover during development. These practices reduce the quantity and rate of runoff from developed areas, thereby reducing the demand on the storm drain system. The expected reductions in sediment loading for dry and annual weather flows are listed in Table 7.1.

Table 7.1 Estimated Reductions in Stormwater TSS Loads

Flow Condition	Percent Reduction in TSS(1)
Dry Weather Flow	31%
Wet Weather Flow	90%

Note:
(1) Reductions based on nonstructural removal estimates and PLAT results within the TMDL Implementation Area.

7.4 Multi-Benefit Summary

Precise benefit quantification is difficult given the absence of site-specific information and uncertainty about BMP performance and efficiencies. A summary of the ancillary benefits to the proposed structural and nonstructural BMPs within the Machado Lake Watershed are listed in Table 7.2.

Table 7.2 Summary of Multi-Benefits of the Implementation Plan BMP Strategies

BMP	Aesthetics	Capture and Reuse	Flood Protection	Groundwater Recharge	Habitat	Property Value	Water Conservation	TSS Reduction
Under Storage/Infiltration			✓	✓	✓		✓	✓
Aboveground Storage/Infiltration	✓		✓	✓	✓	✓		✓
Irrigation Reduction					✓		✓	
Street Sweeping	✓							✓
Pet Waste Management	✓				✓			
Illicit Connection Removal	✓				✓		✓	
Catch Basin Filter Clean Out			✓					✓
Catch Basin Filter								✓

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8.0 IMPLEMENTATION SCHEDULES

The estimated implementation schedules for the nonstructural and structural projects proposed as possible solutions to comply with WLAs from the TMDLs are discussed below. The schedules presented herein are sufficient for long-term planning. Through adaptive management and based on the future monitoring results and response of Lake Machado, the implementation schedules may be modified to reflect the increased knowledge of the watershed. Actual schedule for Implementation of BMPs will occur as funding becomes available.

8.1 TMDL Schedule

The nutrient TMDL implementation schedule consists of a phased approach, with interim WLAs to be met by March 11, 2014 and full compliance by September 11, 2018. The schedules for required actions for both the Nutrient TMDL are outlined in Table 8.1. The full compliance of the Machado Lake toxics TMDL will be achied by September 30, 2019. As stated earlier in this report and in Appendix B, the interim WLAs for total phosphorus and total nitrogen have been met.

Table 8.1 Schedule or Work Plan Elements

ID	Work Plan Element	Schedule
1	Effective Date	March 11, 2009
2	Submit Monitoring Plan	September 12, 2011
3	Begin Monitoring and Implementation	60-days from approval
4	Information Item to LARWQCB on Implementation Progress	March 11, 2013
5	Interim Limits Apply	March 11, 2014
6	LARWQCB to Reconsider TMDL	September 11, 2016
7	Final WLA applicable	September 11, 2018

8.2 Load Reduction Schedule

The Nutrient TMDL contains a phased compliance schedule, with interim limits effective in the first quarter of 2014 and final allocations effective the third quarter of 2018.

8.3 Nonstructural Schedules

An estimated schedule for the nonstructural BMPs described in Section 4 Nonstructural Solutions is summarized in Table 8.2. The schedule accounts for the planning and design of the nonstructural BMP programs and the long-term implementation of the programs.

8.4 Structural Schedules

An estimated schedule for completing the structural BMPs described in Section 5 is presented in Table 8.3. The schedule includes meeting planning and permitting requirements, preparing engineering design documents, bidding and constructing the BMPs and ongoing operations. The timeframe for funding has not been included in this schedule. In addition to the projects noted in the Table, the schedule accounts for the ongoing redevelopment activities that are expected to occur in the TMDL Implementation Area. The schedule also accounts for the ongoing opportunities to retrofit BMPs whether they are on public right-of-ways or private properties.

As discussed in Section 5.3.3., a geotechnical investigation was conducted at the Torrance Airport due to concern regarding infiltration rates at this BMP site. Details of this subsurface investigation are summarized in Appendix E. In summary, it can be concluded that the boring logs indicate that the top layer below surface is not suitable for infiltration and that substantial excavation (25-24 feet below surface) will be required to reach a sand layer that would typically yield higher percolation rates.

To verify if the proposed underground infiltration would work properly at this location, it is recommended that the City take a phased approach. First, it is recommended that the City conduct some percolation testing at the depth of the sand layer. If results are acceptable, it is then recommended that the City implement the project at Site A1 first, where the sandy layer is closest to ground surface (25 below ground surface) and then monitor the performance over multiple years. If the project meets expectations or if design alternations can overcome any identified issues, it is recommended that the City implement projects A2 and A3, where the sandy layer starts at 40 and 45 feet below surface, respectively.

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Table 8.2 Proposed Implementation Schedule for Nonstructural Solutions

Structural Project	Duration (months)	Timeline					
		2013	2014	2015	2016	2017	2018
Catch Basin Filter Cleanouts							
Purchase Advanced cleaning Technology (steam cleaning), as needed							
Focus on Problem Areas	3 - 6						
Increase Frequency of Cleanouts	Ongoing						
Catch basin filter							
Install Catch basin filter in Implementation Area	Ongoing						
Downspout Disconnection Program							
Planning & Assessment	8 - 12						
Implementation	24						
Fats, Oils and Grease Outreach							
Focus on Residents in TMDL Implementation Area	8 - 12						
Continuation of Existing FOG Outreach	Ongoing						
Green Waste Outreach							
Planning & Assessment	8 - 12						
Implementation	24						

Table 8.2 Proposed Implementation Schedule for Nonstructural Solutions

Structural Project	Duration (months)	Timeline					
		2013	2014	2015	2016	2017	2018
Illicit Connection Removal							
Survey System in TMDL Implementation Area	24						
Implementation	24 - 36						
Impervious Cover Reduction							
Assess Feasibility of Reducing Existing Impervious cover	8 - 12						
Implementation, if appropriate	24						
Industrial/Commercial Facilities Control Program							
Nutrients and Toxics Specific Training	3 - 6						
Outreach to Facilities to Improve Onsite Source Control Activities	8 - 12						
Continuation of Existing I/C Facilities Program	Ongoing						
Pet Waste Outreach							
Planning & Assessment	8 - 12						
Implementation of Pet Waste Bag Dispenser Stations in TMDL Implementation Area	8 – 12						
Focus on TMDL Implementation Area Resident Outreach	24						
Continuation of Existing Pet waste Outreach	Ongoing						

Table 8.2 Proposed Implementation Schedule for Nonstructural Solutions

Structural Project	Duration (months)	Timeline 2013	2014	2015	2016	2017	2018
Post Construction Requirements							
Specialized Nutrient, Toxics and Runoff Reduction Training for Staff	3 - 6		■				
Require Implementation of BMPs that Effectively Remove Nutrients and Toxics for Redevelopment Projects in County Islands	Ongoing	■	■	■	■	■	■
Sewer System Maintenance							
Specialized Training for Staff	3 - 6			■			
Focus maintenance in County Islands	8 - 12				■		
Smart Gardening Program							
Planning & Assessment	8 - 12	■	■				
Implementation	Ongoing	■	■	■	■	■	■
Street and Parking Lot Sweeping							
Planning & Assessment	8 - 12	■					
Upgrade/Purchase More Effective Street Sweepers, as needed	3 - 6		■				
Conduct Residential Outreach	8 - 12		■				
Increase Frequency of Sweeping	ongoing	■	■	■	■	■	■

Table 8.3 Implementation Schedule for Structural Projects

Structural Project	Duration (months)	Timeline 2013	2014	2015	2016	2017	2018
Torrance Airport							
Planning and Permitting	15 -24	■	■				
Engineering Design Documents	8 - 12	■	■				
Bid/Construct	6 - 12		■	■			
Operations				■	■	■	■
Walnut Sump							
Planning and Permitting	15 -24		■	■			
Engineering Design Documents	8 - 12		■	■			
Bid/Construct	6 - 12			■	■		
Operations					■	■	■
Baseball Field							
Planning and Permitting	6 - 12			■	■		
Engineering Design Documents	8 -8			■	■		
Bid/Construct	3 - 8				■	■	
Operations					■	■	■
Redevelopment[1]							
Private Development	Continuous	■	■	■	■	■	■
Retrofit							
BMPs on Public Lands	As needed		■	■	■	■	■
BMP on private Property by Land Owner through Incentive Program[2]	As needed		■	■	■	■	■

Notes:
(1)Redevelopment of property is assumed to continue at a moderate pace comparable to the last 20 years and redevelopment will be in accordance with the LID ordinance and SUSMP requirements.
(2)Requires Public – Private partnership

9.0 COST ESTIMATES

The cost estimates for the proposed actions outlined in the Implementation Plan are presented in this section. At the planning level, the costs provided will allow an order of magnitude effort necessary to implement structural and nonstructural BMPs in the Machado Lake Watershed to meet the WLAs of both the Nutrient and Toxics TMDLs using the current information on the loading from the TMDL Implementation Area and effectiveness of implementing BMPs. Changes to the TMDLs, the model estimated loads through watershed specific monitoring, or assumed effectiveness of identified BMPs will result in a change in the required BMPs and their associated costs. Cost estimates presented are at the level of detail necessary for planning and strategic decision-making. The BMPs are to be distributed uniformly across the TMDL Implementation Area, and site-specific issues that may result in excessive costs are likely to occur in a portion of the installations. Costs presented in here cannot consider site-specific issues and are likely to underestimate the final costs for applying the identified BMPs throughout the TMDL Implementation Area.

9.1 Best Management Practices Cost Estimates

The nonstructural costs estimates are presented in Table 9.1. An assumed 3 percent rate of inflation is used in the cost estimates to determine the cost estimates. Of the BMPs discussed in Section 4, the impervious cover reduction and sanitary sewer maintenance are not included in Table 8.3, as the impervious cover reduction ultimately is a component of the structural BMP program, and the sanitary sewer maintenance is required under the collection system permit.

Table 9.1 Nonstructural Best Management Practice Cost Estimates.

Program	Cost ($)[1]
Catch basin filter Cleanouts	1,500,000
Catch basin filter(2)	2,200,000
Downspout Disconnection Program	200,000
Fats, Oils and Grease Outreach	100,000
Green Waste Outreach	100,000
Illicit Connection Removal	200,000
Industrial/ Commercial Facilities Control Program	100,000
Pet Waste Outreach	500,000
Post Construction Requirements	50,000
Sewer System Maintenance	500,000
Smart Gardening Program	500,000
Street and Parking Lot Sweeping	1,500,000
Total	**7,450,000**

Note:
(1)Program costs through 2018 using 3% rate of inflation

Structural cost estimates are listed in Table 9.2. Implementation costs for the conceptual projects do not include engineering design, permitting, construction, building materials, or O&M. Information on these can found in Appendix F. The details of the five conceptual designs are presented in Section 5. As per the quantification analysis, structural BMPs are required in addition to the conceptual projects and projects situated on County lands. Typical costs for the additional projects are used to estimate the cost of projects on leased or private parcels. The costs do not reflect the costs of negotiation with landowners or the cost of land acquisition. The costs for additional projects are subject to change to reflect the specific site conditions. Detailed cost estimates can be found in Appendix F.

Table 9.2 Program Cost Estimates of Structural Best Management Practices

Structural Best Management Practice	Cost ($)
Conceptual Projects	
Walnut Sump	2,500,000
Baseball Field	500,000
Torrance Airport	
1. BMP at Site A1	5,007,000
2. BMP at Site A2	2,000,000
TOTAL	**10,007,000**

9.2 Cost Schedule

The schedule for implementation to achieve the TMDL WLA, requiring 54 percent reduction in phosphorus load, is summarized in Table 6.3. The schedules for nonstructural, structural, redevelopment, and leased property projects were used to distribute the implementation costs over time, ending in 2018, the compliance point for the Nutrients TMDL. The implementation path represented by Table 6.3 is a method of compliance with the Nutrients TMDLs. As the adaptive management and reevaluation of the Nutrient TMDL progresses, the required levels of pollutant loading and the compliance timeline may change. The actual costs and timing of implementation will depend on the specific site characteristics, special studies, and actual effectiveness of installed BMPs.

9.3 FINANCIAL STRATEGY

Financing the implementation of the Torrance EWMP is the greatest challenge confronting the City. In the absence of stormwater utility fees (aside from those specified for maintenance), the City has no dedicated revenue stream to pay for implementation of the EWMP. The City's annual budget for catch basin cleaning is about $140,000 and the annual budget for street sweeping is approximately $1,3000,000.

In addition to current uncertainties associated with costs and funding, there are multiple uncertainties associated with future risks. There will be many deadlines that must be met despite limited resources. The City will need to set priorities and seek funding in order to meet the various compliance deadlines. Therefore, to address the Water Quality Priorities (WQPs), the City is going to pursue a multi-faceted financial strategy. In addition, the City has coordinated the proposed compliance schedule (see Section 5) with the financial strategy.

The latest Los Angeles MS4 Permit has greatly magnified the financial challenges associated with managing stormwater. The absence of a stable stormwater funding mechanism not tied to municipal General Funds is becoming ever more critical. For that reason, the City Manager Committees of the California Contract Cities Association and the League of California Cities, Los Angeles Division, formed a City Managers' Working Group (Working Group) to review stormwater funding options after the LA County proposed Clean Water, Clean Beaches funding initiative did not move forward. The result was a Stormwater Funding Report 3 that notes, "the Los Angeles region faces critical, very costly, and seriously underfunded stormwater and urban runoff water quality challenges." The Report found that funding stormwater programs is so complex and dynamic, and the water quality improvement measures so costly, that Permittees cannot depend on a single funding option at this time. The City Managers' report includes a variety of recommendations, including: organizational recommendations; education and outreach program recommendations; recommendations for legislation, such as State Facilities, Stormwater Capture, and Use; Source Control or Fee Legislation; Clean Water, Clean Beaches recommendations; local funding options; and recommendations for the Regional Water Board.

A summary of funding options identified in the Stormwater Funding Report can be found below.

9.3.1 <u>Organizational</u>

As recommended in the Stormwater Funding Report, the City will consider forming a core group of elected officials to form a committee, including members from the environmental community, the business community, and other stakeholders to improve communication and to reach consensus on fee issues. Additionally, the City plans to engage with other agencies to discuss future partnerships in stormwater programs.

9.3.2 Education and Outreach

The City plans to implement public outreach on a watershed-based level. With these efforts the Participating Agencies will have direct communications with the Governor and the Legislature on the funding needs.

9.3.2.1 Lefislation

The City has considered pursuing legislation in the following areas:

- Schools and Public Facilities (i.e. environmental liability waivers; state architect guidance on schools, etc.)
- Stormwater Capture and Reuse (i.e. provide a clear path to monetize the capture and use of stormwater)
- Source Control or Fee Legislation (i.e. pursue reduction of zinc in tires and/or a per-tire zinc reduction fee)
- Special Assessment Districts (i.e. explore the special assessment district concept for funding stormwater projects)

9.3.2.2 Clean Water

The Participating Agencies will consider a property owner/voter sentiment survey based on new factors and changed circumstances, including a list of specific projects, optional fee amounts and an “opt out” provision. Additionally, the Participating Agencies will explore the formation of the Urban Water Conservation District under the 1931 Act by determining the governance structure under 1931 Act. If it is Board of Supervisors governance, a protest hearing may be considered to vote for a stormwater capture and infiltration fee to fund other program aspects not covered under the 1931 Act Water Conservation District.

9.3.3 Local Funding Options

Local funding options include:

- Adopting local fees;
- Street sweeping contracts to provide NPDES trash controls;
- Adoption of water conservation fees to provide funding for reducing irrigated runoff to conserve water and reduce dry weather discharges;
- Stormwater impact fees;
- Local, statewide, or regional fees on car rentals to contribute to copper and zinc cleanup costs and incorporate stormwater quality features into street and highway projects funded by bonds and other street funds

9.3.3.1 Transportation

Another consideration is future transportation bonds. This can be pursued by encouraging the Metropolitan Transportation Authority (MTA) to include funding stormwater quality features, such as Green Streets, in future bonds and encourage Council of Governments to develop strategic transportation plans that include mitigations designed to address water quality issues from transportation projects.

9.4 Assessment and Adaptive Management Framework

Adaptive management is a key component to the successful implementation, assessment and refinement of the MdR EWMP. Adaptive management is the process by which data are continually assessed in the context of improving and adapting programs to ensure the most effective strategies are implemented. In accordance with the MS4 Permit, every two years from the date of EWMP approval an adaptive management process will be implemented. The process will include consideration of the progress for the following elements as described in Part V1.C.8 of the MS4 Permit:

1. "Progress toward achieving interim and/or final WQBELS or RW limitations according to established schedules;
2. Progress toward achieving improved water quality in MS4 discharges and achieving RW limitations through implementation of the watershed control measures based on an evaluation of outfall based monitoring data and RW monitoring data;
3. Achievement of interim milestones;
4. Re-evaluation of the water quality priorities identified for the area based on more recent water quality data for discharges from the MS4 and the receiving water(s) and a reassessment of sources of pollutants in MS4 discharges;
5. Availability of new information and data from sources other than the Permittees' monitoring program(s) within the area that informs the effectiveness of the actions implemented by the Permittees;
6. Regional Water Board recommendations; and
7. Recommendations for modifications to the Watershed Management Program solicited through a public participation process."

As additional data become available through CIMP monitoring, BMP effectiveness studies, special studies such as the Toxics TMDL required Stressor ID Study, and other scientific studies, they will be integrated and assessed to determine whether programs in the EWMP should be altered to enable compliance in the most efficient manner.

The adaptive management framework will allow the EWMP Agencies to develop an overall program consisting of efficient solutions based on evolving watershed priorities.

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APPENDIX B – DETAILED MAPS OF SAMPLING LOCATIONS

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Figure 4
Special Study Sampling Locations
BMP Implementation Plan
City of Torrance

Preliminary Sampling Results

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TABLE 1
Interim TMDL WLA Attainment Status

Month	Sample Location	Sample Date	Nitrate as N (mg/l)	Nitrite as N (mg/l)	Nitrate/Nitrite as N (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Sum of Nitrogen Values (1) (mg/l)	Monthly Average Nitrogen (mg/l)	Total Phosphorus (mg/l)	Monthly Average Phosphorus (mg/l)
August	RHE City Hall	8/2/2011	0.77	< 0.15	0.77	0.75	1.52	0.57	0.15	0.08
	Valmonte		0.15	< 0.75	0.15	0.59	0.74		0.16	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
September	RHE City Hall	9/8/2011	0.51	< 0.15	0.51	0.48	0.99	0.43	0.13	0.17
	Valmonte		0.14	< 0.15	0.14	0.57	0.71		0.54	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
October	RHE City Hall	10/3/2011	0.91	< 0.15	0.91	0.55	1.46	0.63	0.17	0.19
	Valmonte		0.37	< 0.15	0.37	0.70	1.07		0.59	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
November	RHE City Hall	11/3/2011	0.79	< 0.30	0.79	11	11.79	2.08	0.20	0.12
	Valmonte		< 0.55	< 0.75	< 0.75	0.59	0.59		0.41	
	Solano		No Flow				0.00		0.00	
	Blackwater Cyn		No Flow				0.00		0.00	
	RHE City Hall	11/15/2011	0.62	< 0.75	0.62	< 0.50	0.62		0.071	
	RHE City Hall	11/22/2011	1.0	< 0.15	1.0	< 0.50	1.0		0.12	
	RHE City Hall	11/28/2011	0.58	< 0.30	0.58	< 0.50	0.58		0.058	
December	RHE City Hall	12/9/2011	1.9	< 0.15	1.9	1.2	3.10	0.92	0.083	0.13
	Valmonte		< 0.22	< 0.30	< 0.30	0.56	0.56		0.43	
	Solano		No Flow				0.00		0.00	
	Blackwater Cyn		No Flow				0.00		0.00	
January	RHE City Hall	1/6/2012	0.68	< 0.30	0.68	< 0.50	0.68	0.32	< 0.050	0.11
	Valmonte		< 0.55	< 0.75	<0.75	0.58	0.58		0.42	
	Solano		No Flow				0.00		0.00	
	Blackwater Cyn		No Flow				0.00		0.00	
February	RHE City Hall	2/6/2012	0.91	< 0.75	0.91	0.63	1.54	0.56	< 0.050	0.12
	Valmonte		< 0.55	< 0.75	<0.75	0.70	0.70		0.49	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	

TABLE 1
Interim TMDL WLA Attainment Status

Month	Sample Location	Sample Date	Nitrate as N (mg/l)	Nitrite as N (mg/l)	Nitrate/Nitrite as N (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Sum of Nitrogen Values (1) (mg/l)	Monthly Average Nitrogen (mg/l)	Total Phosphorus (mg/l)	Monthly Average Phosphorus (mg/l)
March	RHE City Hall	3/2/2012	0.35	< 0.15	0.35	< 0.50	0.35	2.04	< 0.050	0.65
	Valmonte		< 0.11	< 0.15	<0.15	0.62	0.62		0.19	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
	RHE City Hall	3/17/2012 (Wet Weather Sample)	1.2	0.27	1.47	1.3	2.77		0.17	
	Valmonte		0.31	<0.15	0.31	0.72	1.03		0.51	
	Solano		0.75	< 0.15	0.75	4.7	5.45		1.40	
	Lariat		3.0	0.30	3.3	4.8	8.1		3.6	
	Lariat	3/28/2012	No Flow				0.00		0.00	
April	RHE City Hall	4/2/2012	0.75	< 1.5	0.75	< 0.50	0.75	1.05	< 0.050	0.16
	Valmonte		0.37	< 1.5	0.37	0.77	1.14		0.35	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
	RHE City Hall	4/11/2012 (Wet Weather Sample)	0.78	< 0.15	0.78	0.79	1.57		0.11	
	Valmonte		0.64	<0.30	0.64	3.0	3.64		0.39	
	Solano		0.48	< 0.15	0.48	0.79	1.27		0.40	
	Lariat		No Flow				0		0.00	
May	RHE City Hall	5/8/2012	< 0.22	< 0.30	<0.30	< 0.50	0.00	0.20	0.056	0.25
	Valmonte		0.26	< 0.30	0.26	0.55	0.81		0.96	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
June	RHE City Hall	6/5/2012	0.87	<0.30	0.87	0.52	1.39	0.65	0.084	0.26
	Valmonte		0.55	<0.75	0.55	0.65	1.20		0.95	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
July	RHE City Hall	7/3/2012	<0.10	<0.10	<0.10	0.224	0.224	0.16	<0.050	0.11
	Valmonte		<0.10	<0.10	<0.10	0.398	0.398		0.45	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
August	RHE City Hall	8/3/2012	<0.10	<0.10	<0.10	0.411	0.411	0.25	<0.050	0.15
	Valmonte		<0.10	<0.10	<0.10	0.579	0.579		0.60	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
September	RHE City Hall	9/11/2012	<0.10	<0.10	<0.10	0.616	0.616	0.35	0.19	0.15
	Valmonte		<0.10	<0.10	<0.10	0.802	0.802		0.40	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	

TABLE 1
Interim TMDL WLA Attainment Status

Month	Sample Location	Sample Date	Nitrate as N (mg/l)	Nitrite as N (mg/l)	Nitrate/Nitrite as N (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Sum of Nitrogen Values (1) (mg/l)	Monthly Average Nitrogen (mg/l)	Total Phosphorus (mg/l)	Monthly Average Phosphorus (mg/l)
October	RHE City Hall	10/1/2012	0.100	<0.10	0.100	0.594	0.694	0.41	0.27	0.73
	Valmonte		<0.10	<0.10	<0.10	0.756	0.756		1.2 Q*	
	Solano		No Flow				0.000		0.00	
	Lariat		No Flow				0.000		0.00	
	Valmonte	10/15/2012	<0.100	<0.100	<0.100	0.587	0.587		2.2 Q*	
November	RHE City Hall	11/2/2012	<0.100	0.100	0.100	0.481	0.581	0.29	<0.050	0.019
	Valmonte		<0.100	<0.100	<0.100	0.588	0.588		0.075	
	Solano		No Flow				0.000		0.00	
	Lariat		No Flow				0.000		0.00	
December	RHE City Hall	12/7/2012	0.820	<0.100	0.820	0.192 B	1.012	0.25	0.05	0.07
	Valmonte		<0.100	<0.500	<0.500	0.301 B	0.301		0.43	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
	RHE City Hall	12/13/2012 (Wet Weather Sample)	0.120 Q*	<0.100	0.12	0.237	0.357		0.05	
	Valmonte		<0.100	<0.100	<0.100	0.342	0.342		<0.050	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
January	RHE City Hall	12/13/2012	0.340	<0.100	0.340	0.337 B	0.677	0.34	<0.050	0.11
	Valmonte		<0.100	<0.100	<0.100	0.680 B	0.680		0.45	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
February	RHE City Hall	2/5/2013	0.470	<0.100	0.470	0.236 Q*	0.706 Q*	0.28	<0.050	0.13
	Valmonte		<0.100	<0.100	<0.100	0.428	0.428		0.52	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
March	RHE City Hall	3/1/2013	0.350 O-04	<0.100 O-04	0.35 O-04	0.495 B N O-04	0.845 B N O-04	1.30	<0.050 O-04	0.26
	Valmonte		<0.100 O-04	<0.100 O-04	<0.100 O-04	0.707 B N O-04	0.707 B N O-04		0.78 O-04	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
	RHE City Hall	3/8/2013 (Wet Weather Sample)	1.02	<0.100	1.020	1.23	2.250		0.31	
	Valmonte		4.90	<0.100	4.900	0.588	5.488		0.63	
	Solano		0.41	<0.100	0.410	0.687	1.097		0.38	
	Lariat		No Flow				0.00		0.00	
April	RHE City Hall	4/1/2013	<0.100	<0.100	<0.100	0.594	0.594	0.32	<0.050	0.16
	Valmonte		<0.100	<0.100	<0.100	0.68	0.680		0.65	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	

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Month	Sample Location	Sample Date	Nitrate as N (mg/l)	Nitrite as N (mg/l)	Nitrate/Nitrite as N (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Sum of Nitrogen Values (1) (mg/l)	Monthly Average Nitrogen (mg/l)	Total Phosphorus (mg/l)	Monthly Average Phosphorus (mg/l)
May	RHE City Hall	5/13/2013	0.150	<0.500	0.150	0.416	0.566	0.25	<0.050	0.19
	Valmonte		<0.050	<0.500	<0.500	0.419	0.419		0.75	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
June	RHE City Hall	6/5/2013	0.230	<0.10	0.230	0.584	0.814	0.36	0.20	0.15
	Valmonte		0.130 Q*	<0.10	0.130 Q*	0.505 Q*	0.635 Q*		0.39 Q*	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
July	RHE City Hall	7/1/2013	<0.100	<0.100	<0.100	<0.400	<0.400	0.12	<0.050	0.15
	Valmonte		<0.100	<0.100	<0.100	0.474	0.474		0.59	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
August	RHE City Hall	8/14/2013	<0.100	<0.100	<0.100	0.632	0.632	0.37	0.24	0.23
	Valmonte		<0.100	<0.100	<0.100	0.834	0.834		0.68	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
September	RHE City Hall	9/26/2013	<0.100	<0.100	<0.100	0.804	0.80	0.20	0.59	0.15
	Valmonte		No Flow				0.00		0.00	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
October	RHE City Hall	10/2/2013	0.24	<0.100	0.24	0.346	0.59	0.47	0.00	0.04
	Valmonte		0.33	<0.100	0.33	0.95	1.280		0.15	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
November	RHE City Hall	11/5/2013	1.16	<0.400	1.16	0.212	1.37	0.48	0.00	0.02
	Valmonte		<0.100	<0.100	<0.100	0.558	0.558		0.07	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
December	RHE City Hall	12/13/2013	0.52	<0.100	0.52	0.053	0.57	0.22	0.085	0.13
	Valmonte		<0.100	<0.100	<0.100	0.322	0.322		0.45	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
January	RHE City Hall	1/10/2014	0.74	<0.200	0.74	0.277 N	1.02	0.34	0.056	0.18
	Valmonte		<0.100	<0.100	<0.100	0.353 N	0.353		0.66	
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
	RHE City Hall		0.75	<0.10	0.75	0.494 N	1.24		0.130	

TABLE 1
Interim TMDL WLA Attainment Status

Month	Sample Location	Sample Date	Nitrate as N (mg/l)	Nitrite as N (mg/l)	Nitrate/Nitrite as N (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Sum of Nitrogen Values (1) (mg/l)	Monthly Average Nitrogen (mg/l)	Total Phosphorus (mg/l)	Monthly Average Phosphorus (mg/l)
February	Valmonte	2/3/2014	<0.10	<0.10	<0.10	0.545 N	0.545	1.78	0.56	0.97
	Solano		No Flow				0.00		0.00	
	Lariat		No Flow				0.00		0.00	
February	RHE City Hall	2/28/2014 (Wet Weather Sample)	0.64	<0.10	0.64	0.316 N	0.96		0.440	
	Valmonte		2.1 O-04	<0.10	2.1	0.872 N	2.972		0.72	
	Solano		0.33	<0.10	0.33	0.57 N	0.90		0.53	
	Lariat		0.27	<0.10	0.27	0.234 N	0.50		1.50	
March	RHE City Hall	3/19/2014	<0.100	<0.100	<0.100	0.255	0.26	0.20	<0.050	0.12
	Valmonte		<0.100	<0.100	<0.100	0.527	0.527		0.470	
	Solano		No Flow						No Flow	
	Lariat		No Flow						No Flow	
April	RHE City Hall	4/16/2014	<0.100	<0.100	<0.100	0.159	0.159	0.11	0.058	0.14
	Valmonte		<0.100	<0.100	<0.100	0.263 Q*	0.263		0.520	
	Solano		No Flow				0.00		No Flow	
	Lariat		No Flow				0.00		No Flow	
May	RHE City Hall	5/9/2014	<0.100	<0.100	<0.100	0.480	0.480	0.27	0.140	0.19
	Valmonte		0.31 O-04	<0.100	0.310	0.592	0.592		0.600	
	Solano		No Flow				0.00		No Flow	
	Lariat		No Flow				0.00		No Flow	
June	RHE City Hall	6/18/2014	<0.100	<0.100	<0.100	0.338 Q*	0.338	0.19	0.074	0.11
	Valmonte		<0.100	<0.100	<0.100	0.436	0.436		0.360	
	Solano		No Flow				0.00		No Flow	
	Lariat		No Flow				0.00		No Flow	
July	RHE City Hall	7/18/2014	<0.100	<0.100	<0.100	0.115	0.115	0.20	<0.050	0.15
	Valmonte		<0.100	<0.100	<0.100	0.682	0.682		0.580	
	Solano		No Flow				0.00		No Flow	
	Lariat		No Flow				0.00		No Flow	
August	RHE City Hall	8/7/2014	0.170	<0.100	<0.100	0.398	0.568	0.27	0.099	0.21
	Valmonte		<0.100	<0.100	<0.100	0.512	0.512		0.730	
	Solano		No Flow				0.00		No Flow	
	Lariat		No Flow				0.00		No Flow	
September	RHE City Hall	9/16/2014	0.10	<0.100	0.10	0.467	0.567	0.28	0.077	0.23
	Valmonte		<0.100	<0.100	<0.100	0.567	0.567		0.830	
	Solano		No Flow				0.00		No Flow	
	Lariat		No Flow				0.00		No Flow	
	RHE City Hall		0.240	<0.100	0.24	0.366	0.606		<0.050	

TABLE 1
Interim TMDL WLA Attainment Status

Month	Sample Location	Sample Date	Nitrate as N (mg/l)	Nitrite as N (mg/l)	Nitrate/Nitrite as N (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Sum of Nitrogen Values (1) (mg/l)	Monthly Average Nitrogen (mg/l)	Total Phosphorus (mg/l)	Monthly Average Phosphorus (mg/l)
October	Valmonte	10/15/2014	<0.100	<0.100	<0.100	0.331	0.331	0.23	0.770	0.19
	Solano		No Flow				0.00		No Flow	
	Lariat		No Flow				0.00		No Flow	
November	RHE City Hall	11/11/2014	<0.100	<0.100	<0.100	0.262	0.262	0.17	<0.050	0.23
	Valmonte		<0.100	<0.100	<0.100	0.42	0.420		0.900	
	Solano		No Flow				0.00		No Flow	
	Lariat		No Flow				0.00		No Flow	
December	RHE City Hall	12/2/2014 (Wet Weather Sample)	0.900	<0.100	0.900	0.655	1.555	1.69	0.410	0.41
	Valmonte		0.450	<0.100	0.450	0.805	1.255		0.500	
	Solano		3.43	0.480	3.91	8.20	12.11		1.600	
	Lariat		0.180	<0.100	0.180	0.902	1.08		0.660	
	RHE City Hall	12/10/2014	0.240	<0.100	0.240	0.476	0.716		<0.050	
	Valmonte		0.140	<0.100	0.140	0.666	0.806		0.350	
	Solano		No Flow				0.00		No Flow	
	Lariat		No Flow				0.00		No Flow	
	RHE City Hall	12/12/2014 (Wet Weather Sample)	0.370	<0.100	0.370	0.472	0.842		0.300	
	Valmonte		<0.100	<0.100	<0.100	0.784	0.784		0.320	
	Solano		0.160	<0.100	0.160	0.726	0.886		0.490	
	Lariat		<0.100	<0.100	<0.100	0.283	0.28		0.320	
January	RHE City Hall	1/8/2015	0.062	<0.100	0.062	0.261	0.323	0.24	<0.050	0.10
	Valmonte		<0.100	<0.100	<0.100	0.642	0.642		0.400	
	Solano		No Flow						No Flow	
	Lariat		No Flow						No Flow	
February	RHE City Hall	2/9/2015	<0.100	<0.100	<0.100	0.304	0.304	0.20	<0.050	0.14
	Valmonte		<0.100	<0.100	<0.100	0.509	0.509		0.560	
	Solano		No Flow						No Flow	
	Lariat		No Flow						No Flow	
March	RHE City Hall	3/11/2015	0.340	<0.100	0.340	0.389	0.729	0.32	0.050	0.14
	Valmonte		<0.100	<0.100	<0.100	0.541	0.541		0.510	
	Solano		No Flow						No Flow	
	Lariat		No Flow						No Flow	
April	RHE City Hall	4/7/2015	0.260	<0.100	0.260	0.201	0.461	0.21	<0.05	0.18
	Valmonte		<0.100	<0.100	<0.100	0.367	0.367		0.710	
	Solano		No Flow						No Flow	
	Lariat		No Flow						No Flow	
	RHE City Hall	5/4/2015	<0.100	<0.100	<0.100	0.215	0.215		<0.05	
	Valmonte		<0.100	<0.100	<0.100	0.437	0.437		0.360	

TABLE 1
Interim TMDL WLA Attainment Status

Month	Sample Location	Sample Date	Nitrate as N (mg/l)	Nitrite as N (mg/l)	Nitrate/Nitrite as N (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Sum of Nitrogen Values (1) (mg/l)	Monthly Average Nitrogen (mg/l)	Total Phosphorus (mg/l)	Monthly Average Phosphorus (mg/l)
May	Solano	5/4/2015	No Flow					0.57	No Flow	0.28
	Lariat		No Flow						No Flow	
	RHE City Hall	5/15/2015 (Wet Weather Sample)	0.500	<0.100	0.500	1.14	1.640		<0.05	
	Valmonte		<0.100	<0.100	<0.100	0.422	0.422		0.600	
	Solano		0.660	<0.100	0.660	1.180	1.840		1.300	
	Lariat		No Flow						No Flow	
June	RHE City Hall	6/3/2015	<0.100	<0.100	<0.100	0.261	0.261	0.09	<0.050	0.17
	Valmonte		<0.100	<0.100	<0.100	0.095	0.095		0.680	
	Solano		No Flow						No Flow	
	Lariat		No Flow						No Flow	
						Interim WLA (3/11/2009)		3.50		1.25
						Interim WLA (3/11/2014)		2.45		1.25
						Final WLA (9/11/2018)		1.00		0.10

Notes:

Table 2-9
Summary of Machado Lake Sediment Data Sets

Source	Sample Data
City of Los Angeles, Machado Lake Watershed Management Plan	May 14 & 15, 2001
SWAMP	August 4, 2003
City of Los Angeles	October 22, 2008
Regional Board	January 14, 2009

Source: Regional Board Machado Lake Pesticides and PCBs TMDL.

Table 2-10
Machado Lake Water Sediment Toxics Data

Lake Region	Sample Date	Sample Depth (cm)	Constituents of Concern (µg/kg)			
			Total Chlordane	Total DDT	Dieldrin	PCBs
North Lake	May 14-15 2001	20- composite	5.8	5.8	ND	No data
Mid North Lake	May 14-15 2001	20- composite	1.4	4.4	ND	No data
Mid Lake	May 14-15 2001	20- composite	2	2	ND	No data
Mid Lake South	May 14-15 2001	20- composite	7	ND	ND	No data
South Lake	May 14-15 2001	20- composite	3	2	ND	No data
North Lake	August 4, 2003	2	39.75	64.22	ND	94.1
Mid North Lake	August 4, 2003	2	60.73	76.13	ND	115.8
Mid Lake	August 4, 2003	2	40.93	57.13	ND	119.3
Mid Lake South	August 4, 2003	2	82.29	80.14	1.54	87.5
South Lake	August 4, 2003	2	64.01	57.35	1.1	75.2
North Lake	October 22, 2008	15	No data	4.69	No data	No data
North Lake	October 22, 2008	76	No data	8.38	No data	No data
Mid Lake (west side)	October 22, 2008	15	No data	10.04	No data	No data
Mid Lake (west side)	October 22, 2008	76	No data	8.7	No data	No data
North Lake	January 14, 2009	2	98.5	ND	ND	16.6
Mid Lake	January 14, 2009	2	56.4	34.8	ND	35.2
South Lake	January 14, 2009	2	60.7	19.8	ND	22.7
South Lake	January 14, 2009	2	67.1	51.9	ND	68.6

Notes:
ND = Non Detect
Detection limit is 1 µg/dry kg
Source: Regional Board *Machado Lake Pesticides and PCBs TMDL*

APPENDIX C – SATELLITE IMAGE OF CITY OF TORRANCE

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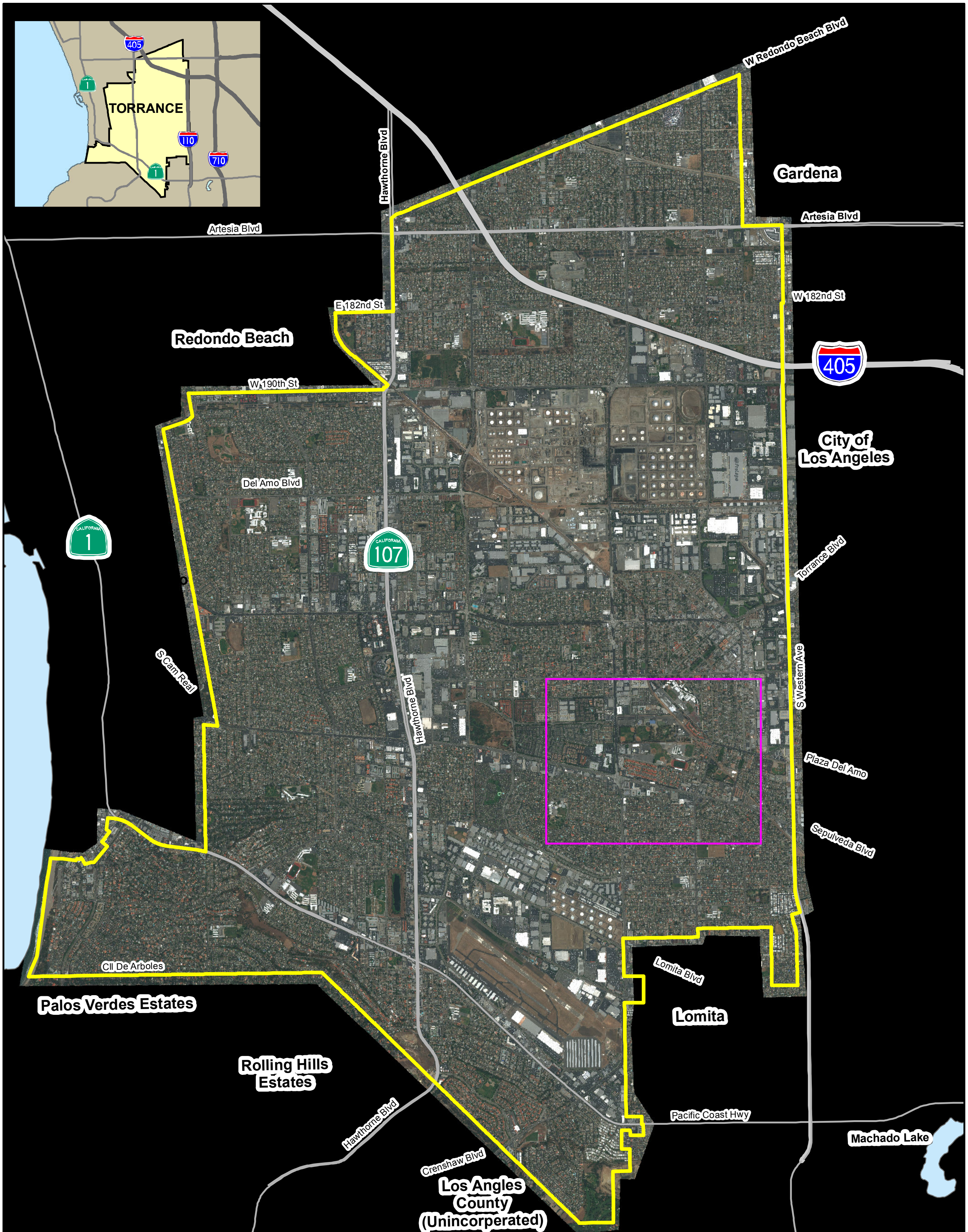

Legend

- City Boundary
- Bodies of Water
- Comparison Area

0 0.25 0.5 1 Miles

Appendix C
Satellite Image
BMP Implementation Plan
City of Torrance

Satellite Imagery from WorldView for July 10, 2010

APPENDIX D – UTILITY SEARCH INFORMATION

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Southern California Gas Company

A Sempra Energy utility

October 21, 2013

Carollo Engineers
199 S. Los Robles Ave., Suite 530
Pasadena, CA 91101

Attention: John Meyerhofer,

Subject: 3 potential stormwater recharge project sites in the City of Torrance
Project No. 43-2013-10-00001
Please refer to the above Job ID Number in all future correspondence.

Enclosed is a copy of our Atlas Sheet/s with the approximate locations of our gas mains for you to post to your proposed project plans. The dimensions and locations of the mains are believed to be reasonably correct but are not guaranteed.

The depths of our facilities vary and can only be confirmed by pot holing, or some other acceptable method of taking elevations.

It is extremely important that you furnish us with "signed" final plans, before construction, including profiles and subsequent plan revisions as soon as they are available. A minimum of twelve (12) weeks is needed to analyze the plans and design alterations for any conflicting facilities. Depending on the magnitude of the work involved, additional time may be required to clear the conflict.

Underground Service Alert (USA), (800) 442-4133 or (800) 227-2600, must be notified 48 hours prior to commencing work. Please keep us informed of construction schedules, pre-construction meetings, etc., so that we can schedule our work accordingly. If no action is taken on this project within 24 months, plans will be discarded. Please call Paul Blood at (310) 687-2011 for further assistance.

Thank you,

Gale Etherly for Paul Blood
Cc: file: Job ID# 43-2013-10-00001
Enclosure: TOR 17 (Plaza Del Amo), C 501-W (Walnut St.), C 570-W (Skypark), TOR 26 (Skypark Dr., Garnier St.), C 508-W (Crenshaw Blvd.)
5atlas.doc

enclosure
atlas.doc

Map Title:
Printed By: CORP\CORP-TPGYE
Printed Date: 10/21/2013

LIABILITY STATEMENT The facilities and their depiction on these maps are believed to be reasonably accurate, but the maps are not to be used in lieu of field verification or calling USA at 800-422-4133. NO WARRANTY expressed or implied (including of merchantability or of fitness for a particular purpose) is made as to any matter, including but not limited to, the design, size, type or location of the facilities, their presence or absence, the accuracy of the maps, the means used to transmit the data, absence of viruses (if transmitted electronically, by disk or diskette), data translation or transmission errors or omissions, compatibility with the user's system or its ability to interpret the data correctly or at all, or any other matter. The Gas Company has no liability for damages (direct, indirect, consequential, incidental or punitive) arising from the transmission, receipt or use by others of the maps or information contained in the maps. "Certain technology used under license from AT&T Intellectual Property I, L.P. Copyright © 1998 - 2007 AT&T Intellectual Property I, L.P. All rights Reserved."

Sempra Energy utility


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378913.7,3741479.57
235TH ST
235TH PL
236TH ST
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237TH ST
237TH PL
238TH ST
240TH ST
CABRILLO AVE
WALNUT ST
WESTERN AVE
SCHILLING CT
HAAS AVE
STANHURST AVE
LAMOUR CT
HUBER AVE
FALMOUTH AVE
ESPELMAN AVE
TORRANCE BAPTIST TEMPLE INC
VIETNAMESE ALLIANCE CHURCH OF BAY
BREA PARK
ADAMS ELEMENTARY SCHOOL
C-501-W
C-502-W
C-509-W
C-510-W
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LA 362
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L55
L65
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100ft
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10/31/2013

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Printed Date: 10/21/2013

Map Title:
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Printed Date: 10/21/2013

Southern California Gas Company
Sempra Energy utility

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SOUTHERN CALIFORNIA
EDISON
An *EDISON INTERNATIONAL* Company

September 12, 2013

Attn: John Meyerhofer
Carollo Engineers
199 S Los Robles Ave Ste 530
Pasadena, CA 91101

RE: Torrance

Enclosed are copies of the existing Southern California Edison overhead and/or underground facilities inventory maps covering the area of your proposed project.

Southern California Edison Company believes this information is correct for purposes intended by the Company and assumes no liability for its accuracy.

Should you need to contact an SCE service planner for review of preliminary or final plans, or to establish a service point, please contact:

SCE PLANNING SUPERVISOR
505 Maple Ave
Torrance, CA 90503
(310) 783-9356

When contacting the SCE service planner, please include copies of the facilities inventory maps that are being provided to you. **SENDING YOUR PLANS TO ANY ADDRESS OTHER THAN THE ONE LISTED WILL CAUSE A DELAYED RESPONSE.**

Thank you, and if you have any further questions, please call me at (714) 796-9932.

Kim Gurule
Facilities Mapping
Power Distribution

Enclosures

Bldg D
P.O. Box 11982
Santa Ana, Ca 92711-1982

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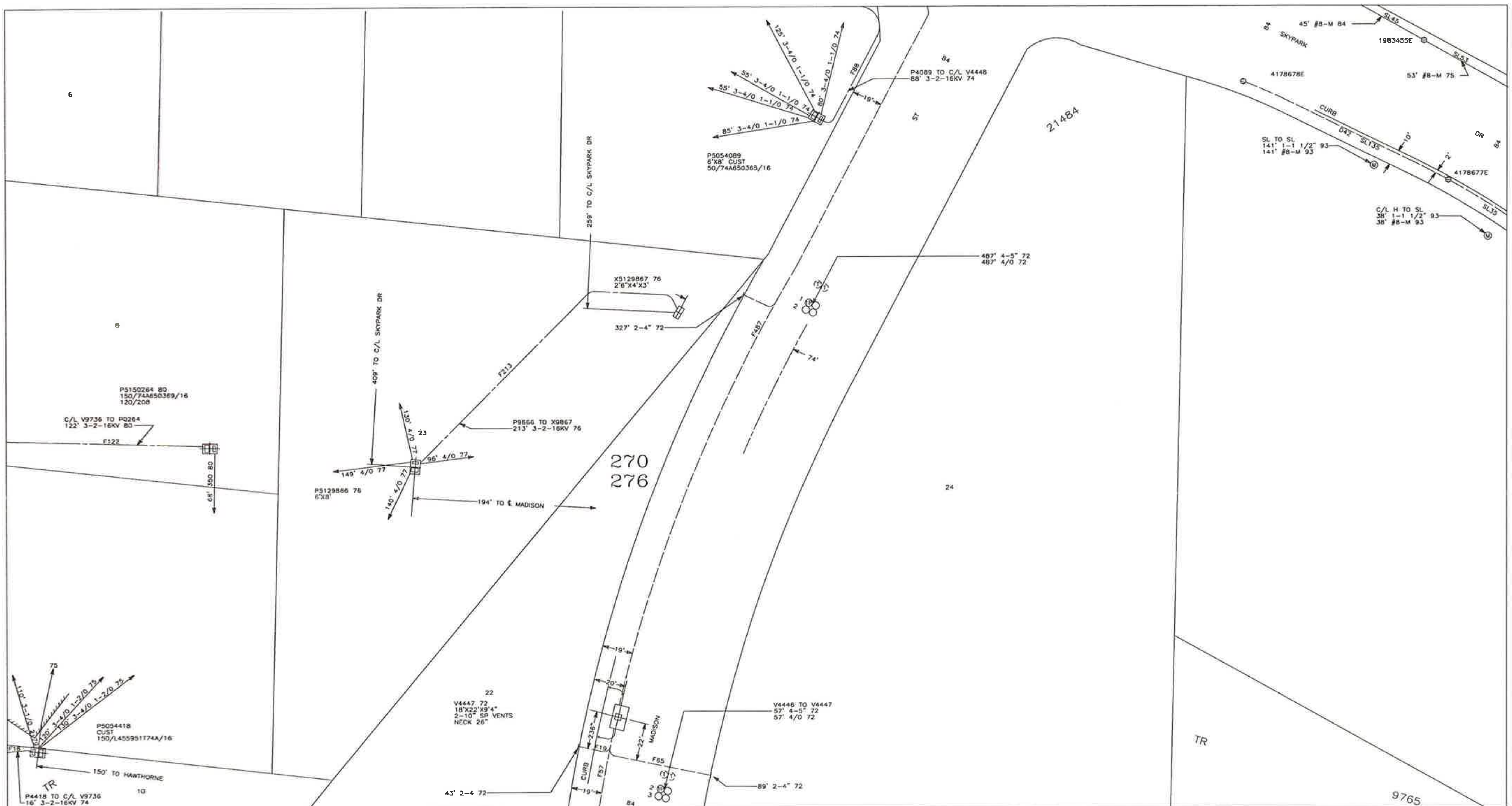
34-65B-1



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34-65B-5

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SCALE IN METERS: 9 18 27 36

SOUTH BAY

04-06

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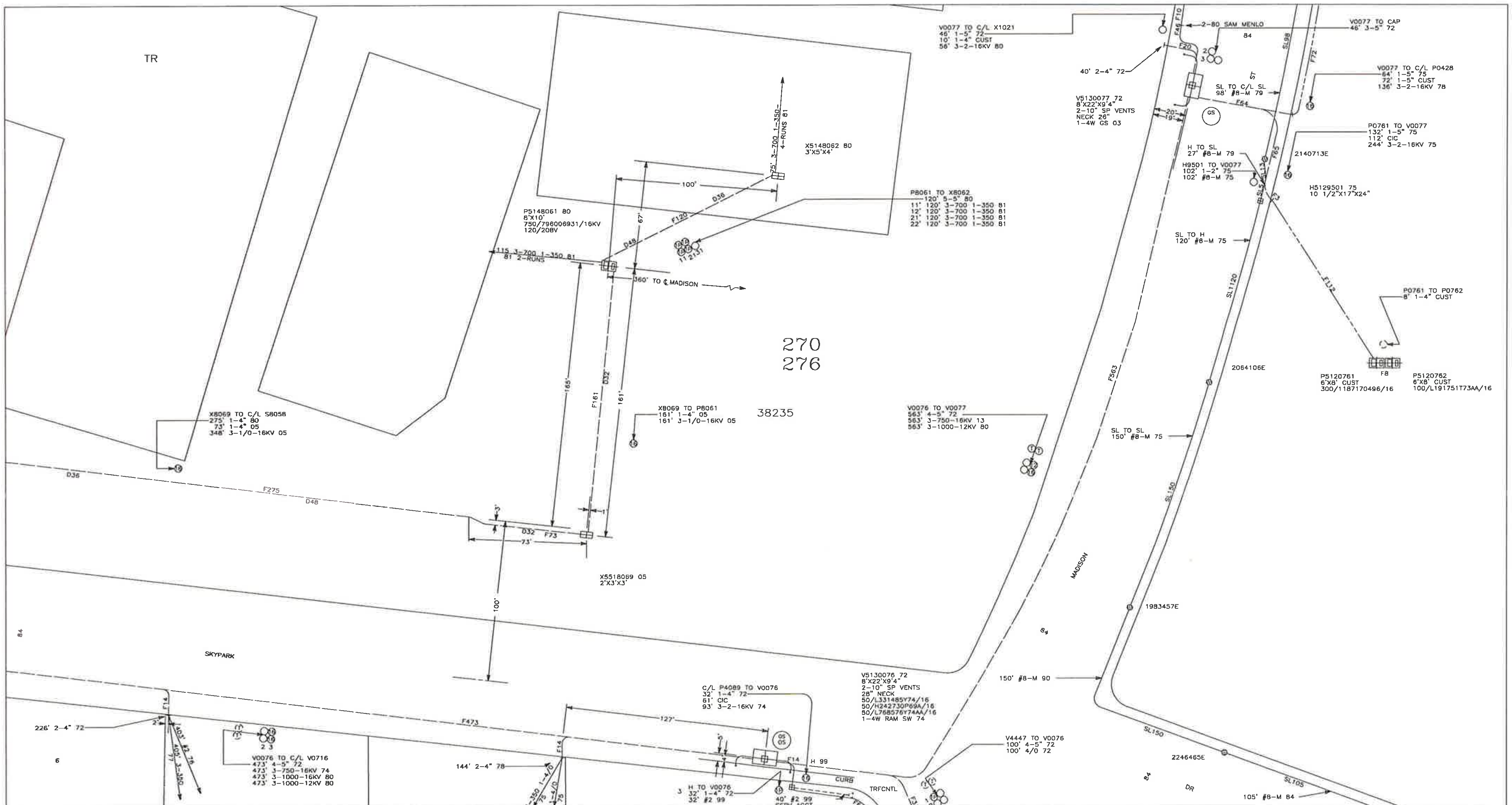
35-65D-5

TORRANCE

LOS ANGELES CO. 35-65D-8

36-65D-7



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SCALE IN METERS

35-65D-9

04-06

34-65B-2

SOUTH BAY

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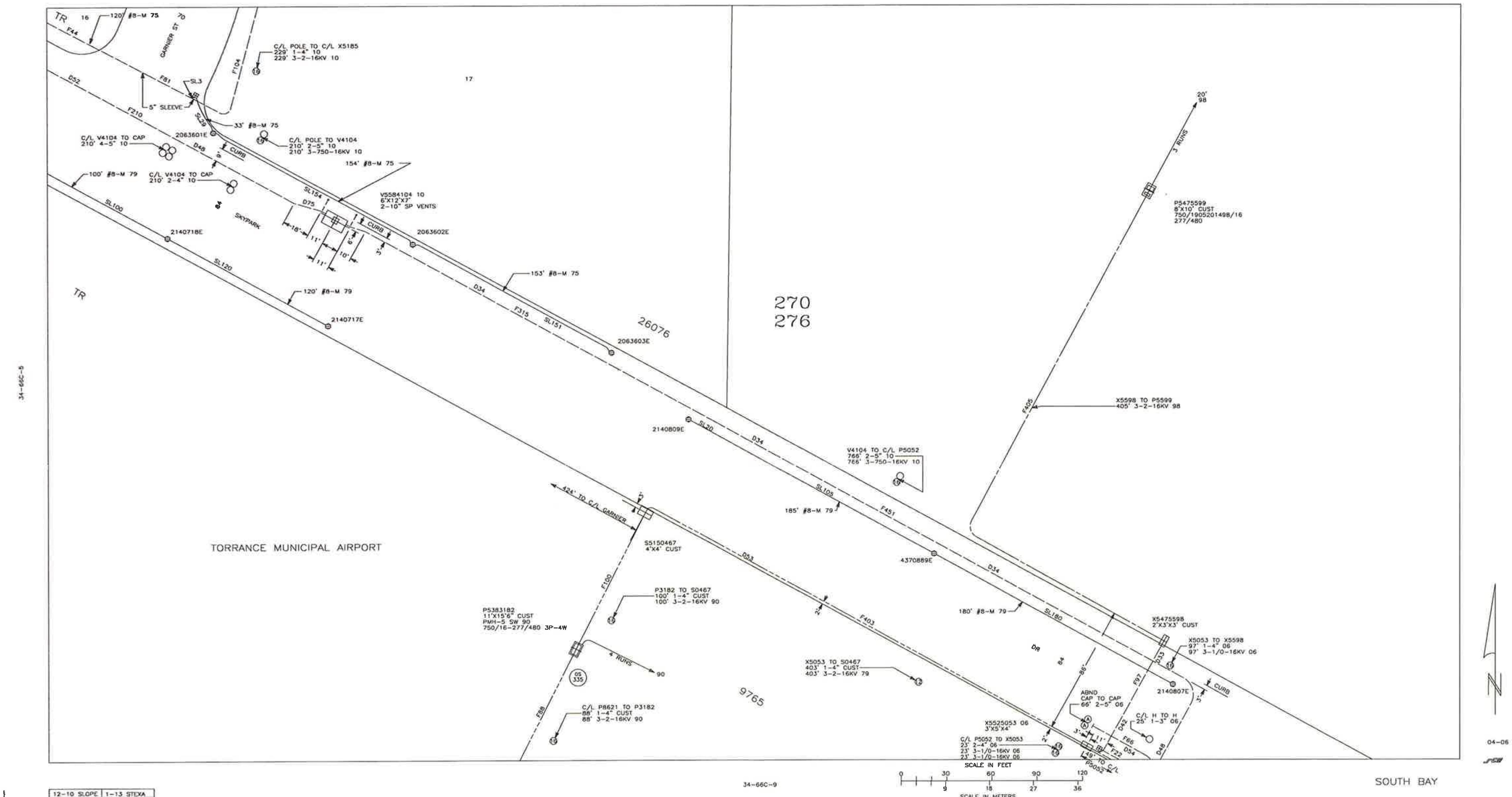

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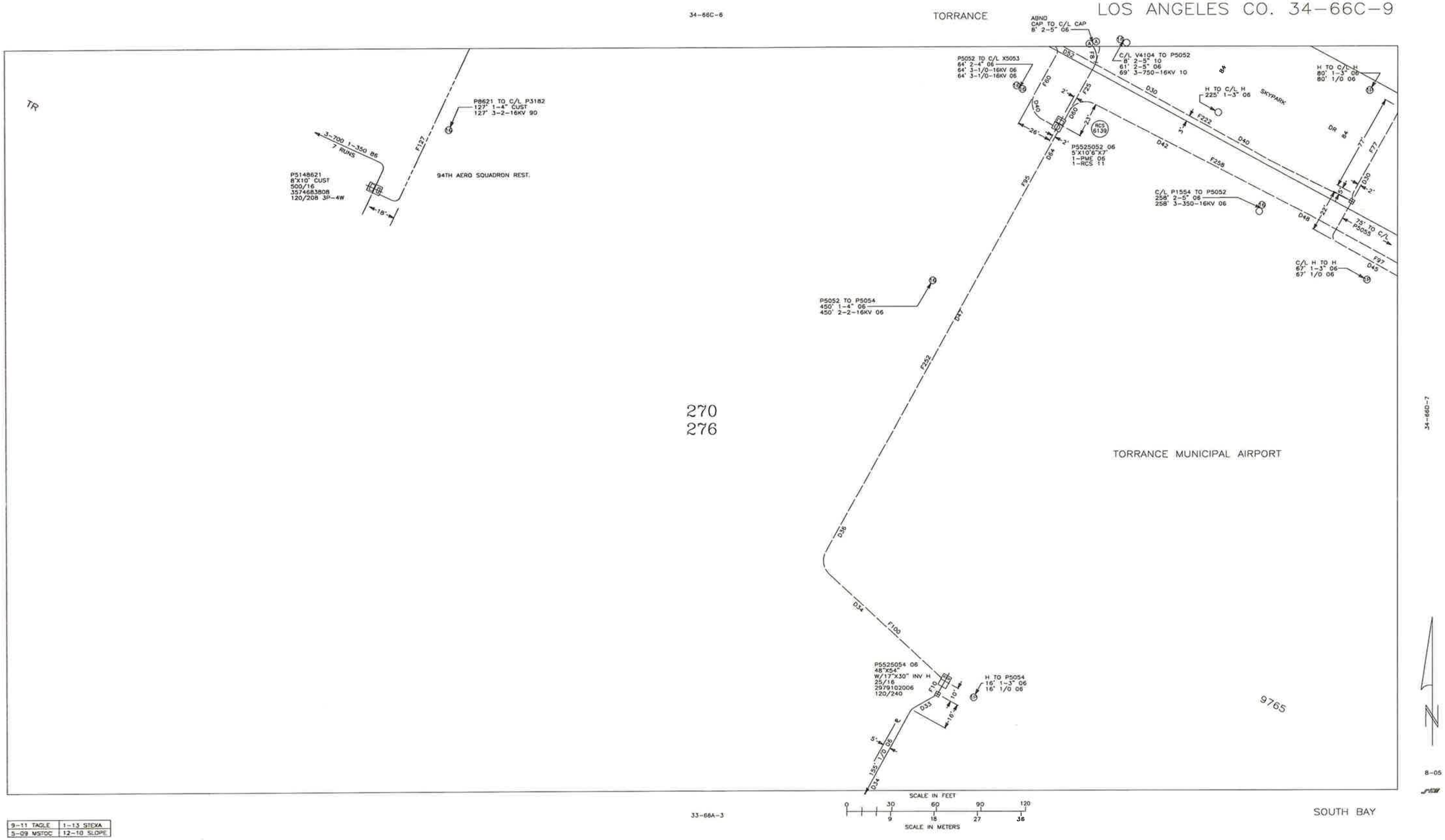

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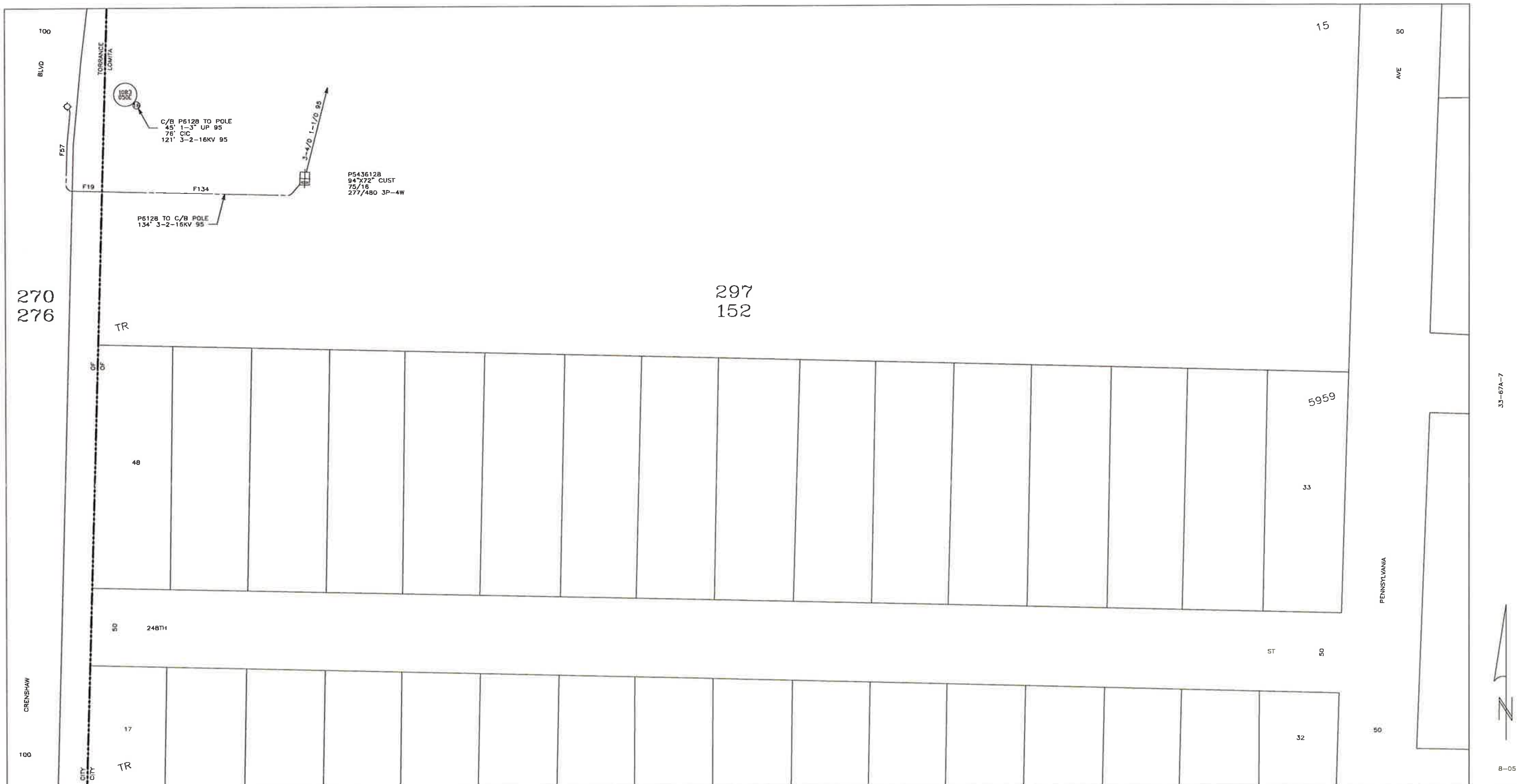

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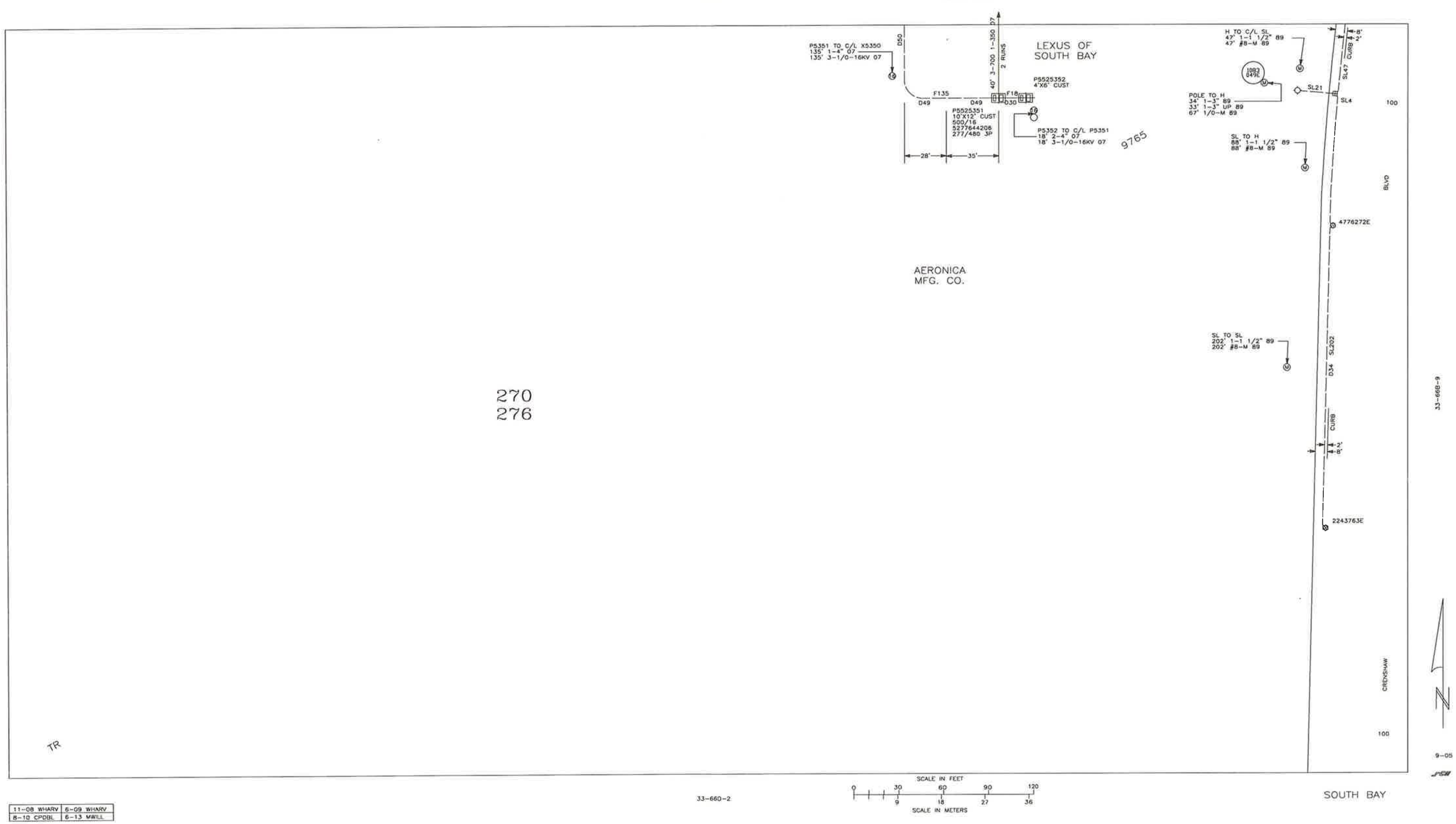

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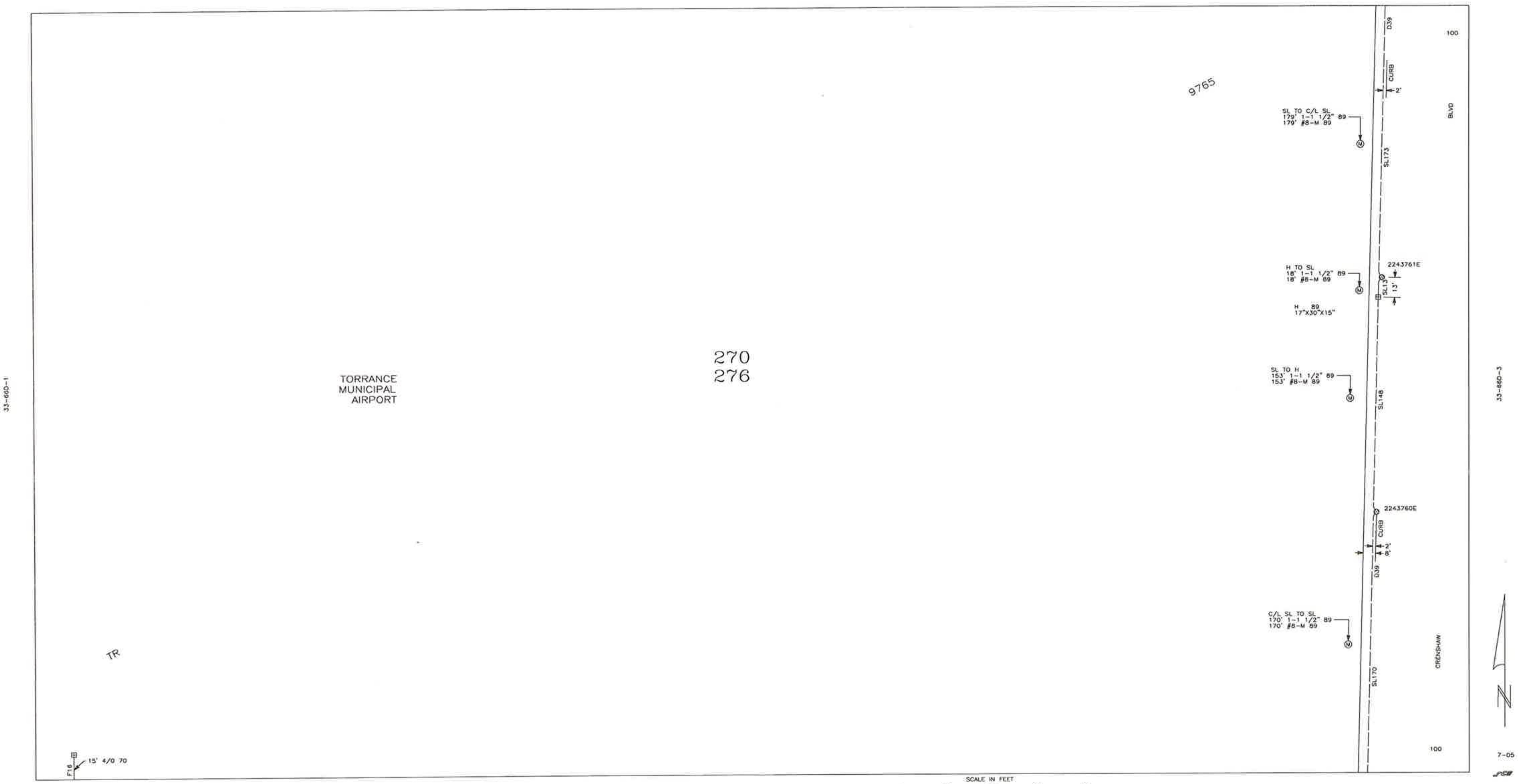

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SCALE IN METERS

SOUTH BAY

7-05

12-12 CPOBL	
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33-66B-9 LOMITA TORRANCE

LOS ANGELES CO. 33-66D-3

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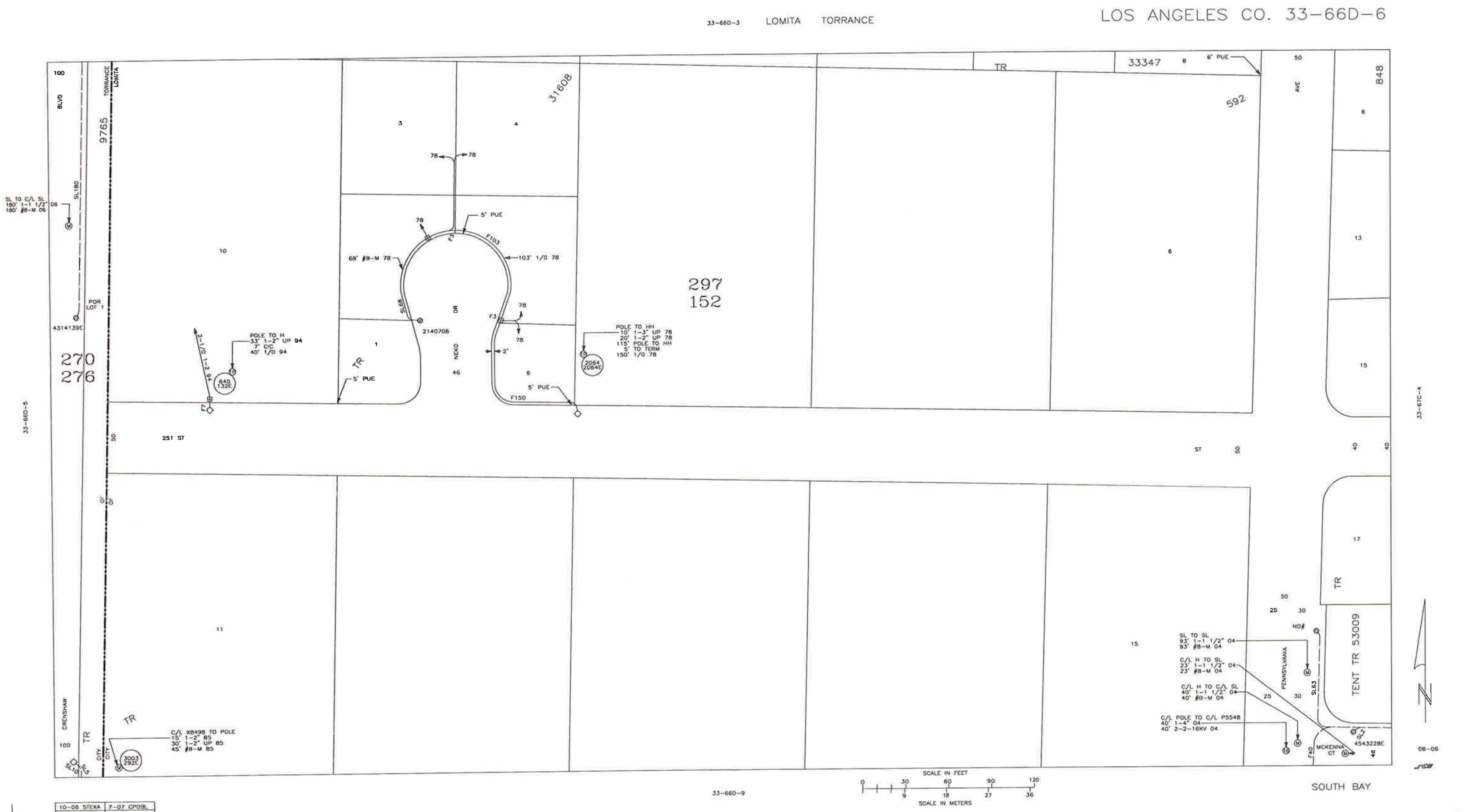
3-08 CANDR	2-10 ACALD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TORRANCE
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CRENSHAW BLVD
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NEKO DR
PENNSYLVANIA AVE
MCKENNA CT
TENT TR 53009
297
152
270
276
31608
33347
592
848
9765
POLE TO H
33' 1-2" UP 94
7' CIC
40' 1/0 94
POLE TO HH
10' 1-3" UP 78
20' 1-2" UP 78
115' POLE TO HH
5' TO TERM
150' 1/0 78
SL TO C/L SL
180' 1-1 1/2" 06
180' #8-M 06
C/L X8498 TO POLE
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30' 1-2" UP 85
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93' 1-1 1/2" 04
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C/L H TO SL
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5' PUE
6' PUE
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7-07 CPOBL
5-11 STEXA
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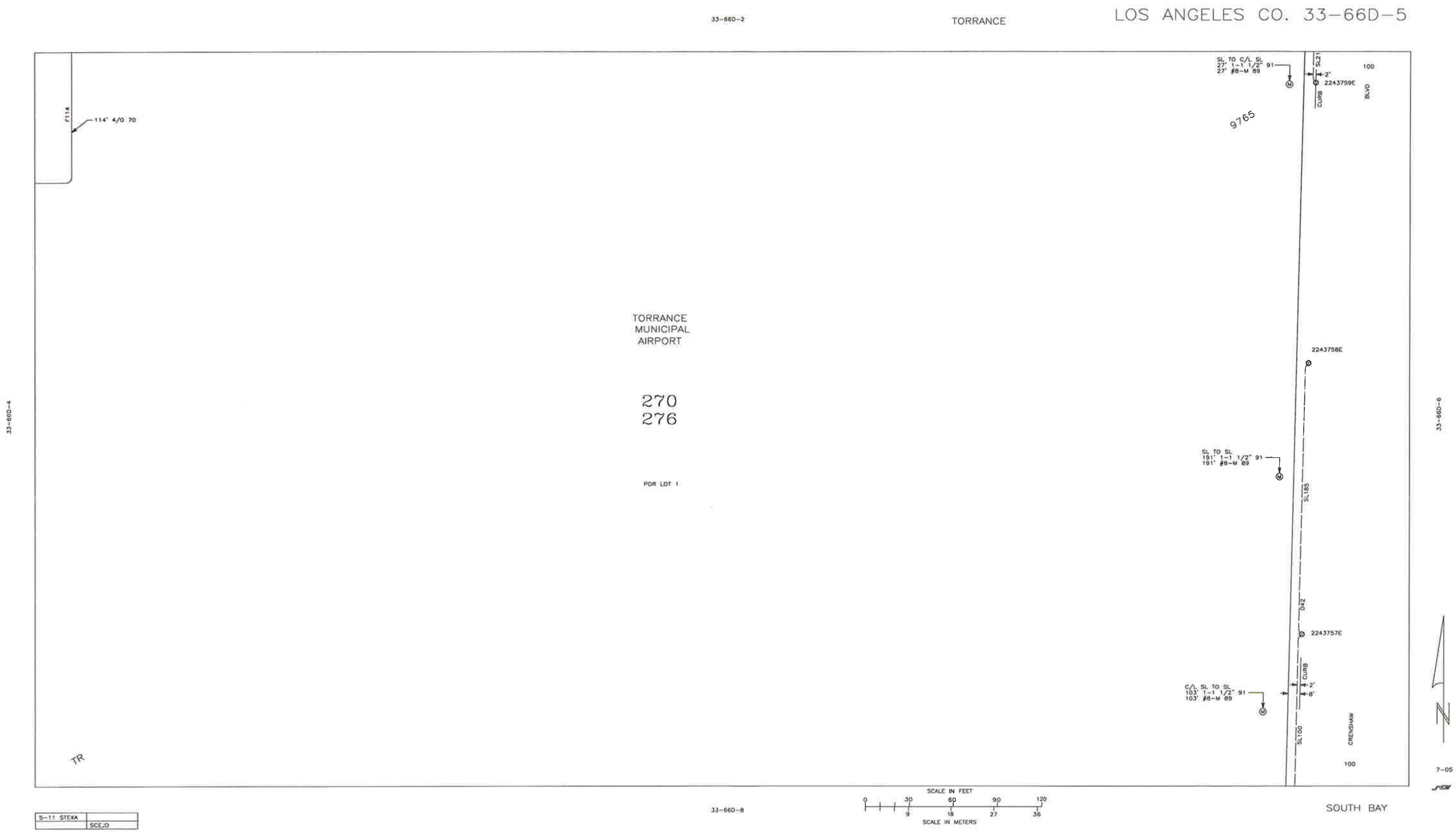
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LOS ANGELES CO. 33-66D-5
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27' #8-M 89
SL21
2'
2243759E
CURB
100
BLVD
9765
TORRANCE
MUNICIPAL
AIRPORT
270
276
POR LOT 1
2243758E
SL TO SL
191' 1-1 1/2" 91
191' #8-M 89
SL185
D42
2243757E
CURB
C/L SL TO SL
103' 1-1 1/2" 91
103' #8-M 89
2'
8'
SL100
CRENSHAW
100
TR
33-66D-4
33-66D-6
7-05
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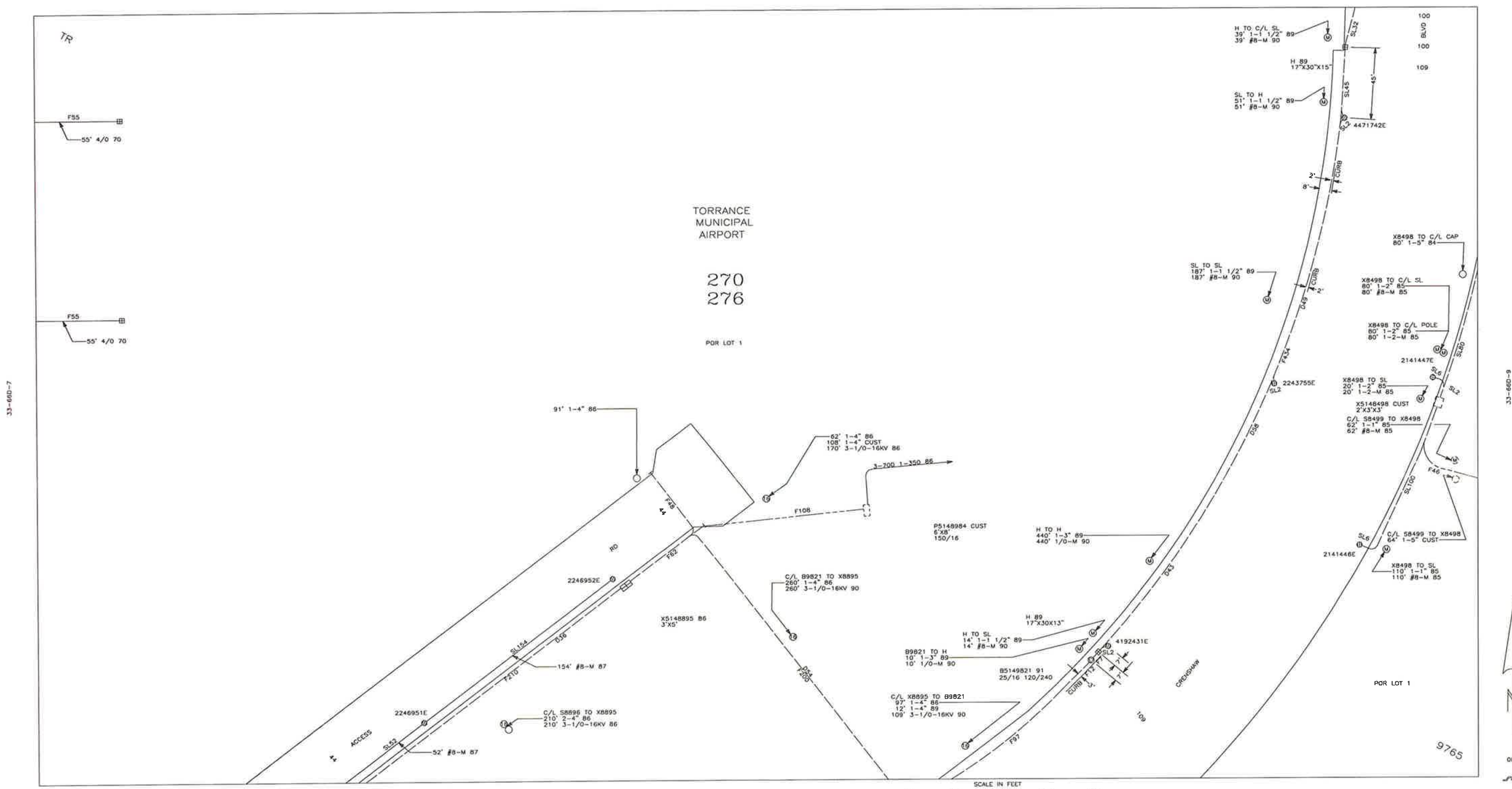
33-66D-8
SOUTH BAY
5-11 STEXA
SCEJO



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SCALE IN METERS 9 18 27 36

SOUTH BAY

08-06

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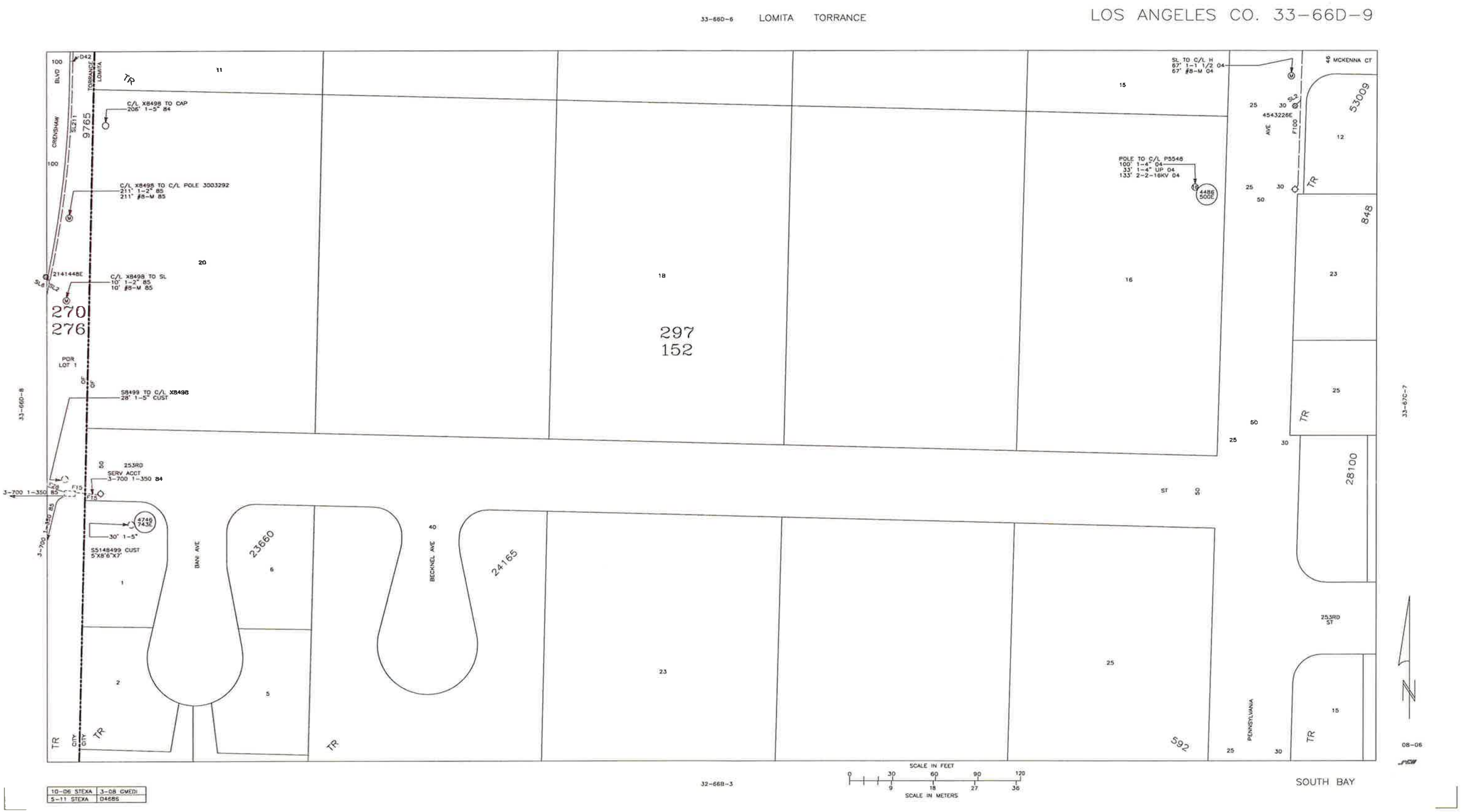
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TORRANCE
LOS ANGELES CO. 33-66D-9
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TORRANCE LOMITA
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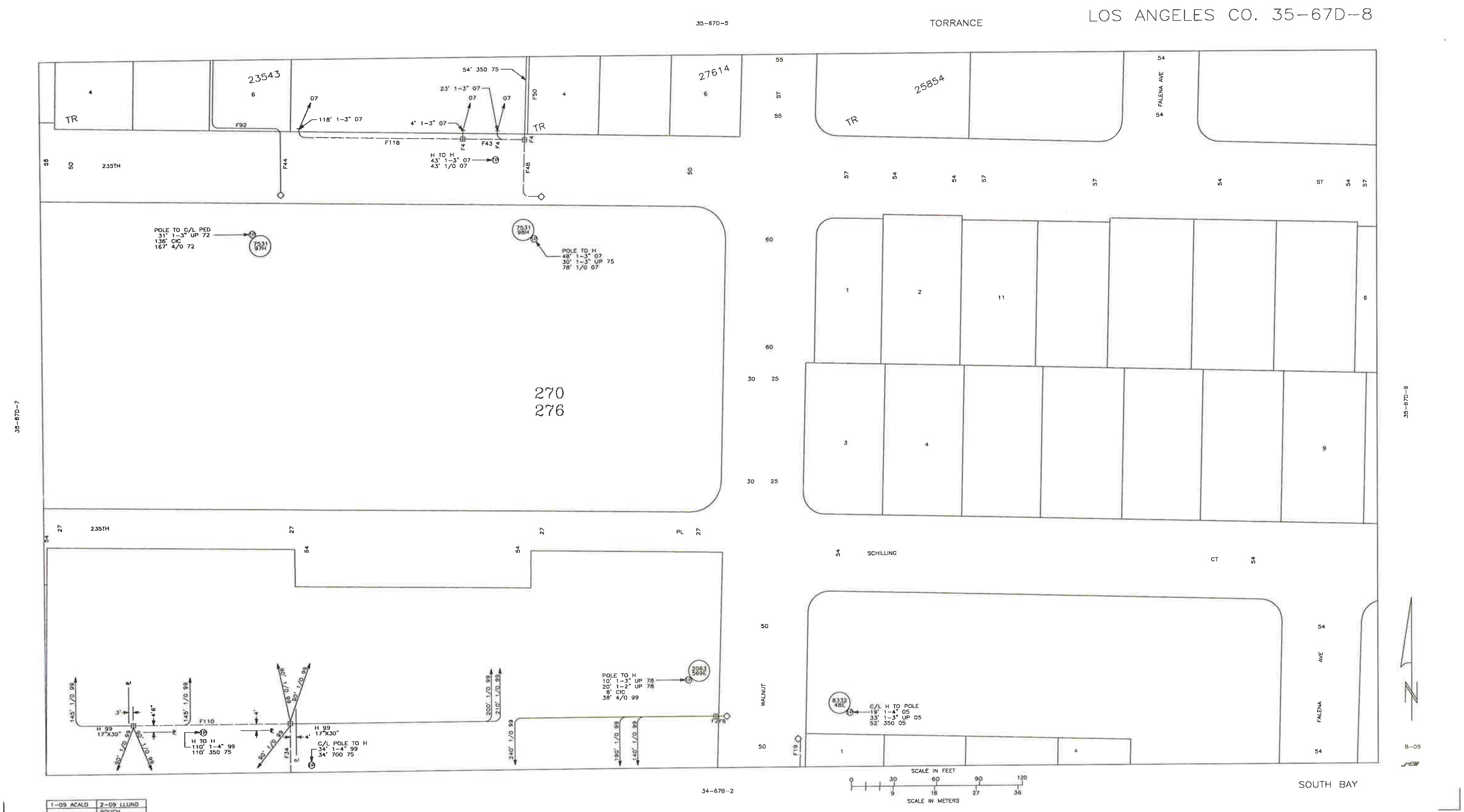
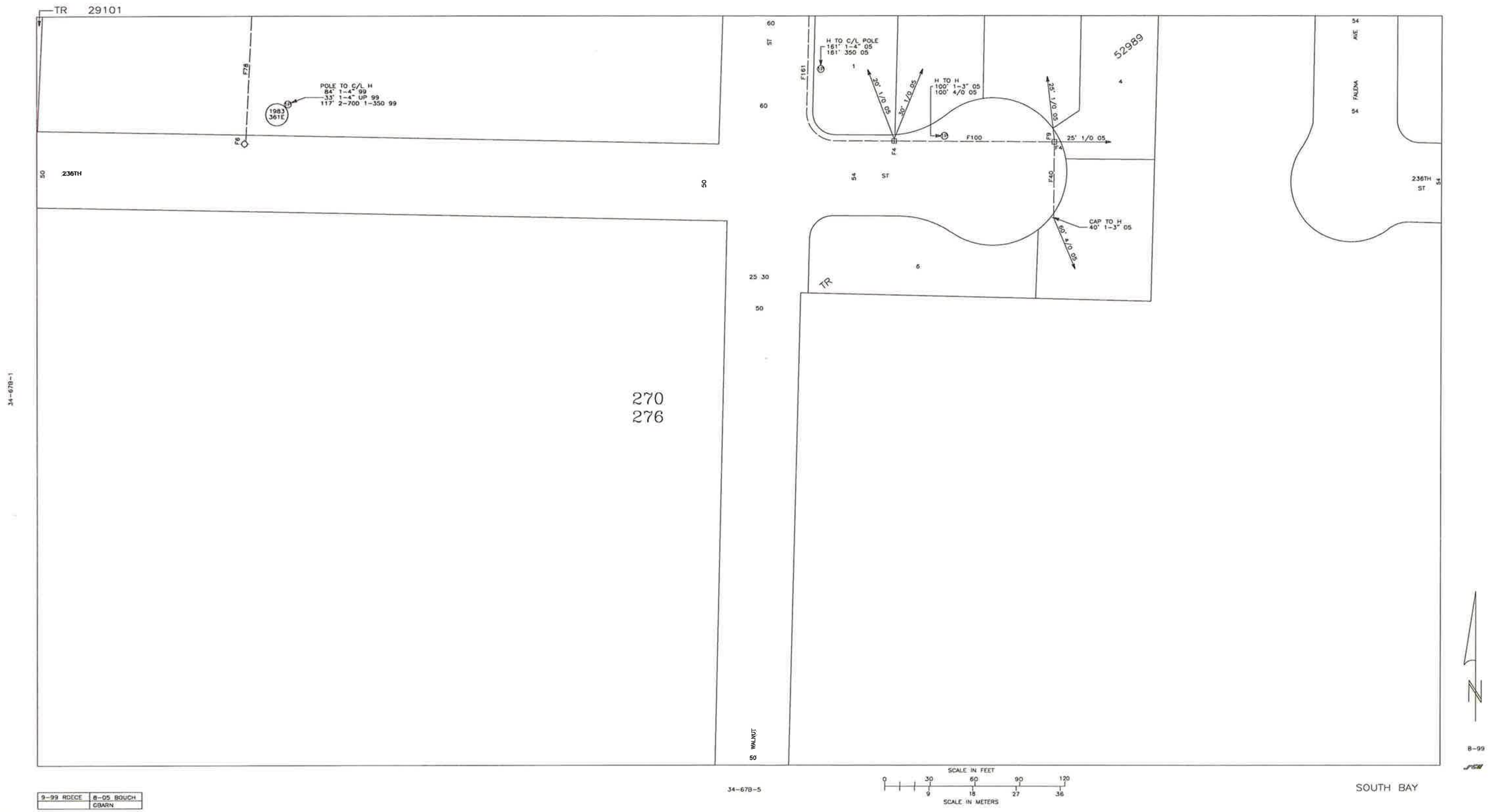
C/L X8498 TO C/L POLE 3003292 211' 1-2" 85 211' #8-M 85
2141448E
C/L X8498 TO SL 10' 1-2" 85 10' #8-M 85
270
276
POR LOT 1
S8499 TO C/L X8498 28' 1-5" CUST
297
152
SL TO C/L H 67' 1-1 1/2 04 67' #8-M 04
MCKENNA CT
53009
4543226E
POLE TO C/L P5546 100' 1-4" 04 33' 1-4" UP 04 133' 2-2-16KV 04
4486 500E
848
28100
253RD SERV ACCT 3-700 1-350 84
3-700 1-350 85
4749 743E
S5148499 CUST 5'X8'6"X7'
BANI AVE
23660
BECKNEL AVE
24165
PENNSYLVANIA AVE
253RD ST
592
33-67C-7
33-66D-8
32-66B-3
SCALE IN FEET
SCALE IN METERS
SOUTH BAY
08-06
10-06 STEXA 3-08 GMEDI
5-11 STEXA D4685

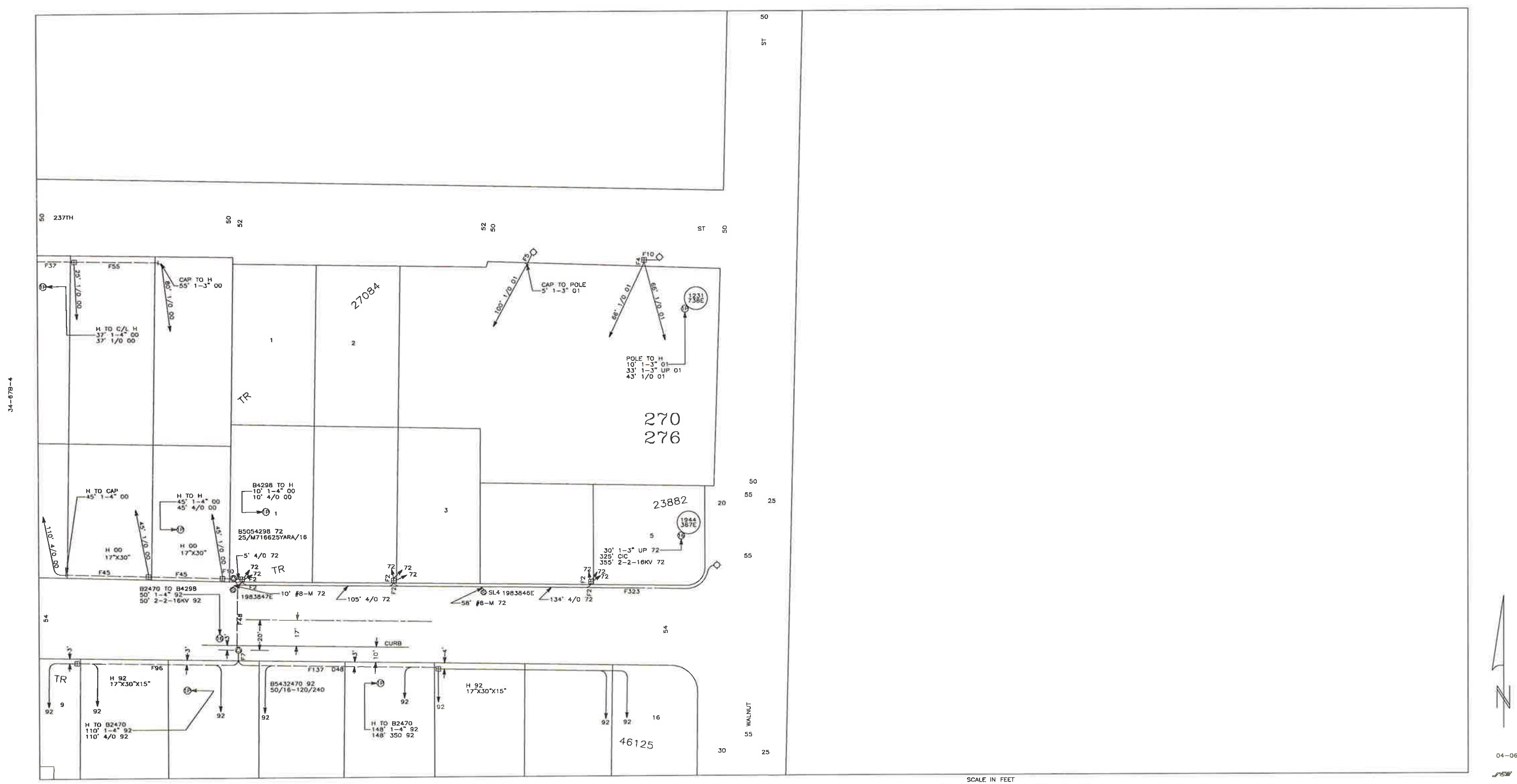

LOS ANGELES CO. 35-67D-8
TORRANCE
35-67D-5
35-67D-7
35-67D-9
34-67B-2
23543
27614
25854
270
276
235TH
235TH
PL
WALNUT
ST
SCHILLING
CT
FALENA AVE
POLE TO C/L PED
31' 1-3" UP 72
136' CIC
167' 4/0 72
POLE TO H
48' 1-3" 07
30' 1-3" UP 75
78' 1/0 07
H TO H
43' 1-3" 07
43' 1/0 07
POLE TO H
10' 1-3" UP 78
20' 1-2" UP 78
8' CIC
38' 4/0 99
C/L H TO POLE
19' 1-4" 05
33' 1-3" UP 05
52' 350 05
H TO H
110' 1-4" 99
110' 350 75
C/L POLE TO H
34' 1-4" 99
34' 700 75
SCALE IN FEET
SCALE IN METERS
SOUTH BAY
1-09 ACALD
2-09 LLUND
BOUCH
8-05

35-670-8 TORRANCE LOS ANGELES CO. 34-67B-2



SOUTH BAY

34-67B-2 TORRANCE LOS ANGELES CO. 34-67B-5

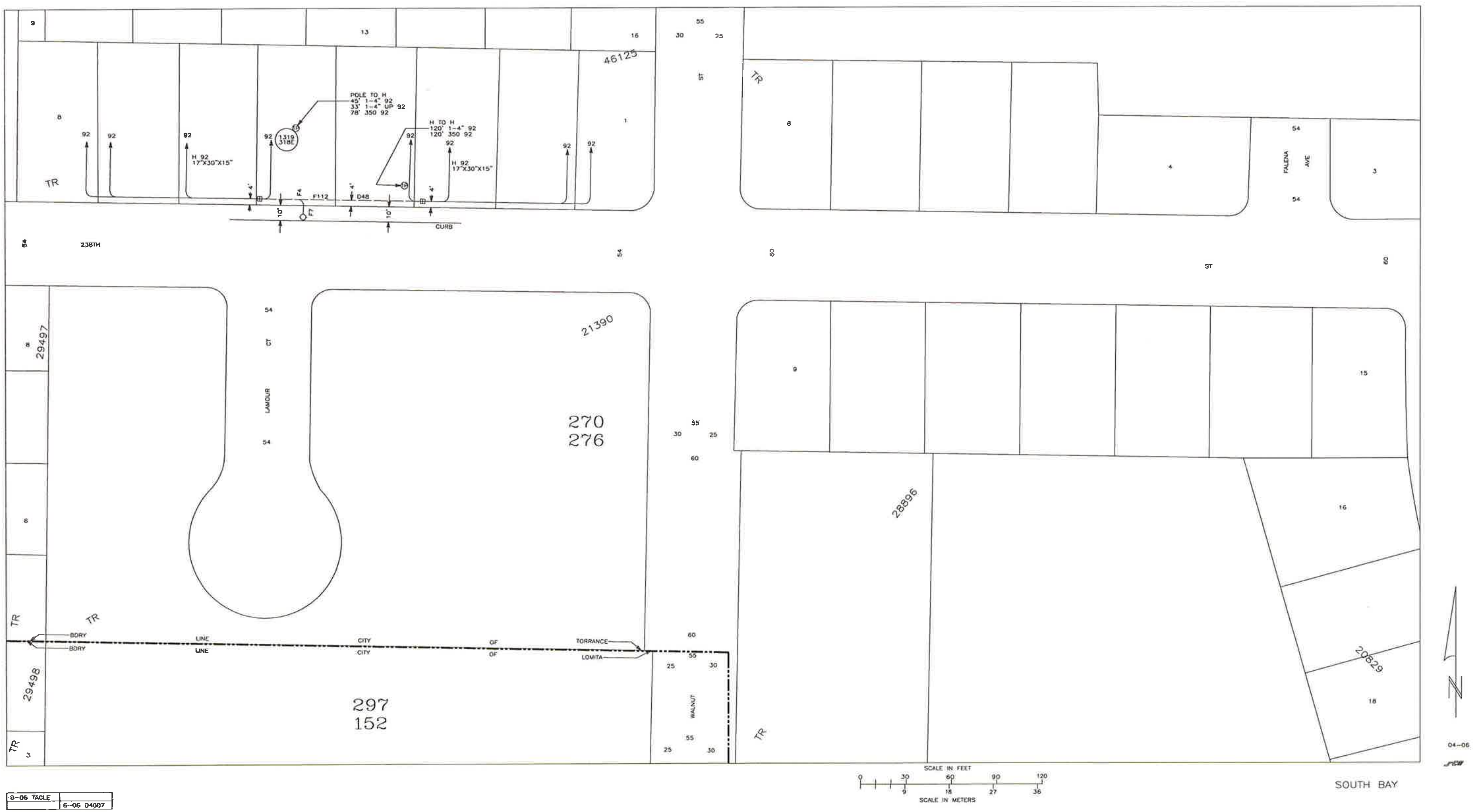


SOUTH BAY

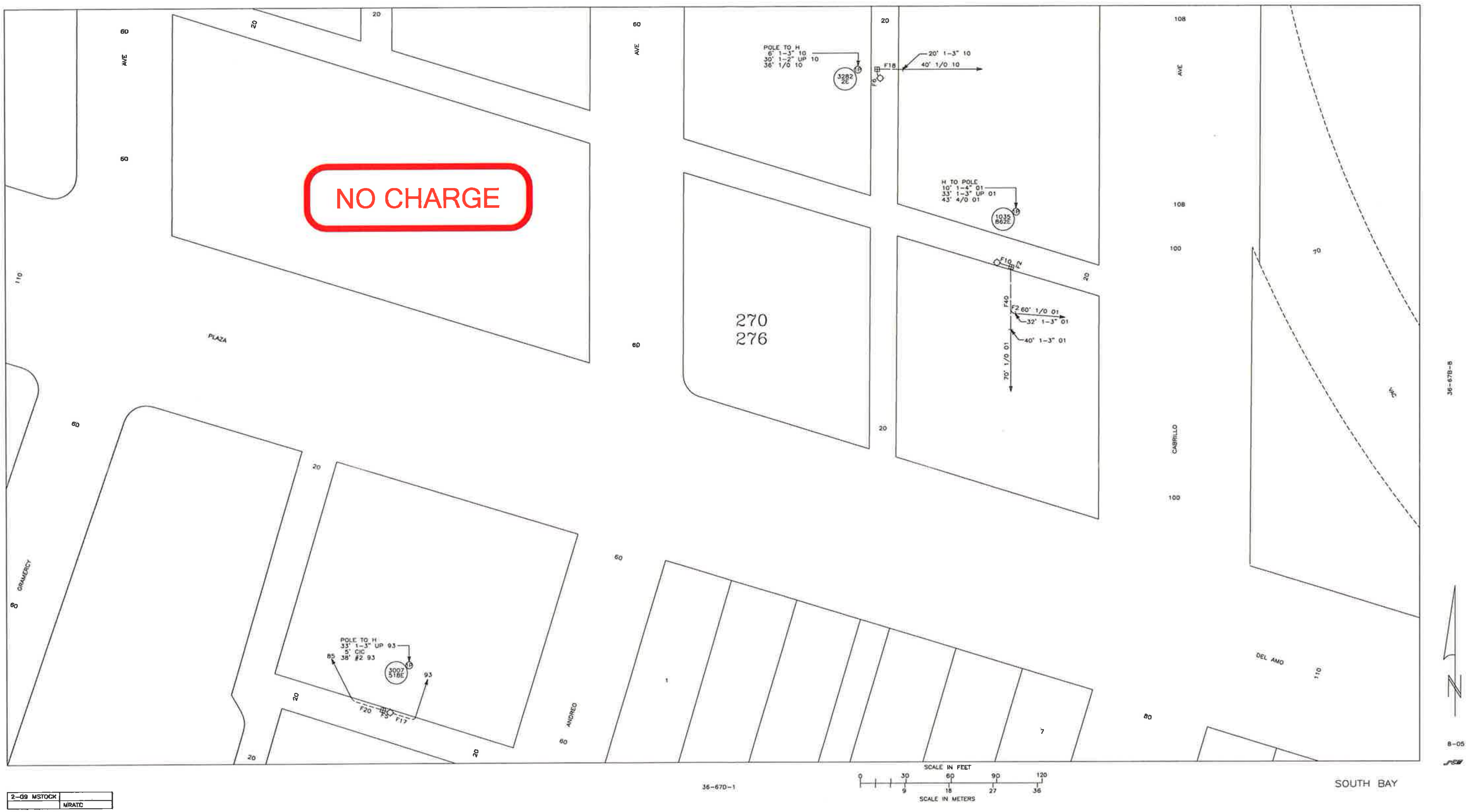
9-06 TAGLE	
	6-06 04007

34-67B-5 LOMITA TORRENCE

LOS ANGELES CO. 34-67B-8

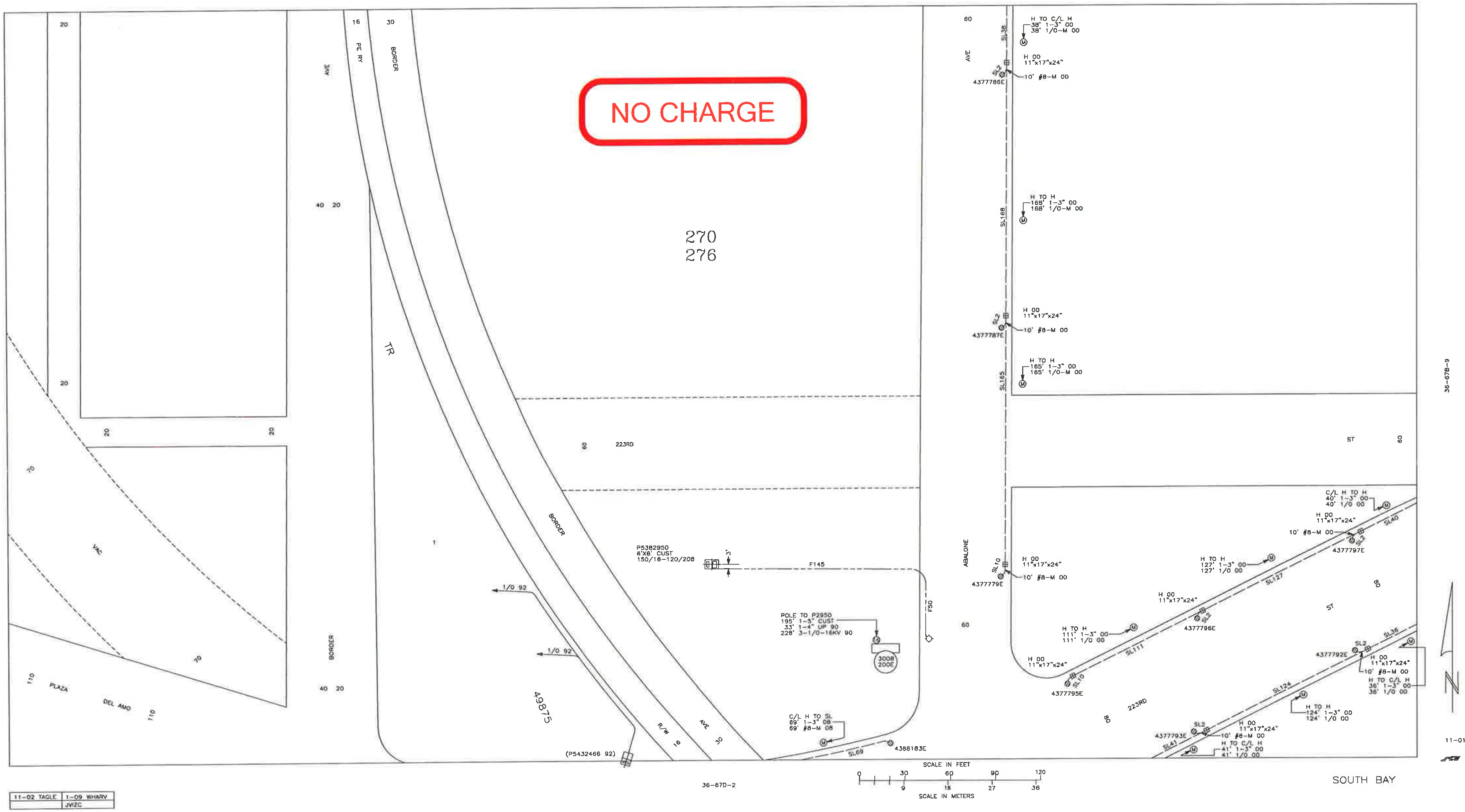


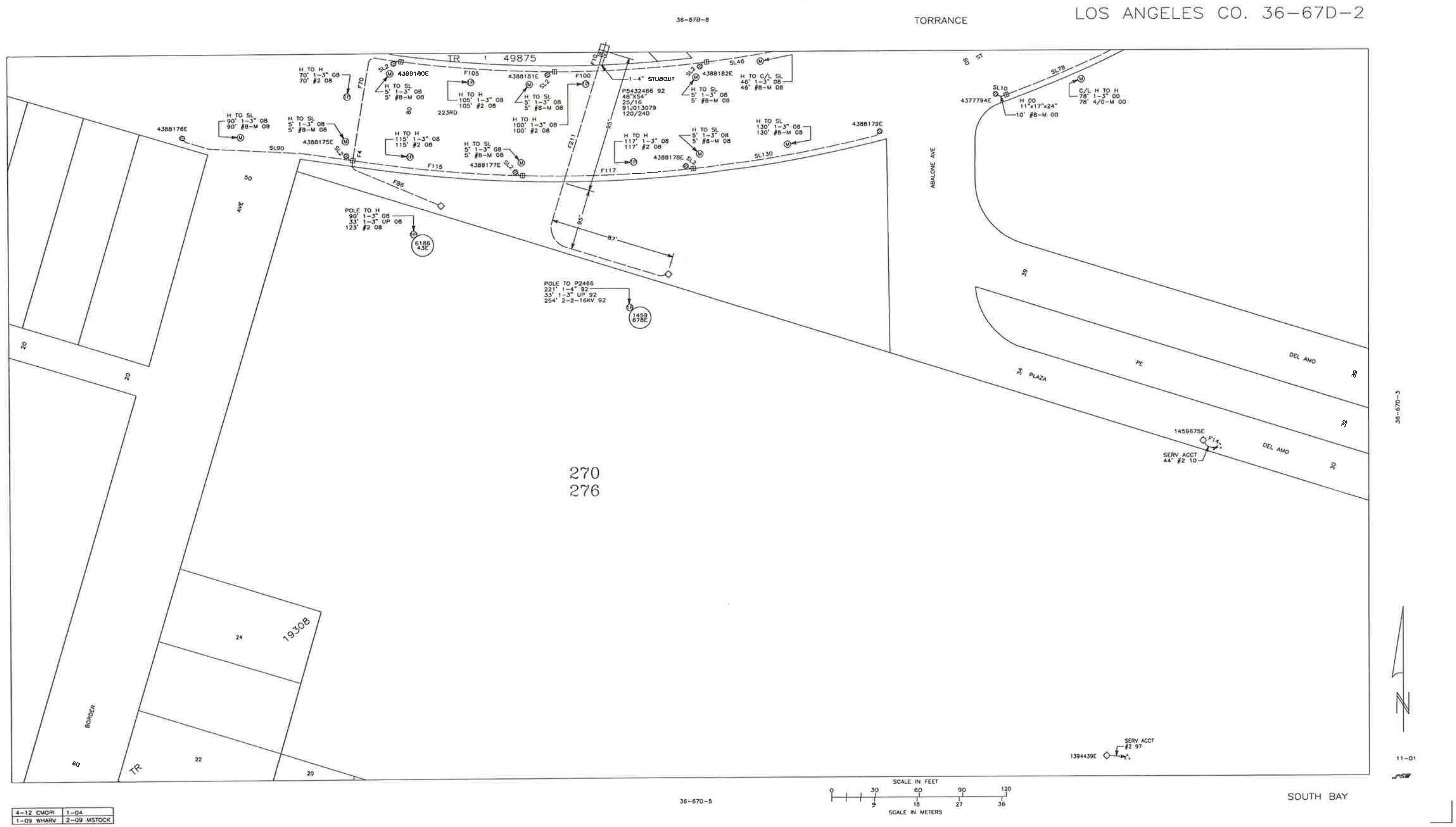
LOS ANGELES CO. 36–67B–7



LOS ANGELES CO. 36-67B-8

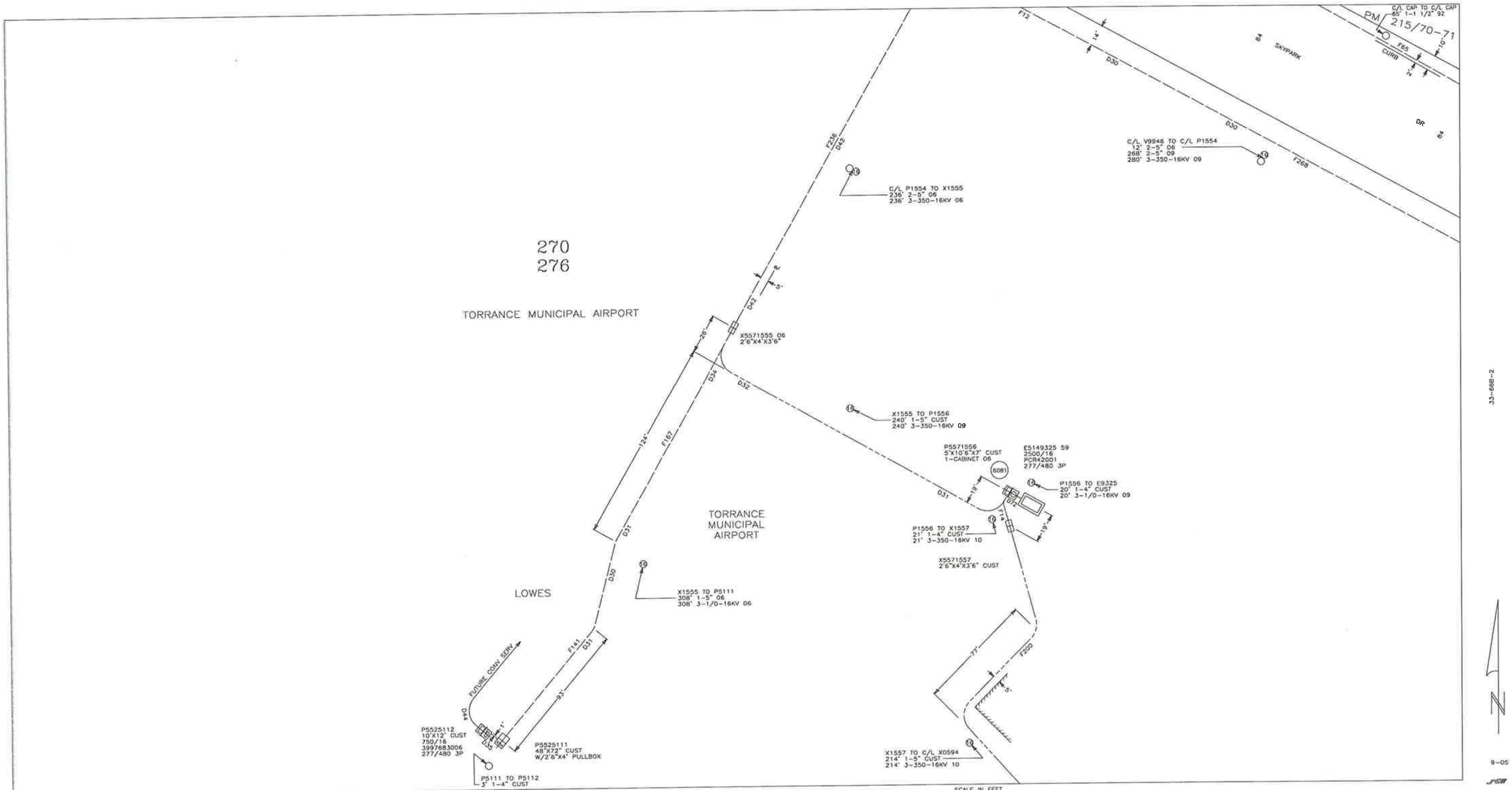
TORRANCE




LOS ANGELES CO. 36-67D-2
TORRANCE
36-67B-8
TR 1 49875
ABALONE AVE
PLAZA
DEL AMO
DEL AMO
270
276
19308
BORDER
AVE
TR
36-67D-1
36-67D-3
36-67D-5
SCALE IN FEET
SCALE IN METERS
SOUTH BAY
4-12 CMORI 1-04
1-09 WHARV 2-09 MSTOCK

LOS ANGELES CO. 33-66B-1

34-66D-7 TORRANCE



33-66B-4

SCALE IN FEET 0 30 60 90 120
SCALE IN METERS 9 18 27 36

SOUTH BAY

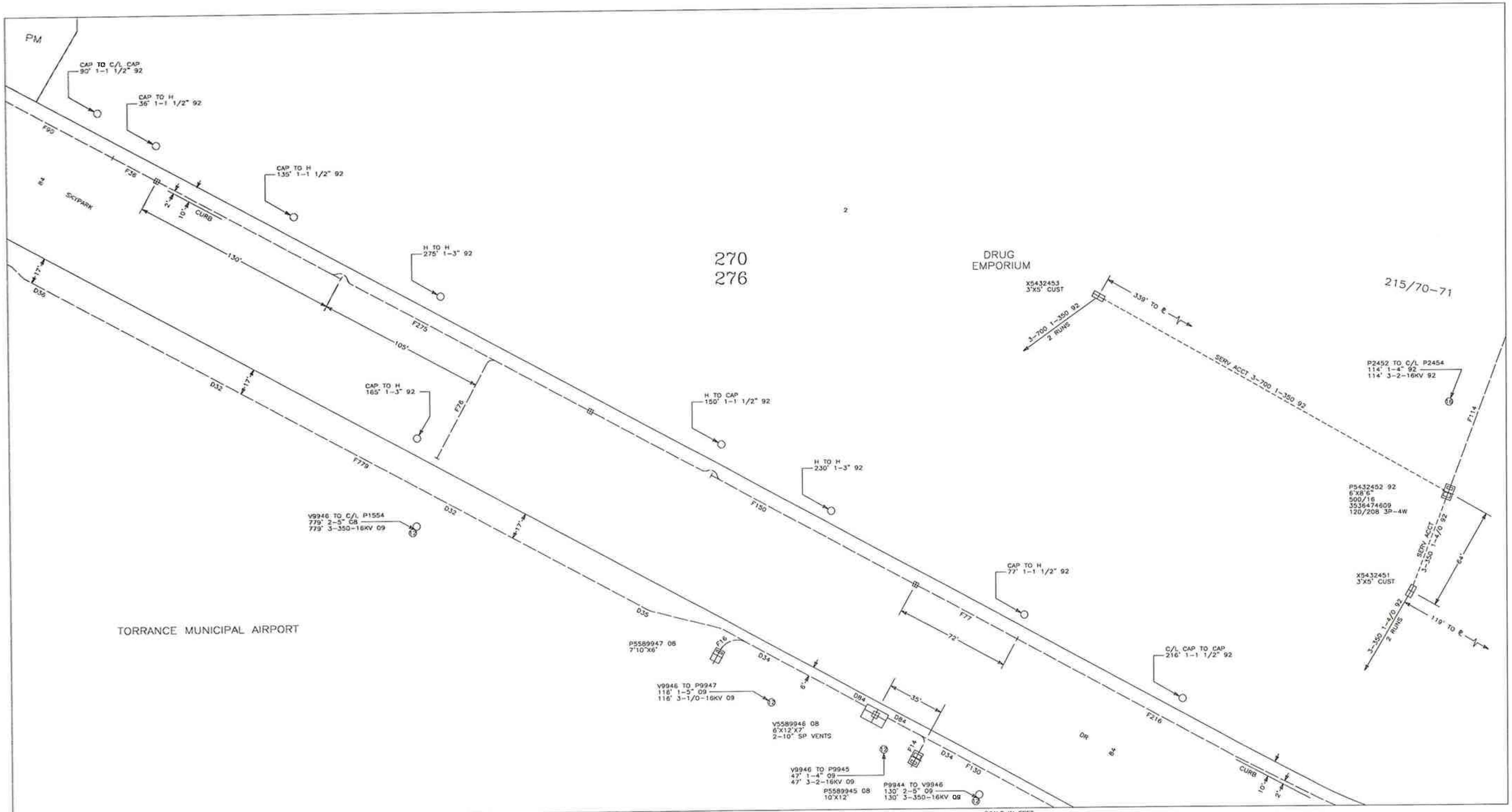
1-07 FVENE	3-10 AMEND
7-10 MROSE	1-13 STEXA

CONFIDENTIAL: CRITICAL ENERGY INFRASTRUCTURE

This diagram contains information relating to Southern California Edison Company's electric transmission/distribution system. It is classified as Critical Energy Infrastructure Information as defined in 18 code of Federal Regulations section 388.113(c)(1).

FOR REFERENCE ONLY This map has been created to SCE standards to be used by SCE personnel only and is not intended to be a legal representation of real property. Please don't forget to call Dig Alert: 1-800-227-2600

34-66D-8 TORRANCE LOS ANGELES CO. 33-66B-2



33-66B-1 33-66B-3

33-66B-5

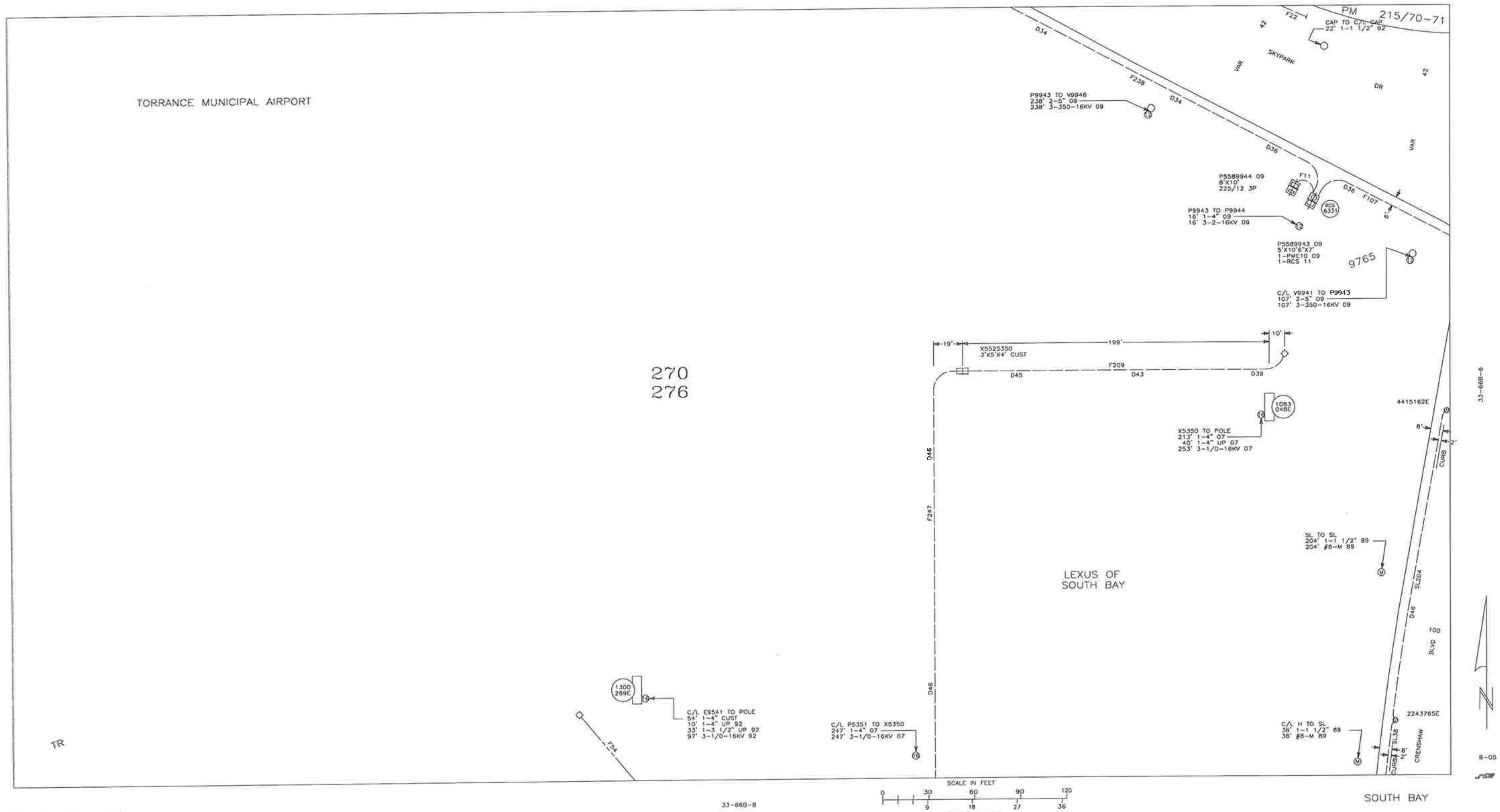
SCALE IN FEET 0 30 60 90 120
SCALE IN METERS 9 18 27 36

SOUTH BAY

9-05

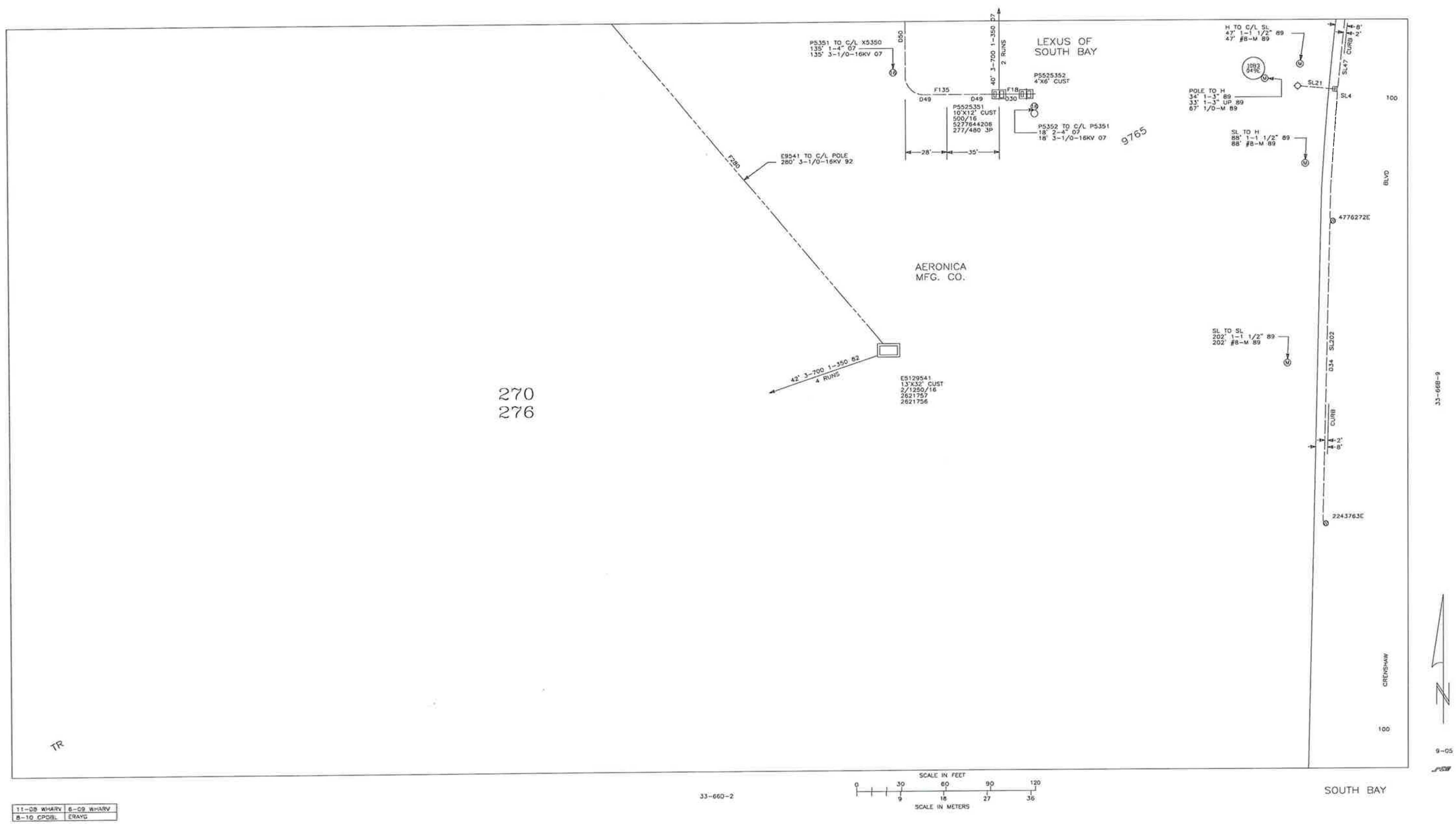
1-07 FVENE	3-10 AMEND
11-11 SSARE	1-13 STEXA

LOS ANGELES CO. 33-66B-5

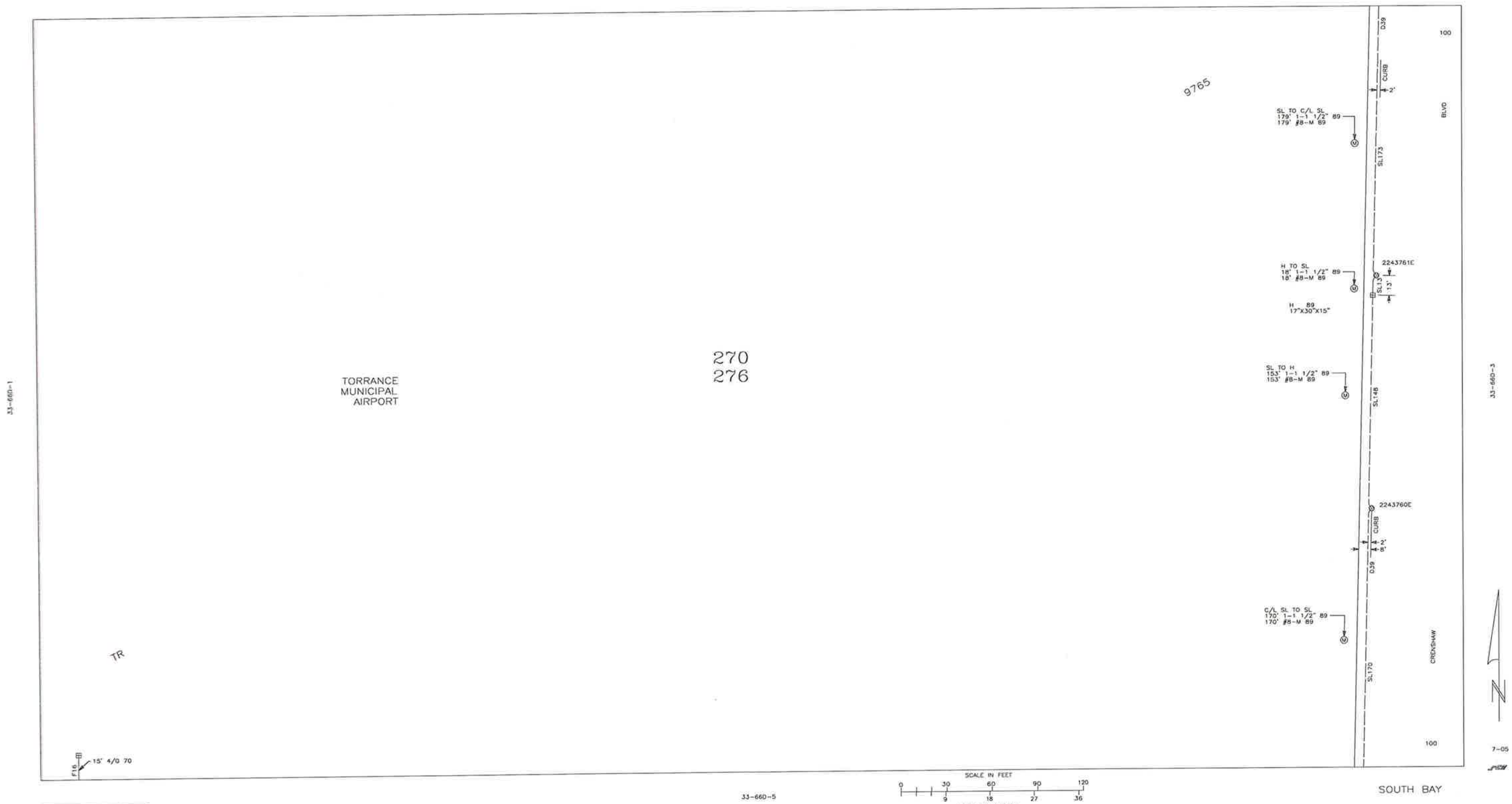


8-10 CPCBL	1-13 STEXA
11-08 WHARV	3-10 AMEND

LOS ANGELES CO. 33-66B-8

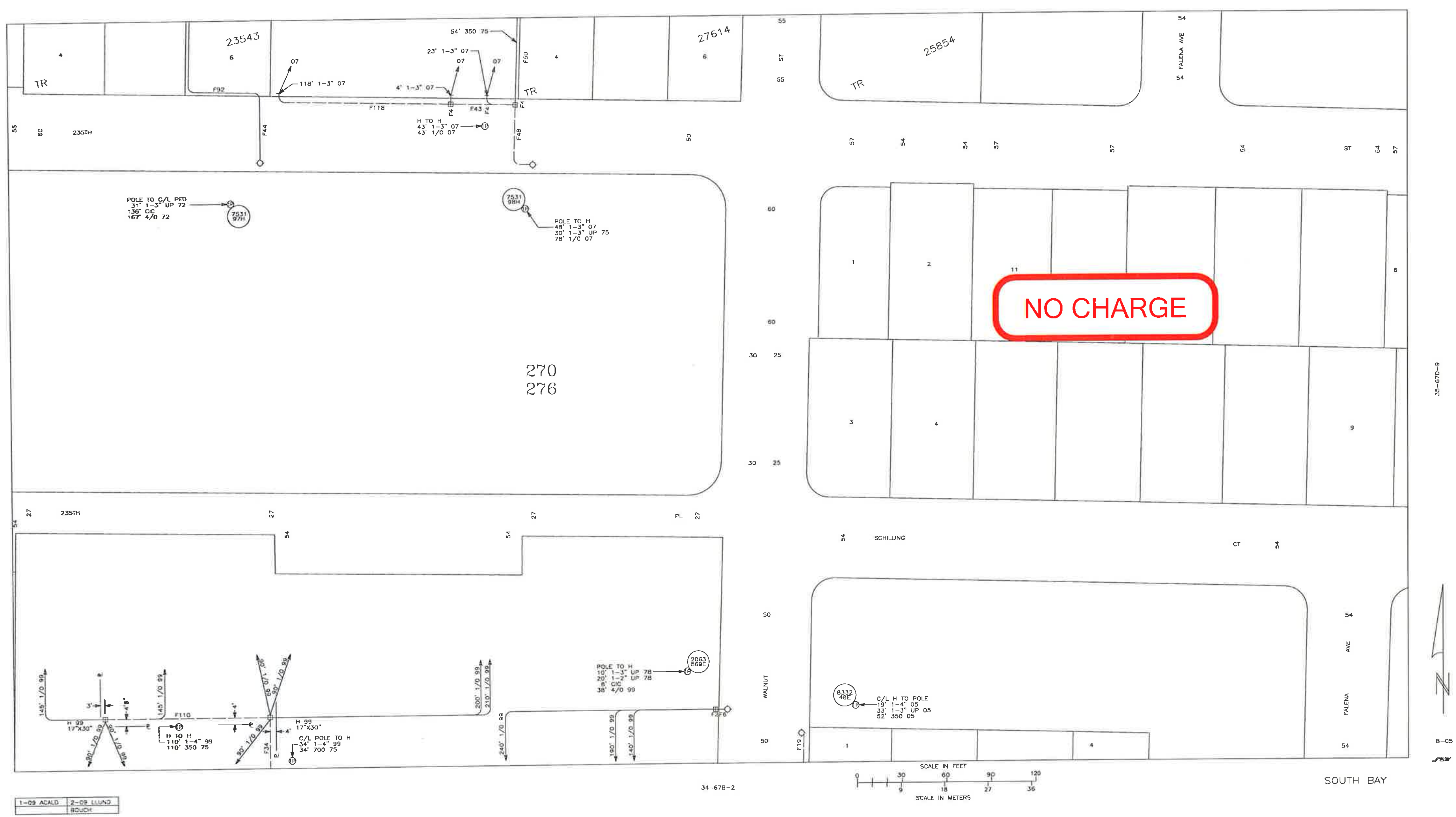


33-66D-8 TORRANCE LOS ANGELES CO. 33-66D-2



12-12 CPO8L	
	SCEJO

LOS ANGELES CO. 35-67D-8



35-67D-6 TORRANCE LOS ANGELES

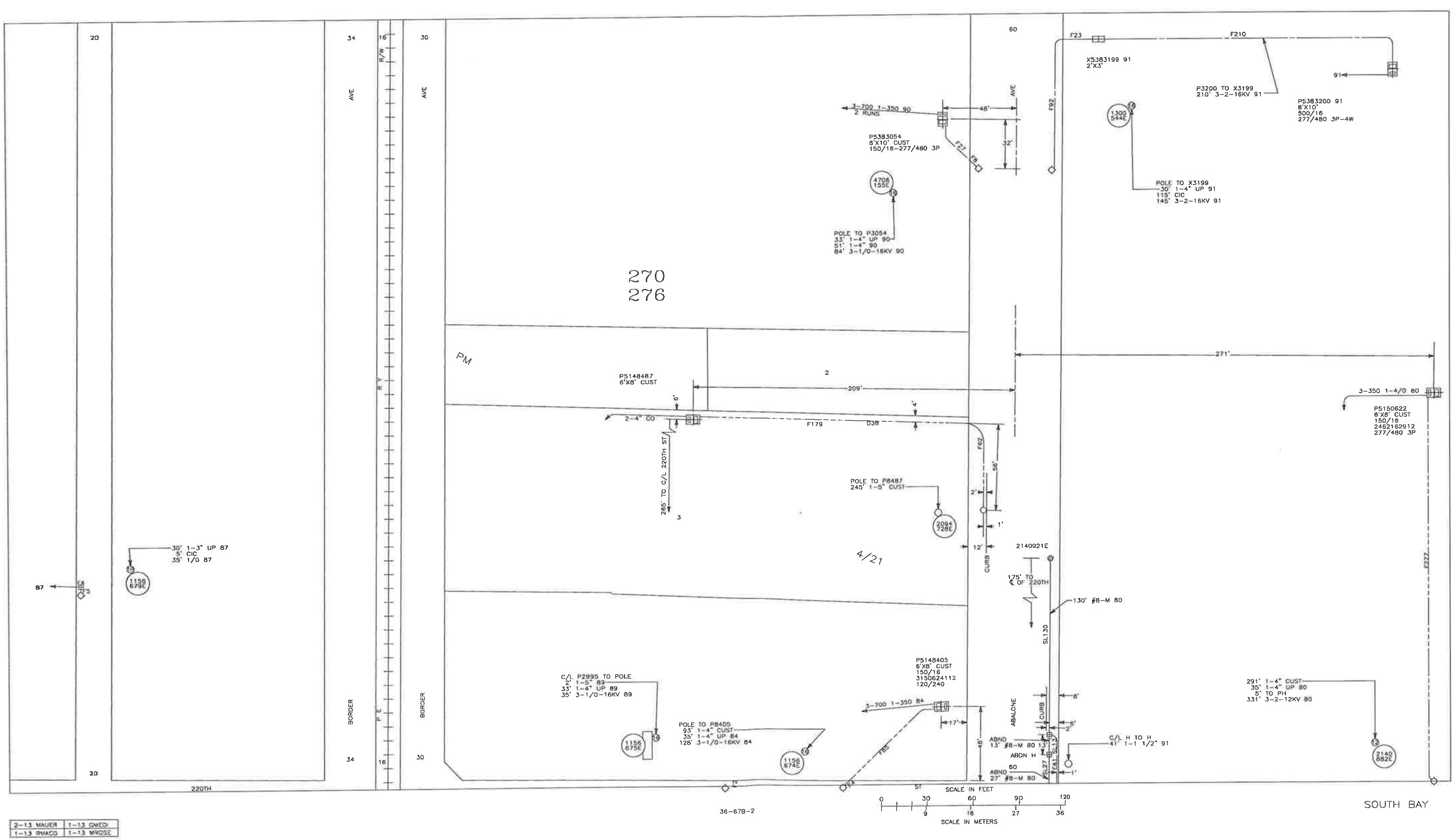
LOS ANGELES CO. 35-67D-9

SOUTH BAY

2-09 ACALD 5-10 MBATE STEXA

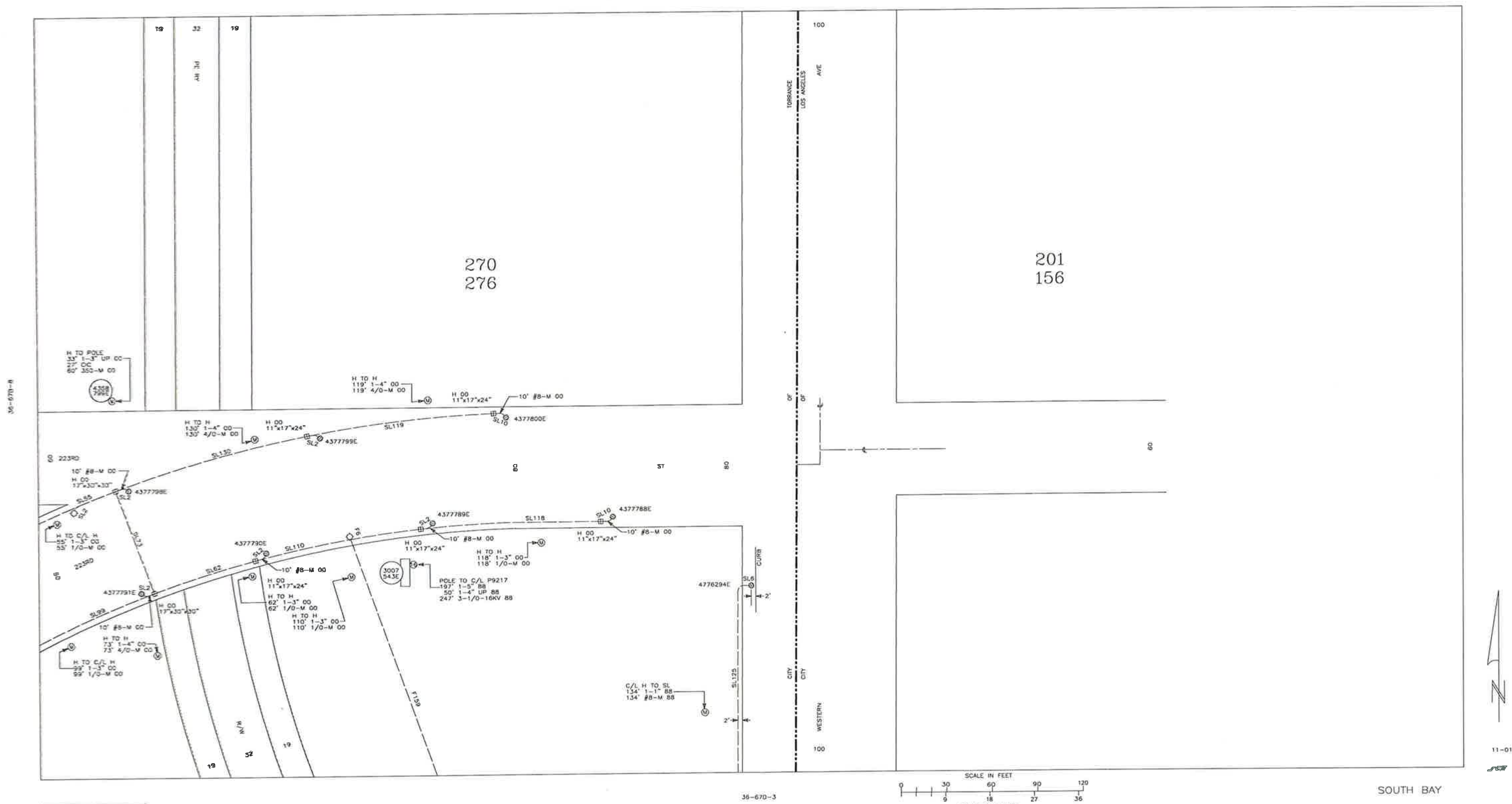
CONFIDENTIAL: CRITICAL ENERGY INFRASTRUCTURE
This diagram contains information relating to Southern California Edison Company's electric transmission/distribution system. It is classified as Critical Energy Infrastructure Information as defined in 18 code of Federal Regulations section 388.113(c)(1).
FOR REFERENCE ONLY This map has been created to SCE standards to be used by SCE personnel only and is not intended to be a legal representation of real property. Please don't forget to call Dig Alert: 1-800-227-2600

LOS ANGELES CO. 37-67D-8



36-67B-6 TORRANCE LOS ANGELES

LOS ANGELES CO. 36-67B-9



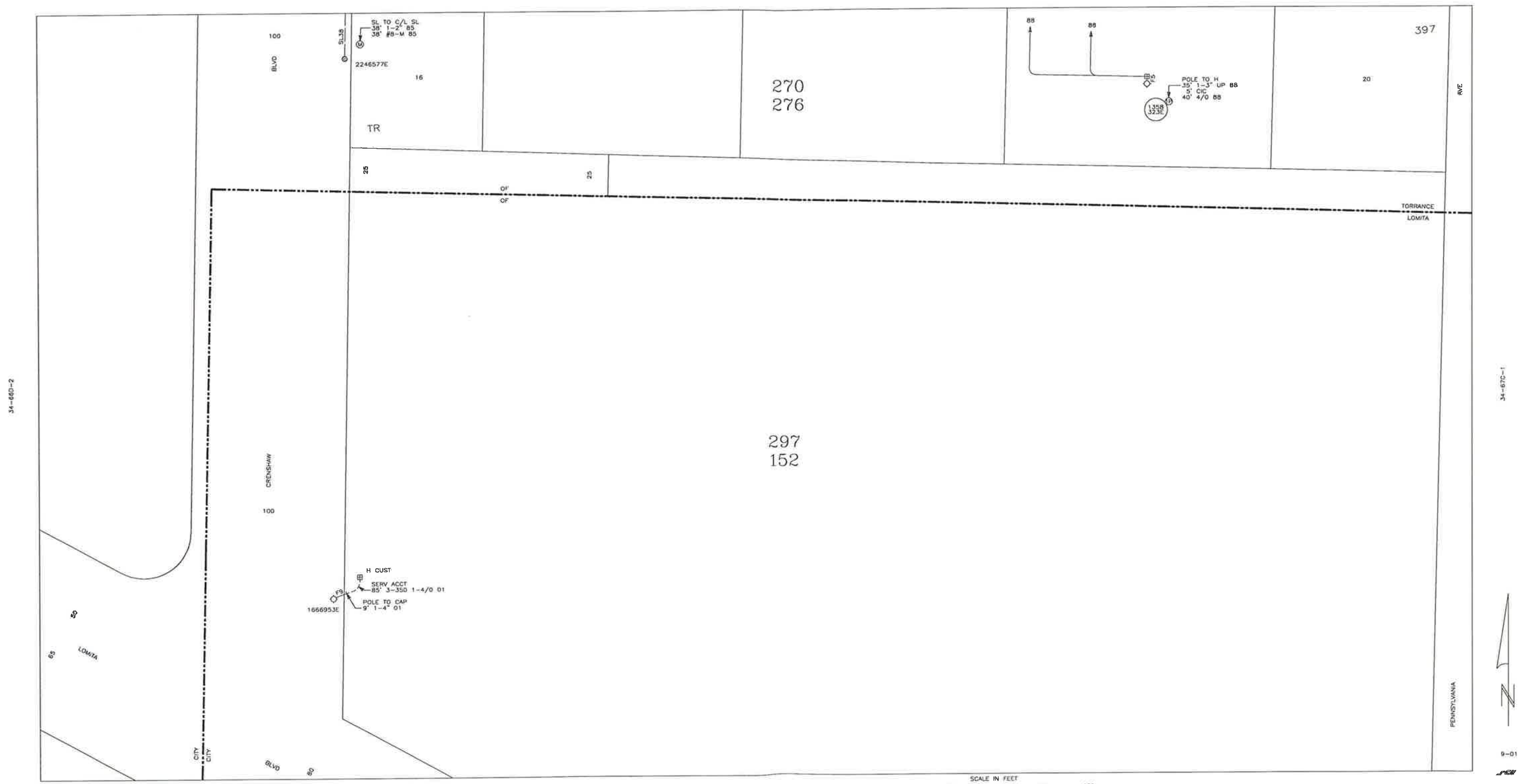
36-67D-3

SOUTH BAY

11-02 TADLE	2-10 AMEND
12-12 SLOPE	JMZC

34-66B-9 LOMITA TORRANCE

LOS ANGELES CO. 34-66D-3



34-66D-6

SCALE IN FEET 0 30 60 90 120
SCALE IN METERS 9 18 27 36

SOUTH BAY

1-13 STEXA	
	BCOST

THE METROPOLITAN WATER DISTRICT
OF SOUTHERN CALIFORNIA

Office of the General Manager

MWD Second Lower Feeder
Sta. 1853+00 to 1957+00
MWD Palos Verdes Feeder
Sta. 1504+00 to 1573+00
MWD Sepulveda Feeder
Sta. 2268+00 to 2273+28
Substr. Job No. 4033-13-013

May 16, 2013

Mr. John Meyerhofer
Carollo Engineers
Suite 530
199 South Los Robles Avenue
Pasadena, CA 91101

Dear Mr. Meyerhofer:

Utility Information Request — Storm Water Projects

Thank you for your email dated May 2, 2013, requesting Metropolitan's utility information in the areas of your proposed storm drain improvements project located in various streets in the city of Torrance.

As shown on the enclosed maps, our 78-inch-inside-diameter prestressed-concrete Second Lower Feeder pipeline and appurtenant manhole structures are located along 220th Street and along Western Avenue, our 51-inch-inside-diameter welded-steel Palos Verdes Feeder pipeline and appurtenant manhole structures traverses in a northeasterly and southwesterly direction which also crosses Western Avenue, and our 84-inch-inside-diameter prestressed-concrete Sepulveda Feeder pipeline and appurtenant manhole structure are located along Western Avenue within your proposed project limits.

We are transmitting a copy of our "Guidelines for Developments in the Area of Facilities, Fee Properties, and/or Easements of The Metropolitan Water District of Southern

California," and a prints of our Drawings B-22797 through B-22805, B-23305 through B-23310 and B-54584, for your information and use.

We request that our facilities be fully shown and identified as Metropolitan's on your project plans and that prints of the preliminary plans be submitted for our review and written approval as they pertain to our facilities. We also request that all applicable portions of the enclosed guidelines be incorporated in your plans.

We also request that new storm drain lines and manhole structure proposed to cross over or located within 10 feet from the edges of our pipelines must include secondary containment, which consists of either a continuous steel casing or HDPE pipe with fusion-welded joints. Alternatively, we will allow a storm drain line without double containment if HDPE pipe with fusion-welded joints is used.

We also request that a stipulation be added to your plans or specifications to notify Samuel Teare of our Water System Operations Group, telephone (323) 276-7623, at least two working days prior to starting any work in the vicinity of our facilities.

For any further correspondence with Metropolitan relating to this project, please make reference to the Substructures Job Number shown in the upper right-hand corner of the first page of this letter. Should you require any additional information, please contact Ken Chung, telephone (213) 217-7670.

Very truly yours,

Kieran M. Callanan, P.E.
Manager, Substructures Team

KC/km
DOC#: 4033-13-013

Enclosures (19)

From: Metropolitan Water District MAY 0 6 2013
Substructures Team

Re: Your Project Stormwater Project - Torrance

Your Project No. ____________

MWD Substructures Job No. 4033-13-013

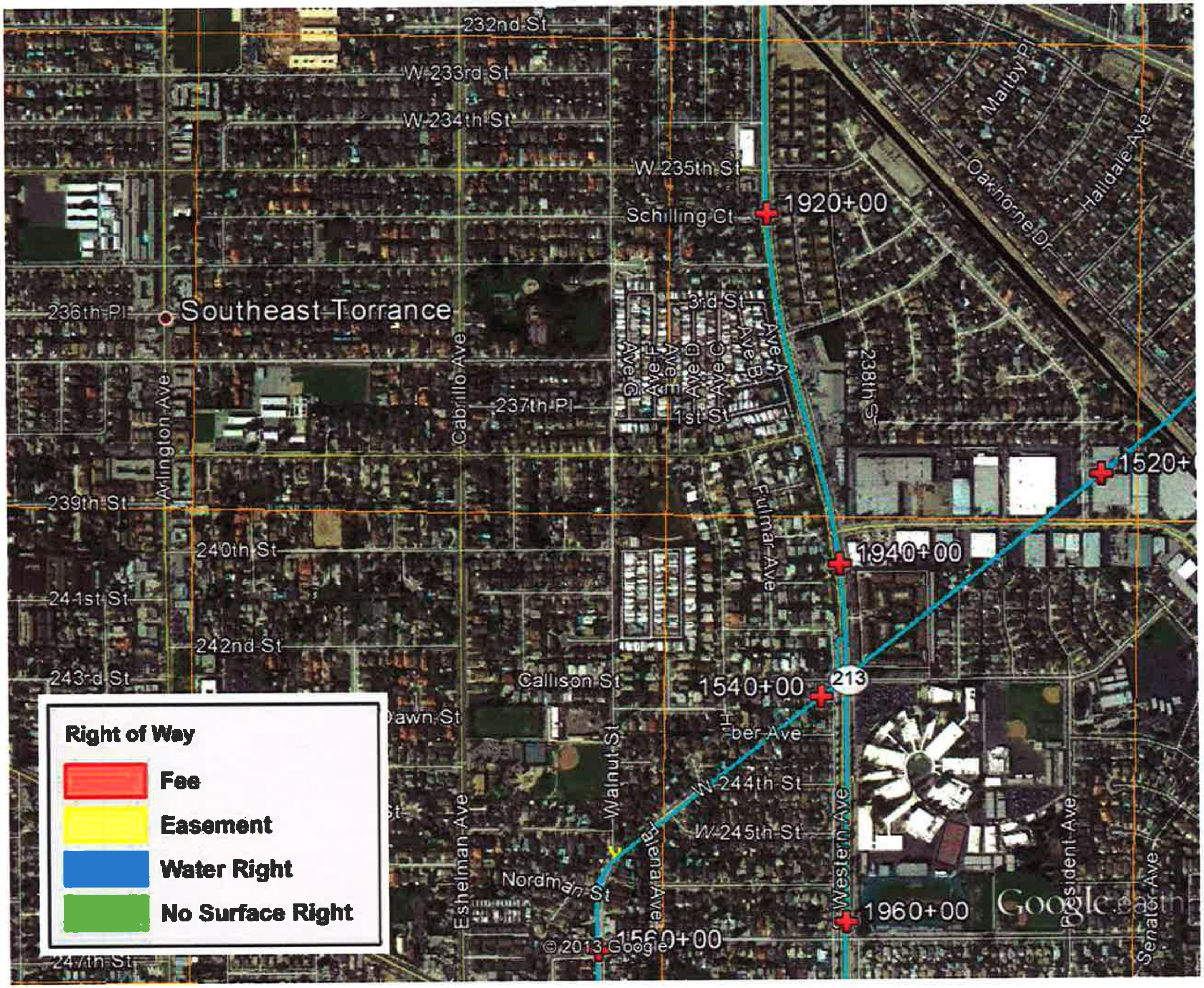
We received your above-referenced project submittal on 5/2/13
We will review your project proposal as it affects our facilities and rights-of-way and transmit our comments to you by written correspondence.

We typically respond within 30 days of receipt of the project submittal.

Your project has been assigned to Ken Chung
Telephone: (213) 217- 7670.

Please contact this Substructures Team coordinator if you have any questions.

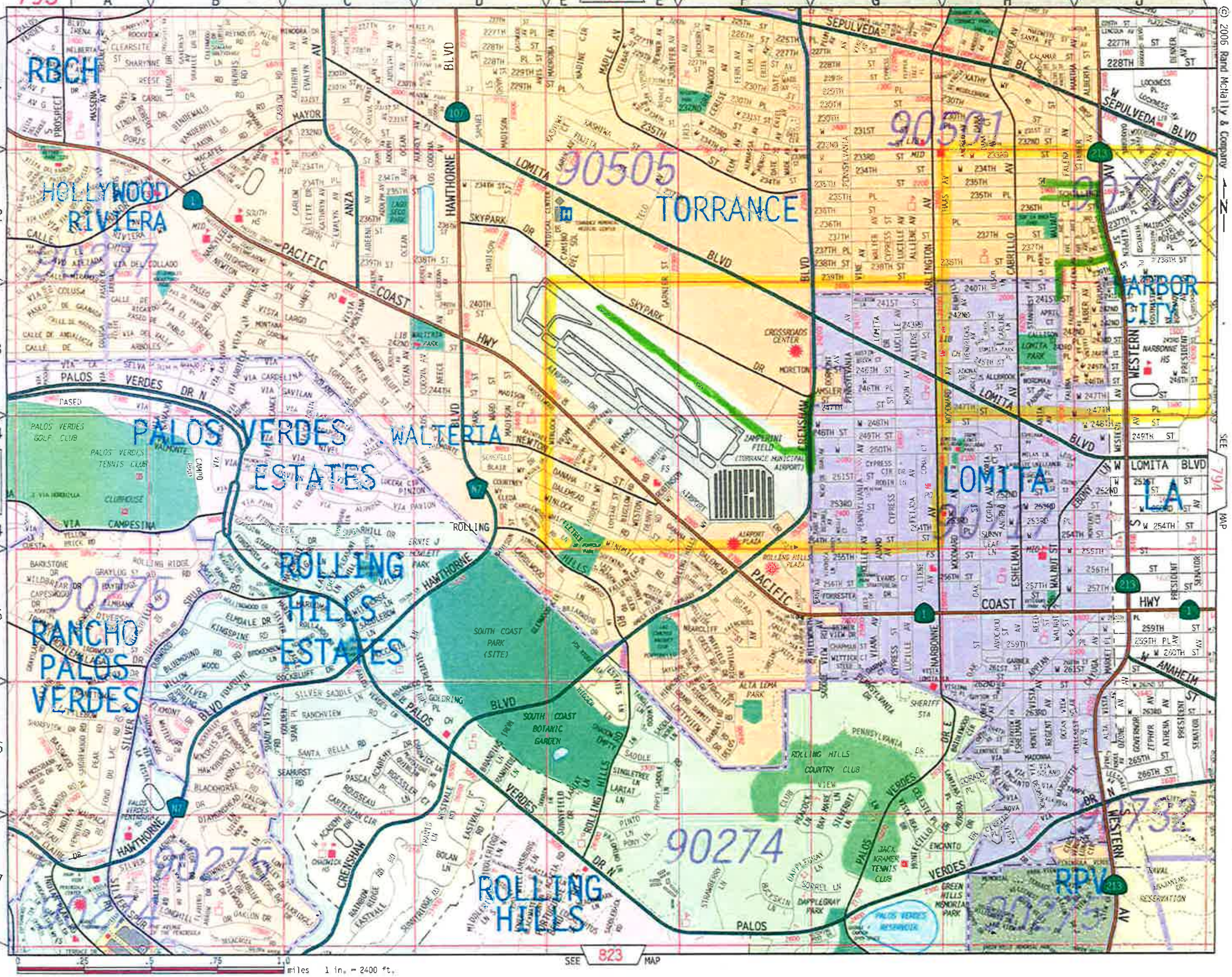
Thank you.



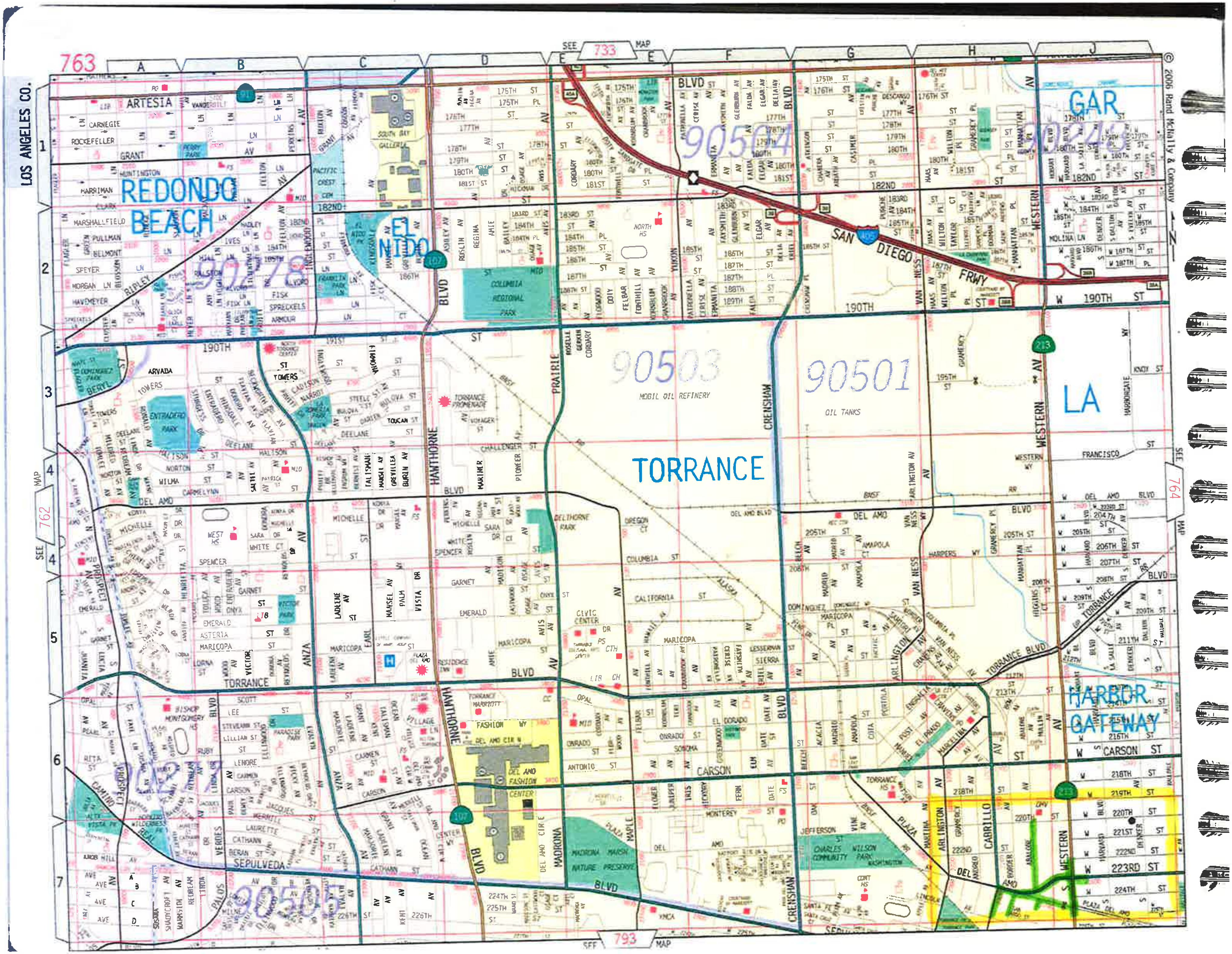
Google earth

feet 4000
km 1

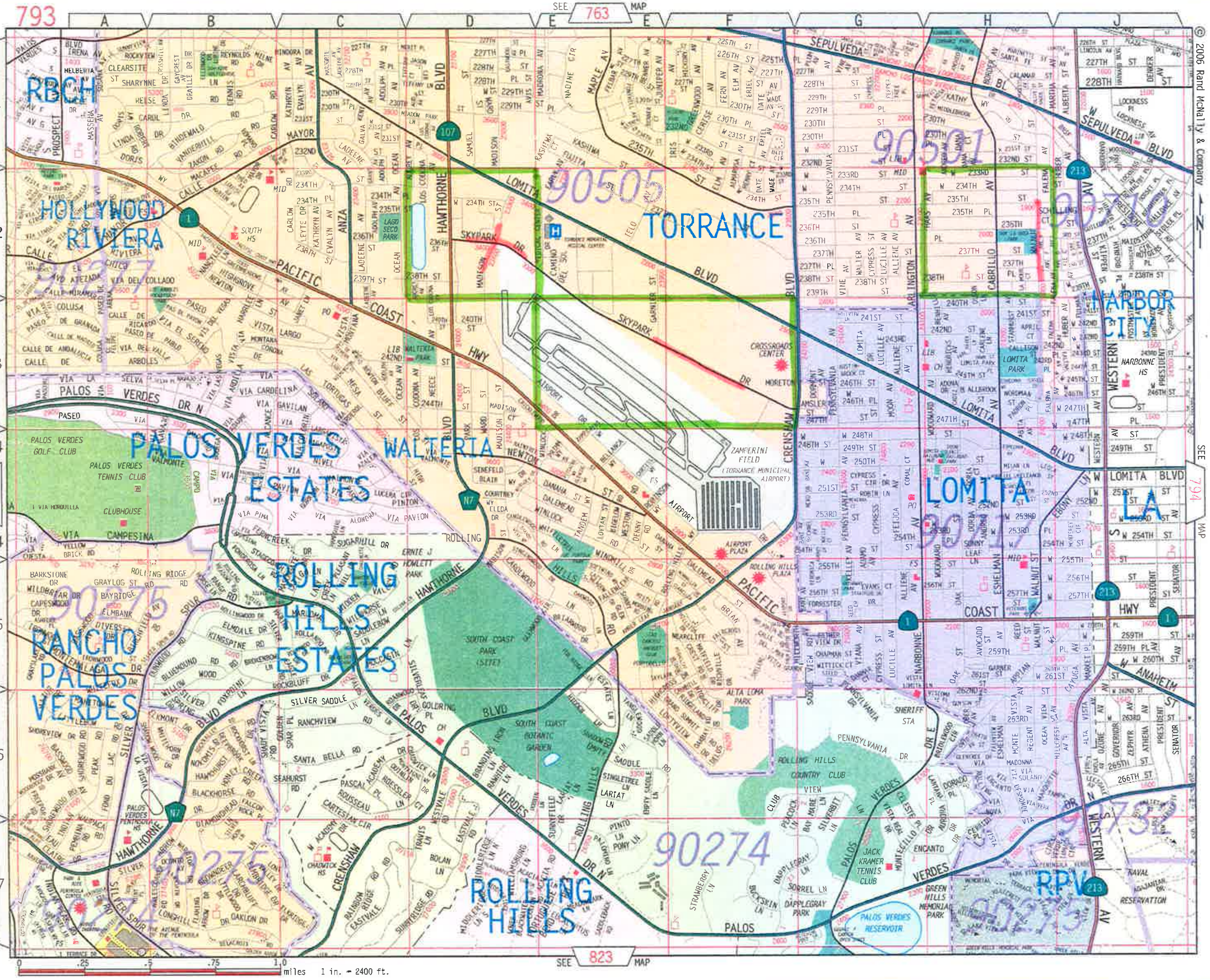
SEE 763 MAP

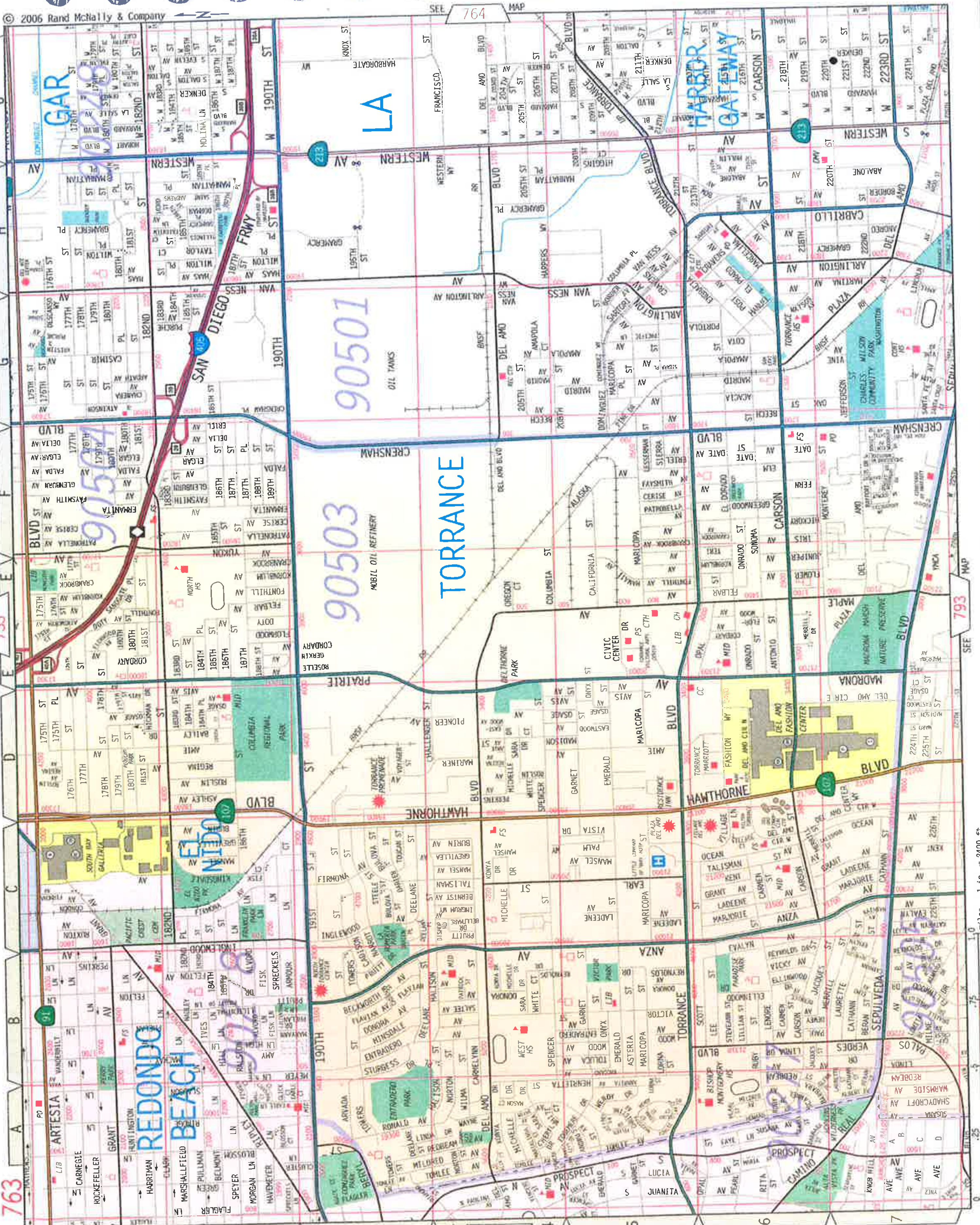


SEE 792 MAP
SEE 794 MAP
SEE 823 MAP



© 2006 Rand McNally & Company
SEE 733 MAP
SEE 764 MAP
SEE 793 MAP
SEE 762 MAP
763
LOS ANGELES CO.
TORRANCE
LA
REDONDO BEACH
EL NIDO
HARBOR GATEWAY
GAR
90501
90503
90504
90278
90505
WESTERN AV
CRENSHAW BLVD
HAWTHORNE BLVD
PRAIRIE AV
ARTESIA BLVD
SAN DIEGO FRWY
190TH ST
TORRANCE BLVD
CARSON ST
SEPULVEDA BLVD
MADRONA AV
ANZA AV
VAN NESS AV
ARLINGTON AV
CABRILLO AV
DEL AMO BLVD
MOBIL OIL REFINERY
OIL TANKS
COLUMBIA REGIONAL PARK
DEL AMO FASHION CENTER
MADRONA MARSH NATURE PRESERVE
CHARLES WILSON COMMUNITY PARK
SOUTH BAY GALLERIA
TORRANCE PROMENADE


SEE 763 MAP
SEE 794 MAP
SEE 823 MAP
SEE 792 MAP
RBCH
HOLLYWOOD RIVIERA
TORRANCE
90505
90501
90710
HARBOR CITY
LA
LOMITA
90717
WALTERIA
PALOS VERDES ESTATES
ROLLING HILLS ESTATES
RANCHO PALOS VERDES
90275
90274
ROLLING HILLS
90732
RPV
90277
ZAMPERINI FIELD (TORRANCE MUNICIPAL AIRPORT)
SOUTH COAST BOTANIC GARDEN
PALOS VERDES GOLF CLUB
ROLLING HILLS COUNTRY CLUB
PALOS VERDES RESERVOIR
PACIFIC COAST HWY
HAWTHORNE BLVD
CRENSHAW BLVD
SEPULVEDA BLVD
WESTERN AV
LOMITA BLVD
miles 1 in. = 2400 ft.



LOS ANGELES CO.

FIELD BOOKS
Plane table sheets — 44-224 & 44-225
Geology — 25
Profile — 25-2A
Alinement — 25-1
Bench marks — 24-8
Construction grades — 25-3A
Utilities — 25-4
Structures — 24-6

Note: For detail design of pipe see dwg. B-5605

Stations and elevations apply to invert of pipe

REFERENCE DRAWINGS H-2273 & H-2274

Nº	DATE	DWN.	CKD.	REVISION	REC.	APP.
2	10-29-92	Y.E.C.	BG	ADDED CATHODIC PROTECTION		
1	5-21-71	F.U.D.		Added relief structure and storm drain		

THE METROPOLITAN WATER DISTRICT
OF SOUTHERN CALIFORNIA

COLORADO RIVER AQUEDUCT
PALOS VERDES FEEDER

190th ST. TO PALOS VERDES RESERVOIR
STA 1561+00 TO STA 1573+00

PLAN AND PROFILE

DRAWN
TRACED
CHECKED
RECOMMENDED
APPROVED

LOS ANGELES 1966 B-23310

.TROPOLITAN WATER DISTRICT ASSUMES N RESPONSIBILITY FOR THE ACCURACY OF TH SUBSTRUCTURE INFORMATION HEREIN PROVID ED. THE USER ASSUMES RESPONSIBILITY FOR VERIFYING SUBSTRUCTURE LOCATION BEFORE EXCAVATING AND ASSUMES ALL LIABILITY FOR DAMAGE TO METROPOLITAN'S FACILITIES AS A RESULT OF SUCH EXCAVATION. CALL UNDER GROUND SERVICE ALERT AND THE RELEVANT REPRESENTATIVE FROM METROPOLITAN AT ... DAYS ...

0-11-203-8008

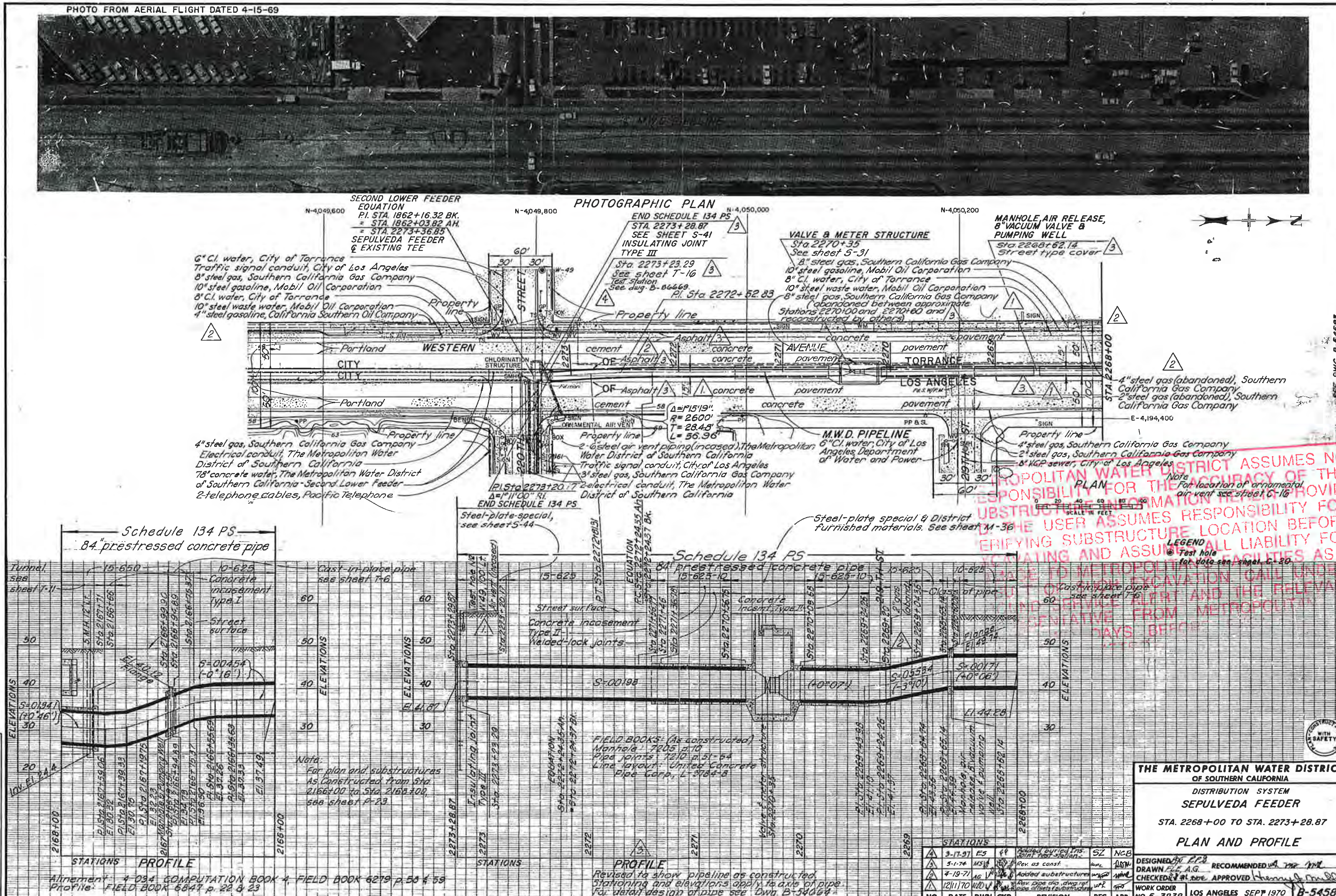


PHOTO FROM AERIAL FLIGHT DATED 4-15-69
PHOTOGRAPHIC PLAN
SECOND LOWER FEEDER EQUATION
P.I. STA. 1862+16.32 BK.
= STA. 1862+03.82 AH.
= STA. 2273+36.85
SEPULVEDA FEEDER
℄ EXISTING TEE
END SCHEDULE 134 PS
STA. 2273+28.87
SEE SHEET S-41
INSULATING JOINT TYPE III
Sta. 2273+23.29
See sheet T-16
Test Station
See dwg. B-64469
P.I. Sta 2272+52.83
VALVE & METER STRUCTURE
Sta 2270+35
See sheet S-31
MANHOLE, AIR RELEASE, 8" VACUUM VALVE & PUMPING WELL
Sta 2268+62.14
Street type cover
6" C.I. water, City of Torrance
Traffic signal conduit, City of Los Angeles
8" steel gas, Southern California Gas Company
10" steel gasoline, Mobil Oil Corporation
8" C.I. water, City of Torrance
10" steel waste water, Mobil Oil Corporation
4" steel gasoline, California Southern Oil Company
8" steel gas, Southern California Gas Company
10" steel gasoline, Mobil Oil Corporation
8" C.I. water, City of Torrance
10" steel waste water, Mobil Oil Corporation
8" steel gas, Southern California Gas Company (abandoned between approximate Stations 2270+00 and 2270+60 and reconstructed by others)
Property line
WESTERN AVENUE
CITY OF TORRANCE
CITY OF LOS ANGELES
STREET
Portland cement concrete
Asphalt concrete pavement
CHLORINATION STRUCTURE
ORNAMENTAL AIR VENT
Δ=1°15'19"
R=2600'
T=28.48'
L=56.96'
M.W.D. PIPELINE
STA. 2268+00
4" steel gas (abandoned), Southern California Gas Company
2" steel gas (abandoned), Southern California Gas Company
4" steel gas, Southern California Gas Company
Electrical conduit, The Metropolitan Water District of Southern California
78" concrete water, The Metropolitan Water District of Southern California - Second Lower Feeder
2-telephone cables, Pacific Telephone
Property line
2-6" steel air vent piping (incased), The Metropolitan Water District of Southern California
Traffic signal conduit, City of Los Angeles
3" steel gas, Southern California Gas Company
2-electrical conduit, The Metropolitan Water District of Southern California
6" C.I. water, City of Los Angeles Department of Water and Power
4" steel gas, Southern California Gas Company
2" steel gas, Southern California Gas Company
8" VCP sewer, City of Los Angeles
P.I. Sta 2273+20.17
Δ=1°11'00" Rt.
END SCHEDULE 134 PS
208TH ST.
209TH ST.
PLAN
Note: For location of ornamental air vent see sheet C-16
SCALE IN FEET
LEGEND
Test hole for data see sheet C-20
Schedule 134 PS
84" prestressed concrete pipe
Steel-plate-special, see sheet S-44
Steel-plate special & District furnished materials. See sheet M-36
Tunnel see sheet T-11
Concrete incasement Type I
Street surface
Cast-in-place pipe see sheet T-6
Concrete incasement Type II
Welded-lock joints
Concrete incasement Type II
Class of pipe
S=0.1941 (10°46')
S=.00454 (-0°16')
S=.00198
(+0°07')
S=.05554 (-3°10')
S=.00171 (+0°06')
El. 41.87
El. 44.28
Inv. El. 24.4
ELEVATIONS
Insulating joint Type III
Valve & meter structure
Manhole, air release & vacuum valve & pumping well
Note: For plan and substructures As Constructed from Sta 2166+00 to Sta. 2168+00, see sheet P-23
FIELD BOOKS: (As constructed)
Manhole - 7205 p.10
Pipe joints - 7210 p.51-54
Line layout - United Concrete Pipe Corp. L-9784-8
STATIONS PROFILE
Alinement - 4-034 COMPUTATION BOOK 4, FIELD BOOK 6279 p.58 & 59
Profile - FIELD BOOK 6847 p. 22 & 23
PROFILE
Revised to show pipeline as constructed. Stationing and elevations apply to axis of pipe. For detail design of pipe see Dwg. B-54064
SEE DWG B-54583
THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
DISTRIBUTION SYSTEM
SEPULVEDA FEEDER
STA. 2268+00 TO STA. 2273+28.87
PLAN AND PROFILE
DESIGNED
DRAWN
CHECKED
RECOMMENDED
APPROVED
WORK ORDER NO. 5-3838
LOS ANGELES SEPT 1970
B-54584
NO. | DATE | DWN. | CKD. | REVISION | REC. | APP.
4 | 3-17-97 | ES | | Added buried Ins. Joint test station
3 | 5-1-74 | | | Rev. as const.
2 | 4-19-71 | | | Added substructures
1 | 12-11-70 | | | Rev. pipe dia. dwg ref.
REVISION
ORIGINAL RELEASE
INTER-SECTION CO-ORDINATION CHECK
MECH. STRUCT. ELEC. CIVIL
CO-ORDINATION CHECK
GEOTRONICS A TELEDYNE COMPANY Long Beach, California

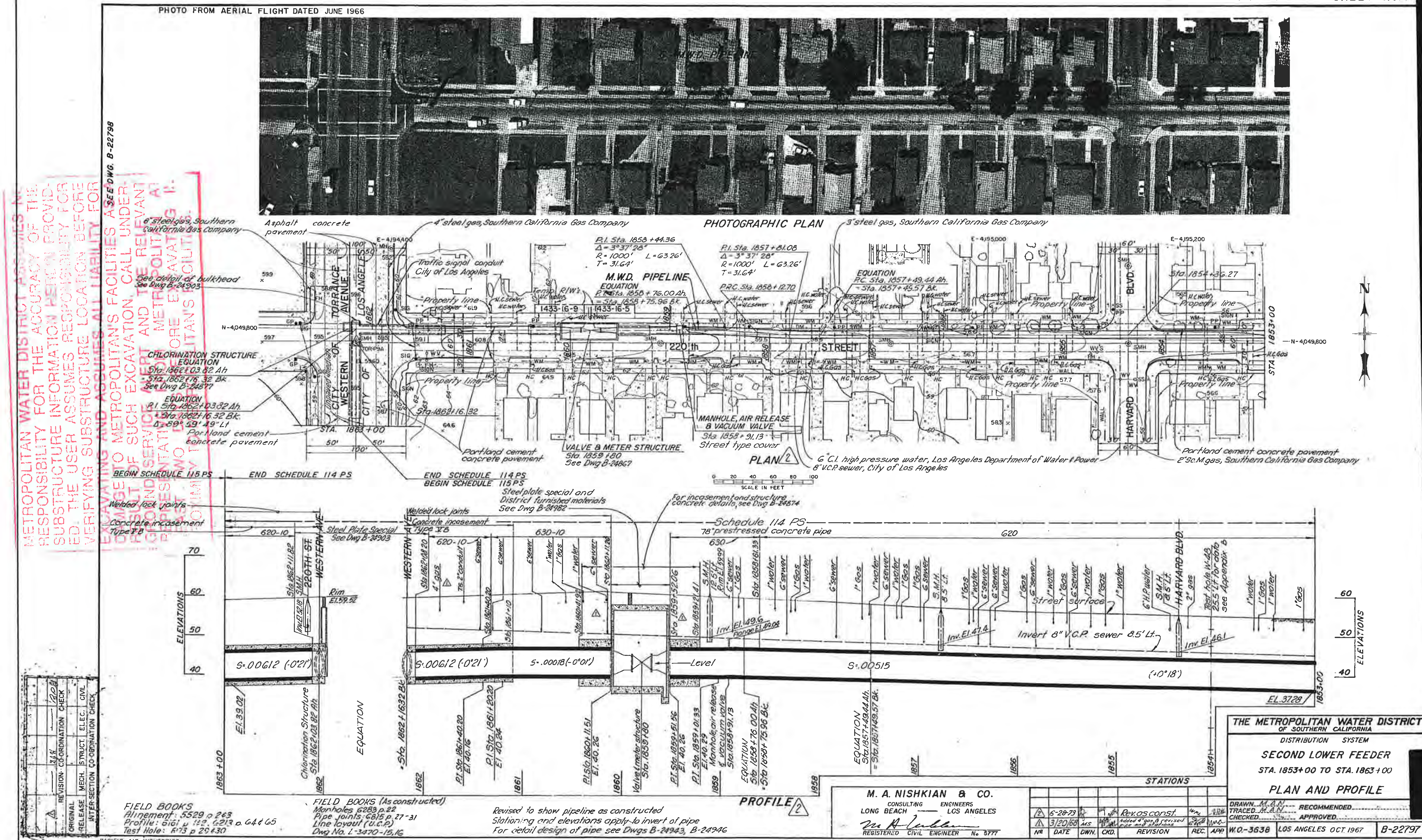
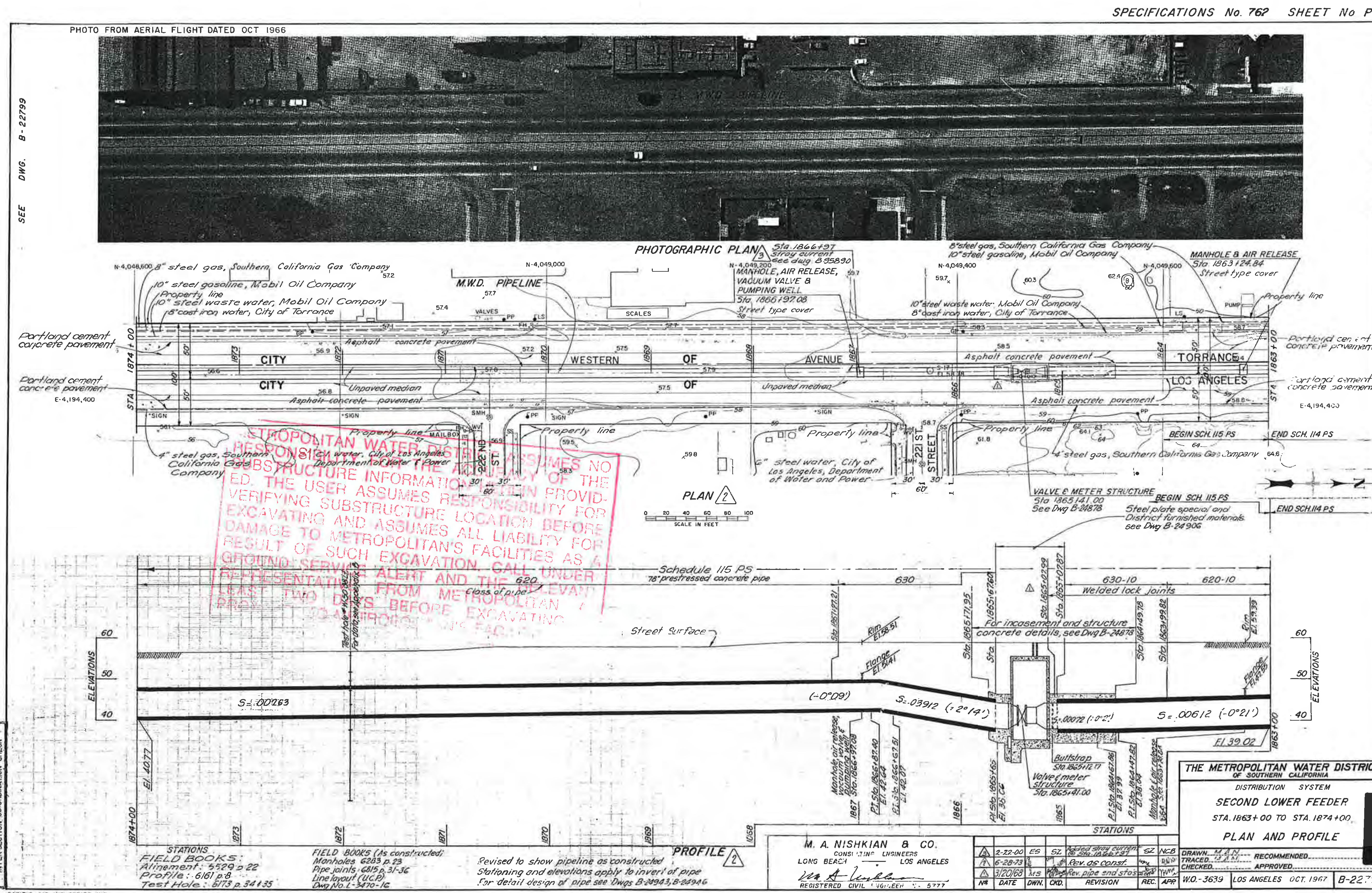
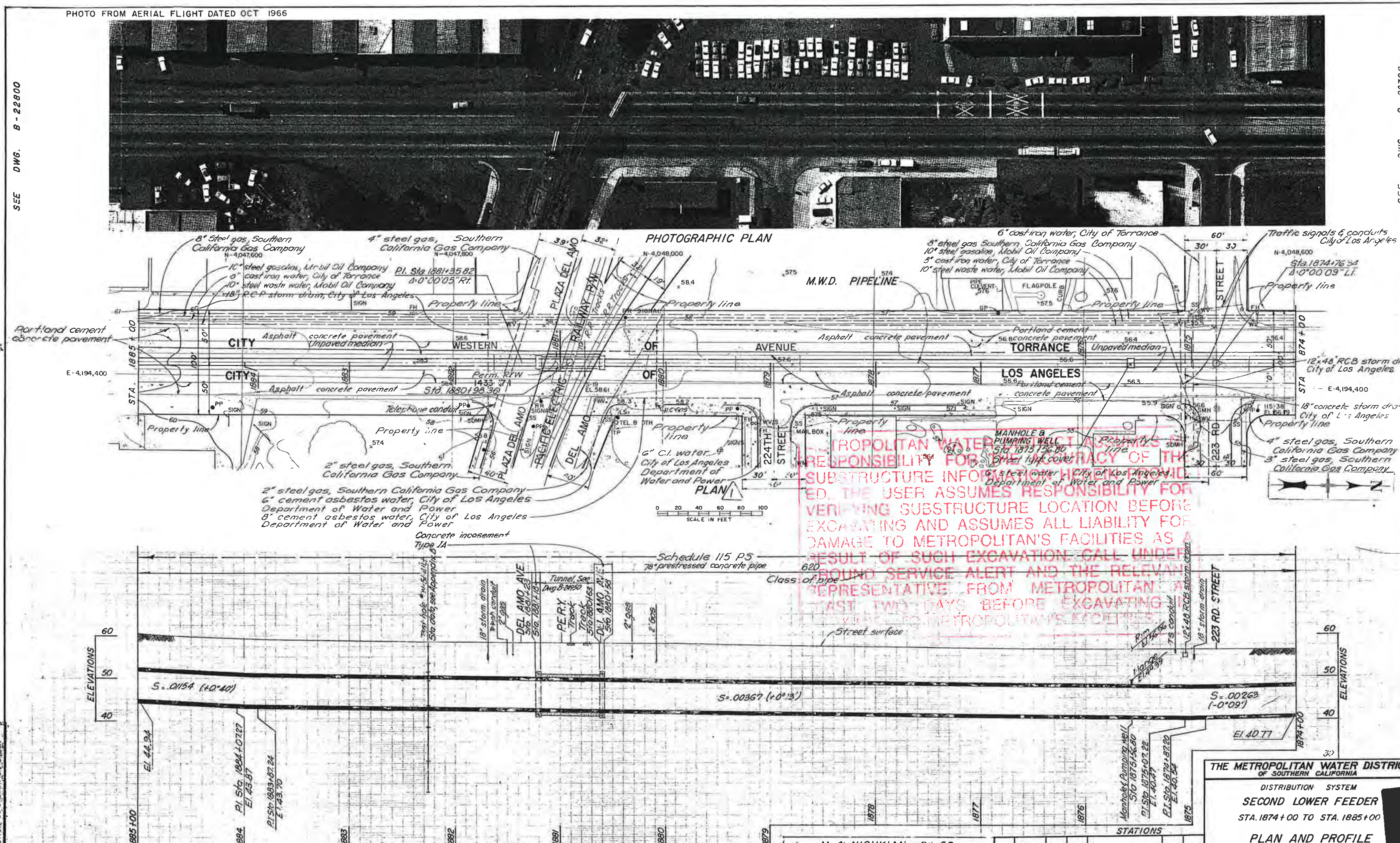


PHOTO FROM AERIAL FLIGHT DATED JUNE 1966
PHOTOGRAPHIC PLAN
M.W.D. PIPELINE
220 th STREET
TORRANCE AVENUE
LOS ANGELES
WESTERN AVENUE
HARVARD BLVD.
CHLORINATION STRUCTURE
MANHOLE, AIR RELEASE & VACUUM VALVE
VALVE & METER STRUCTURE
PLAN 2
BEGIN SCHEDULE 115 PS
END SCHEDULE 114 PS
END SCHEDULE 114 PS
BEGIN SCHEDULE 115 PS
Schedule 114 PS
78" prestressed concrete pipe
ELEVATIONS
STATIONS
PROFILE 2
SEE DWG. B-22798
METROPOLITAN WATER DISTRICT ASSUMES NO RESPONSIBILITY FOR THE ACCURACY OF THE SUBSTRUCTURE INFORMATION HEREON PROVIDED. THE USER ASSUMES RESPONSIBILITY FOR VERIFYING SUBSTRUCTURE LOCATION BEFORE EXCAVATING AND ASSUMES ALL LIABILITY FOR DAMAGE TO METROPOLITAN'S FACILITIES AS A RESULT OF SUCH EXCAVATION. CALL UNDERGROUND SERVICE ALERT AND THE RELEVANT REPRESENTATIVE OF METROPOLITAN AT LEAST TWO DAYS BEFORE EXCAVATING IN PROXIMITY TO METROPOLITAN'S FACILITIES.
FIELD BOOKS
Alinement: 5529 p 263
Profile: 6161 p 122, 6213 p 64 & 65
Test Hole: 6173 p 29 & 30
FIELD BOOKS (As constructed)
Manholes 6283 p 22
Pipe joints 6815 p 27-31
Line layout (U.C.P.)
Dwg No. L-3470-15,16
Revised to show pipeline as constructed
Stationing and elevations apply to invert of pipe
For detail design of pipe see Dwgs B-24943, B-24946
M. A. NISHKIAN & CO.
CONSULTING ENGINEERS
LONG BEACH — LOS ANGELES
REGISTERED CIVIL ENGINEER No. 5777
Rev. as const.
THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
DISTRIBUTION SYSTEM
SECOND LOWER FEEDER
STA. 1853+00 TO STA. 1863+00
PLAN AND PROFILE
W.O.-3638
LOS ANGELES OCT 1967
B-22797
PACIFIC AIR INDUSTRIES, INC.


SPECIFICATIONS No. 762 SHEET No P
PHOTO FROM AERIAL FLIGHT DATED OCT 1966
SEE DWG. B-22799
PHOTOGRAPHIC PLAN 3
8" steel gas, Southern California Gas Company
10" steel gasoline, Mobil Oil Company
Property line
10" steel waste water, Mobil Oil Company
8" cast iron water, City of Torrance
M.W.D. PIPELINE
MANHOLE, AIR RELEASE, VACUUM VALVE & PUMPING WELL
Sta. 1866+97.08
Street type cover
Sta. 1866+97 stray current see dwg B-25890
MANHOLE & AIR RELEASE
Sta. 1863+24.84
Street type cover
Portland cement concrete pavement
Asphalt concrete pavement
Unpaved median
CITY OF TORRANCE
CITY OF LOS ANGELES
WESTERN AVENUE
222 ND ST.
221 ST STREET
4" steel gas, Southern California Gas Company
6" steel water, City of Los Angeles, Department of Water and Power
VALVE & METER STRUCTURE
Sta. 1865+41.00
See Dwg B-24878
BEGIN SCH. 115 PS
END SCH. 114 PS
Steel plate special and District furnished materials see Dwg B-24906
PLAN 2
SCALE IN FEET
METROPOLITAN WATER DISTRICT ASSUMES NO RESPONSIBILITY FOR THE ACCURACY OF THE SUBSTRUCTURE INFORMATION HEREIN PROVIDED. THE USER ASSUMES RESPONSIBILITY FOR VERIFYING SUBSTRUCTURE LOCATION BEFORE EXCAVATING AND ASSUMES ALL LIABILITY FOR DAMAGE TO METROPOLITAN'S FACILITIES AS A RESULT OF SUCH EXCAVATION. CALL UNDERGROUND SERVICE ALERT AND THE RELEVANT REPRESENTATIVE FROM METROPOLITAN AT LEAST TWO DAYS BEFORE EXCAVATING
Schedule 115 PS
78" prestressed concrete pipe
Class of pipe
Welded lock joints
For incasement and structure concrete details, see Dwg B-24878
Street Surface
ELEVATIONS
S=.00263
S=.03912 (+2°14')
S=.00612 (-0°21')
Valve & meter structure Sta. 1865+41.00
Buttstrap
STATIONS
PROFILE 2
FIELD BOOKS:
Alinement: 5529 p.22
Profile: 6161 p.8
Test Hole: 6173 p.34 & 35
FIELD BOOKS (As constructed):
Manholes 6283 p.23
Pipe joints 6815 p.31-36
Line layout (UCP)
Dwg No. L-3470-16
Revised to show pipeline as constructed
Stationing and elevations apply to invert of pipe
For detail design of pipe see Dwgs B-24943, B-24946
M. A. NISHKIAN & CO.
CONSULTING ENGINEERS
LONG BEACH LOS ANGELES
REGISTERED CIVIL ENGINEER
REVISION
Rev. pipe and stas.
Rev. as const.
Added stray current
THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
DISTRIBUTION SYSTEM
SECOND LOWER FEEDER
STA. 1863+00 TO STA. 1874+00
PLAN AND PROFILE
DRAWN
TRACED
CHECKED
RECOMMENDED
APPROVED
W.O.-3639
LOS ANGELES OCT. 1967
ORIGINAL RELEASE
REVISION
CO-ORDINATION CHECK
MECH. STRUCT. ELEC. CIVIL
INTER-SECTION CO-ORDINATION CHECK
PACIFIC AIR INDUSTRIES, INC.



FIELD BOOKS
Alinement 5529 p. 22, 23 & 24
Profile 6161 p. 8
Test Hole 6173 p. 36 & 37

FIELD BOOKS (As constructed)
Manholes 6283 p. 24
Pipe joints 6815 p. 36-39
Line layout (U.C.P.)
Dwg No. L-3470-16,17

Revised to show pipeline as constructed
Stationing and elevations apply to invert of pipe
For detail design of pipe see Dwgs B-24943, B-24946

M. A. NISHKIAN & CO.
CONSULTING ENGINEERS
LONG BEACH — LOS ANGELES
REGISTERED CIVIL ENGINEER

No.	DATE	DWN.	CKD.	REVISION	REC.	APP.
1	6-28-73			Rev. as const.		

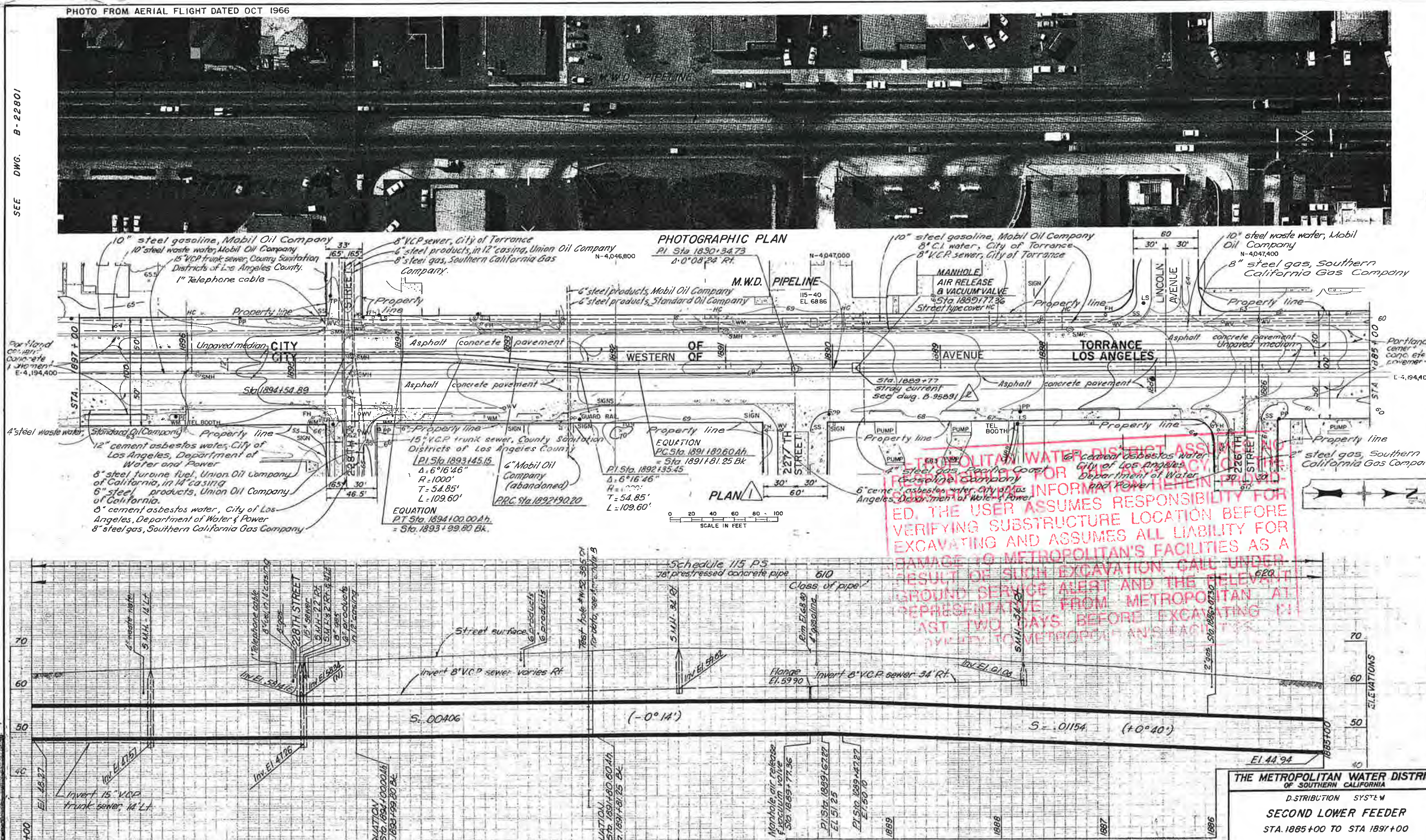
THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
DISTRIBUTION SYSTEM
SECOND LOWER FEEDER
STA. 1874+00 TO STA. 1885+00
PLAN AND PROFILE

DRAWN M.A.N. RECOMMENDED
TRACED M.A.N. APPROVED
CHECKED

W.O.-3639 LOS ANGELES OCT. 1967 B-22799

REVISION	CO-ORDINATION CHECK
ORIGINAL RELEASE	MECH. STRUCT. ELEC. CIVIL
INTER-SECTION CO-ORDINATION CHECK	

PACIFIC AIR INDUSTRIES, INC.



STATIONS
FIELD BOOKS
Alinement: 5529 p 23, 24+25
Profile: 5161 p 81
Test Hole: 5173 p 38+39

FIELD BOOKS (As constructed)
Manholes 6283 p 25
Pipe joints 6815 p 34-44
Line layout (U.C.P.)
Dwg No. L-3470-17

Revised to show pipeline as constructed
Stationing and elevations apply to invert of pipe
For detail of design of pipe see Dwgs B-24943, B-24946

M. A. NISHKIAN & CO.
CONSULTING ENGINEERS
LONG BEACH — LOS ANGELES
REGISTERED CIVIL ENGINEER No. 5777

Nº	DATE	DWN.	CKD.	REVISION	REC.	APR.
2	2-22-06	ES	SZ	Added stray current @ Sta. 1889+77	SZ	NCB
1	6-28-73			Rev. as const.		

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

DISTRIBUTION SYSTEM

SECOND LOWER FEEDER

STA. 1885+00 TO STA 1897+00

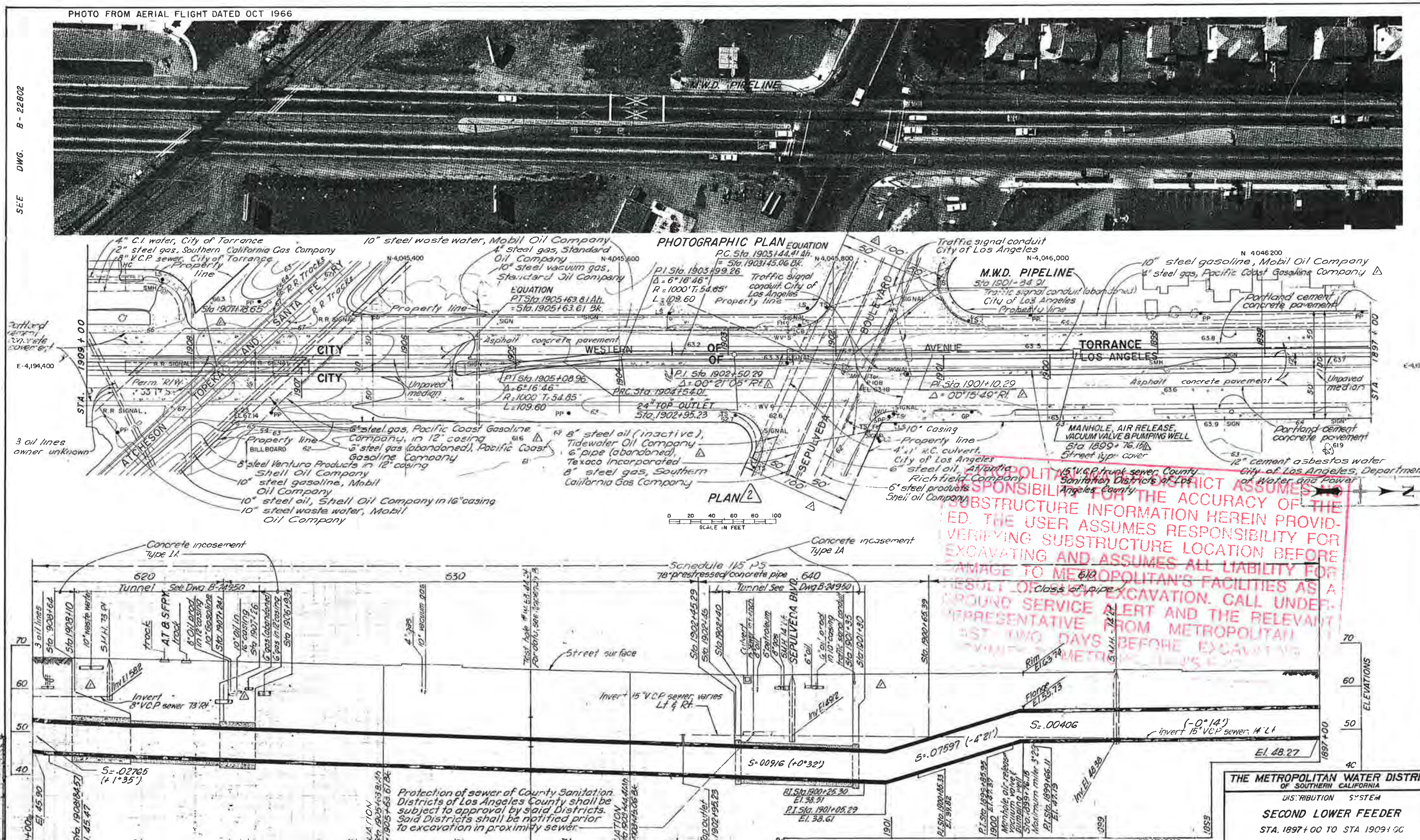
PLAN AND PROFILE

DRAWN M.A.N. RECOMMENDED
TRACED M.A.N. APPROVED
CHECKED

WO-3639 LOS ANGELES OCT 6 B-2280

ORIGINAL RELEASE / REVISION / MECH. STRUCT. ELEC. CIVIL / INTER-SECTION CO-ORDINATION CHECK

SPECIFICATIONS No. 762 SHEET No P-



STATIONS
FIELD BOOKS
Alinement 5529 p. 24, 25 & 26
Profile: 5161 p. 9-12
Test holes: 6173 p. 40 & 41

FIELD BOOKS (As constructed)
Manholes 6283 p. 26
Pipe joints: 6815 p. 44, 45
Line layout (U.C.P.)
Dwg No 3470-18, 19

Revised to show pipeline as constructed
Stationing and elevations apply to invert of pipe
For detail design of pipe see Dwgs B-24949, B-24946

M. A. NISHKIAN & CO
CONSULTING ENGINEERS
LONG BEACH — LOS ANGELES
REGISTERED CIVIL ENGINEER No. 5177

Nº	DATE	DWN.	CKD.	REVISION	REC.	APP.
2	5-28-73			Rev. as const.		
1	10-3-68	F.L.E.				

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
DISTRIBUTION SYSTEM
SECOND LOWER FEEDER
STA. 1897+00 TO STA 1909+00
PLAN AND PROFILE

DRAWN M.A.N. RECOMMENDED
TRACED M.A.N.
CHECKED APPROVED
W.O. 3639 LOS ANGELES OCT 1967 B-2280

REVISION CO-ORDINATION CHECK
ORIGINAL RELEASE MECH. STRUCT. ELEC. CIVIL
INTER-SECTION CO-ORDINATION CHECK

PACIFIC AIR INDUSTRIES, INC.

SPECIFICATIONS No. 762 SHEET No P-2

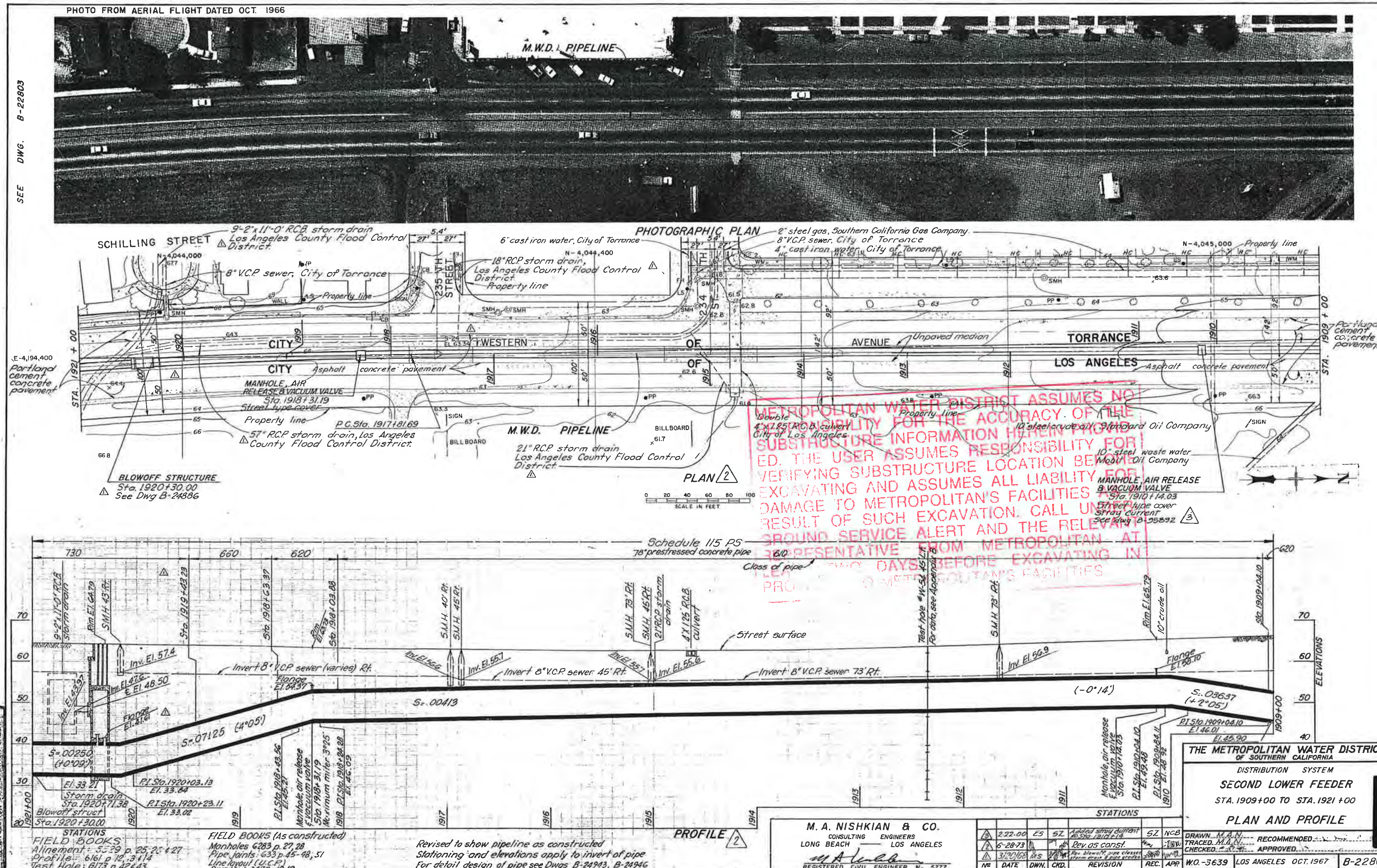
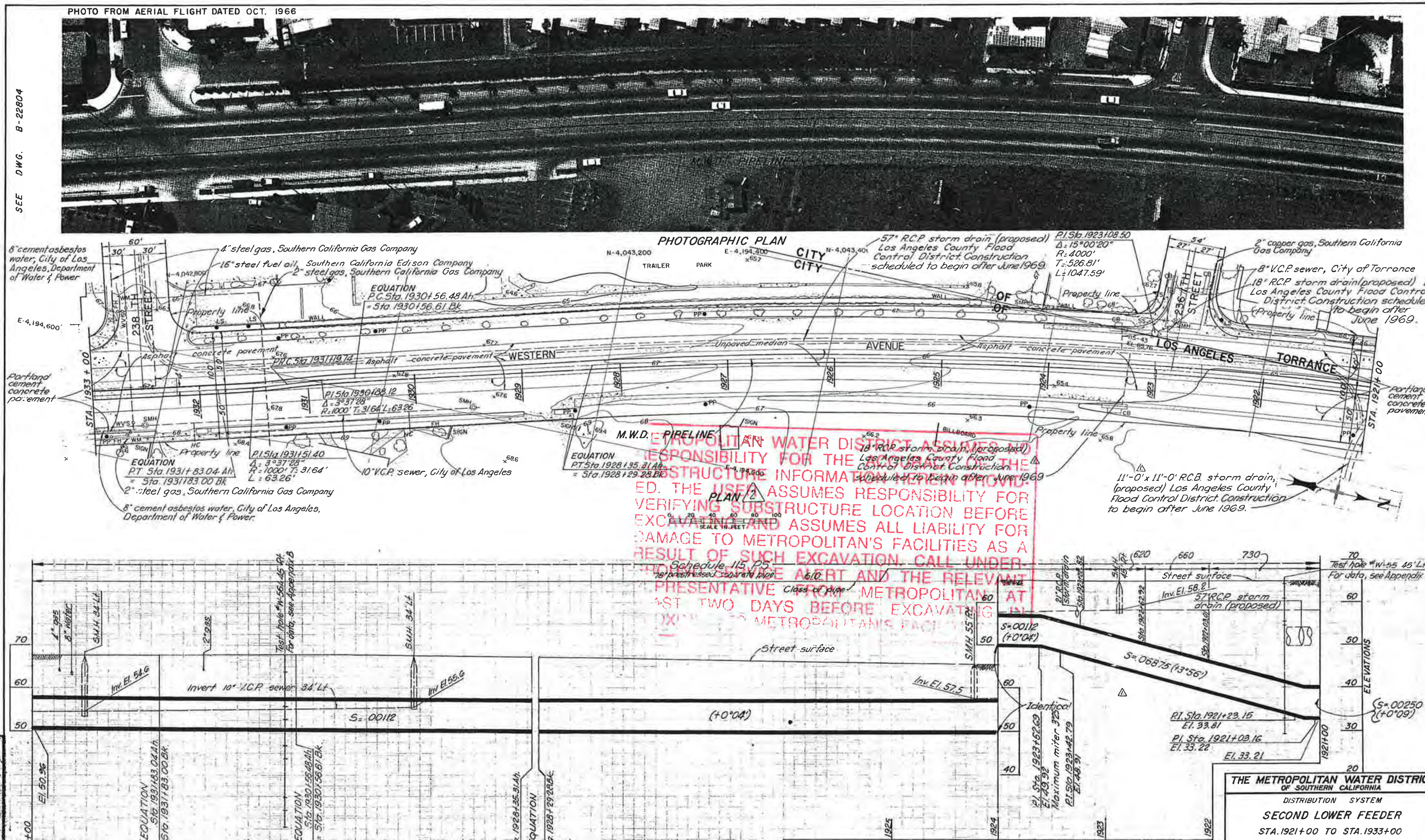


PHOTO FROM AERIAL FLIGHT DATED OCT. 1966



ETROPOLITAN WATER DISTRICT ASSUMES NO RESPONSIBILITY FOR THE ACCURACY OF THE SUBSTRUCTURE INFORMATION HEREIN PROVIDED. THE USER ASSUMES RESPONSIBILITY FOR VERIFYING SUBSTRUCTURE LOCATION BEFORE EXCAVATING AND ASSUMES ALL LIABILITY FOR DAMAGE TO METROPOLITAN'S FACILITIES AS A RESULT OF SUCH EXCAVATION. CALL UNDERGROUND SERVICE ALERT AND THE RELEVANT REPRESENTATIVE FROM METROPOLITAN AT LEAST TWO DAYS BEFORE EXCAVATING IN PROXIMITY TO METROPOLITAN'S FACILITIES.

FIELD BOOKS
Alinement: 5529 p. 26, 27 & 28
Profile: 6161 p. 14-17
Test Hole: 6173 p. 44-47

FIELD BOOKS (As constructed)
Pipe joints: 6818 p. 14-17
Line layout (U.C.P.)
Dwg No. L-3470-19, 20

Revised to show pipeline as constructed
Stationing and elevations apply to invert of pipe
For detail design of pipe see Dwg. B-24943

M. A. NISHKIAN & CO.
CONSULTING ENGINEERS
LONG BEACH — LOS ANGELES
REGISTERED CIVIL ENGINEER No. 5777

Nº	DATE	DWN.	CKD.	REVISION	REC.	APR.
2	6-28-73			Rev. as const.		
1	3/20/69	MS		Rev. SD, pipe classes and pipe grade		

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
DISTRIBUTION SYSTEM
SECOND LOWER FEEDER
STA. 1921+00 TO STA. 1933+00
PLAN AND PROFILE

DRAWN M.A.N. RECOMMENDED
TRACED M.A.N.
CHECKED APPROVED
W.O.-3639 LOS ANGELES OCT. 1967 B-22803

ORIGINAL / RELEASE / INTER-SECTION CO-ORDINATION CHECK / REVISION CO-ORDINATION CHECK / MECH. / STRUCT. / ELEC. / CIVIL

PACIFIC AIR INDUSTRIES, INC.

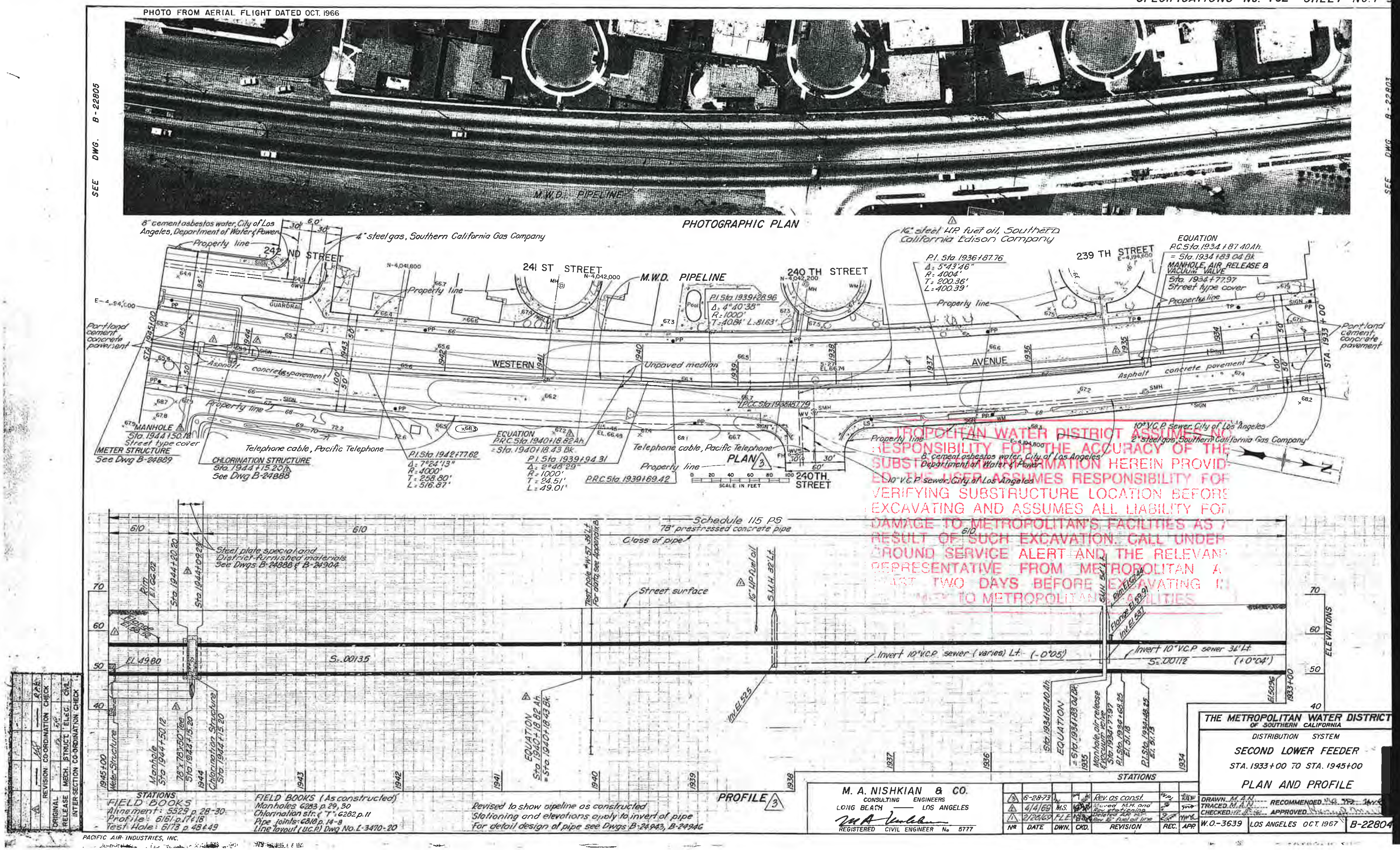
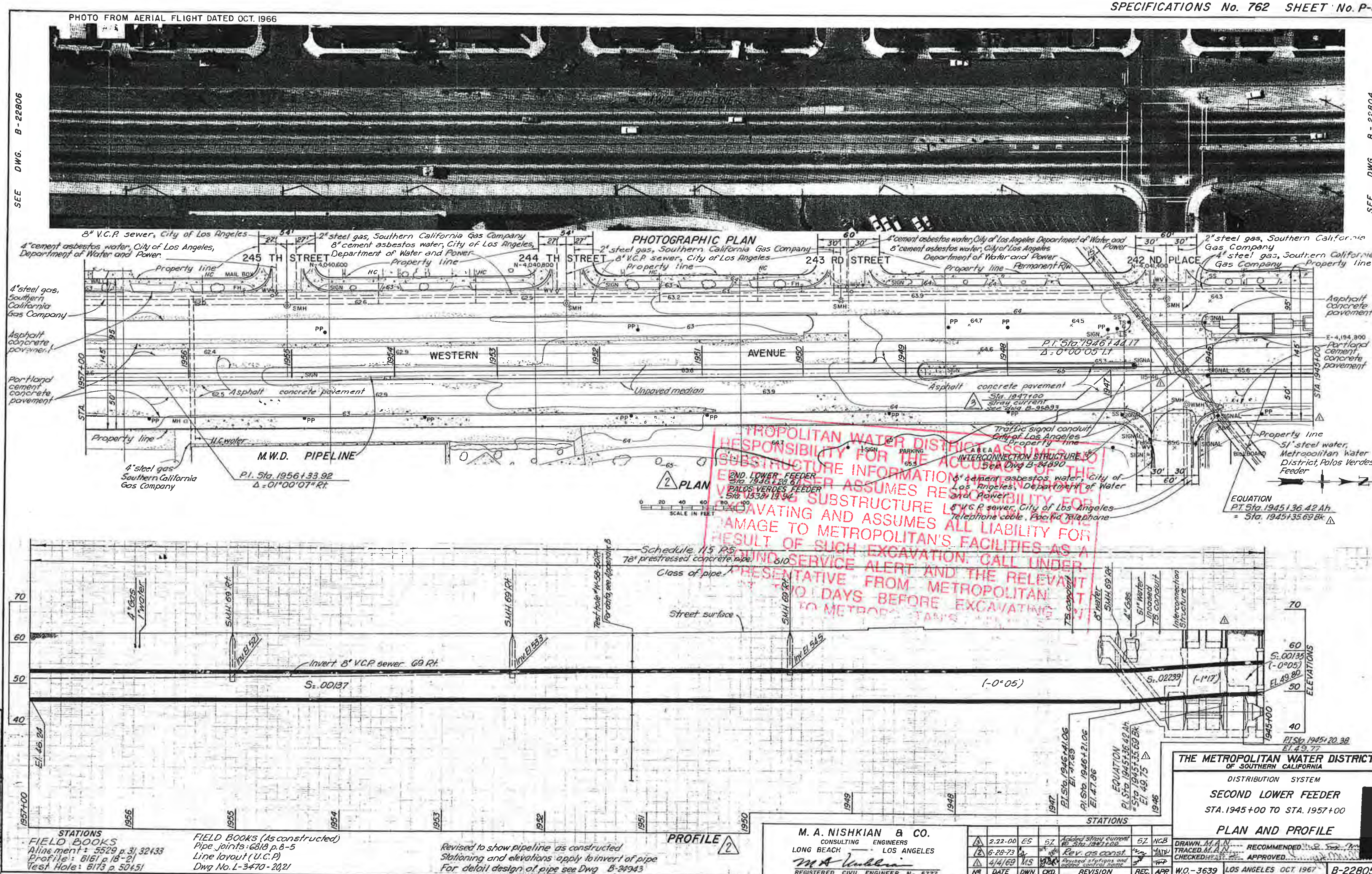
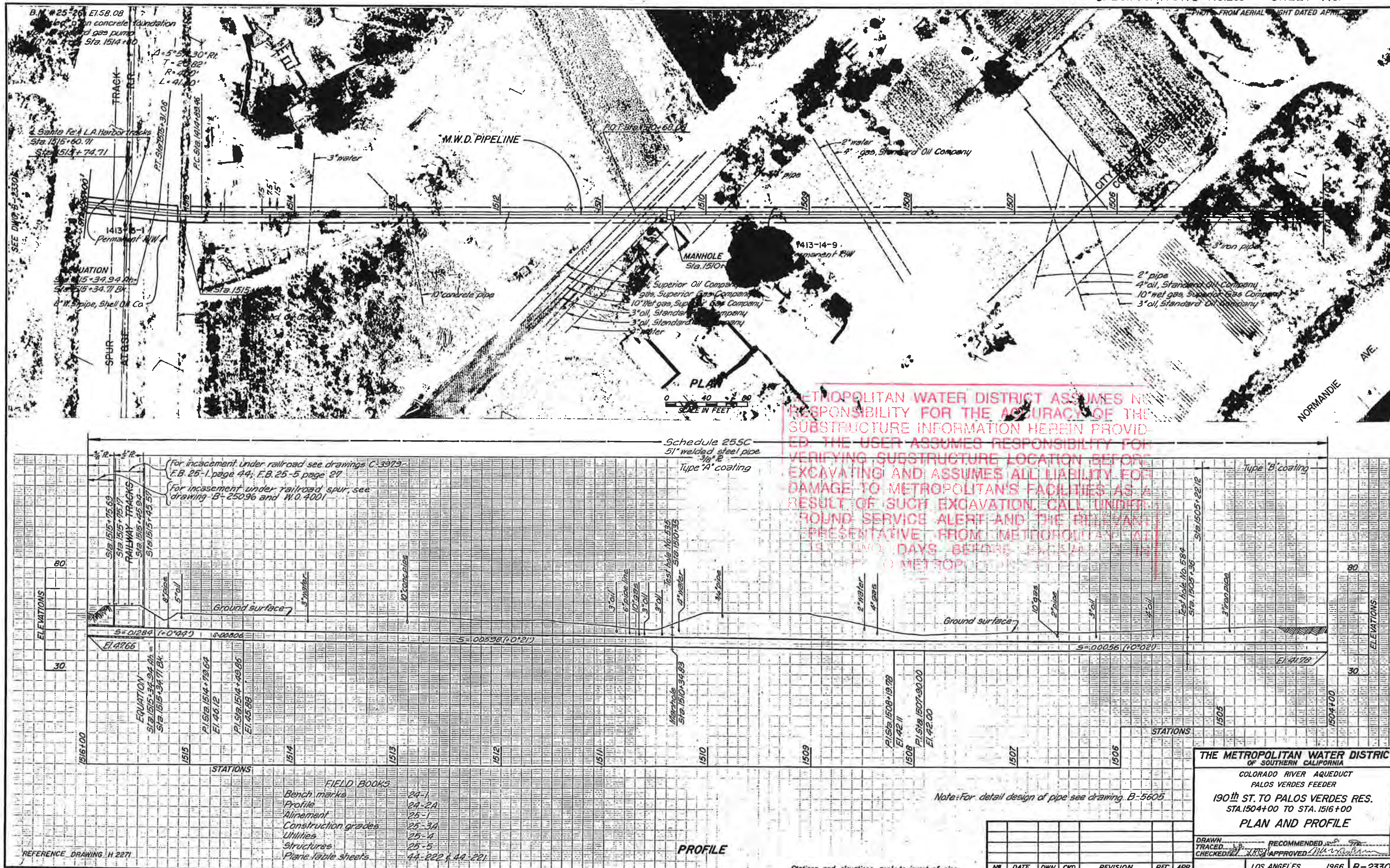


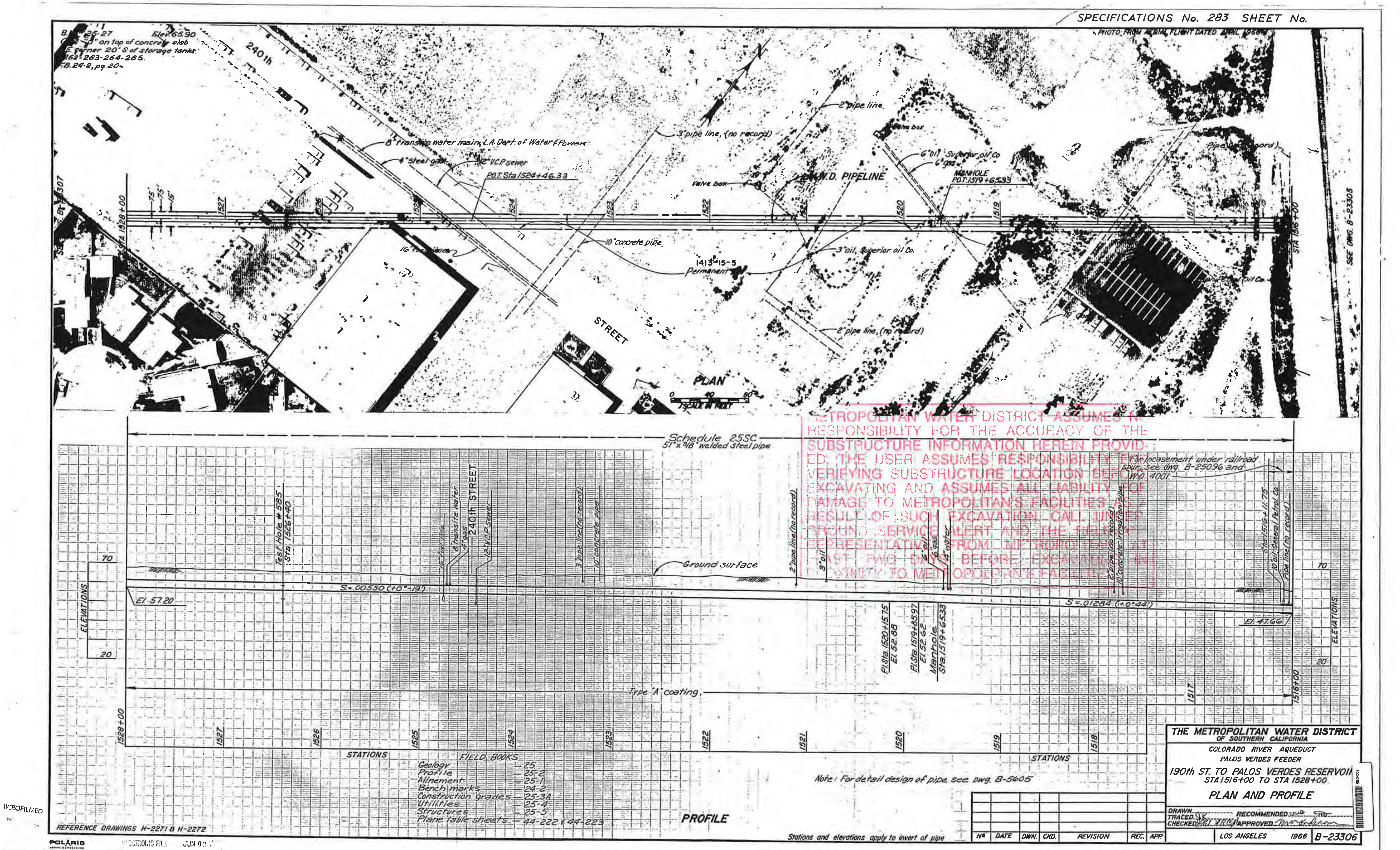
PHOTO FROM AERIAL FLIGHT DATED OCT. 1966
SEE DWG. B-22805
SEE DWG. B-22803
M.W.D. PIPELINE
PHOTOGRAPHIC PLAN
8" cement asbestos water, City of Los Angeles, Department of Water & Power
4" steel gas, Southern California Gas Company
242 ND STREET
241 ST STREET
240 TH STREET
239 TH STREET
M.W.D. PIPELINE
16" steel H.P. fuel oil, Southern California Edison Company
P.I. Sta 1936+87.76
Δ: 5°43'46"
R: 4004'
T: 200.36'
L: 400.39'
P.I. Sta 1939+28.96
Δ: 4°40'38"
R: 1000'
T: 40.84' L: 81.63'
EQUATION
P.C. Sta. 1934+87.40 Ah.
= Sta. 1934+83.04 Bk.
MANHOLE, AIR RELEASE & VACUUM VALVE
Sta. 1934+77.97
Street type cover
Property line
Portland cement concrete pavement
Asphalt concrete pavement
WESTERN AVENUE
Unpaved median
MANHOLE
Sta. 1944+50.12
Street type cover
METER STRUCTURE
See Dwg B-24889
CHLORINATION STRUCTURE
Sta. 1944+15.20
See Dwg B-24888
Telephone cable, Pacific Telephone
EQUATION
P.R.C. Sta. 1940+18.82 Ah.
= Sta. 1940+18.43 Bk.
P.I. Sta 1942+77.62
Δ: 7°24'13"
R: 4000'
T: 258.80'
L: 516.87'
P.I. Sta 1939+94.31
Δ: 2°48'29"
R: 1000'
T: 24.51'
L: 49.01'
P.R.C. Sta. 1939+69.42
P.C.C. Sta. 1938+51.79
PLAN
SCALE IN FEET
10" V.C.P. sewer, City of Los Angeles
2" steel gas, Southern California Gas Company
8" cement asbestos water, City of Los Angeles Department of Water & Power
10" V.C.P. sewer, City of Los Angeles
METROPOLITAN WATER DISTRICT ASSUMES NO RESPONSIBILITY FOR THE ACCURACY OF THE SUBSTRUCTURE INFORMATION HEREIN PROVIDED. THE USER ASSUMES RESPONSIBILITY FOR VERIFYING SUBSTRUCTURE LOCATION BEFORE EXCAVATING AND ASSUMES ALL LIABILITY FOR DAMAGE TO METROPOLITAN'S FACILITIES AS A RESULT OF SUCH EXCAVATION. CALL UNDERGROUND SERVICE ALERT AND THE RELEVANT REPRESENTATIVE FROM METROPOLITAN AT LEAST TWO DAYS BEFORE EXCAVATING IN ... TO METROPOLITAN'S FACILITIES
Schedule 115 PS
78" prestressed concrete pipe
Class of pipe
Steel plate special and District-furnished materials
See Dwgs B-24888 & B-24904
Street surface
S: .00135
S: .00112
Invert 10" V.C.P. sewer (varies) Lt. (-0°05')
Invert 10" V.C.P. sewer 31' Lt. (+0°04')
EL 49.80
ELEVATIONS
STATIONS
PROFILE
FIELD BOOKS
Alinement: 5529 p. 28-30
Profile: 6161 p. 17 & 18
Test Hole: 6173 p. 48 & 49
FIELD BOOKS (As constructed)
Manholes 6283 p. 29, 30
Chlorination str. & "T": 6282 p. 11
Pipe joints: 6818 p. 14-8
Line layout (U.C.P.) Dwg No. L-3470-20
Revised to show pipeline as constructed
Stationing and elevations apply to invert of pipe
For detail design of pipe see Dwgs B-24943, B-24946
M. A. NISHKIAN & CO.
CONSULTING ENGINEERS
LONG BEACH — LOS ANGELES
REGISTERED CIVIL ENGINEER No. 5777
THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
DISTRIBUTION SYSTEM
SECOND LOWER FEEDER
STA. 1933+00 TO STA. 1945+00
PLAN AND PROFILE
DRAWN M.A.N.
TRACED M.A.N.
CHECKED
RECOMMENDED
APPROVED
W.O.-3639
LOS ANGELES OCT. 1967
B-22804
REVISION
DATE
DWN.
CKD.
REC.
APP.
Rev. as const.
PACIFIC AIR INDUSTRIES, INC.

SPECIFICATIONS No. 762 SHEET No. P-31

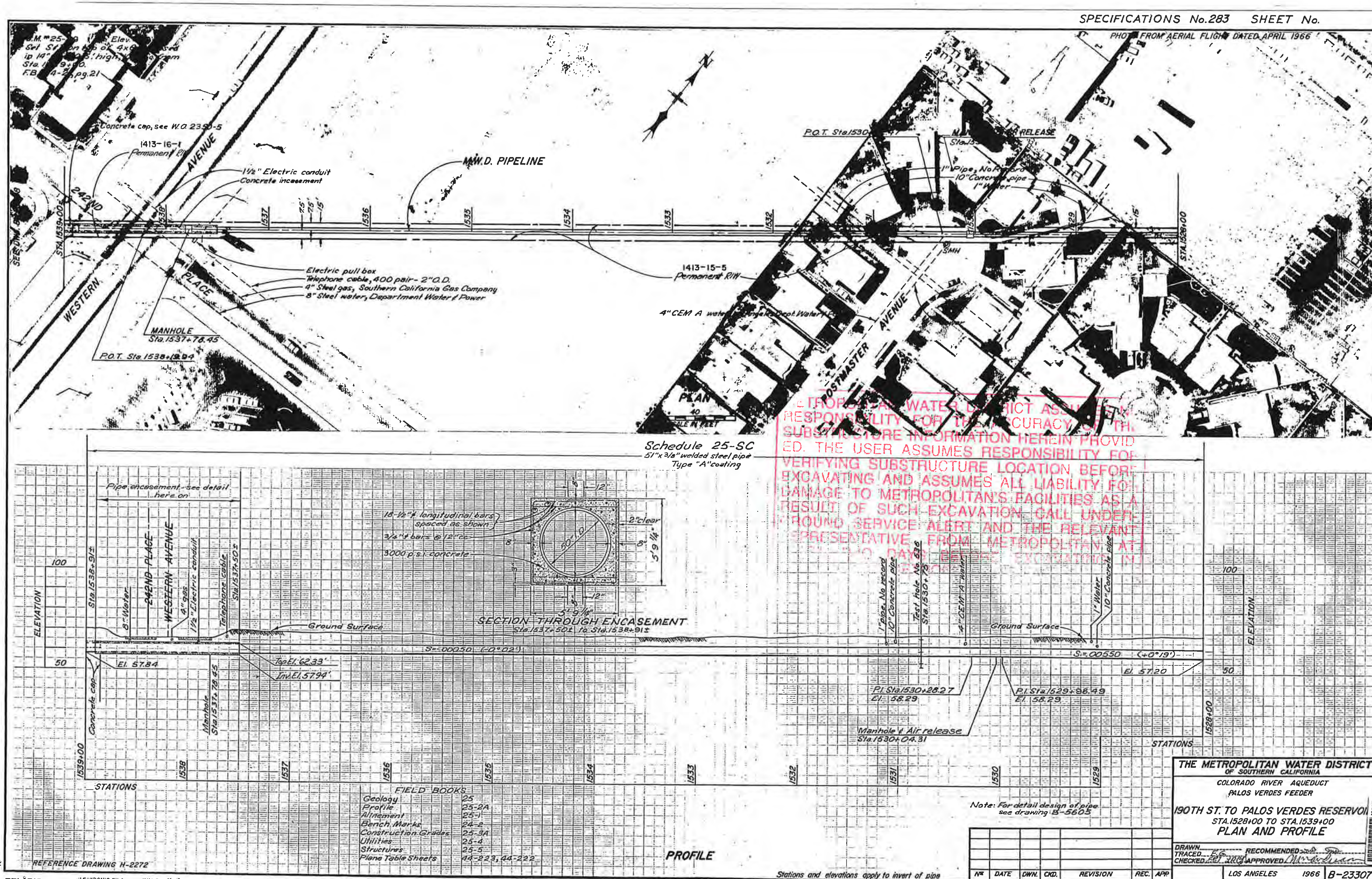


SPECIFICATIONS No.283 SHEET No.

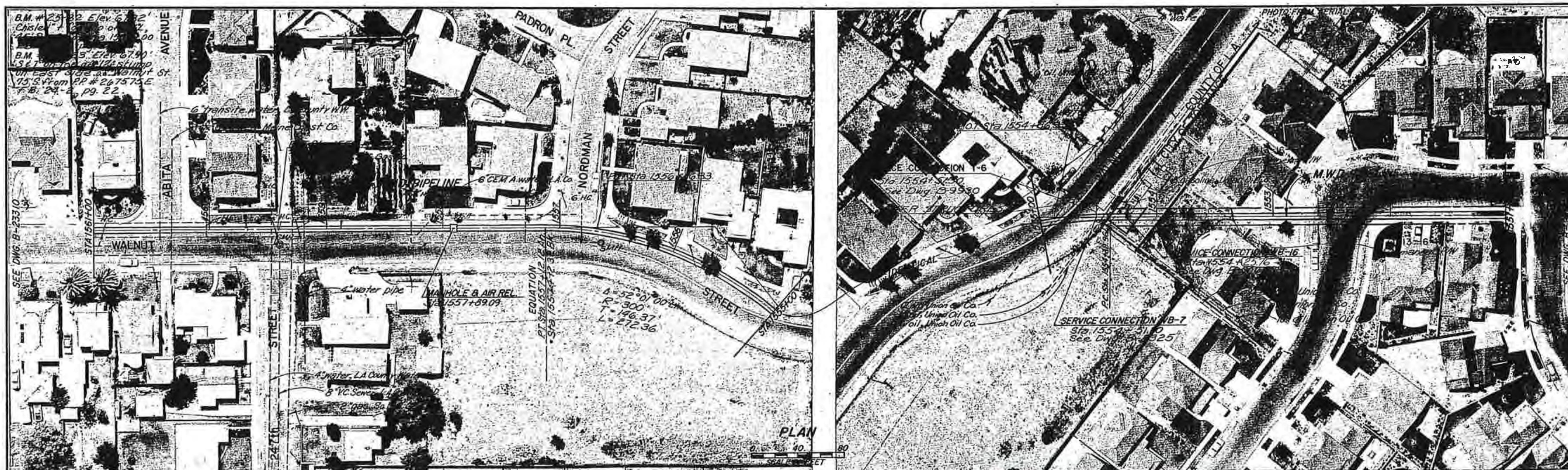


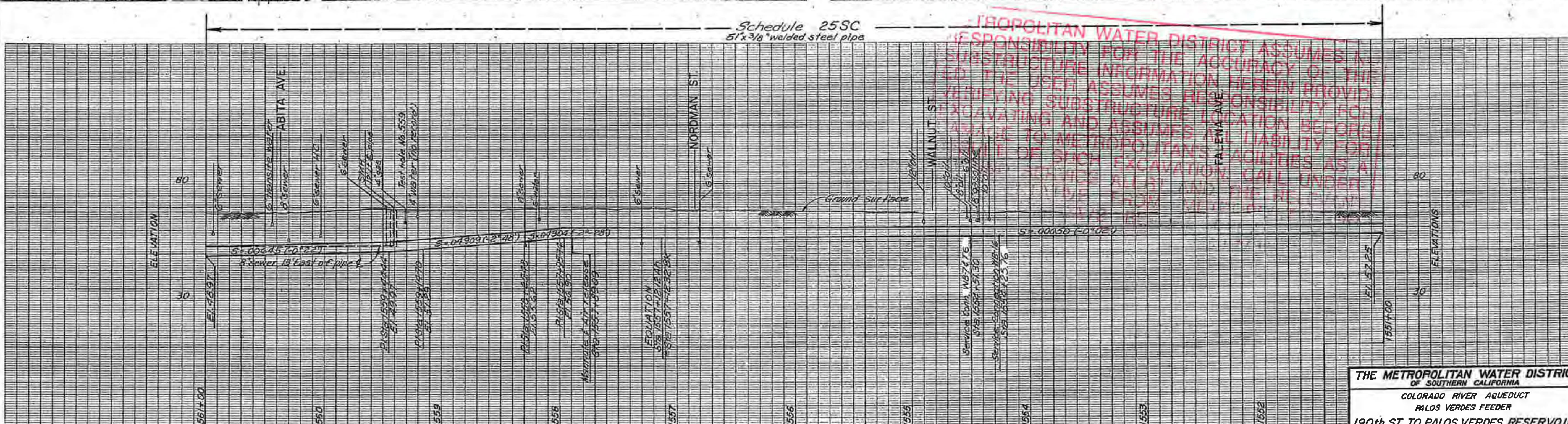


SPECIFICATIONS No. 283 SHEET No.
PHOTO FROM AERIAL FLIGHT DATED APRIL 1966
Elev. 65.90
on top of concrete slab
F.B. 24-2, pg. 20
240th
STREET
8" transite water main, L.A. Dept. of Water & Power
4" steel gas
12" V.C.P. sewer
P.O.T. Sta 1524+46.33
3" pipe line, (no record)
2" pipe line
Valve box
M.W.D. PIPELINE
6" oil Superior oil Co.
6" gas
MANHOLE
P.O.T. 1519+65.33
10" Concrete pipe
3" oil, Superior oil Co.
Permanent
2" pipe line, (no record)
STA 1528+00
STA 1516+00
SEE DWG. B-23305
PLAN
SCALE IN FEET
Schedule 25SC
51" x 3/8" welded steel pipe
For incasement under railroad spur, see dwg. B-25096 and WO 4001
Test Hole # 585
Sta 1526+40
240th STREET
12" V.C.P. sewer
3" pipe line (no record)
10" concrete pipe
Ground surface
2" pipe line (no record)
3" oil
S=.00550 (+0°-19')
S=.01284 (+0°44')
El. 57.20
El. 47.66
ELEVATIONS
70
20
P.I. Sta. 1520+15.75
El. 52.88
P.I. Sta. 1519+85.97
El. 52.62
Manhole
Sta. 1519+65.33
Sta. 1516+11.75
10" oil, General Petrol. Co.
Pipe line (no record)
Type 'A' coating
1528+00 1527 1526 1525 1524 1523 1522 1521 1520 1519 1518 1517 1516+00
STATIONS
FIELD BOOKS
Geology — 25
Profile — 25-2
Alinement — 25-1
Bench marks — 24-2
Construction grades — 25-3A
Utilities — 25-4
Structures — 25-5
Plane table sheets — 44-222 & 44-223
Note: For detail design of pipe see dwg. B-5605
PROFILE
REFERENCE DRAWINGS H-2271 & H-2272
Stations and elevations apply to invert of pipe
No. DATE DWN. CKD. REVISION REC. APP.
THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
COLORADO RIVER AQUEDUCT
PALOS VERDES FEEDER
190th ST. TO PALOS VERDES RESERVOIR
STA 1516+00 TO STA 1528+00
PLAN AND PROFILE
DRAWN
TRACED
CHECKED
RECOMMENDED
APPROVED
LOS ANGELES 1966 B-23306
METROPOLITAN WATER DISTRICT ASSUMES NO RESPONSIBILITY FOR THE ACCURACY OF THE SUBSTRUCTURE INFORMATION HEREIN PROVIDED. THE USER ASSUMES RESPONSIBILITY FOR VERIFYING SUBSTRUCTURE LOCATION BEFORE EXCAVATING AND ASSUMES ALL LIABILITY FOR DAMAGE TO METROPOLITAN'S FACILITIES AS A RESULT OF SUCH EXCAVATION. CALL UNDERGROUND SERVICE ALERT AND THE FIELD REPRESENTATIVE FROM METROPOLITAN AT LEAST TWO DAYS BEFORE EXCAVATING IN VICINITY TO METROPOLITAN'S FACILITIES.
MICROFILMED
POLARIS


SPECIFICATIONS No.283 SHEET No.
PHOTO FROM AERIAL FLIGHT DATED APRIL 1966
M.W.D. PIPELINE
Concrete cap, see W.O. 2350-5
1413-16-1
Permanent R/W
1½" Electric conduit
Concrete incasement
WESTERN AVENUE
242ND PLACE
Electric pull box
Telephone cable, 400 pair - 2" O.D.
4" Steel gas, Southern California Gas Company
8" Steel water, Department Water & Power
MANHOLE
Sta. 1537+78.45
P.O.T. Sta. 1538+19.94
1413-15-5
Permanent R/W
POSTMASTER AVENUE
SMH
STA. 1539+00
STA. 1528+00
PLAN
SCALE IN FEET
METROPOLITAN WATER DISTRICT ASSUMES NO RESPONSIBILITY FOR THE ACCURACY OF THE SUBSTRUCTURE INFORMATION HEREIN PROVIDED. THE USER ASSUMES RESPONSIBILITY FOR VERIFYING SUBSTRUCTURE LOCATION BEFORE EXCAVATING AND ASSUMES ALL LIABILITY FOR DAMAGE TO METROPOLITAN'S FACILITIES AS A RESULT OF SUCH EXCAVATION. CALL UNDERGROUND SERVICE ALERT AND THE RELEVANT REPRESENTATIVE FROM METROPOLITAN AT LEAST TWO DAYS BEFORE EXCAVATING IN ...
Schedule 25-SC
51" x 3/8" welded steel pipe
Type "A" coating
Pipe encasement - see detail here on
15-1/2" longitudinal bars spaced as shown
3/4" bars @ 12" c.c.
3000 p.s.i. concrete
2" clear
5'9¼"
SECTION THROUGH ENCASEMENT
Sta. 1537+50± To Sta. 1538+91±
Ground Surface
S=.00050 (-0°02')
S=.00550 (+0°19')
El. 57.84
Top El. 62.33'
Inv. El. 57.94'
El. 57.20
P.I. Sta. 1530+28.27
El. 58.29
P.I. Sta. 1529+98.49
El. 58.29
Manhole & Air release
Sta. 1530+04.31
ELEVATION
STATIONS
FIELD BOOKS
Geology 25
Profile 25-2A
Alignment 25-1
Bench Marks 24-2
Construction Grades 25-3A
Utilities 25-4
Structures 25-5
Plane Table Sheets 44-223, 44-222
REFERENCE DRAWING H-2272
PROFILE
Stations and elevations apply to invert of pipe
Note: For detail design of pipe see drawing B-5605
Nº DATE DWN. CKD. REVISION REC. APP.
THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
COLORADO RIVER AQUEDUCT
PALOS VERDES FEEDER
190TH ST. TO PALOS VERDES RESERVOIR
STA. 1528+00 TO STA. 1539+00
PLAN AND PROFILE
DRAWN
TRACED E.G.
CHECKED
RECOMMENDED
APPROVED
LOS ANGELES 1966 B-23307

SPECIFICATIONS No. 283 SHEET No.
AVE
243rd
242nd
FALENA
244th
STREET
245th
STREET
STREET
AVENUE
WESTERN
PLAN
M.W.D. PIPE
2"oil line
6"water, Torrance Water Co.
MANHOLE
SEE DWG. B-23309
Schedule 25SC
51"x 3/8" welded steel pipe
METROPOLITAN WATER DISTRICT ASSUMES N
RESPONSIBILITY FOR THE ACCURACY OF THE
SUBSTRUCTURE INFORMATION HEREIN PROVID
Ground surface
S=.00050 (-0°02')
Top curb 64.10
40' concrete cap
ELEVATIONS
80
30
246th STREET
244th STREET
243rd STREET
2-1/2" Elec. conduits
6"water
3/4"Elec. conduit
2"Elec. conduit
Manhole Sta 1548+02.08
El. 57.25
El. 57.64
1551+00
1550
1549
1548
1547
1546
1545
1544
1543
1542
1541
1540
1539+00
STATIONS
STATIONS
FIELD BOOKS
Bench marks — 25
Construction grades — 25-3A
Utilities — 25-4
Structures — 25-5
Geology — 25
Profile — 25-2A
Alinement — 25-1
Plane table sheets 44-223 & 44-224 see H-2278
REFERENCE DRAWINGS H-2272 & H-2273
PROFILE
Note: For detail design of pipe see dwg. B-5605
Stations and elevations apply to invert of pipe
Nº DATE DWN. CKD. REVISION REC. APP.
THE METROPOLITAN WATER DISTRICT
OF SOUTHERN CALIFORNIA
COLORADO RIVER AQUEDUCT
PALOS VERDES FEEDER
190TH ST. TO PALOS VERDES RESERVO
STA 1539+00 TO STA 1551+00
PLAN AND PROFILE
DRAWN
TRACED
CHECKED
RECOMMENDED
APPROVED
LOS ANGELES 1966 B-23308





FIELD BOOKS

Bench marks	24-2
Alinement	25-1 & Plane table sheets 44-223 & 44-224
Construction grades	25-3A
Utilities	25-4
Structures	25-5
Geology	25
Profile	25-2A

Note: For detail design of pipe see dwg. B-5605

PROFILE

Stations and elevations apply to invert of pipe

REFERENCE DRAWING H-2273

Nº	DATE	DWN.	CKD.	REVISION	REC.	APP.

THE METROPOLITAN WATER DISTRICT
OF SOUTHERN CALIFORNIA

COLORADO RIVER AQUEDUCT
PALOS VERDES FEEDER

190th ST. TO PALOS VERDES RESERVOIR
STA 1551+00 TO STA 1561+00

PLAN AND PROFILE

DRAWN RECOMMENDED
TRACED
CHECKED APPROVED

LOS ANGELES 1966 B-23309

MICROFILMED JUN 6 1972

POLARIS ELECTRONIC FILE JUN 03 1997

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APPENDIX E – GEOTECHNICAL STUDY REPORT

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Converse Consultants
Geotechnical Engineering, Environmental & Groundwater Science, Inspection & Testing Services

GEOTECHNICAL STUDY REPORT
Proposed Torrance Airport Infiltration Galleries Project
3301 Airport Drive
Torrance, California

Converse Project No. 13-31-225-01

September 27, 2013

PREPARED FOR
Corollo Engineers, Inc.
199 South Los Robles Ave. Suite 530
Pasadena, CA 91101

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Converse Consultants

Geotechnical Engineering, Environmental & Groundwater Science, Inspection & Testing Services

September 27, 2013

Mr. Bijan Sadeghi, P.E.
Carollo Engineers, Inc.
199 South Los Robles Avenue, Suite 530
Pasadena, CA 91101

Subject: **GEOTECHNICAL STUDY REPORT**
Proposed Torrance Airport Infiltration Galleries Project
3301 Airport Drive
Torrance, California
Converse Project No. 13-31-225-01

Dear Mr. Sadeghi:

Converse Consultants (Converse) is pleased to present this Geotechnical Study Report for the design of Torrance Airport Infiltration Galleries Project in Torrance, California. Our services were performed in accordance with our proposal dated June 27, 2013.

Based on our field exploration, laboratory testing, geologic evaluation and geotechnical analysis, the site is suitable from a geotechnical standpoint for the proposed project, provided our conclusions and recommendations are implemented during design and construction.

We appreciate the opportunity to be of service to Carollo Engineers, Inc. If you should have any questions, please do not hesitate to contact us at (626) 930-1200.

CONVERSE CONSULTANTS

William H. Chu, P.E., G.E.
Senior Vice President/Principal Engineer

Dist: 4/Addressee

MM/SCL/WHC/amm

PROFESSIONAL CERTIFICATION

This report for the proposed Torrance Airport Infiltration Galleries Project located at 3301 Airport Drive in the City of Torrance, California has been prepared by the staff of Converse under the professional supervision of the individuals whose seals and signatures appear hereon.

The findings, recommendations, specifications or professional opinions contained in this report were prepared in accordance with generally accepted professional engineering and engineering geologic principles and practice in this area of Southern California. There is no warranty, either expressed or implied.

In the event that changes to the property occur, or additional, relevant information about the property is brought to our attention, the conclusions contained in this report may not be valid unless these changes and additional relevant information are reviewed and the recommendations of this report are modified or verified in writing.

Mohammad-Saad Malim, E.I.T
Staff Engineer

William H. Chu, G.E.
Principal Engineer, Senior Vice President

REGISTERED PROFESSIONAL ENGINEER
CHU HSUEH-HSIN WILLIAM
No. 2482
Exp. 6/30/14
GEOTECHNICAL
STATE OF CALIFORNIA

EXECUTIVE SUMMARY

The following is the summary of our geotechnical study, findings, conclusions, and recommendations, as presented in the body of this report. Please refer to the appropriate sections of the report for complete conclusions and recommendations. In the event of a conflict between this summary and the report, or an omission in the summary, the report shall prevail.

- The project site is located at 3301 Airport Drive in the City of Torrance, California
- Three (3) exploratory borings (BH-1 through BH-3) were drilled within the project site on September 3, 2013. The borings were advanced using a truck mounted 8-inch diameter hollow stem auger drill rig to depths of 51.5 feet below the existing ground surface (bgs). Every boring was visually logged by a Converse engineer and sampled at regular intervals and at changes in subsurface soils.
- The earth materials encountered during our investigation consist of existing fill soils placed during previous site grading operations and natural alluvial soils. The fill soils encountered to depths of f feet below ground surface (bgs) are described as silty sand and sandy clay. Deeper fills may be present at the other areas at the site based on our field observations of existing on-site structures. The alluvial soils below the fill primarily consist of clay and sand to a maximum depth of 51.5 feet below ground surface (bgs).
- Groundwater was not encountered in our exploratory borings drilled to a maximum depth of 51.5 feet below the ground surface. Review of LA County Department of Public Works groundwater monitoring well number 769 and 271N indicate the historical highest groundwater level is reportedly deeper than 80 feet below the ground surface. Groundwater is not anticipated during construction and will not need to be considered in design.
- The site is not located within a mapped Seismic Hazard Zone for liquefaction potential. Based on the results of our subsurface exploration, including the absence of groundwater within 50 feet, and our experience on similar projects, the site is not considered susceptible to liquefaction and seismically-induced settlement is negligible.
- Results of our study indicate that the site is suitable from a geotechnical standpoint for the proposed development, provided that the recommendations contained in this report are incorporated into the design and construction of the project.
- The proposed buildings can be supported on conventional shallow foundations embedded into compacted fill.
- Soil can be excavated with conventional heavy-duty earthmoving equipments.

- The near surface site soils have a high expansion potential. Mitigation measures for expansive soil are anticipated. We recommend that two feet of suitable, non-expansive, sandy import materials approved by Converse be placed under planned footings and slabs.
- Based on the soil corrosivity test results, the near surface sols is not considered corrosive to concrete, However, the minimum saturated resistivity testing result indicates the onsite soil is considered corrosive to ferrous metal. Protections of underground metal pipe should be considered.
- Based on our field exploration, surficial clayey soils encountered up to 40 feet deep are not considered effective for planned infiltration systems. Sandy soils encountered below the clayey soil layers are relatively dense and also might not be conducive to good percolation rates. It is recommended that a specific percolation testing program be performed for any planned infiltration system to determine percolation rates at specific depths.

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APPENDICES

1.0 INTRODUCTION

This report contains the findings and recommendations of our geotechnical study performed for the proposed Torrance Airport Infiltration Galleries Project located at 3301 Airport Drive in the City of Torrance, California as shown on Drawing No. 1, *Site Location Map*.

The purpose of this work was to evaluate the subsurface soil conditions, specifically the depths of clays and other impermeable layers, and provide geotechnical recommendations and design recommendations for the proposed project, including current standard of practice seismic and geotechnical engineering interpretations.

This report for geologic and geotechnical design parameters for the project described herein and is intended for use solely by Carollo Engineers, Inc and the City of Torrance. This report should not be used as a bidding document but may be made available to the potential contractors for information on faculty data only. For bidding purposes, the contractors should be responsible for making their own interpretation of the data contained in this report.

2.0 SITE AND PROJECT DESCRIPTION

2.1 Site Description

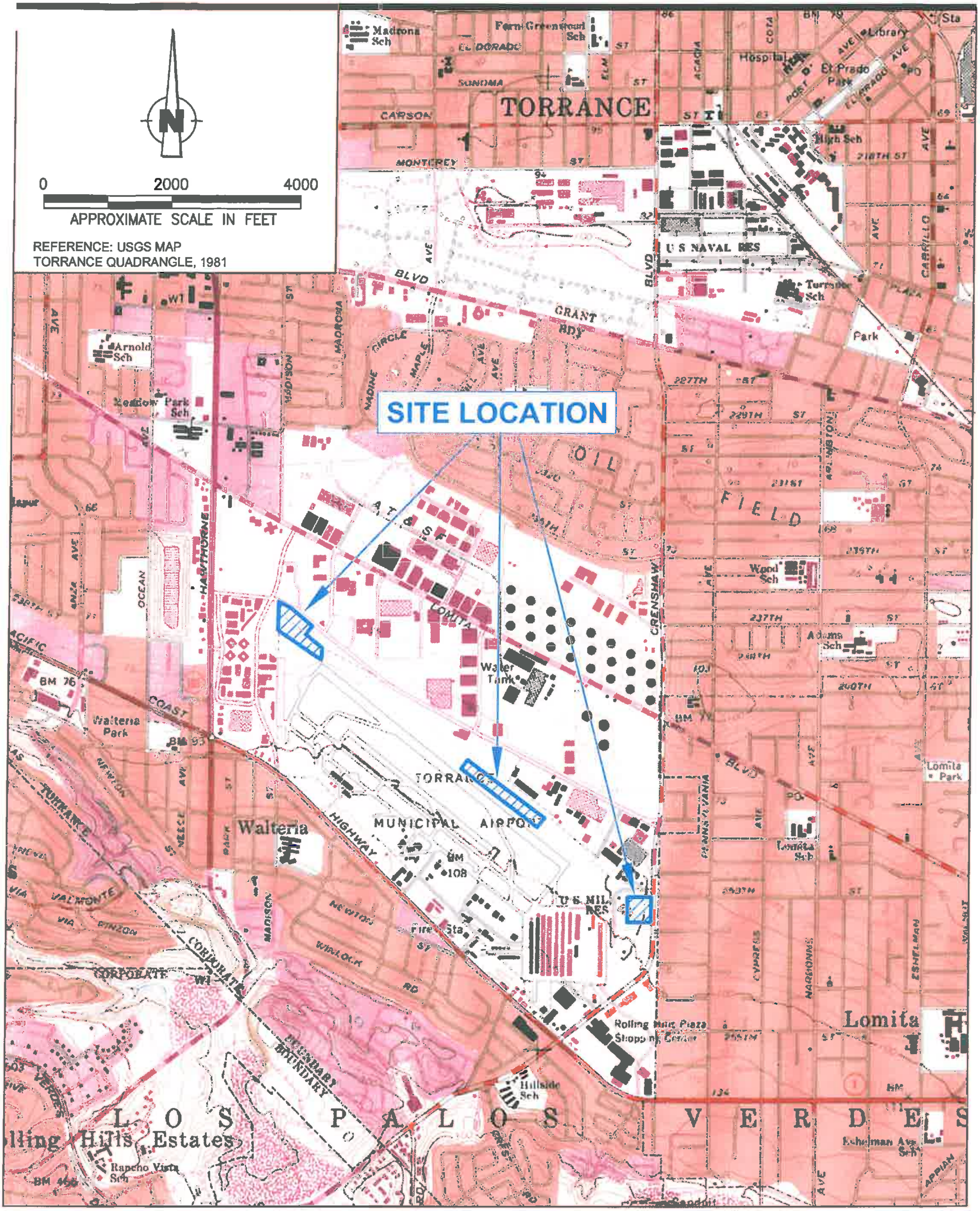
The project site is located at 3301 Airport Drive in the City of Torrance, California. The site currently consists of open fields adjacent to the Torrance Airport runway. The site is gently sloping towards the northwest and the ground elevation is about 90 feet above Mean Sea Level (MSL). The coordinates for the project site are: North latitude: 33.8017 degrees and West longitude: 118.3346 degrees. The project site is shown on Drawing No. 2, *Site Plan and Boring Locations*.

2.2 Project Description

The proposed project consists of the construction of three (3) potential infiltration galleries at Area 1 (approximately 246,400 square feet), Area 2 (approximately 105,000 square feet), and Area 3 (165,000 square feet) within Torrance Airport as shown on Drawing No. 2, *Site Plan and Boring Locations.* The proposed infiltration galleries are planned to divert flow from Machado Lake.

3.0 SCOPE OF WORK

The scope of our present study includes a review of the existing site plan, site reconnaissance, subsurface exploration, soil sampling, laboratory testing, preliminary

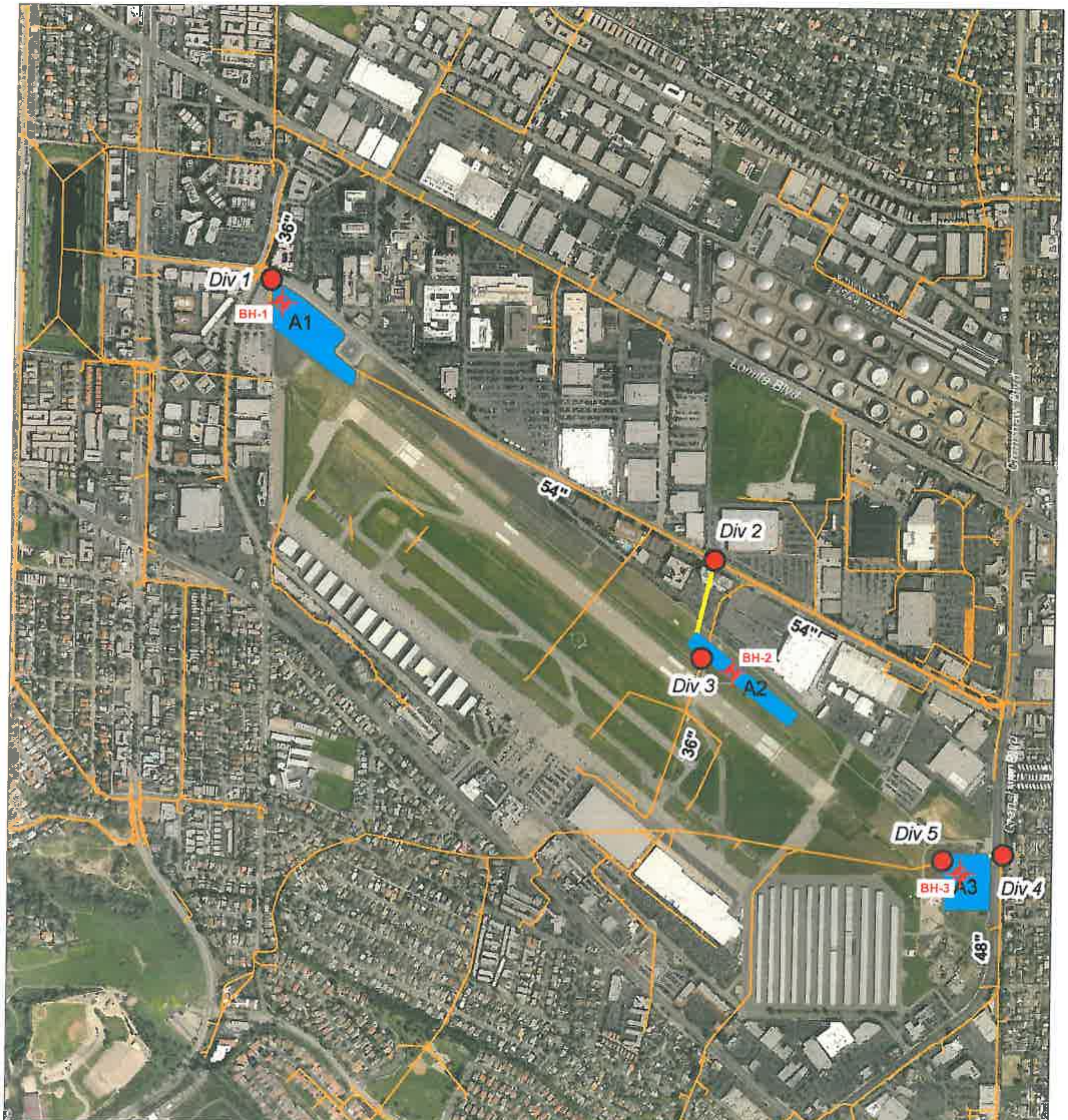


SITE LOCATION MAP

Converse Consultants

TORRANCE AIRPORT INFILTRATION GALLERIES
TORRANCE, CALIFORNIA

Project No.	Drawing No.
13-31-225-01	1



REFERENCE: DRAWING BY CAROLLO ENGINEERS

Legend

- Diversions
- New Conveyance
- Infiltration/Recharge
- Storm Drains
- Approximate Location of Boring (Converse 2013)

N

0 1,000 2,000 Feet

SITE PLAN AND BORING LOCATIONS

Converse Consultants	TORRANCE AIRPORT INFILTRATION GALLERIES TORRANCE, CALIFORNIA	Project No. 13-31-225-01	Drawing No. 2

engineering analysis, and preparation of this report. Details of the tasks are addressed in the following sections:

3.1 Site Reconnaissance

As a part of our project set-up task, available published geotechnical and geologic data were reviewed for the project area to ascertain regional geologic and groundwater conditions, and to screen for potential geologic hazards.

Converse representatives also visited the site prior to drilling to assess the site accessibility for drilling equipment, and to mark the boring locations on August 29, 2013. Underground Service Alert of Southern California was notified at least 48 hours prior to the field exploration.

3.2 Subsurface Exploration

Three (3) exploratory borings (BH-1 through BH-3) were drilled within the project site on September 3, 2013. The borings were advanced using a truck mounted 8-inch diameter hollow stem auger drill rig to depths 51.5 feet below the existing ground surface (bgs). Every boring was visually logged by a Converse engineer and sampled at regular intervals and at changes in subsurface soils. Detailed descriptions of the field exploration and sampling program are presented in Appendix A, *Field Exploration*.

California Modified Sampler (Ring samples), Standard Penetration Test samples, and bulk soil samples were obtained for laboratory testing. Standard Penetration Tests (SPTs) were performed in selected borings at selected intervals using a standard (1.4 inches inside diameter and 2.0 inches outside diameter) split-barrel sampler. The bore holes were backfilled and compacted with soil cuttings and cement by reverse spinning of the auger following the completion of drilling. Borings within paved areas were patched with asphalt cold-patch, with the patch thickness matching the surrounding pavement section.

The approximate locations of the exploratory borings are shown in Drawing No. 2, *Site Plan and Boring Locations.* The detailed description of the field exploration and sampling program are presented in Appendix A, *Field Exploration*.

3.3 Laboratory Testing

Representative samples of the site soils were tested in the laboratory to aid in the classification and to evaluate relevant engineering properties. The tests performed included:

- *In situ* moisture contents and dry densities (ASTM Standard D2216)

- Maximum dry density and optimum-moisture content relationship (ASTM Standard D1557)
- Percent Finer than Sieve No. 200 (ASTM D1140)
- Direct shear (ASTM Standard D3080)
- Consolidation (ASTM Standard D2435)
- Expansion Index (ASTM D4829)
- Atterburg Limits (ASTM D4318)
- Soil corrosivity tests (Caltrans 643, 422, 417 and 532)

The detailed description of the laboratory test methods and test results are presented in Appendix B, *Laboratory Testing Program*.

3.4 Analyses and Report

Data obtained from the exploratory fieldwork and laboratory-testing program were analyzed and evaluated with respect to the planned construction. This report was prepared to provide the findings, conclusions and recommendations developed during our study and evaluation.

4.0 SUBSURFACE CONDITIONS

4.1 Regional Geologic Setting

The project site is located within the west coast portion of the Los Angeles Basin and underlain by alluvial soils as shown on Drawing No. 3, *Regional Geologic Map*.

4.2 Subsurface Soil Profile of Project Site

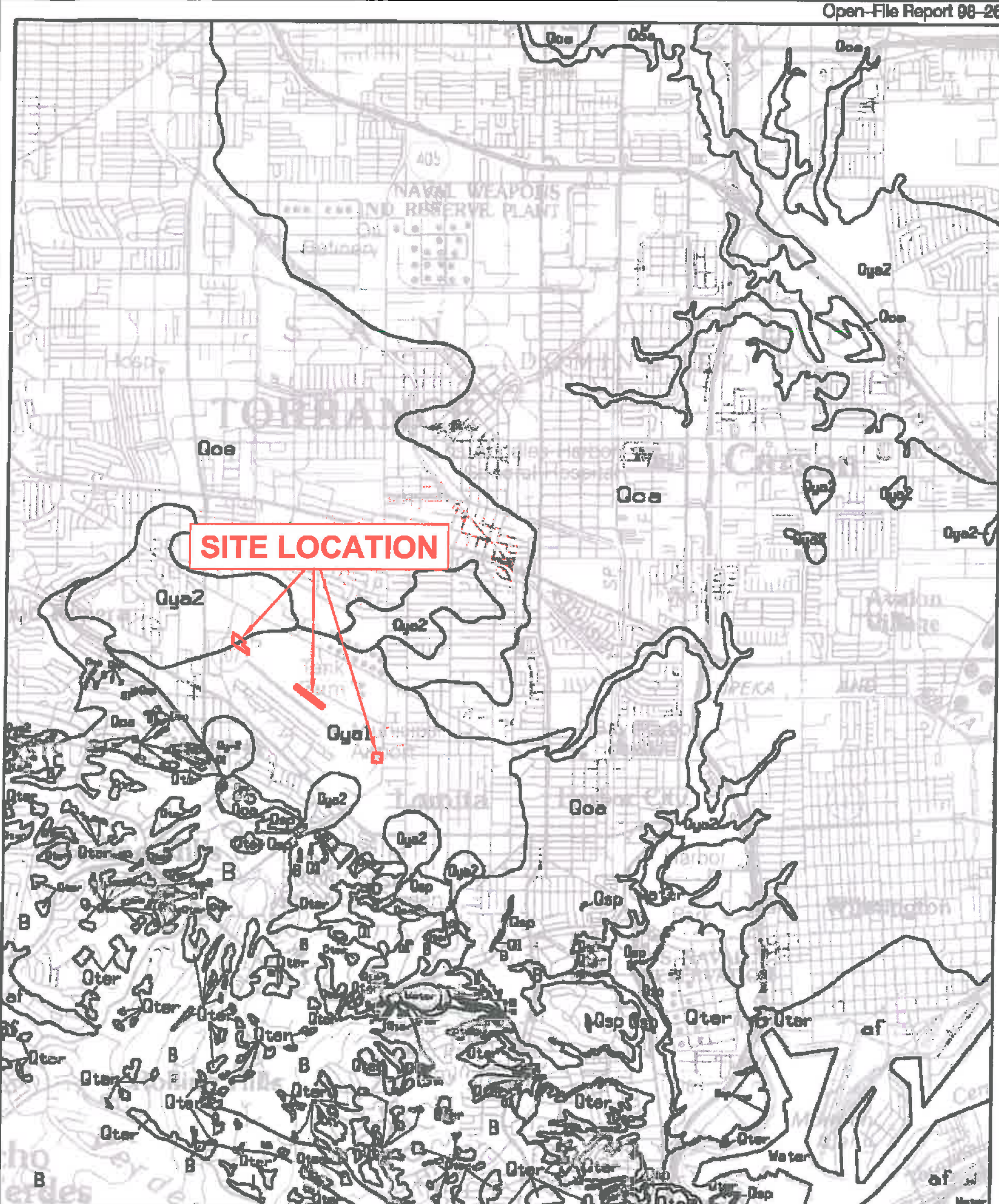
The earth materials encountered during our investigation consist of existing fill soils placed during previous site grading operations and natural alluvial soils. Based on our field exploration, undocumented fill up to a maximum observed depth of five (5) feet were encountered in the borings. The fill soils encountered are described as silty sand and sandy clay. Deeper fills may be present at the other areas at the site based on our field observations of existing on-site structures. The alluvial soils below the fill primarily consist of clay and sand to a maximum depth of 51.5 feet below ground surface (bgs).

The detailed description of the materials encountered in each boring is presented in Appendix A, *Field Exploration*.

4.3 Groundwater

Groundwater was not encountered in our exploratory borings drilled to a maximum depth of 51.5 feet below the ground surface. Review of LA County Department of Public

Open-File Report 98-26



Base map enlarged from U.S.G.S. 30 x 60-minute series

Plate 1.1 Quaternary Geologic Map of the Torrance Quadrangle.
See Geologic Conditions section in report for descriptions of the units.
B = Pre-Quaternary bedrock.

ONE MILE
SCALE

REGIONAL GEOLOGIC MAP

Converse Consultants

TORRANCE AIRPORT INFILTRATION GALLERIES
TORRANCE, CALIFORNIA

Project No.	Drawing No.
13-31-225-01	3

Works groundwater monitoring wells number 769 and 271N indicate the historical highest groundwater level is reportedly deeper than 80 feet below the ground surface. Groundwater is not anticipated during construction and will not need to be considered in design.

4.4 Subsurface Variations

Based on results of the subsurface exploration and our experience, some variations in the continuity and nature of subsurface conditions within the project site should be anticipated. Because of the uncertainties involved in the nature and geologic characteristics of the earth material at the site, care should be exercised in interpolating or extrapolating subsurface conditions between or beyond the boring locations. If during construction, subsurface conditions differ significantly from those presented in this report; this office should be notified immediately so that recommendations can be modified, if necessary.

5.0 FAULTING AND GEOLOGIC HAZARDS

Geologic hazards are defined as geologically related conditions that may present a potential danger to life and property. Typical geologic hazards in Southern California include earthquake ground shaking, fault surface rupture, landslides, and liquefaction.

5.1 Fault Surface Rupture and Active Faults

The project site is not located within a currently designated State of California Earthquake Fault Zone (formerly Alquist-Priolo Special Studies Zones) for surface fault rupture. No surface faults are known to project through or towards the site. The closest known fault to the project site is the Palos Verdes Hills Fault Zone located at approximately 1.2 km to the south-west.

5.2 Liquefaction

Liquefaction is the sudden decrease in the strength of cohesionless soils due to dynamic or cyclic shaking. Saturated soils behave temporarily as a viscous fluid (liquefaction) and, consequently, lose their capacity to support the structures founded on them. The potential for liquefaction decreases with increasing clay and gravel content, but increases as the ground acceleration and duration of shaking increase. Liquefaction potential has been found to be the greatest where the groundwater level and loose sands occur within 50 feet of the ground surface. The site is not located within a mapped Seismic Hazard Zone for liquefaction (CDMG, 1998) as shown in Drawing No. 4, *Seismic Hazard Zones Map*.

Based on the results of our subsurface exploration, including the absence of shallow groundwater, high SPT blow counts, and our experience on similar projects we anticipate liquefaction potential to be very low and seismically-induced settlement to be negligible.

5.3 Landslides

The site is not located within a Seismic Hazard Zone for required investigation for earthquake-induced landsliding (CDMG, 1999). The project site is relatively flat and not located near any hillside terrain. In the absence of significant ground slopes, the potential for seismically induced landslides to affect the proposed site is considered to be nil.

6.0 SEISMIC ANALYSIS

6.1 CBC Seismic Design Parameters

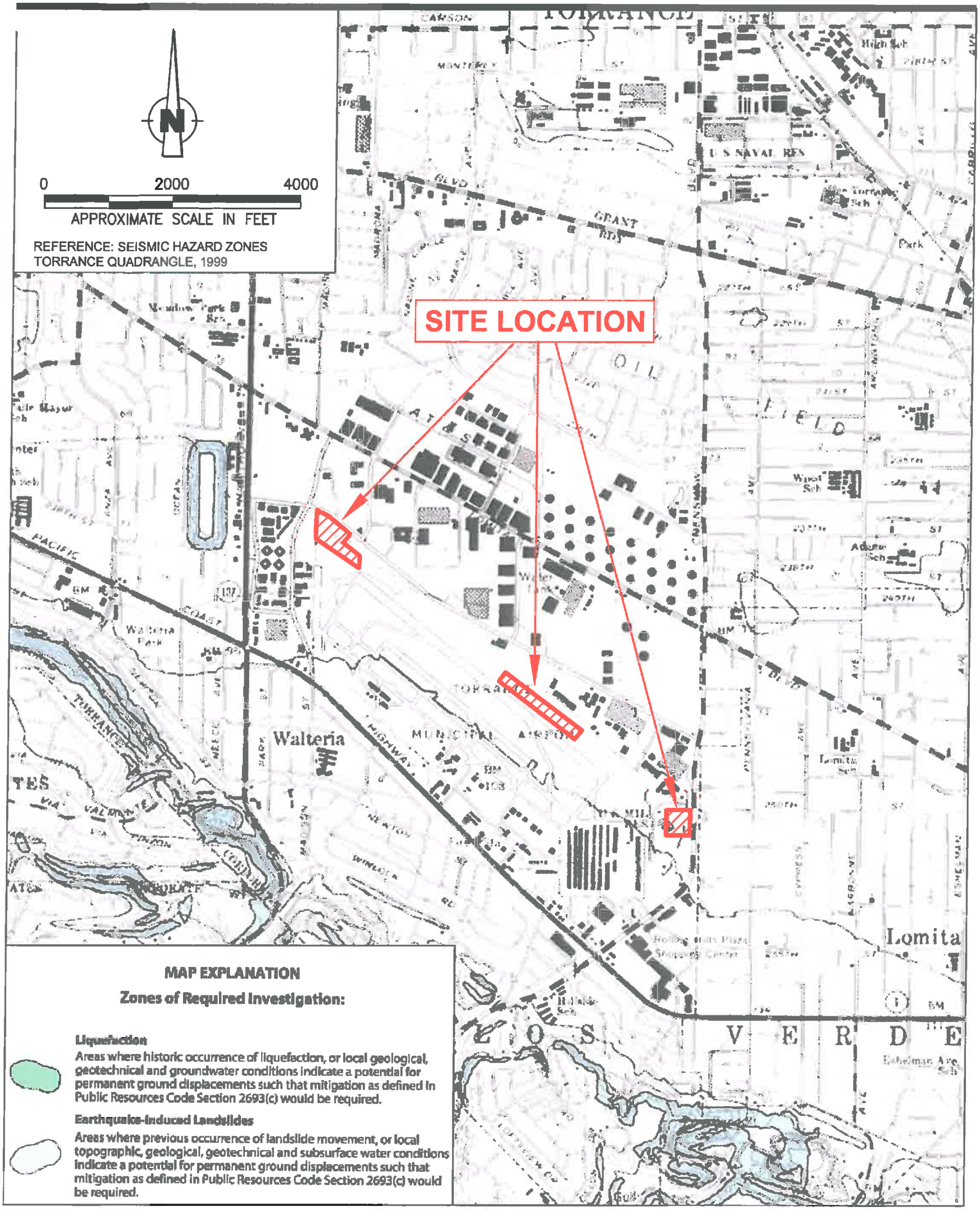
Seismic parameters based on the 2010 and 2013 California Building Code are calculated using the United States Geological Survey *U.S. Seismic Design Maps* website application. The seismic parameters are presented below.

Table No. 1, 2010 and 2013 CBC Seismic Parameters

Seismic Parameters	2010 CBC	2013 CBC
Site Class	D	D
Mapped Short period (0.2-sec) Spectral Response Acceleration, S_S	2.096 g	1.715 g
Mapped 1-second Spectral Response Acceleration, S_1	0.872 g	0.665 g
Site Coefficient (from Table 1613.5.3(1)), F_a	1.0	1.0
Site Coefficient (from Table 1613.5.3(2)), F_v	1.5	1.5
MCE 0.2-sec period Spectral Response Acceleration, S_{MS}	2.096 g	1.715 g
MCE 1-second period Spectral Response Acceleration, S_{M1}	1.308 g	0.997 g
Design Spectral Response Acceleration for short period, S_{DS}	1.397 g	1.143 g
Design Spectral Response Acceleration for 1-second period, S_{D1}	0.872 g	0.665 g
Seismic Design Category	D	D

6.2 Deaggregated Seismic Source Parameters

Based on our analyses utilizing the USGS 2008 NSHMP PSHA Interactive Deaggregation web site, the mean and modal earthquake magnitudes for a return time of 2475 years is calculated to be 6.92 and 7.19, respectively. The earthquake magnitude of 7.19 should be considered for seismic design at the project site.



SEISMIC HAZARD ZONES MAP

Converse Consultants	TORRANCE AIRPORT INFILTRATION GALLERIES TORRANCE, CALIFORNIA	Project No. 13-31-225-01	Drawing No. 4

7.0 DESIGN RECOMMENDATIONS

7.1 General Evaluation

Based on the results of our literature review, subsurface exploration, laboratory testing, geotechnical analyses, and understanding of the planned site improvements, it is our opinion that the proposed project is feasible from a geotechnical standpoint, provided the following conclusions and recommendations are incorporated into the project plans, specifications, and are followed during site construction. The following geotechnical findings should be considered for the planned projects:

- Groundwater was not encountered in our exploratory borings to a maximum depth of 51.5 feet. Groundwater is not anticipated during construction and will not need to be considered in design.
- It is our opinion that the proposed structures can be supported on conventional shallow foundations embedded into compacted fill.
- Due to existing surficial undocumented fill, we recommend over-excavation and re-compaction to be at least 5-feet from the existing ground surface, or 2-feet below bottom of footings, whichever is deeper at the structure area. Lateral over-excavation limits should extend at least 5 feet beyond edge of footings, where the space is available. For pavement and flatwork area, we recommend 2 feet over-excavation and re-compaction.
- Laboratory testing indicates the site soils have a high expansion potential. Mitigation measures for expansive soil are anticipated. We recommend that two feet of suitable, non-expansive, sandy import materials approved by Converse be placed under planned footings and slabs.
- The on-site soil is not considered corrosive to concrete. However, the minimum saturated resistivity testing result indicates the onsite soil is considered corrosive to ferrous metal. Protections of underground metal pipe should be considered.
- Soil can be excavated with conventional heavy-duty earthmoving equipments.
- Based on our field exploration, surficial clayey soils encountered up to 40 feet deep are not considered effective for planned infiltration systems. Sandy soils encountered below the clayey soil layers are relatively dense and also might not be conducive to good percolation rates. It is recommended that a specific percolation testing program be performed for any planned infiltration system to determine percolation rates at specific depths.

7.2 Shallow Foundations

7.2.1 Vertical Capacity

We recommend the bottoms of continuous and square footings be founded at least 18 inches below lowest adjacent final grade on compacted fills. A minimum footing width of 24 inches is recommended for square footings and 15 inches for continuous footings. The allowable bearing value for footings with above minimum sizes is 2,000 psf for dead plus live load. The net allowable bearing pressure can be increase by 150 psf for each additional foot of excavation depth and by 150 psf for each additional foot of excavation width up to a maximum value of 3,000 psf.

The net allowable bearing values indicated above are for the dead loads and frequently applied live loads and are obtained by applying a factor of safety of 3.0 to the net ultimate bearing capacity.

7.2.2 Lateral Capacity

Resistance to lateral loads can be provided by friction acting at the base of the foundation and by passive earth pressure. A coefficient of friction of 0.3 may be assumed with normal dead load forces. An allowable passive earth pressure of 300 psf per foot of depth up to a maximum of 3,000 psf may be used for footings poured against properly compacted fill. The values of coefficient of friction and allowable passive earth pressure include a factor of safety of 1.5.

7.2.3 Settlement

The static settlement of structures supported on continuous and/or spread footings founded on compacted fill will depend on the actual footing dimensions and the imposed vertical loads. Most of the footing settlement at the project site is expected to occur immediately after the application of the load. Based on the maximum allowable net bearing pressures presented above, static settlement is anticipated to be less than 0.5 inch. Differential settlement is expected to be up to one-half of the total settlement over a 30-foot span.

7.2.4 Dynamic Increases

Bearing values indicated above are for total dead load and frequently applied live loads. The above vertical bearing may be increased by 33% for short durations of loading which will include the effect of wind or seismic forces. The allowable passive pressure may be increased by 33% for lateral loading due to wind or seismic forces.

7.3 Slabs-on-grade

Slabs-on-grade should be supported on compacted fill and have a minimum thickness of four inches nominal for support of normal ground-floor live loads. Minimum reinforcement for slabs-on-grade should be No. 3 reinforcing bars, spaced at 18 inches on-center each way. The thickness and reinforcement of more heavily-loaded slabs will be dependent upon the anticipated loads and should be designed by a structural engineer. A static modulus of subgrade reaction equal to 150 pounds per square inch per inch may be used in structural design of concrete slabs-on-grade.

It is critical that the exposed subgrade soils should not be allowed to desiccate prior to the slab pour. Care should be taken during concrete placement to avoid slab curling. Slabs should be designed and constructed as promulgated by the ACI and Portland Cement Association (PCA). Prior to the slab pour, all utility trenches should be properly backfilled and compacted.

In areas where a moisture-sensitive floor covering (such as vinyl tile or carpet) is used, a 10-mil-thick moisture retarder/barrier between the bottom of slab and subgrade that meets the performance criteria of ASTM E 1745 Class A material. Retarder/barrier sheets should be overlapped a minimum of six inches, and should be taped or otherwise sealed per the product specifications.

7.4 Earth Pressures for Retaining Structures

The following design values can be used for the retaining walls, if proposed. The earth pressure behind any retaining wall depends primarily on the allowable wall movement, type of soil behind the wall, backfill slopes, wall inclination, surcharges, and any hydrostatic pressure. The following earth pressures are recommended for vertical walls with no hydrostatic pressure.

Table No. 2, Lateral Earth Pressures for Retaining Wall Design

Backfill Slope (H:V)	Cantilever Wall Equivalent Fluid Pressure (pcf)	Restrained Wall (psf)
Level	30 (triangular pressure distribution)	23H (uniform pressure distribution)

The recommended lateral pressures assume that the walls are fully back-drained to prevent build-up of hydrostatic pressure. Adequate drainage could be provided by means of permeable drainage materials wrapped in filter fabric installed behind the walls. The drainage system should consist of perforated pipe surrounded by a minimum one (1) square feet per lineal feet of free draining, uniformly graded, ¾ -inch washed, crushed aggregate, and wrapped in filter fabric such as Mirafi 140N or equivalent. The filter fabric should overlap approximately 12 inches or more at the joints. The subdrain pipe should consist of perforated, four-inch diameter, rigid ABS (SDR-35) or PVC A-2000, or equivalent, with perforations placed down. Alternatively, a prefabricated drainage composite system such as the Miradrain G100N or equivalent can be used. The subdrain should be connected to solid pipe outlets, with a maximum outlet spacing of 100 feet.

Walls subjected to surcharge loads located within a distance equal to the height of the wall should be designed for an additional uniform lateral pressure equal to one-third or one-half the anticipated surcharge load for unrestrained or restrained walls, respectively. These values are applicable for backfill placed between the wall stem and an imaginary plane rising 45 degrees from below the edge (heel) of the wall footings.

Retaining walls greater than 12 feet should be designed to resist additional earth pressure caused by seismic ground shaking. A seismic earth pressure of 16H (psf), based on an inverted triangular distribution, can be used for design of wall.

7.5 Soil Corrosivity Evaluation

Based on our review of soil corrosivity test results (see Appendix B), the pH and chloride content are not in the corrosive range to ferrous metal. The soluble sulfate concentration is not in the corrosive range to concrete. However the minimum saturated resistivity is in the corrosive range to ferrous metal. Protections of underground metal pipe should be considered.

A corrosion engineer may be consulted for appropriate mitigation procedures and construction design, if needed. General considerations for corrosion mitigation measures may include the following:

- Steel and wire concrete reinforcement should have at least three inches of concrete cover where cast against soil, unformed.
- Below-grade ferrous metals should be given a high-quality protective coating, such as 18-mil plastic tape, extruded polyethylene, coal-tar enamel, or Portland cement mortar.
- Below-grade metals should be electrically insulated (isolated) from above-grade metals by means of dielectric fittings in ferrous utilities and/or exposed metal structures breaking grade.

7.6 *Percolation Testing*

Percolation testing was not part of the initial scope for this investigation. However, based on the findings of our field exploration, we recommend that a specific percolation testing program be performed for any planned infiltration systems in layers of permeable soils to determine definite percolation rates at the desired depths for infiltration system design.

7.7 Site Drainage

Adequate positive drainage should be provided away from the structure foundations to prevent ponding and to reduce percolation of water into the foundation soils. We recommend that any landscape areas immediately adjacent to the foundation shall be designed sloped away from the foundation with a minimum 2 percent slope gradient for at least 10 feet measured perpendicular to the face of the foundation. Impervious surfaces within 10 feet of the structure foundation shall be sloped a minimum of 1 percent away from the structure.

8.0 SITE GRADING AND EARTHWORK RECOMMENDATIONS

8.1 General

Based on our review of soil boring and laboratory data, the upper five (5) feet of soils consisting of undocumented fills and loose to moderately dense native alluvial soils should be removed and recompacted to provide sufficient lateral resistance and a relatively uniform soil condition for the footings and slab. To help reduce the potential for differential settlement, variations in the soil type, degree of compaction, and thickness of the compacted fill placed underneath slab and/or footings should be kept uniform. Site grading recommendations provided in this report are based on our experience with similar projects in the area and our site-specific geotechnical evaluation.

The existing soils removed during over-excavation can be placed as compacted fill in structural areas after proper processing (free of vegetation, shrubs, roots and debris). Earthwork should be performed with suitable equipment and techniques to selectively screen/remove debris from soils placed as engineered fill. Following remedial grading, compacted fill soils are anticipated to have similar engineering characteristics with the underlying dense alluvial soils.

8.2 Over-Excavation/Removal

For infiltration galleries, we recommend over-excavation be at least five (5) feet below existing grade, or two (2) foot below bottom of footing, or to the depth of undocumented fill, whichever is deeper for slab and foundation support. Deeper removal will be needed if firm soil conditions are not exposed on the excavation bottom. The lateral limits of the over-excavation should extend at least five (5) feet beyond the footing and slab areas, where space is available.

For pavement and concrete flatwork, we recommend over-excavation be at least two (2) feet below existing grade and two (2) feet laterally beyond the footprints, where space is available.

The exposed bottom of the over-excavation area should be scarified at least six (6) inches; moisture conditioned as needed to near-optimum moisture content, and compacted to 90 percent relative compaction. Over-excavation should not undermine adjacent off-site improvements. Remedial grading should not extend within a projected 1:1 (horizontal to vertical) plane projected down from the outer edge of adjacent off-site improvements.

If loose, yielding soil conditions are encountered at the excavation bottom, the following options can be considered:

a. Over-excavate until reach firm bottom.
b. Scarify or over-excavate additional 18 inches deep, and then place at least 18-inch-thick compacted base material (CAB or equivalent) to bridge the soft bottom. Base should be compacted to 90% relative compaction.
c. Over-excavate additional 18 inches deep, and then place a layer of geofabric (i.e. Marifi HP570, X600 or equivalent), place 18-inch-thick compacted base material (CAB or equivalent) to bridge the soft bottom. Base should be compacted to 90% relative compaction. An additional layer of Geo-Fabric may be needed on top of base depending on the actual site conditions.

8.3 Engineered Fill

All engineered fill should be placed on competent, scarified and compacted bottom as evaluated by the geotechnical engineer and in accordance with the recommendations presented in this section. Excavated site soils, free of deleterious materials and rock particles larger than three (3) inches in the largest dimension, should be suitable for placement as compacted fill. Any proposed import fill should be evaluated and approved by Converse prior to import to the site. Import fill material should have an expansion index less than 20.

Prior to compaction, fill materials should be thoroughly mixed and moisture conditioned within three (3) percent above the optimum moisture content. Fill soils shall be evenly spread in maximum 8-inch lifts, watered or dried as necessary, mixed and compacted to at least the density specified below. The fill shall be placed and compacted on a horizontal plane, unless otherwise approved by the Geotechnical Engineer. Upper 12 inches below pavement subgrade should be compacted to at least 95 percent of the laboratory dry density in accordance with the ASTM Standard D1557 test method. All fill, if not specified otherwise elsewhere in this report, should be compacted to at least

90 percent of the laboratory dry density in accordance with the ASTM Standard D1557 test method.

8.4 Excavatability

Based on our field exploration, the earth materials at the site may be excavated with conventional heavy-duty earth moving and trenching equipment. The onsite materials will contain demolition debris, gravel, cobbles and/or boulders. Earthwork should be performed with suitable equipment and methods for removal of debris from the engineered fill.

8.5 Expansive Soil

The near surface soils have a “High” expansive potential. Mitigation measures for expansive soil are anticipated. We recommend that two (2) feet of suitable, non-expansive, sandy import materials approved by Converse be placed under planned footings and slabs.

8.6 Shrinkage and Subsidence

Soil shrinkage and/or bulking as a result of remedial grading depends on several factors including the depth of over-excavation, and the grading method and equipment utilized, and average relative compaction. For preliminary estimation, bulking and shrinkage factors for various units of earth material at the site may be taken as presented below:

- The approximate shrinkage factor for the undocumented fill soils is estimated to range from ten (10) to fifteen (15) percent.
- The approximate shrinkage factor for the native alluvial soils is estimated to range from ten (10) to fifteen (15) percent.
- For estimation purposes, ground subsidence may be taken as 0.1 feet as a result of remedial grading.

Although these values are only approximate, they represent our best estimates of the factors to be used to calculate lost volume that may occur during grading. If more accurate shrinkage and subsidence factors are needed, it is recommended that field-testing using the actual equipment and grading techniques be conducted.

9.0 CONSTRUCTION CONSIDERATIONS

9.1 Temporary Excavations

Based on the materials encountered in the exploratory borings, sloped temporary excavations may be constructed according to the slope ratios presented in the following table:

Table No. 3, Slope Ratios for Temporary Excavation

Maximum Depth of Cut (feet)	Maximum Slope Ratio* (horizontal: vertical)
0 – 4	vertical
4 – 8	1:1
>8	1.5:1

*Slope ratio assumed to be uniform from top to toe of slope.

Any loose utility trench backfill or other fill encountered in excavations will be less stable than the native soils. Temporary cuts encountering loose fill or loose dry sand should be constructed at a flatter gradient than presented in the table above. Surfaces exposed in slope excavations should be kept moist but not saturated to minimize raveling and sloughing during construction. Adequate provisions should be made to protect the slopes from erosion during periods of rainfall. Surcharge loads, including construction, should not be placed within five (5) feet of the unsupported excavation edge. Temporary excavations less than six (6) feet vertical may be proceeded with “A-B-C” slot cut method. The width of each slot should be less than eight (8) feet.

All applicable requirements of the California Construction and General Industry Safety Orders, the Occupational Safety and Health Act of 1987 and current amendments, and the Construction Safety Act should be met. The soils exposed in cuts should be observed during excavation by the project's geotechnical consultant. If potentially unstable soil conditions are encountered, modifications of slope ratios for temporary cuts may be required.

9.2 Geotechnical Services during Construction

This report has been prepared to aid in the foundation plans and specifications, and to assist the architect, civil and structural engineers in the design of the proposed structures. It is recommended that this office be provided an opportunity to review final design drawings and specifications to verify that the recommendations of this report have been properly implemented.

Recommendations presented herein are based upon the assumption that adequate earthwork monitoring will be provided by Converse. Footing excavations should be observed by Converse prior to placement of steel and concrete so that footings are founded on satisfactory materials and excavations are free of loose and disturbed materials. Trench backfill should be placed and compacted with observation and field density testing provided by this office.

During construction, the geotechnical engineer and/or their authorized representatives should be present at the site to provide a source of advice to the client regarding the geotechnical aspects of the project and to observe and test the earthwork performed. Their presence should not be construed as an acceptance of responsibility for the performance of the completed work, since it is the sole responsibility of the contractor performing the work to ensure that it complies with all applicable plans, specifications, ordinances, etc.

This firm does not practice or consult in the field of safety engineering. We do not direct the contractor's operations, and cannot be responsible for other than our own personnel on the site; therefore, the safety of others is the responsibility of the contractor. The contractor should notify the owner if he considers any recommended actions presented herein to be unsafe.

10.0 CLOSURE

The findings and recommendations of this report were prepared in accordance with generally accepted professional engineering and engineering geologic principles and practice. We make no other warranty, either expressed or implied. Our conclusions and recommendations are based on the results of the field and laboratory studies, combined with an interpolation and extrapolation of soil conditions between and beyond boring locations. If conditions encountered during construction appear to be different from those shown by the borings, this office should be notified.

Design recommendations given in this report are based on the assumption that the earthwork and site grading recommendations contained in this report are implemented. Additional consultation may be prudent to interpret Converse's findings for contractors, or to possibly refine these recommendations based upon the review of the final site grading and actual site conditions encountered during construction. If the scope of the project changes, if project completion is to be delayed, or if the report is to be used for another purpose, this office should be consulted.

This report was prepared for Carollo Engineers, Inc. for the subject project described herein. We are not responsible for technical interpretations made by others of our exploratory information. Specific questions or interpretations concerning our findings and conclusions may require a written clarification to avoid future misunderstandings.

11.0 REFERENCES

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APPENDIX A

FIELD EXPLORATION

APPENDIX A

FIELD EXPLORATION

Field exploration included a site reconnaissance and subsurface exploration program. During the site reconnaissance, the surface conditions were noted, and the approximate locations of the boring were determined. The exploratory borings were approximately located using existing boundary and other features as a guide and should be considered accurate only to the degree implied by the method used. The various field study methods performed are discussed below.

Exploratory Borings

Three (3) exploratory borings (BH-1 through BH-3) were drilled within the project site on September 3, 2013. The borings were advanced using a truck mounted 8-inch diameter hollow stem auger drill rig to depths of 51.5 feet below the existing ground surface (bgs). Encountered earth materials were continuously logged by a Converse professional staff and classified in the field by visual examination in accordance with the Unified Soil Classification System (USCS). Where appropriate, field descriptions and classifications have been modified to reflect laboratory test results.

Ring samples of the subsurface materials were obtained at frequent intervals in the exploratory borings using a drive sampler (2.4-inches inside diameter and 3.0-inches outside diameter) lined with sample rings. The steel ring sampler was driven into the bottom of the borehole with successive drops of a 140-pound driving weight falling 30 inches, using an automatic hammer. Samples are retained in brass rings (2.4-inches inside diameter and 1.0-inch in height). The central portion of the sample was retained and carefully sealed in waterproof plastic containers for shipment to the Converse laboratory. Blow counts for each sample interval are presented on the logs of borings. Bulk samples of typical soil types were also obtained.

Standard Penetration Tests (SPTs) were performed in selected borings at selected intervals using a standard (1.4 inches inside diameter and 2.0 inches outside diameter) split-barrel sampler. The bore holes were backfilled and compacted with soil cuttings by reverse spinning of the auger following the completion of drilling and patched with asphalt.

It should be noted that the exact depths at which material changes occur cannot always be established accurately. Changes in material conditions that occur between driven samples are indicated in the logs at the top of the next drive sample. A key to soil symbols and terms is presented as Drawing No. A-1, *Soil Classification Chart*. The log of the exploratory boring is presented in Drawing Nos. A-2a through A-4b, *Log of Borings*.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

BORING LOG SYMBOLS

SAMPLE TYPE

STANDARD PENETRATION TEST
Split barrel sampler in accordance with ASTM D-1586-84 Standard Test Method

DRIVE SAMPLE 2.42" I.D. sampler.

DRIVE SAMPLE No recovery

BULK SAMPLE

GROUNDWATER WHILE DRILLING

GROUNDWATER AFTER DRILLING

LABORATORY TESTING ABBREVIATIONS

TEST TYPE
(Results shown in Appendix B)

CLASSIFICATION	
Plasticity	pi
Grain Size Analysis	ma
Passing No. 200 Sieve	wa
Sand Equivalent	se
Expansion Index	ei
Compaction Curve	max
Hydrometer	h

STRENGTH	
Pocket Penetrometer	p
Direct Shear	ds
Direct Shear (single point)	ds*
Unconfined Compression	uc
Triaxial Compression	tx
Vane Shear	vs
Consolidation	c
Collapse Test	col
Resistance (R) Value	r
Chemical Analysis	ca
Electrical Resistivity	er

UNIFIED SOIL CLASSIFICATION AND KEY TO BORING LOG SYMBOLS

Converse Consultants

Project Name	Project No.	Drawing No.
TORRANCE AIRPORT INFILTRATION GALLERIES	13-31-225-01	A-1

Log of Boring No. BH-1

Dates Drilled: 9/3/2013 | Logged by: MM | Checked By: SCL

Equipment: 8" HOLLOW STEM AUGER | Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): N/A | Depth to Water (ft): NOT ENCOUNTERED

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES DRIVE	SAMPLES BULK	BLOWS/FT	MOISTURE (%)	DRY UNIT WT. (pcf)	
		FILL (Af): **SILTY SAND (SM):** fine to medium-grained, with gravels up to 0.5" in maximum dimension, with few clays, brown.		X				ei
		SANDY CLAY (CL): fine to medium-grained sand, brown.		X				
5		**ALLUVIUM (Qa):** **CLAY (CL):** trace of fine-grained sand and silt, light brown.	■		10/13/17	19	97	c
10			■		6/13/25	21	101	
15		-trace of fine-grained sand, dark brown	■		5/11/16	26	92	
20			☒		3/5/8			
25		**SAND (SP):** fine to medium-grained, orange brown.	■		4/20/28	7	102	
30			☒		9/13/17			

Converse Consultants

Project Name: TORRANCE AIRPORT INFILTRATION GALLERIES

Project No.: 13-31-225-01

Drawing No.: A-2a

Log of Boring No. BH-1

Dates Drilled: 9/3/2013 Logged by: MM Checked By: SCL

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): N/A Depth to Water (ft): NOT ENCOUNTERED

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES DRIVE	SAMPLES BULK	BLOWS/FT	MOISTURE (%)	DRY UNIT WT. (pcf)	
		SAND (SP): fine to medium-grained, light brown.			21/50(5")	6	85	
40					14/25/40			
45					16/50(6")	4	96	
50					14/36/50(5")			
		End of boring at 51.5 feet. Groundwater not encountered during drilling. Borehole backfilled with soil cuttings and portland cement on 9-3-13.						

Converse Consultants

Project Name: TORRANCE AIRPORT INFILTRATION GALLERIES

Project No. 13-31-225-01

Drawing No. A-2b

Log of Boring No. BH-2

Dates Drilled: 9/3/2013 Logged by: MM Checked By: SCL

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): N/A Depth to Water (ft): NOT ENCOUNTERED

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES DRIVE	SAMPLES BULK	BLOWS/FT	MOISTURE (%)	DRY UNIT WT. (pcf)	
		FILL (Af): **SILTY SAND (SM):** fine to medium-grained, with gravels up to 0.5" in maximum dimension, few clays, brown. **SANDY CLAY (CL):** fine to medium-grained sand, brown.		X				max,ds
5		**ALLUVIUM (Qa):** **CLAY (CL):** trace of fine-grained sand, dark brown.	X		7/8/13	15	86	
10		**Fat CLAY (CH):** trace of fine-grained sand, dark brown.	X		10/19/25	19	100	pi
15		-trace of fine to medium-grained sand, brown	X		5/11/24	19	103	wa (fc=81%)
20		**CLAY (CL):** trace of fine to medium-grained sand, light brown.	X		14/26/35	20	104	pi
25			X		6/10/16			wa (fc=88%)
30		**Fat CLAY (CH):** trace of fine-grained sand, light brown.	X		6/18/31	22	98	pi

Converse Consultants

Project Name: TORRANCE AIRPORT INFILTRATION GALLERIES

Project No. 13-31-225-01

Drawing No. A-3a

Log of Boring No. BH-2

Dates Drilled: 9/3/2013 Logged by: MM Checked By: SCL

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): N/A Depth to Water (ft): NOT ENCOUNTERED

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES DRIVE	SAMPLES BULK	BLOWS/FT	MOISTURE (%)	DRY UNIT WT. (pcf)	
		Fat CLAY (CH): trace of fine to medium-grained sand, brown.			6/10/15			wa (fc=75%)
40		**SAND (SP):** fine-grained, yellow brown.			7/36/50	6	106	
45					11/20/35			wa (fc=7%)
50		-light brown			10/24/50(3")	5	95	
		End of boring at 51.5 feet. Groundwater not encountered during drilling. Borehole backfilled with soil cuttings and portland cement on 9-3-13.						

Converse Consultants

Project Name: TORRANCE AIRPORT INFILTRATION GALLERIES

Project No.: 13-31-225-01

Drawing No.: A-3b

Log of Boring No. BH-3

Dates Drilled: 9/3/2013 Logged by: MM Checked By: SCL

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): N/A Depth to Water (ft): NOT ENCOUNTERED

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES DRIVE	SAMPLES BULK	BLOWS/FT	MOISTURE (%)	DRY UNIT WT. (pcf)	
		FILL (Af): **SILTY SAND (SM):** fine to medium-grained, with gravels up to 1" in maximum dimension, brown. **SANDY CLAY (CL):** fine to medium-grained sand, brown.		X				ca,er
5		**ALLUVIUM (Qa):** **CLAY (CL):** trace of fine-grained sand, with gravels up to 1.5" in maximum dimension, dark brown.	■		15/24/20	18	101	
10		-with few gravels up to 1" in maximum dimension, dark brown	■		9/8/15	19	103	
15		-trace of fine-grained sand, orange brown/brown	■		14/32/42	17	106	
20		-trace of fine to medium-grained sand, with gravels up to 0.5" in maximum dimension	X		7/3/7			
25			■		8/18/32	24	100	
30		-trace of silt, light brown	X		6/10/15			

Converse Consultants

Project Name: TORRANCE AIRPORT INFILTRATION GALLERIES

Project No. 13-31-225-01

Drawing No. A-4a

Log of Boring No. BH-3

Dates Drilled: 9/3/2013 Logged by: MM Checked By: SCL

Equipment: 8" HOLLOW STEM AUGER Driving Weight and Drop: 140 lbs / 30 in

Ground Surface Elevation (ft): N/A Depth to Water (ft): NOT ENCOUNTERED

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES DRIVE	SAMPLES BULK	BLOWS/FT	MOISTURE (%)	DRY UNIT WT. (pcf)	
		CLAY (CL): trace of fine-grained sand and silt, light brown.	■		6/16/25	11	112	
40		**CLAYEY SAND (SC):** fine-grained, light brown.	☒		10/19/24			
45		**SAND (SP):** fine-grained with silt, light brown.	■		7/28/34	19	108	
50		-fine to medium-grained, with few gravels up to 0.5" in maximum dimension, light brown	☒		9/20/20			
		End of boring at 51.5 feet. Groundwater not encountered during drilling. Borehole backfilled with soil cuttings and portland cement on 9-3-13.						

Converse Consultants

Project Name: TORRANCE AIRPORT INFILTRATION GALLERIES

Project No. 13-31-225-01

Drawing No. A-4b

APPENDIX B

LABORATORY TESTING PROGRAM

APPENDIX B

LABORATORY TESTING PROGRAM

Tests were conducted in our laboratory on representative soil samples for the purpose of classification and evaluation of their relevant physical characteristics and engineering properties. The amount and selection of tests were based on the geotechnical requirements of the project. Test results are presented herein and on the Logs of Borings in Appendix A, *Field Exploration*. The following is a summary of the laboratory tests conducted for this project.

Moisture Content and Dry Density

Results of moisture content and dry density tests, performed on relatively undisturbed ring samples were used to aid in the classification of the soils and to provide quantitative measure of the *in situ* dry density. Data obtained from this test provides qualitative information on strength and compressibility characteristics of site soils. For test results, see the Logs of Borings in Appendix A, *Field Exploration*.

Percent Finer than Sieve No. 200

The percent finer than sieve No. 200 tests were performed on four (4) representative soil samples to aid in the classification of the on-site soils and to estimate other engineering parameters. Testing was performed in general accordance with the ASTM Standard D1140 test method. Test results are presented in the Logs of Borings in Appendix A, *Field Exploration*.

Atterberg Limits

Atterberg limits test were performed on three (3) representative samples to assist the classification of the soil and fill materials according to ASTM Standard D4318 test method. The test results are presented in the following table and on Drawing No. B-1, *Atterburg Limits Results*.

Table No. B-1 Atterberg Limit Test Results

Boring No.	Depth (feet)	Soil Classification	Liquid Limit (%)	Plastic Limit (%)	Plastic Index (%)
BH-2	10	Fat Clay (CH)	63	20	43
BH-2	20	Clay (CL)	49	15	34
BH-2	30	Fat Clay (CH)	60	19	41

Maximum Density Test

One (1) representative bulk sample was tested in the laboratory to determine the maximum dry density and optimum moisture content. The tests were conducted in accordance with the ASTM Standard D1557 laboratory procedure. The test results are presented in Drawing No. B-2, *Moisture-Density Relationship Results*.

Direct Shear

Direct shear tests were performed on one (1) sample remolded to 90% relative compaction. For each test, three brass sampler rings were placed, one at a time, directly into the test apparatus and subjected to a range of normal loads appropriate for the anticipated conditions. The sample was then sheared at a constant strain rate of 0.01 inch/minute. Shear deformation was recorded until a maximum of about 0.25-inch shear displacement was achieved. Ultimate strength was selected from the shear-stress deformation data and plotted to determine the shear strength parameters. For test data, including sample density and moisture content, see Drawing No. B-2, *Direct Shear Test Results.*

Table No. B-2, Direct Shear Test Results

Boring No.	Depth (feet)	Soil Classification	Ultimate Strength Parameters	
			Friction Angle (degrees)	Cohesion (psf)
BH-2	0 – 5*	Sandy Clay (CL)	31	450

Note: Sample remolded to 90% relative compaction

Consolidation

Consolidation test was performed on one (1) relatively undisturbed in-situ sample. Data obtained from this test procedure was used to evaluate the settlement characteristics of the foundation soils under load. Preparation for this test involved trimming the sample and placing the one-inch high brass ring into the test apparatus, which contained porous stones, both top and bottom, to accommodate drainage during testing. Normal axial loads were applied to one end of the sample through the porous stones, and the resulting deflections were recorded at various time periods. The load was increased after the sample reached a reasonable state equilibrium. Normal loads were applied at a constant load-increment ratio, successive loads being generally twice the preceding load. The sample was tested at field and submerged conditions. The test results, including sample density and moisture content, are presented in Drawing No. B-4, *Consolidation Test Results*.

Expansion Index

One (1) representative bulk samples were tested to evaluate the expansion potential of material encountered at the site. The test results are presented in the following table:

Table No. B-3, Expansion Index Test Results

Sample Locatio n	Depth (ft)	Soil Description	Expansion Index	Expansion Potential
BH-1	0-5	Sandy Clay (CL)	94	High

Soil Corrosivity

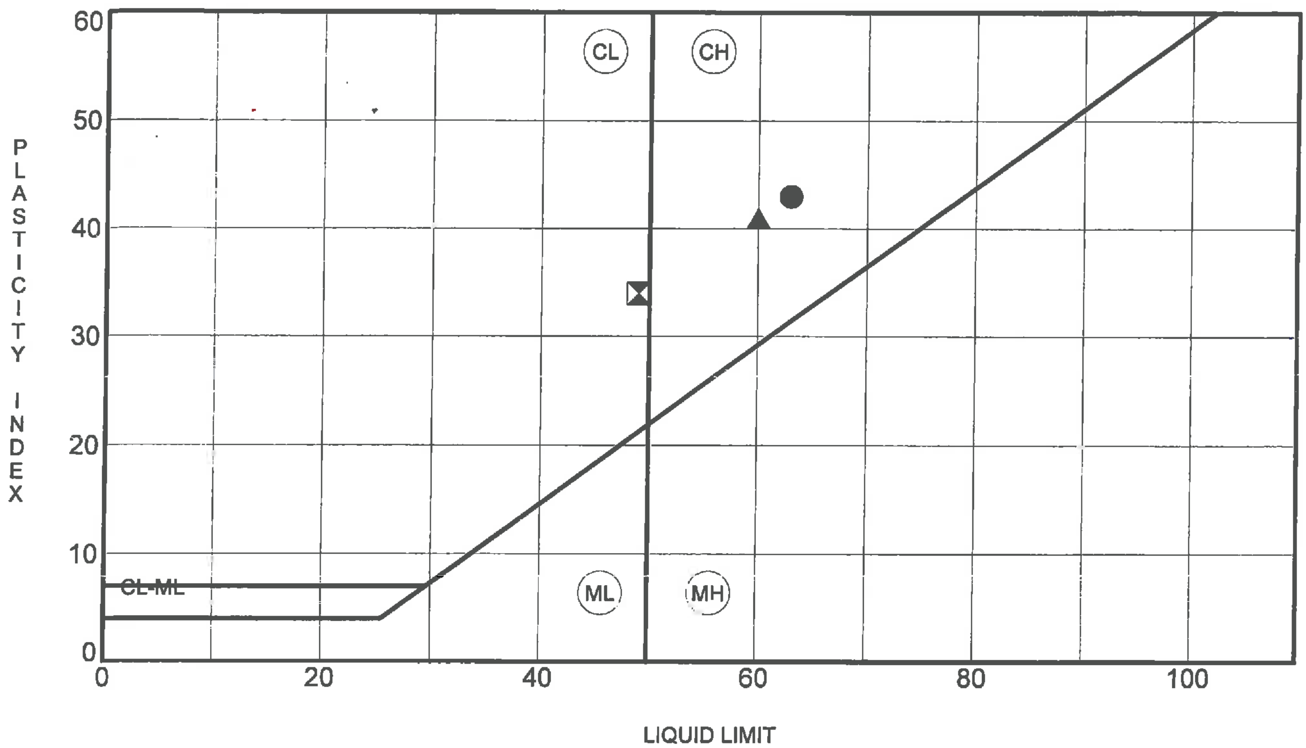
One (1) representative soil samples were tested to evaluate minimum electrical resistivity, pH, and chemical content, including soluble sulfate and chloride concentrations. The purpose of these tests is to determine the corrosion potential of site soils when placed in contact with common construction materials. These tests were performed by Environmental Geotechnology Laboratory, Inc. (EGL), located in Arcadia, California. The test results received from EGL are included in the following table:

Table No. B-4, Corrosivity Test Results

Boring No.	Sample Depth (feet)	pH (Caltrans 643)	Soluble Chlorides (Caltrans 422) ppm	Soluble Sulfate (Caltrans 417) (%)	Saturated Resistivity (Caltrans 643) Ohm-cm
BH-3	0 – 5	7.75	120	0.034	540

Sample Storage

Soil samples presently stored in our laboratory will be discarded 30 days after the date of this report, unless this office receives a specific request to retain the samples for a longer period.



Symbol	Boring No.	Depth (ft)	LL (%)	PL (%)	PI (%)	Description
●	BH-2	10	63	20	43	Fat CLAY (CH)
⊠	BH-2	20	49	15	34	CLAY (CL)
▲	BH-2	30	60	19	41	Fat CLAY (CH)

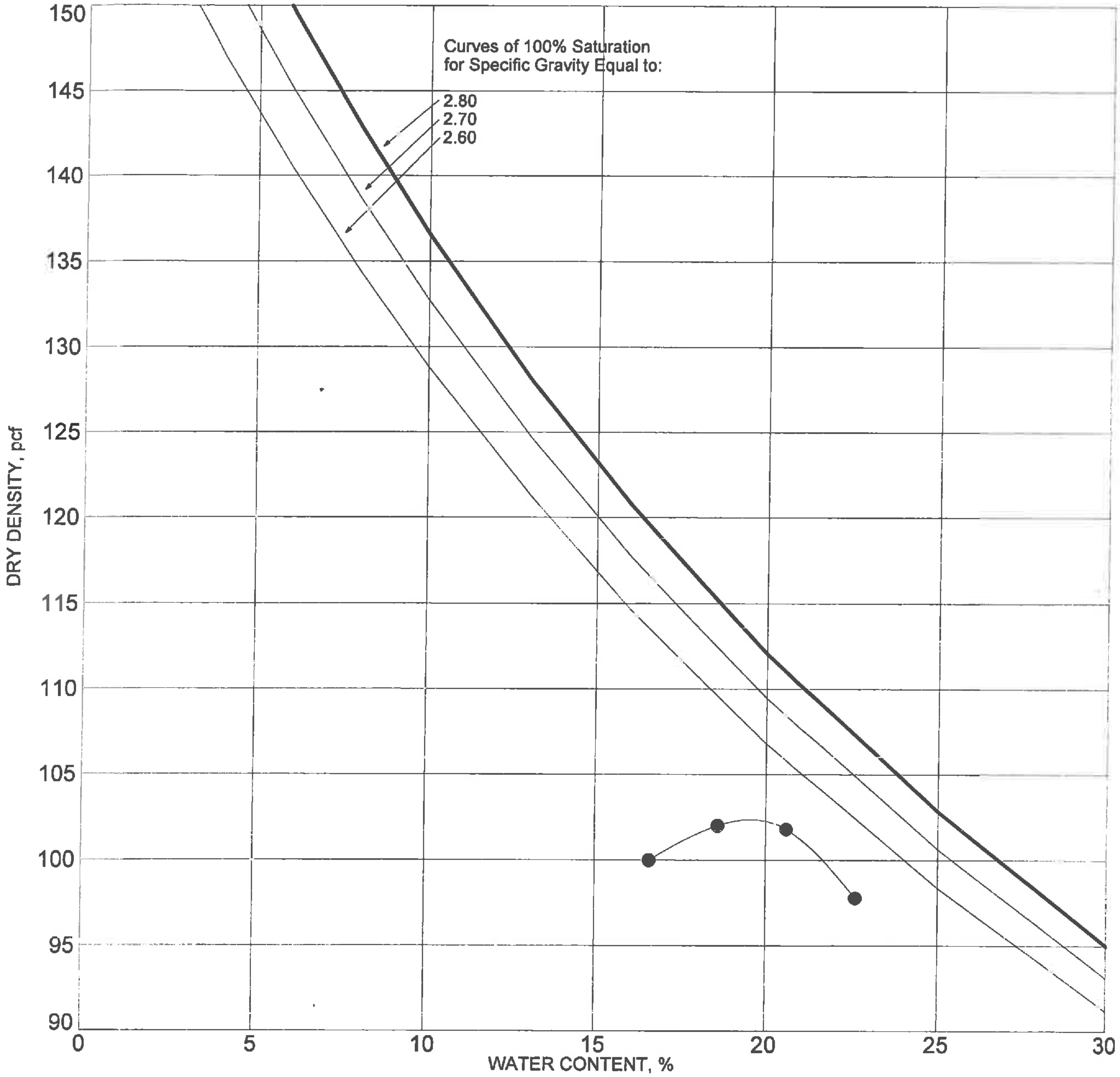
ATTERBERG LIMITS RESULTS

Converse Consultants

Project Name
TORRANCE AIRPORT
INFILTRATION GALLERIES

Project No.
13-31-225-01

Drawing No.
B-1



SYMBOL	BORING NO.	DEPTH (ft)	DESCRIPTION	ASTM TEST METHOD	OPTIMUM WATER, %	MAXIMUM DRY DENSITY, pcf
●	BH-2	0-5	SANDY CLAY (CL)	D1557 Method B	19.8	103

NOTE:

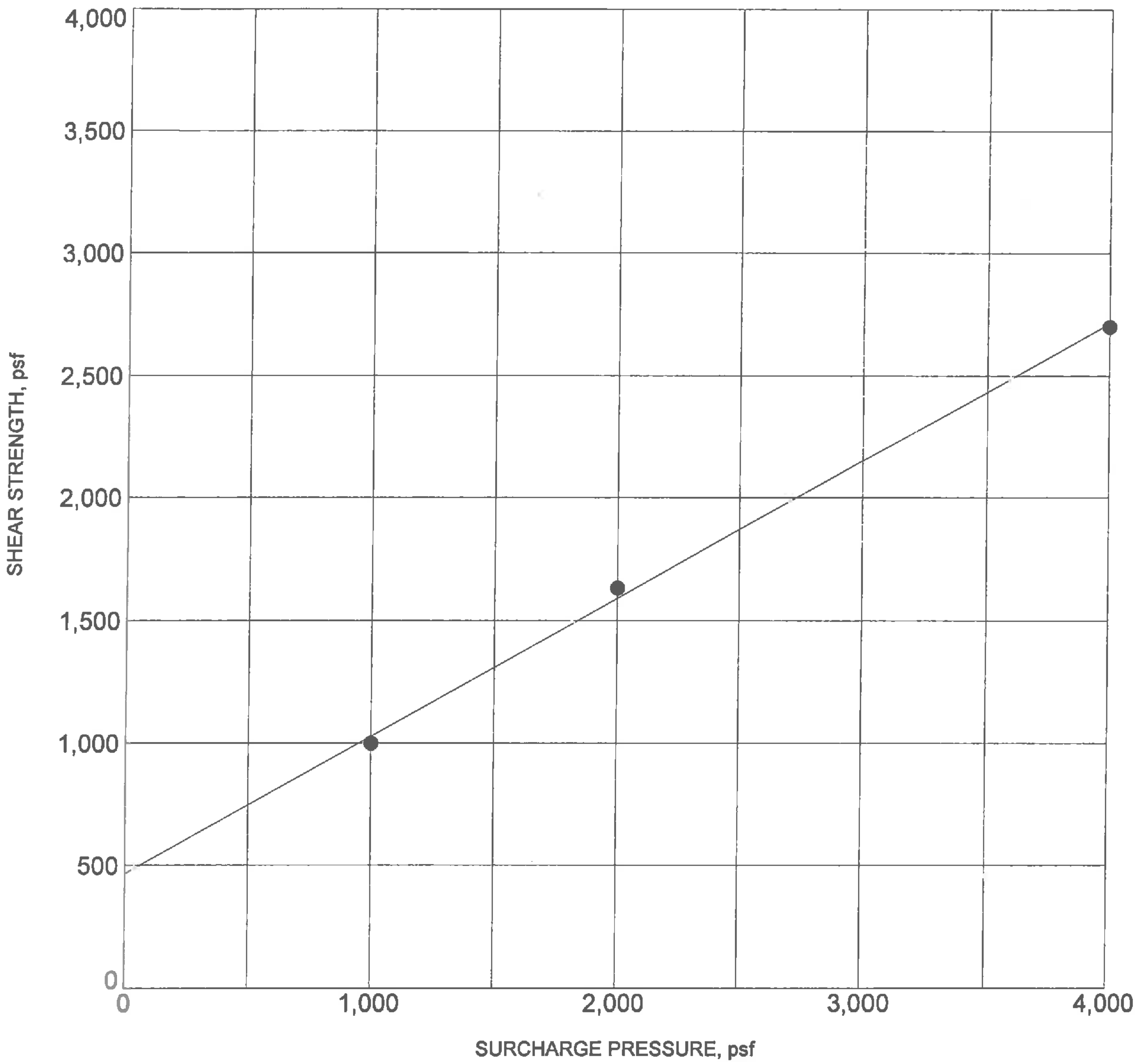
MOISTURE-DENSITY RELATIONSHIP RESULTS

Converse Consultants

Project Name
TORRANCE AIRPORT
INFILTRATION GALLERIES

Project No.
13-31-225-01

Drawing No.
B-2



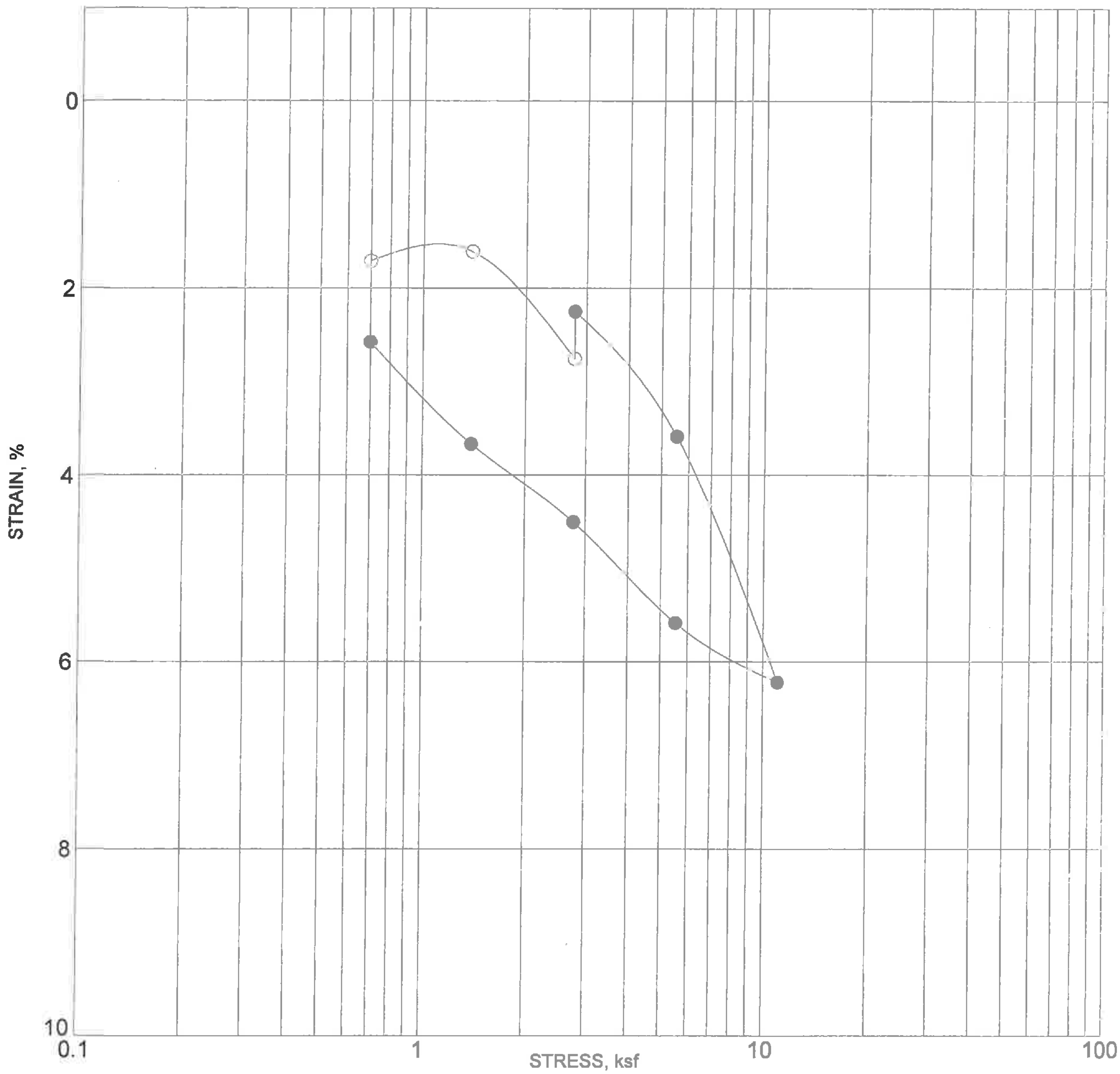
BORING NO. :	BH-2	DEPTH (ft) :	0-5
DESCRIPTION :	SANDY CLAY (CL)		
COHESION (psf) :	450	FRICTION ANGLE (degrees)	31
MOISTURE CONTENT (%) :	93.3	DRY DENSITY (pcf) :	18.8

NOTE: Ultimate Strength, sample remolded to 90% relative compaction.

DIRECT SHEAR TEST RESULTS

Converse Consultants

Project Name	Project No.	Drawing No.
TORRANCE AIRPORT INFILTRATION GALLERIES	13-31-225-01	B-3



BORING NO. :	BH-1	DEPTH (ft) :	5
DESCRIPTION :	CLAY (CL)		

	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	PERCENT SATURATION	VOID RATIO
INITIAL	23.5	96.3		
FINAL	18.1	98.3		

NOTE: SOLID CIRCLES INDICATE READINGS AFTER ADDITION OF WATER

CONSOLIDATION TEST RESULTS

Converse Consultants

Project Name
TORRANCE AIRPORT
INFILTRATION GALLERIES

Project No.
13-31-225-01

Drawing No.
B-4

APPENDIX F – DETAILED BMP COST ESTIMATES

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TORRANCE AIRPORT - Phase 1: BMP at SITE A1

Airport Infiltration System - Site A1: Diversion, Gravity Main, and Infiltration Sytem

Water Quality Benefits Construction Cost Estimate

Description	Unit	Quantity	Unit Cost	Cost ($)
Diversion structure	EA	4	$50,000	$200,000
Infiltration System - StormChamber (12 ac-ft)	LS	1	$1,968,343	$1,968,343
Instalation Cost - 50% to 100% Material	LS	60%		$1,181,006
Gravity main - 100 feet of 24" Pipe	LF	300	$350	$105,000
Power/Electrical cabinets	LS	1	$100,000	$100,000
Subtotal (1)				***$3,554,348***
Mobilization - 0% to 7% of Subtotal (1)		5%		$177,717
Permits - 2% to 5% of Subtotal (1)		3%		$106,630
Subtotal (2)				***$3,838,696***
Estimating contingency - 10% to 25% of Subtotal (2)		15%		$575,804
Subtotal (3)				***$4,414,500***
Escalation - 5% to 10% per year of subtotal (3)		3%		$132,435
Subtotal (4)				**$4,546,935**
Construction contingency - 10% to 20% of subtotal (4)		10%		$454,694
Total Estimated Project Construction Cost				**$5,001,629**

TORRANCE AIRPORT - Phase 2 - BMP at SITE A2

Airport Infiltration System - Site A1: Diversion, Gravity Main, and Infiltration Sytem

Water Quality Benefits Construction Cost Estimate

Description	Unit	Quantity	Unit Cost	Cost ($)
Diversion structure	EA	4	$50,000	$200,000
Infiltration System - StormChamber (12 ac-ft)	LS	1	$705,890	$705,890
Instalation Cost - 50% to 100% Material	LS	60%		$423,534
Gravity main - 100 feet of 15" Pipe	LF	50	$250	$12,500
Power/Electrical cabinets	LS	1	$100,000	$100,000
Subtotal (1)				**$1,441,924**
Mobilization - 0% to 7% of Subtotal (1)		5%		$72,096
Permits - 2% to 5% of Subtotal (1)		3%		$43,258
Subtotal (2)				**$1,557,278**
Estimating contingency - 10% to 25% of Subtotal (2)		15%		$233,592
Subtotal (3)				**$1,790,870**
Escalation - 5% to 10% per year of subtotal (3)		3%		$53,726
Subtotal (4)				**$1,844,596**
Construction contingency - 10% to 20% of subtotal (4)		10%		$184,460
Total Estimated Project Construction Cost				**$2,029,055**

TORRANCE AIRPORT - Phase 3

Installation of 57 Catch Basin Filters Subcatchment AS1

Water Quality Benefits Construction Cost Estimate

Description	Unit	Quantity	Rate	Cost ($)
Diversion structure	EA	0	$50,000	$0
Sump Preparation	LS	0	$250,000	$0
Earth Dam	LS	0	$350,000	$0
Catch Basin Filter Inserts	EA	57	$2,200	$28,500
Gravity Main 1000 ft of 24"	LF	0	$350	$0
Power/Electrical cabinets	LS			$100,000
Subtotal (1)				**$128,500**
Mobilization - 0% to 7% of Subtotal (1)		0%		$0
Permits - 2% to 5% of Subtotal (1)		0%		$0
Subtotal (2)				**$128,500**
Estimating contingency - 10% to 25% of Subtotal (2)		0%		$0
Subtotal (3)				**$128,500**
Escalation - 5% to 10% per year of subtotal (3)		0%		$0
Subtotal (4)				**$128,500**
Construction contingency - 10% to 20% of subtotal (3)		0%		$0
Total Estimated Project Construction Cost				**$128,500**

TORRANCE - WALNUT SUMP - PHASE 1

Water Quality Benefits Construction Cost Estimate

Description	Unit	Quantity	Rate	Cost ($)
Diversion structure	EA	1	$50,000	$50,000
Sump Preparation	LS	0	$250,000	$0
Earth Dam	LS	0	$350,000	$0
Gravity Main 500 ft of 24"	LF	500	$350	$250,000
Power/Electrical cabinets	LS			$100,000
Subtotal (1)				**$400,000**
Mobilization - 0% to 7% of Subtotal (1)		5%		$20,000
Permits - 2% to 5% of Subtotal (1)		3%		$12,000
Subtotal (2)				**$432,000**
Estimating contingency - 10% to 25% of Subtotal (2)		15%		$64,800
Subtotal (3)				**$496,800**
Escalation - 5% to 10% per year of subtotal (3)		3%		$14,904
Subtotal (4)				**$511,704**
Construction contingency - 10% to 20% of subtotal (3)		10%		$51,170
Total Estimated Project Construction Cost				**$562,874**

TORRANCE - WALNUT SUMP - PHASE 2

Water Quality Benefits Construction Cost Estimate

Description	Unit	Quantity	Rate	Cost ($)
Diversion structure	EA	0	$50,000	$0
Sump Preparation	LS	0	$250,000	$0
Earth Dam	LS	0	$350,000	$0
Catch Basin Filter Inserts	EA	50	$2,200	$25,000
Gravity Main 1000 ft of 24"	LF	0	$350	$0
Power/Electrical cabinets	LS			$100,000
Subtotal (1)				**$125,000**
Mobilization - 0% to 7% of Subtotal (1)		0%		$0
Permits - 2% to 5% of Subtotal (1)		0%		$0
Subtotal (2)				**$125,000**
Estimating contingency - 10% to 25% of Subtotal (2)		0%		$0
Subtotal (3)				**$125,000**
Escalation - 5% to 10% per year of subtotal (3)		0%		$0
Subtotal (4)				**$125,000**
Construction contingency - 10% to 20% of subtotal (3)		0%		$0
Total Estimated Project Construction Cost				**$125,000**

TORRANCE - WALNUT SUMP - PHASE 3

Water Quality Benefits Construction Cost Estimate

Description	Unit	Quantity	Rate	Cost ($)
Diversion structure	EA	2	$50,000	$100,000
Sump Preparation	LS	1	$250,000	$250,000
Earth Dam	LS	1	$350,000	$350,000
Stormwater Lift Station No. 2 - 20 MF Mixed Flow Pump	LS	3	140000	420,000
Gravity Main 500 ft of 60"	LF	500	$1,820	$250,000
Force Main 1175 ft of 24"	LF	1175	$348	$408,900
Pretreatment Unit	EA	1	$200,000	$200,000
Power/Electrical cabinets	LS			$100,000
Subtotal (1)				**$2,078,900**
Mobilization - 0% to 7% of Subtotal (1)		5%		$103,945
Permits - 2% to 5% of Subtotal (1)		3%		$62,367
Subtotal (2)				**$2,245,212**
Estimating contingency - 10% to 25% of Subtotal (2)		15%		$336,782
Subtotal (3)				**$2,581,994**
Escalation - 5% to 10% per year of subtotal (3)		3%		$77,460
Subtotal (4)				**$2,659,454**
Construction contingency - 10% to 20% of subtotal (3)		10%		$265,945
Total Estimated Project Construction Cost				**$2,925,399**

APPENDIX G – CATCH BASIN FILTER INFORMATION

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UNIVERSAL
ENGINEERING SCIENCES
Consultants In: Geotechnical Engineering • Environmental Sciences
Construction Material Testing • Threshold Inspection

820 Brevard Avenue • Rockledge, Florida 32955
(321) 638-0808 Fax (321) 638-0978

November 7, 2007

Mr. Henry Happel
Suntree Technologies
798 Clearlake Road, Suite 2
Cocoa, FL 32922

Re: Suspended Soils Retention Testing for
Suntree Curb Inlet Basket and Grate Inlet Skimmer Box
Rockledge, FL
Universal Project No. 34184-004-01
Docs No. 622763

Dear Mr. Happel:

As requested, we have performed testing of a curb inlet and a skimmer box of your design at our laboratory in Rockledge, Florida. The purpose of the test was to determine the percentage of 100 micron grain size particles of OK90 sand that would be retained in the baskets of the devices following a 3 minute wash through the devices.

To perform the test, we recorded certain amounts of dry OK90 sand and washed it though each of the devices using an electric pump with a flow of approximately 1200 gallons per hour for 3 minutes. The sand that passed through the baskets and was retained on the reservoir was then dried and weighed. The percentage of sand that has a grain size larger than 100 microns was determined from the attached sieve analyses and used to calculate the removal efficiencies.

Based on the results of the testing, the Suntree Curb Inlet Basket had a removal efficiency of 93 percent for particle sizes of 100 microns or greater.

Based on the results of the testing, the Suntree Grate Inlet Skimmer Box had a removal efficiency of 86 percent for particle sizes of 100 microns or greater.

We trust that this information is sufficient. Please call if you need any further information.

Sincerely,

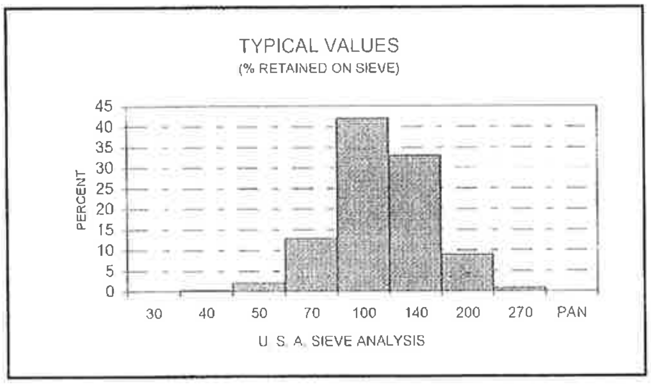
Universal Engineering Sciences, Inc.

Richard E. Hoaglin, P.E.
Branch Manager
FL Reg. no. 48796

11/7/07

U.S. SILICA
Sands of Time

PRODUCT DATA



INTERIM OK-90

UNGROUND SILICA

PLANT: MILL CREEK, OKLAHOMA

		TYPICAL VALUES		
USA STD SIEVE SIZE		% RETAINED		% PASSING
MESH	MILLIMETERS	INDIVIDUAL	CUMULATIVE	CUMULATIVE
30	0.600	0.0	0.0	100.0
40	0.425	0.3	0.3	99.7
50	0.300	2.1	2.4	97.6
70	0.212	12.9	15.3	84.7
100	0.150	42.0	57.3	42.7
140	0.106	33.0	90.3	9.7
200	0.075	9.0	99.3	0.7
270	0.053	0.8	100.0	0.0
PAN		0.0	100.0	

TYPICAL PHYSICAL PROPERTIES

AFS[1] ACID DEMAND (@pH 7) 0.4
AFS[1] GRAIN FINENESS 84
COLOR .... WHITE
GRAIN SHAPE .... ROUND
HARDNESS (Mohs) 7

MELTING POINT (Degrees F) 3100
MINERAL .... QUARTZ
MOISTURE CONTENT (%) .... <0.5
pH 6.8
SPECIFIC GRAVITY 2.65

(1) AMERICAN FOUNDRYMEN'S SOCIETY

TYPICAL CHEMICAL ANALYSIS, %

SiO_2 (Silicon Dioxide) 99.8
Fe_2O_3 (Iron Oxide) 0.015
Al_2O_3 (Aluminum Oxide) 0.05
TiO_2 (Titanium Dioxide) .... <0.01
CaO (Calcium Oxide) .... <0.01

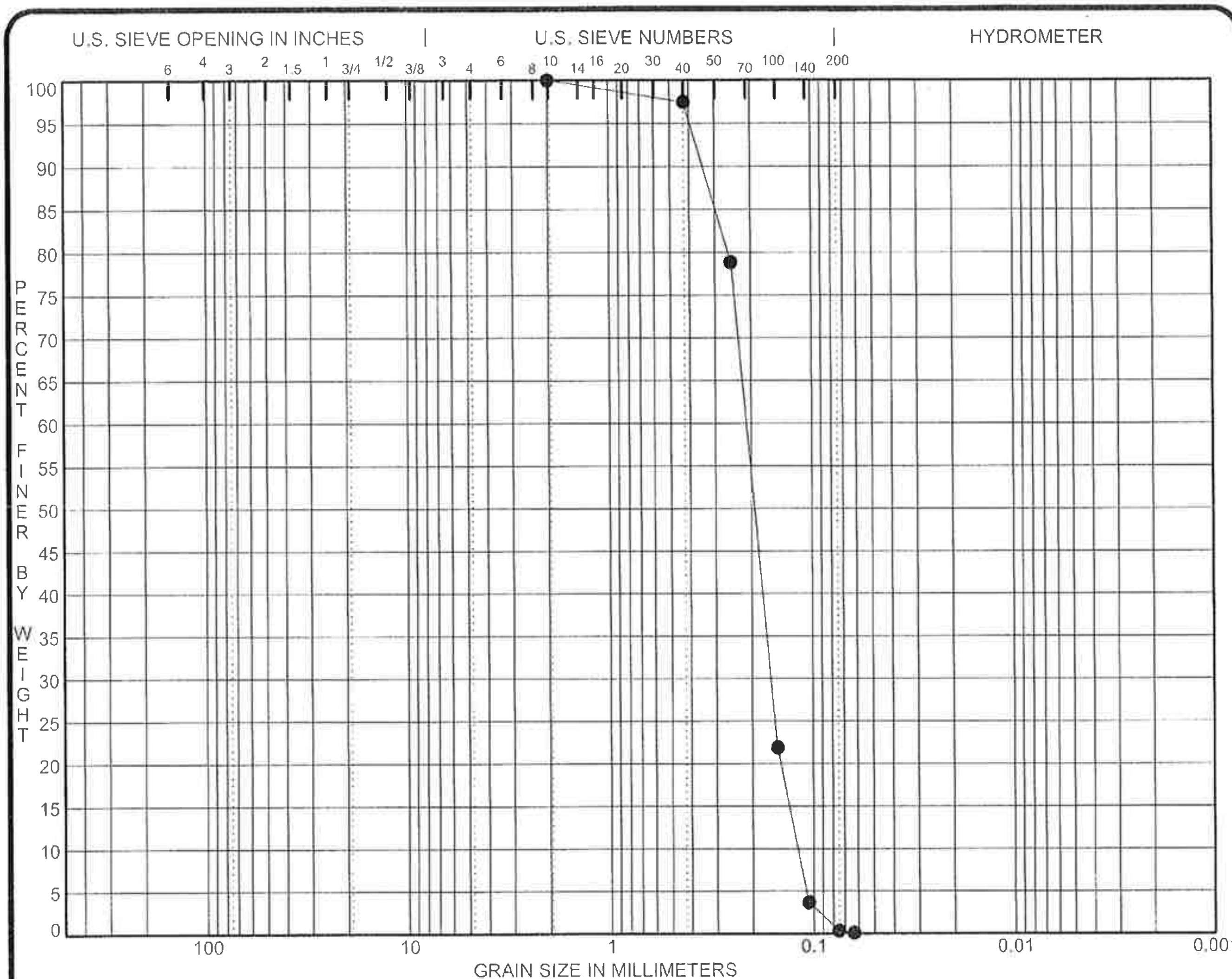
MgO (Magnesium Oxide) .... <0.01
Na_2O (Sodium Oxide) .... <0.01
K_2O (Potassium Oxide) 0.02
LOI (Loss On Ignition) 0.1

February 1, 2007

DISCLAIMER: The information set forth in this Product Data Sheet represents typical properties of the product described; the information and the typical values are not specifications. U.S. Silica Company makes no representation or warranty concerning the Products, expressed or implied, by this Product Data Sheet.

WARNING: The product contains crystalline silica - quartz, which can cause silicosis (an occupational lung disease) and lung cancer. **For detailed information on the potential health effect of crystalline silica - quartz, see the U.S. Silica Company Material Safety Data Sheet.**

U.S. Silica Company   P.O. Box 187, Berkeley Springs, WV 25411-0187   (800) 243-7500



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	**P1**	**CURB INLET BASKET**					**1.03**	**1.8**
	0							

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**P1**	**2.00**	**0.21**	**0.161**	**0.1196**	**0.0**	**99.6**	**0.4**	

3/4"	3/8"	NO. 4	NO. 10	NO. 40	NO. 60	NO. 100	NO. 200
			100.0	**97.5**	**78.9**	**21.9**	**0.4**

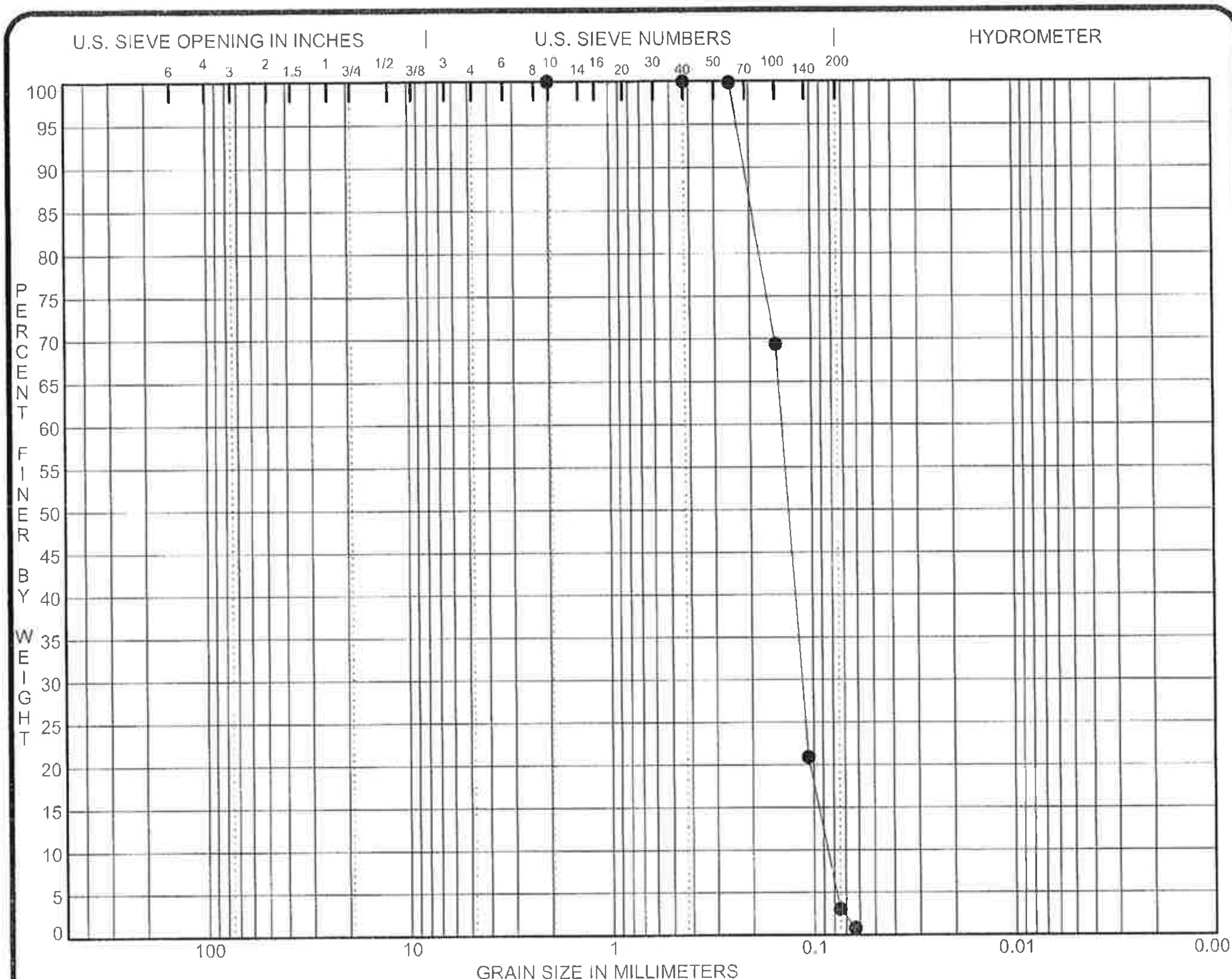
Client: **SUNTREE TECHNOLOGIES**
798 CLEARLAKE ROAD
COCOA FLORIDA 32922

Client No: **34184-004-01**
Report No: **1116**
Date: **11/7/07**

Project: **SUSPENDED SOILS RETENTION TESTING FOR**
GRATE INLET SKIMMER BOX
ROCKLEDGE, FLORIDA

SOIL GRADATION CURVES

Universal Engineering Sciences, Inc.
ROCKLEDGE, FLORIDA



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● P1	CURB INLET RESERVOIR					1.06	1.6
0							

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● P1	2.00	0.14	0.113	0.0858	0.0	97.0	3.0	

3/4"	3/8"	NO. 4	NO. 10	NO. 40	NO. 60	NO. 100	NO. 200
			100.0	100.0	99.8	69.4	3.0

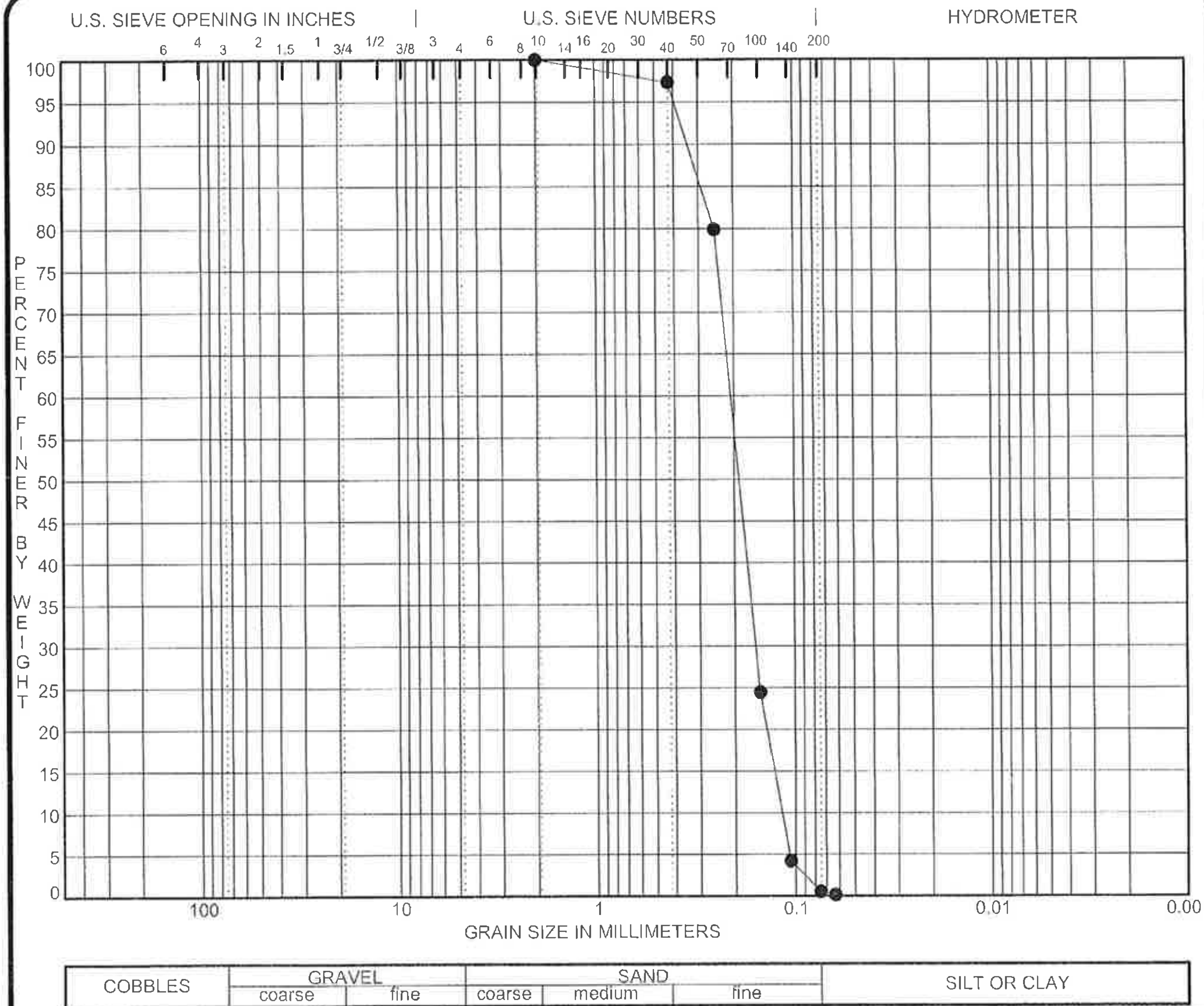
Client: SUNTREE TECHNOLOGIES
798 CLEARLAKE ROAD
COCOA FLORIDA 32922

Client No: 34184-004-01
Report No: 1118
Date: 11/7/07

Project: SUSPENDED SOILS RETENTION TESTING FOR
GRATE INLET SKIMMER BOX
ROCKLEDGE, FLORIDA

SOIL GRADATION CURVES

Universal Engineering Sciences, Inc.
ROCKLEDGE, FLORIDA



	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	P1	SKIMMER BOX BASKET					1.02	1.8
	0							

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	P1	2.00	0.21	0.158	0.1171	0.0	99.5	0.5	

3/4"	3/8"	NO. 4	NO. 10	NO. 40	NO. 60	NO. 100	NO. 200
			100.0	97.3	79.9	24.4	0.5

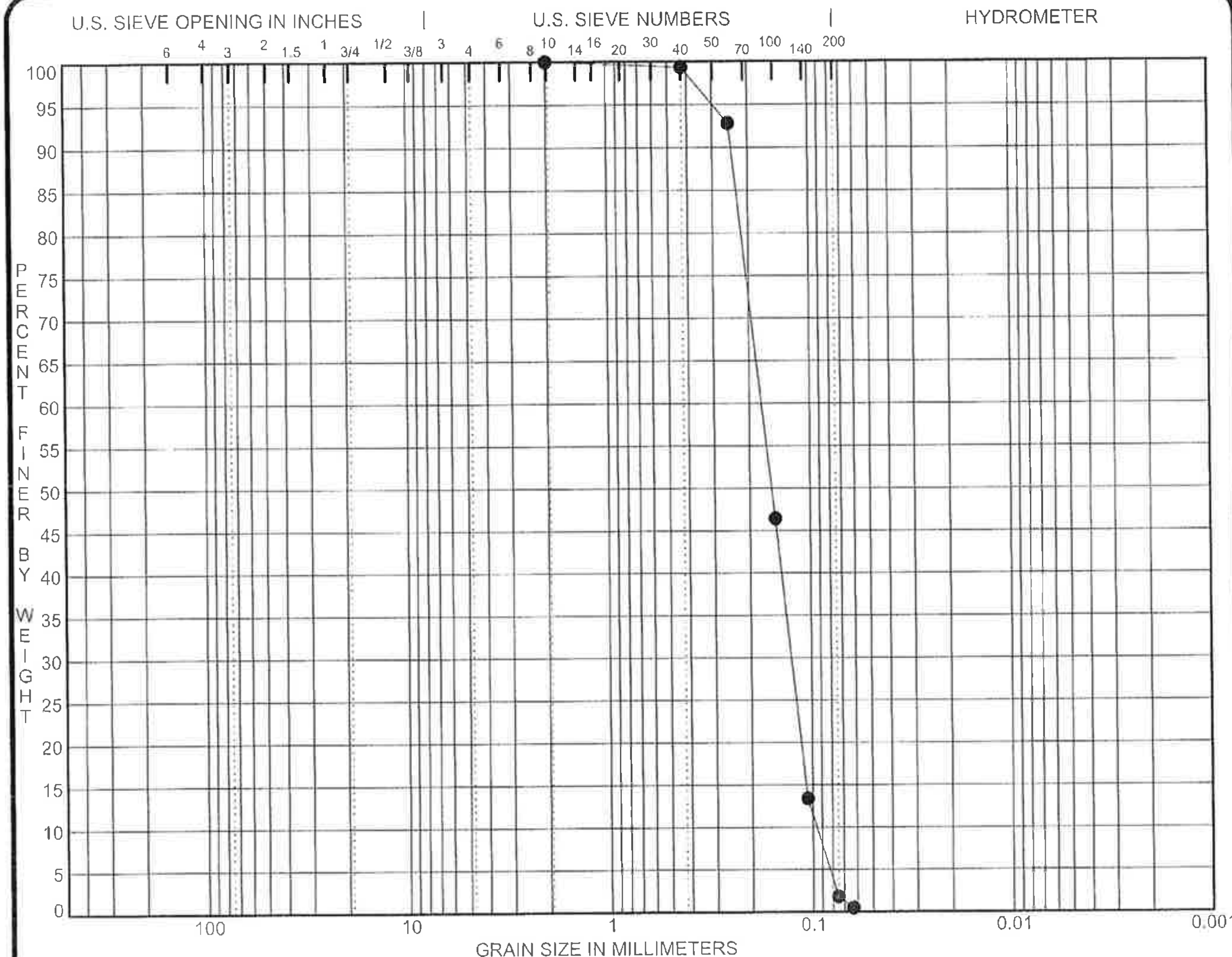
Client: SUNTREE TECHNOLOGIES
798 CLEARLAKE ROAD
COCOA FLORIDA 32922

Client No: 34184-004-01
Report No: 1117
Date: 11/7/07

Project: SUSPENDED SOILS RETENTION TESTING FOR
GRATE INLET SKIMMER BOX
ROCKLEDGE, FLORIDA

SOIL GRADATION CURVES

Universal Engineering Sciences, Inc.
ROCKLEDGE, FLORIDA



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● P1	SKIMMER BOX RESERVOIR					0.95	1.8
0							

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● P1	2.00	0.17	0.126	0.0958	0.0	98.2	1.8	

3/4"	3/8"	NO. 4	NO. 10	NO. 40	NO. 60	NO. 100	NO. 200
			100.0	99.3	92.8	46.4	1.8

Client: SUNTREE TECHNOLOGIES
798 CLEARLAKE ROAD
COCOA FLORIDA 32922

Client No: 34184-004-01
Report No: 1115
Date: 11/7/07

Project: SUSPENDED SOILS RETENTION TESTING
FOR GRATE INLET SKIMMER BOX
ROCKLEDGE, FLORIDA

SOIL GRADATION CURVES

Universal Engineering Sciences, Inc.
ROCKLEDGE, FLORIDA

SITE EVALUATION OF SUNTREE TECHNOLOGIES, INC. GRATE INLET SKIMMER BOXES FOR DEBRIS, SEDIMENT, AND OIL & GREASE REMOVAL

Reedy Creek Improvement District
Planning & Engineering Department
Eddie Snell, Compliance Specialist

Stormwater is now recognized as the leading source of pollution to our remaining natural water bodies in the United States. Development and urbanization have removed most of the natural filtration and sediment trapping systems provided by the environment. Current development must address this need through the implementation of stormwater treatments systems in the project design. Most of these systems perform reasonably well, if properly designed, constructed, and maintained.

Retrofit of older urban areas lacking these modern stormwater systems is a continually expensive challenge. The Downtown Disney complex, formerly the Lake Buena Vista Shopping Village, has several drainage basins with 1970's stormwater systems. These older systems discharge directly into the adjacent drainage canal with no pollutant treatment. Over time the accumulation of sediments, nutrients, intensive development, and recreational/entertainment pressures are contributing to water quality degradation.

Whenever new development or redevelopment occurs, the stormwater system is brought to current code/permit requirements. In the interim, several areas are in need for rapid, effective, and economical improvement in the quality of its stormwater discharge.

Suntree Technologies Incorporated, located in Cape Canaveral, FL, manufactures stormwater grate inlet skimmer boxes. They are made of a high quality fiberglass frame, with stainless steel filter screens backed by heavy-duty aluminum grating. Each unit is custom made to accommodate various inlet sizes. A hydrocarbon absorption boom is attached to the top of the skimmer box for petroleum, oil, and grease removal.

These devices fit below the grate and catch sediment, debris, and petroleums, oils & greases. Clean-out, maintenance, and performance reporting is provided by Suntree on a scheduled basis.

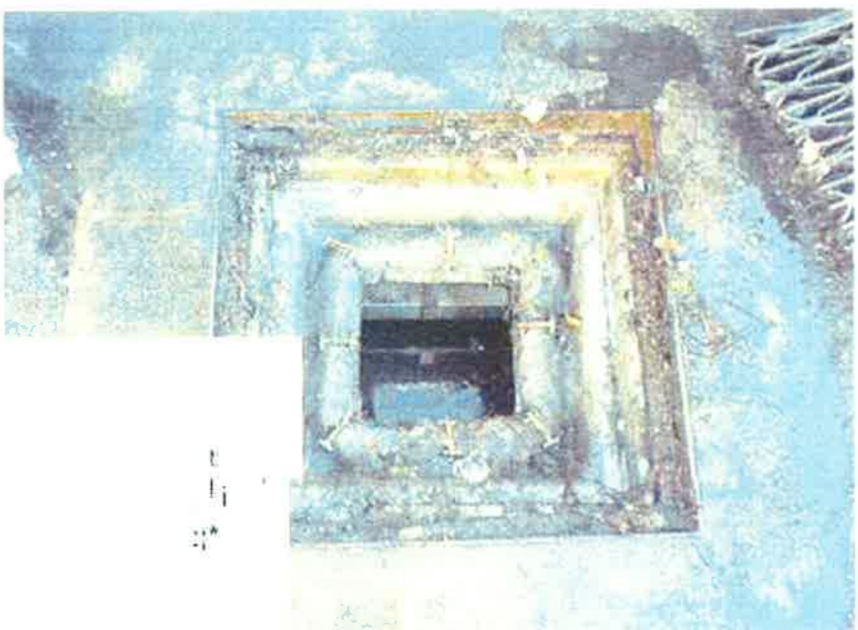
Picture of Grate Inlet Skimmer Box

The Reedy Creek Improvement District (RCID) selected six (6) test sites in the Lake Buena Vista area to evaluate the performance of these units. One unit was placed in a curb inlet along Hotel Plaza Boulevard to trap landscape leaf litter, sediment, and oil & grease from a high use roadway. Three (3) units were placed in the backstage service area of the Rain Forest Cafe. Two (2) units were placed in the backstage service area of the McDonald's restaurant and Legos merchandise shop.

After several field meetings, during which Suntree took extensive measurements, photos, and other documentation of each stormwater drain, the Grate Inlet Skimmer Boxes were manufactured and delivered for installation. All units were installed without mishap approximately two weeks before the 1999 Christmas holiday season. The target time period for particle catchment was one month. Mr. Henry and Tom Happel, Suntree Technologies, visited each site several times during the month to ensure that debris would not fill the units too soon.

On January 25,2000, Suntree serviced the six units. At each site, the material captured in the skimmer boxes was removed, measured, weighed, visually identified, photographed, and recorded. Some units were slightly field modified for optimum performance. All units performed as expected **removing, on average, 20 pounds of debris from each of the six sites.** The composition of debris varied considerably.

The Hotel Plaza (roadway) site was 90% leaf litter and 10% sediment. The Rain Forest Cafe sites ran in opposition as you got close to the lake. First inlet was about 50% leaf litter and cigarette butts and 50% sediment. The middle inlet was 60 % sediment and 30 % leaf litter (10% miscellaneous). The inlet closest to the lake was 95% sediment and 5% leaf litter. The two sites at the McDonalds/Legos area were similar to each other. The site closest to the lake was 95% sediment and 5% leaf litter. The site closest to the entrance gate was 98% litter sediment and 2% leaf litter.



This composition is indicative of the human activities and drainage flow patterns of that site. Backstage areas in the Walt Disney World Resort receive an artificial rain event each night during cleaning operations. This washes a continual flow over the impervious site, washing all materials into the stormwater system.

Municipalities in Brevard, Volusia and Dade counties have successfully used inlet skimmers in Florida. RCID partnered with Walt Disney Imagineering (WDI) Research and Development to coordinate some basic chemical sampling for pollutant removal efficiency determination. Mr. Craig Duxbury, WDI, provided technical support and guidance for this. An ingeniously simple device was fabricated by Suntree to allow sampling of the First Flush of water going into the units and ultimately coming out of the skimmer boxes.

Collected samples were processed and analyzed by the RCID Environmental Services Laboratory. Analysis parameter were:

Ammonia, Chemical Oxygen Demand, Fecal Coliform (MPN), Nitrite and Nitrate, Total Kjeldahl Nitrogen, Oil and Grease, Total Phosphate. Suspended Solids, and Metals.

Analysis results are presented in the following table:

ANALYSIS	LOCATION	LAB NO.	VALUE	UNITS	SAM-DATE	Pollutant Change	% Chanae
Ammonia, Salicylate	RF-IN	1646	0.38	mg/l	09-Feb-00	0.14	37 %
Ammonia, Salicylate	RF-OUT	1646	0.23	mg/l	09-Feb-00		
Ammonia, Salicylate	RF-OUT-I	1646	0.25	mg/l	09-Feb-00		
Chemical Oxygen Demand	RF-IN	1646	2670	mg/l	09-Feb-00	1035	
Chemical Oxygen Demand	RF-OUT	1646	1780	mg/l	09-Feb-00		
Chemical Oxygen Demand	RF-OUT-I	1646	1490	mg/l	09-Feb-00		
Coliform, Fecal MPN	RF-IN	1646	1600	#IOO ml	09-Feb-00	-93400	
Coliform, Fecal MPN	RF-OUT	1646	160,000	#IOO ml	09-Feb-00		
Coliform, Fecal MPN	RF-OUT-I	1646	30,000	#IOO ml	09-Feb-00		
Nitrate and Nitrite	RF-IN	1646	0.06	mg/l	09-Feb-00	0.035	
Nitrate and Nitrite	RF-OUT	1646	0.04	mg/l	09-Feb-00		
Nitrate and Nitrite	RF-OUT-I	1646	0.01	mg/l	09-Feb-00		
Nitrogen, Total Kjeldahl	RF-IN	1646	24.3	mg/l	09-Feb-00	13.55	
Nitrogen, Total Kjeldahl	RF-OUT	1646	10.4	mg/l	09-Feb-00		
Nitrogen, Total Kjeldahl	RF-OUT-I	1646	11.1	mg/l	09-Feb-00		
Oil and Grease	RF-IN	1646	526	mg/l	09-Feb-00	283	

Pollutant removal efficiencies averaged about 50% for all parameters tested. The minimal removal was 37% for Ammonia and the maximum removal was 74% for Suspended Solids.

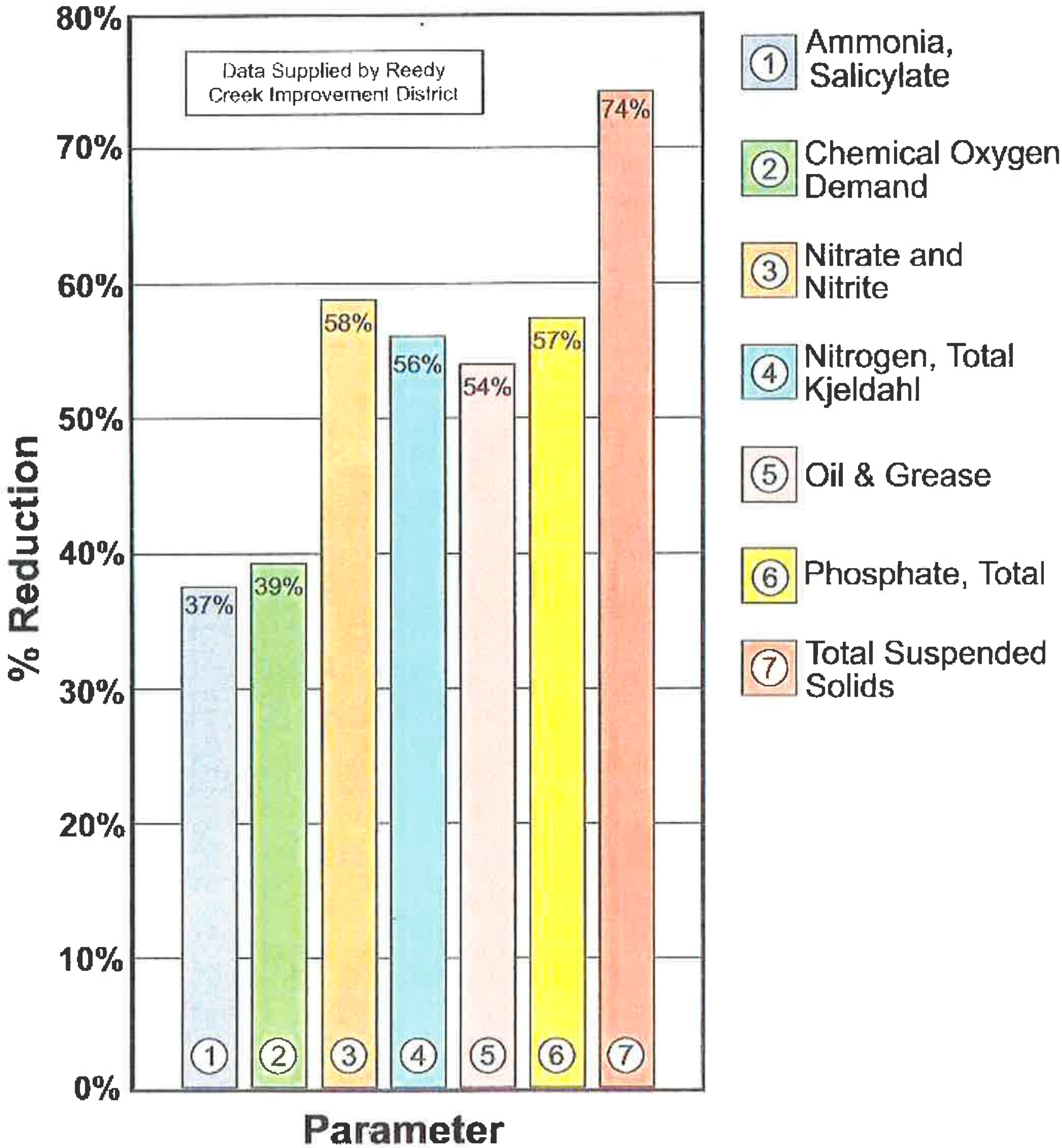
Coliform bacteria were not effectively removed by the skimmer boxes, although, they are not designed to provide water disinfection. Oil and Grease are a food source for bacteria and reduction of this pollutant should provide some effect on bacterial numbers.

Reedy Creek 24” x 24” Grate Inlet Skimmer Box

Pollutant Removal Efficiency

Grate Inlet Skimmer Box

Using Storm Boom #1 Type Absorbent



Grate Inlet Skimmer Box/Round Curb Inlet Basket - Removal Efficiencies

Numeric Reductions (mg/L)

	Total Suspended Solids mg/L			Total Phosphorus mg/L			Total Nitrogen mg/L		
Location	Inlet	Outlet	Removal Efficiency	Inlet	Outlet	Removal Efficiency	Inlet	Outlet	Removal Efficiency
Site Evaluation - Reedy Creek			74%			57%	24.3	10.4	57%
Creech Engineering Report			73%			79%			79%
Witman's Pond	978	329	66%	18.6	0.452	98%	48.08	9.86	79%
Universal Engineering - 2007 (100 Microns) LATEST REPORT			86%						

	Zinc mg/L			Lead mg/L			Copper mg/L		
Location	Inlet	Outlet	Removal Efficiency	Inlet	Outlet	Removal Efficiency	Inlet	Outlet	Removal Efficiency
UC Irvine						99%			
Longo Toyota	13.7	0.73	95%	1.5	0.2	87%	1.9	0.1	95%

	Ammonia, Salicylate mg/L			Fecal Coliform CFU/100 mL			Cadmium		
Location	Inlet	Outlet	Removal Efficiency	Inlet	Outlet	Removal Efficiency	Inlet	Outlet	Removal Efficiency
Site Evaluation - Reedy Creek	0.38	0.23	39%						
UC Irvine						33%			94%

	Hydrocarbons mg/L		
Location	Inlet	Outlet	Removal Efficiency
UC Irvine			90%
Longo Toyota	199	10.43	95%

Reedy Creek - Site Evaluation of a Grate Inlet Skimmer Box for Debris, Sediment, and Oil & Grease Removal - 1999 - Independent Test

Creech Engineering Report - Pollutant Removal Testing for a Grate Inlet Skimmer Box - 2001

Witman's Pond - Restoration Project - Massachusetts Dept of Environmental Management - 1998 -Independent Test

UC Irvine - Optimization of Stormwater Filtration at the Urban/Watershed Interface - Dept of Environmental Health - 2005 - Independent Test

Longo Toyota - Field Test - City of El Monte - 2002 - Independent Test

Universal Engineering Sciences - Suspended Soils Retention Study - 2007 -Independent Test

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820 Brevard Avenue • Rockledge, Florida 32955
(321) 638-0808 Fax (321) 638-0978

November 29, 2007

Henry Happel
President
Suntree Technologies, Inc.
798 Clearlake Road
Cocoa, Florida 32922

Reference: Suspended Solids Retention Testing
Curb Inlet Basket and Grate Inlet Skimmer Box
Universal Project No. 34184-004-01

Dear Mr. Happel:

Universal Engineering Sciences, Inc. (Universal) is pleased to submit this letter report to Suntree Technologies, Inc. including laboratory analysis and photo documentation of the testing procedures used, as described below.

SCOPE OF WORK

Universal measured the percentage (by dry weight) of OK-90 calibrated sand provided by the client that was retained in the Curb Inlet Basket and Grate Inlet Skimmer Box. In addition, gradation analyses were performed on the OK-90 sand before it was used in the testing beds and again after it had been used in the testing beds, on both the portions of sand retained in the skimmer box and curb basket, and the portions of sand that passed through the skimmer box and curb basket.

DESCRIPTION OF TESTING APPARATUS

On November 6, 2007 Suntree Technologies arrived at the Universal branch office located at 820 Brevard Avenue in Rockledge, FL with the Curb Inlet Basket test bed and Grate Inlet Skimmer Box test bed, as shown in **APPENDIX B**. Two 100 pound bags of U.S. Silica OK-90 Unground Silica Sand were previously delivered to the Universal laboratory in preparation for the Suspended Solids Testing.

Grate Inlet Skimmer Box

The Grate Inlet Skimmer Box test bed consisted of a two-tiered formed fiberglass table and water pumping apparatus designed to simulate a standard storm water catch basin that would typically be found in a parking lot. The dimensions of the Grate Inlet Skimmer Box test bed are approximately 64" by 45". The top tier is ringed with a 1-inch diameter PVC tube, perforated so as to form water jets at 2 inch intervals once pressurized water is pumped into the tubes. The surface of the top tier is sloped towards the center of the table so that water from the jets will flow towards the center of the top tier, where a 36" by 27" rectangular opening has been cut into the surface. The Grate Inlet Skimmer Box is placed into the opening. Water and/or debris are washed into the Skimmer Box. Debris is retained on the mesh sieves that line the bottom and sides of the Skimmer Box, while water drains freely through the sieves.

Once the water has passed through the Skimmer Box apparatus, it collects in the bottom tier of the table. The bottom tier is separated into two areas by a wall with large openings in it which allows water to pass freely between the two areas. The larger area acts as a reservoir for the recirculation pumps, which are located in the smaller area. A screen has been placed along the face of the wall to prevent debris which has passed through the Skimmer Box and into the reservoir from entering the pump intake area. The recirculation pumps supply water to the PVC tubes located on the top tier.

Curb Inlet Basket

The Curb Inlet Basket test bed consisted of a basin approximately 48" by 48" and approximately 36" deep. A shelf is located along one side of the basin approximately 15" wide that runs the length of the basin approximately two inches below the top edge of the basin (see photos in **APPENIDX B**). A one-inch diameter PVC tube similar to the one used for the Skimmer Box test bed runs the length of the shelf and is supplied by a single pump located in the reservoir of the test bed. Similarly to the Skimmer Box test bed, the Curb Inlet test bed has a reservoir divided by a wall with screened opening. The Curb Inlet Basket has two hooks on it which are hung through slots that have been cut into the edge of the shelf, which allows the shelf to simulate a standard "D.O.T. Type F" curb. The Basket is hung so that water flows off of the shelf and into the Basket (see photos in **APPENIDX B**).

OK-90 Unground Silica Sand

Two 100 pound bags of US Silica OK-90 sand were provided by Suntree Technologies to use for suspended solids testing. A gradation analysis (AASHTO T-88) was performed at the Universal office on a representative sample of each bag of the OK-90 sand provided by the client to determine the percentage of OK-90 sand that has a grain size larger than 100 microns for future calculations. The results of the sieve analysis are presented in **APPENDIX A** along with the sieve analysis provided by the manufacturer.

Approximately 60 pounds of the OK-90 sand obtained from Bag 1 was thoroughly mixed and air dried in preparation for the suspended solids testing.

SKIMMER BOX TESTING PROCEDURE

The testing bed reservoir was filled with water and the pump system was turned on to begin water circulation. Additional water was added to maintain a water level in the reservoir approximately 1.5 inches below the bottom of the Skimmer Box (see photos in **APPENDIX B**).

The Skimmer Box was removed and weighed wet to establish the container weight.

The Skimmer Box was placed back into the testing bed and a bead of RTV (Room Temperature Vulcanizing) silicon approximately ¼-inch wide was applied around the edge of the Skimmer Box to ensure a positive seal between the edge of the Skimmer Box and the test bed (for testing purposes only), preventing any sand from bypassing the Skimmer Box and washing directly into the reservoir (see photos in **APPENDIX B**). The silicon was then allowed to cure for approximately one hour before testing.

A 546 gram sample of the OK-90 sand was taken for moisture content determination (ASTM-D 2216), then a 25.09 pound (wet weight) sample of OK-90 sand was placed around the Skimmer Box in the top of the test bed over a period of six minutes, while the water jets washed the sand into the Skimmer Box, which resulted in a suspended solids introduction rate of approximately 4.2 pounds of sand per minute (see photos in **APPENDIX B**).

The pumps remained on and water was circulated through the test bed for a period of three minutes, washing all of the sand into the Skimmer Box (see photos in **APPENDIX B**).

The pumps were turned off and the Skimmer Box was removed and weighed wet again, with the sand retained inside.

20.88 pounds (dry weight) of the original 24.99 pound (dry weight) sample of sand was retained in the Skimmer Box. A grain size analysis sample was taken from the sand retained inside the Skimmer Box to determine the retained weight of OK-90 sand that was greater than 100 microns in diameter. The results of this test are presented in **APPENDIX A**.

The reservoir in the lower tier of the test bed was carefully drained, so that only a small amount of water and all of the sand that passed through the Skimmer Box was left in the bottom tier of the test bed. The sand that passed through the Skimmer Box was then washed into a container and a grain size analysis was performed on this sample (see photos in **APPENDIX B**). The results of this test are presented in **APPENDIX A**.

The laboratory worksheet results of the Suspended Solids Retention Testing for the Skimmer Box are presented in **APPENDIX A**.

CURB INLET TESTING PROCEDURE

The testing bed reservoir was filled with water and the pump system was turned on to begin water circulation. Additional water was added to maintain a water level in the reservoir approximately 1.5 inches below the bottom of the Curb Inlet (see photos in **APPENDIX B**).

The Curb Inlet was removed and weighed wet to establish the container weight.

A 12.77 pound (wet weight) sample of OK-90 sand was placed approximately midway along the length of the shelf of the Curb Inlet test bed over a period of three minutes, while the water jets washed the sand into the Curb Inlet, which resulted in a suspended solids introduction rate of approximately 4.3 pounds of sand per minute (see photos in **APPENDIX B**).

The pump remained on and water was circulated through the test bed for a period of three minutes, washing all of the sand into the Curb Inlet (see photos in **APPENDIX B**).

The pump was turned off and the Curb Inlet was removed and weighed wet again, with the sand retained inside.

11.70 pounds (dry weight) of the original 12.72 pound (dry weight) sample of sand was retained in the Curb Inlet. A grain size analysis sample was taken from the sand retained inside the Curb Inlet basket. The results of this test are presented in **APPENDIX A**.

The basin of the test bed was carefully drained, so that only a small amount of water and all of the sand that passed through the Curb Inlet was left in the bottom of the test bed. The sand that passed through the Curb Inlet was then washed into a container and a grain size analysis was performed on this sample to determine the retained weight of OK-90 sand that was greater than 100 microns in diameter (see photos in **APPENDIX B**). The results of this test are presented in **APPENDIX A**.

The laboratory worksheet results of the Suspended Solids Retention Testing for the Curb Inlet are presented in **APPENDIX A**.

SUMMARY

The Grate Inlet Skimmer Box by Suntree Technologies, Inc. retained a minimum of 84% of the portion of OK-90 sand in suspension with an average grain size greater than 100 microns (.100 mm).

The Curb Inlet Basket by Suntree Technologies, Inc. retained a minimum of 93% of the portion of OK-90 sand in suspension with an average grain size greater than 100 microns (.100 mm).

Universal appreciates this opportunity to provide testing services to you, and looks forward to working with you on future projects. Please do not hesitate to contact us if you have questions or require any additional information.

Sincerely,

UNIVERSAL ENGINEERING SCIENCES, INC.
Certificate of Authorization No. 549

Keith A. Ellis, E.I.
Project Engineer

Richard E. Hoaglin, P.E. 11/29/07
Branch Manager
Florida Registration No. 48796

2-Addressee

Suspended Solids Testing Results

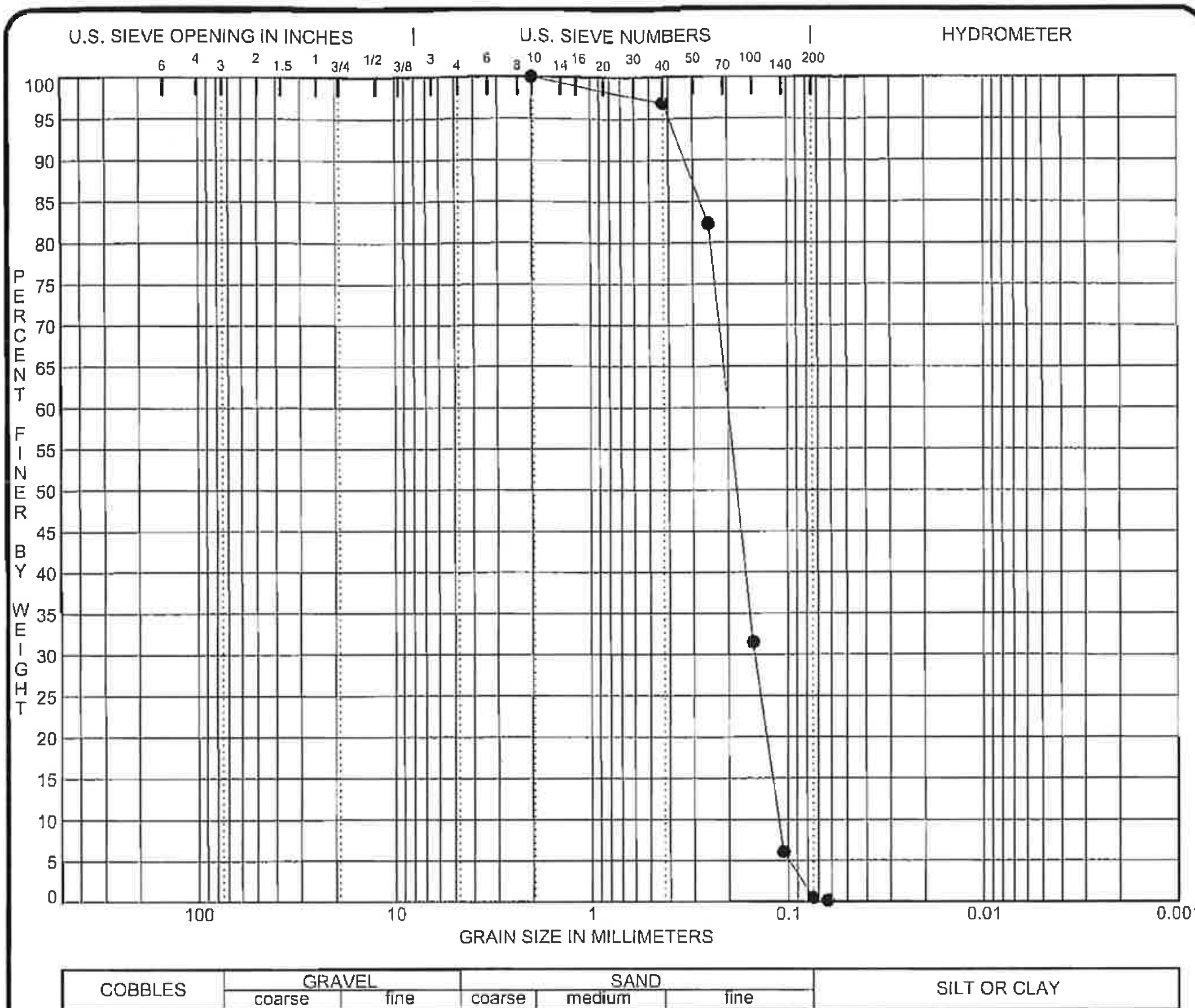
Curb Inlet Basket

A.)	Wet Weight of OK-90 Sand (pre test):	12.77 pounds
B.)	Moisture Content of Sand Prior to Testing:	0.40 % by mass
A/(1+(B/100)) = C.)	Dry Weight of OK-90 Sand (pre test):	12.72 pounds
D.)	Weight of Curb Inlet Basket:	19.40 pounds
E.)	Weight of Curb Inlet Basket and Sand:	33.92 pounds
E-D = F.)	Wet Weight of Sand Retained in Basket:	14.52 pounds
G.)	Moisture Content of Sand After Testing:	24.00 % by mass
F/(1+(G/100)) = H.)	Dry Weight of Sand Retained in Basket:	11.71 pounds
I.)	Dry Weight of Sand Passing Basket:	444.50 grams
I/453.6 = J.)		0.98 pounds
100*(1-(H+J)/C) = K.)	Loss of Sample:	0.23 % by mass
(from Soil Gradation, Bag #1) L.)	OK-90 Sand larger than 100 microns placed in Curb Inlet test bed:	95.00 % by mass
C*L = M.)	Mass of OK-90 sand placed in Curb Inlet test bed greater than 100 microns, based on initial gradation of Bag #1:	12.08 pounds
(from Soil Gradation, Curb Inlet Basket) N.)	OK-90 Sand larger than 100 microns retained in Curb Inlet basket:	96.50 % by mass
H*N = O.)	Mass of OK-90 sand retained in Curb Inlet Basket greater than 100 microns, based on post-test gradation:	11.30 pounds
100*(O/M) = P.)	Percentage of particles greater than 100 microns retained in Curb Inlet Basket:	93.54 % by mass

Suspended Solids Testing Results

Grate Inlet Skimmer Box

A.)	Wet Weight of OK-90 Sand (pre test):	25.09 pounds
B.)	Moisture Content of Sand Prior to Testing:	0.40 % by mass
A/(1+(B/100)) = C.)	Dry Weight of OK-90 Sand (pre test):	24.99 pounds
D.)	Weight of Skimmer Box:	48.14 pounds
E.)	Weight of Skimmer Box and Sand:	73.26 pounds
E-D = F.)	Wet Weight of Sand Retained in Box:	25.12 pounds
G.)	Moisture Content of Sand After Testing:	20.28 % by mass
F/(1+(G/100)) = H.)	Dry Weight of Sand Retained in Box:	20.88 pounds
I.)	Dry Weight of Sand Passing Skimmer Box:	1627.60 grams
I/453.6 = J.)		3.59 pounds
100*(1-(H+J)/C) = K.)	Loss of Sample:	2.08 % by mass
(from Soil Gradation, Bag #1) L.)	OK-90 Sand larger than 100 microns placed in Skimmer Box test bed:	95.00 % by mass
C*L = M.)	Mass of OK-90 sand placed in Skimmer Box test bed greater than 100 microns, based on initial gradation of Bag #1:	23.74 pounds
(from Soil Gradation, Skimmer Box Basket) N.)	OK-90 Sand larger than 100 microns retained in Skimmer Box basket:	96.00 % by mass
H*N = O.)	Mass of OK-90 sand retained in Skimmer Box greater than 100 microns, based on post-test gradation:	20.04 pounds
100*(O/M) = P.)	Percentage of particles greater than 100 microns retained in Skimmer Box:	84.41 % by mass



Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● P1	OK-90 SAND BAG #1					0.97	1.8
0' Depth							

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● P1	2.00	0.20	0.147	0.1119	0.0	99.5	0.5	

NO. 4	NO. 10	NO. 40	NO. 60	NO. 100	NO. 140	NO. 200	NO. 230
	100.0	96.9	82.3	31.5	6.0	0.5	0.2

Client: SUNTREE TECHNOLOGIES
798 CLEARLAKE ROAD
COCOA FLORIDA 32922

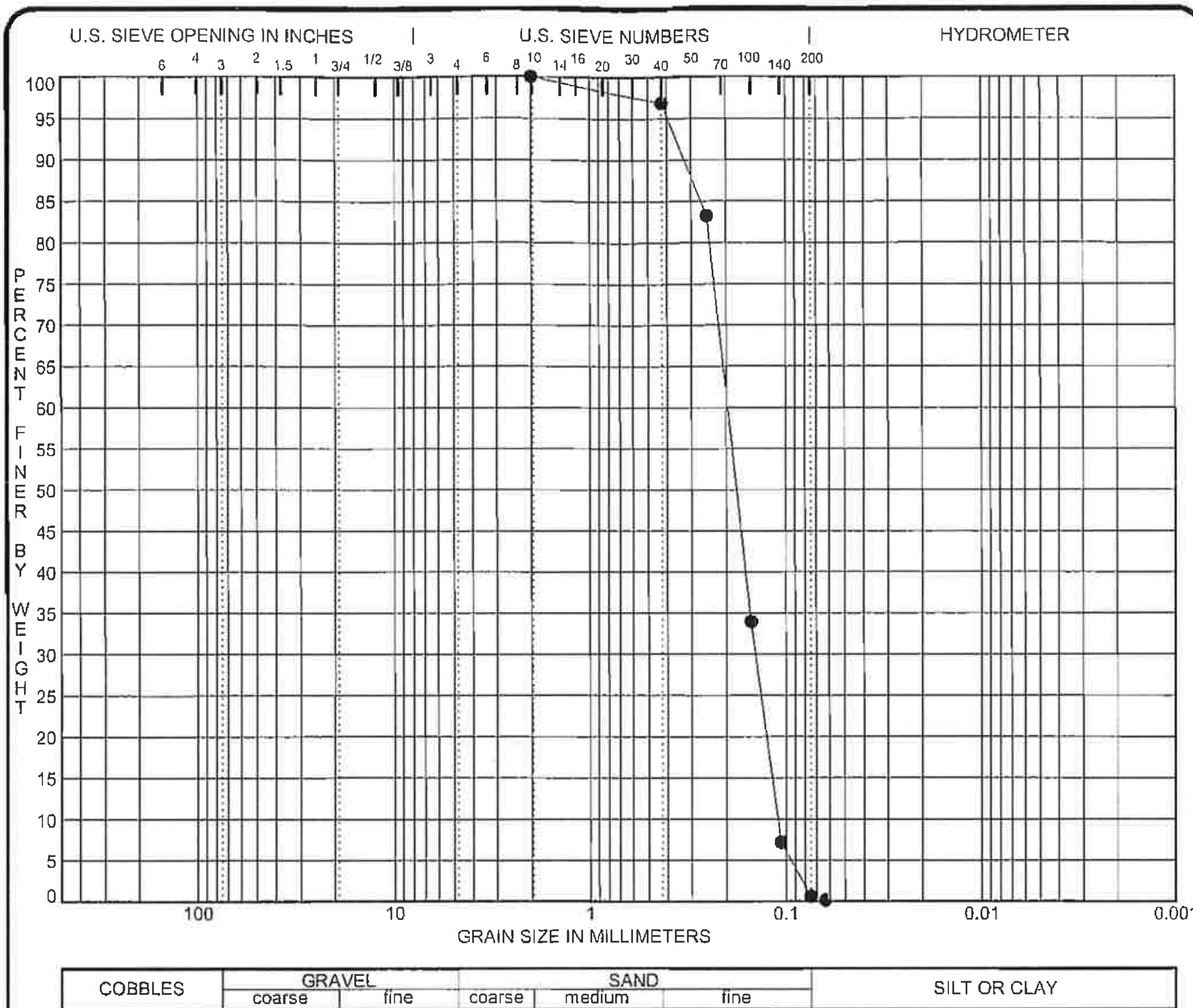
Client No: 34184-004-01

Date: 11/21/07

Project: SUSPENDED SOILS RETENTION TESTING FOR
GRATE INLET SKIMMER BOX
ROCKLEDGE, FLORIDA

SOIL GRADATION CURVES

Universal Engineering Sciences, Inc.
ROCKLEDGE, FLORIDA



Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● **P1**	**OK-90 SAND BAG #2**					**0.94**	**1.8**
0' Depth							

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **P1**	**2.00**	**0.20**	**0.142**	**0.1099**	**0.0**	**99.4**	**0.6**	

NO. 4	NO. 10	NO. 40	NO. 60	NO. 100	NO. 140	NO. 200	NO. 230
	100.0	**96.9**	**83.3**	**34.0**	**7.2**	**0.6**	**0.1**

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COCOA FLORIDA 32922

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GRATE INLET SKIMMER BOX
ROCKLEDGE, FLORIDA

SOIL GRADATION CURVES

Universal Engineering Sciences, Inc.
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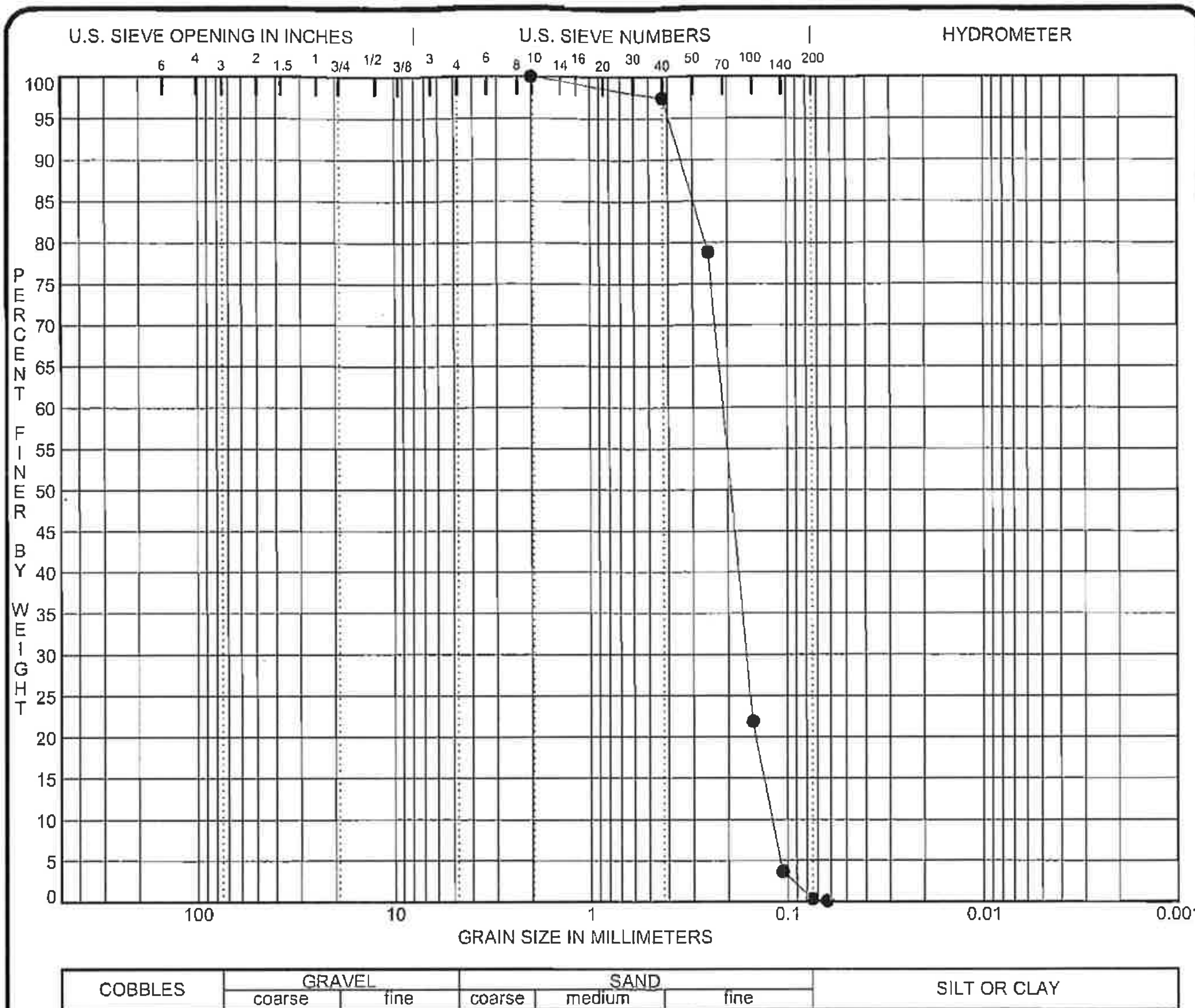

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	**P1**	**CURB INLET BASKET (Material retained in Curb Inlet)**					**1.03**	**1.8**
	0' Depth							

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**P1**	**2.00**	**0.21**	**0.161**	**0.1196**	**0.0**	**99.6**	**0.4**	

NO. 4	NO. 10	NO. 40	NO. 60	NO. 100	NO. 140	NO. 200	NO. 230
	100.0	**97.5**	**78.9**	**21.9**	**3.7**	**0.4**	**0.1**

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COCOA FLORIDA 32922

Client No: 34184-004-01

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GRATE INLET SKIMMER BOX
ROCKLEDGE, FLORIDA

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Universal Engineering Sciences, Inc.
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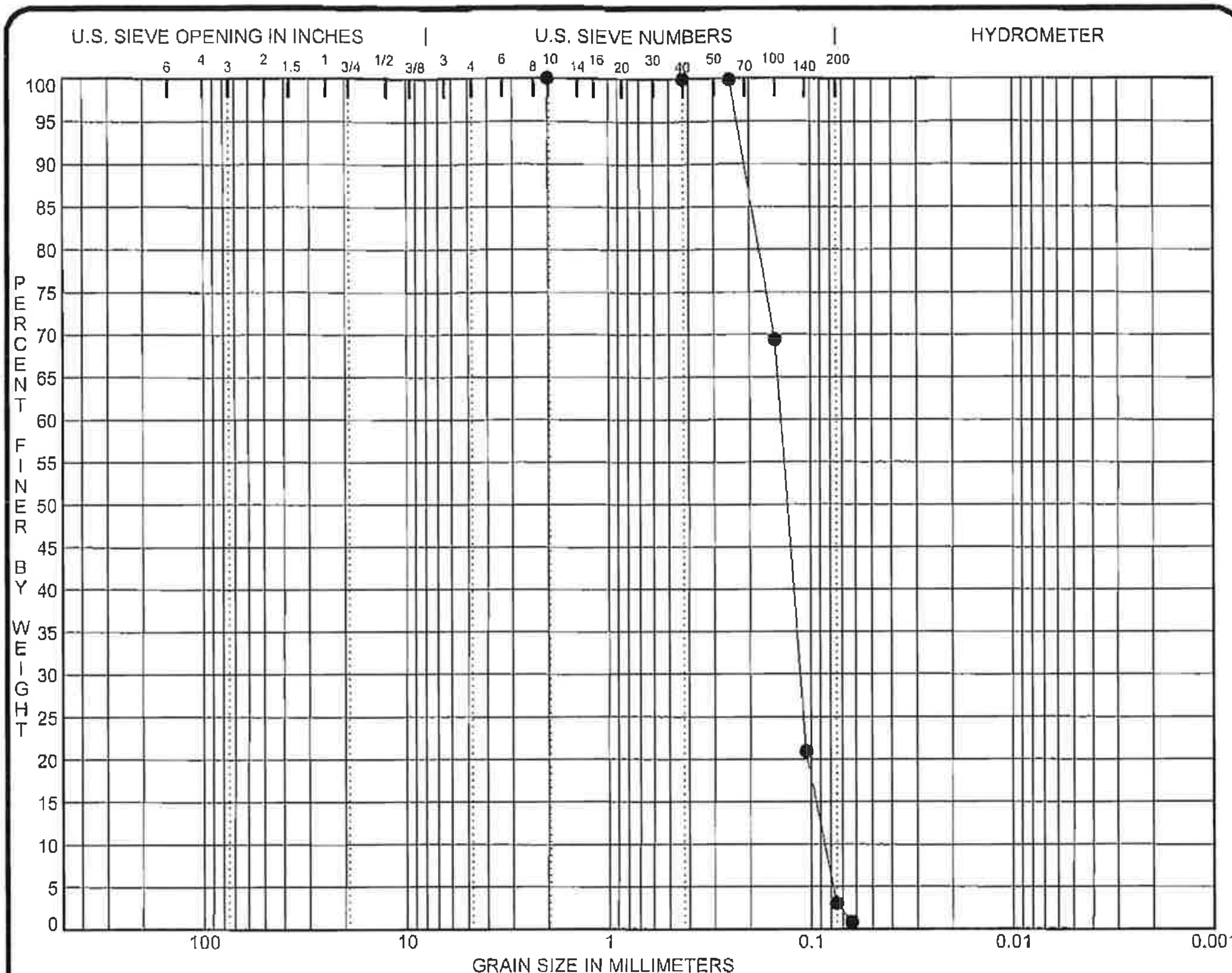

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	P1	CURB INLET RESERVOIR (Material passing Curb Inlet Basket)					1.06	1.6
	0' Depth							

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	P1	2.00	0.14	0.113	0.0858	0.0	97.0	3.0	

NO. 4	NO. 10	NO. 40	NO. 60	NO. 100	NO. 140	NO. 200	NO. 230
	100.0	100.0	99.8	69.4	20.9	3.0	0.8

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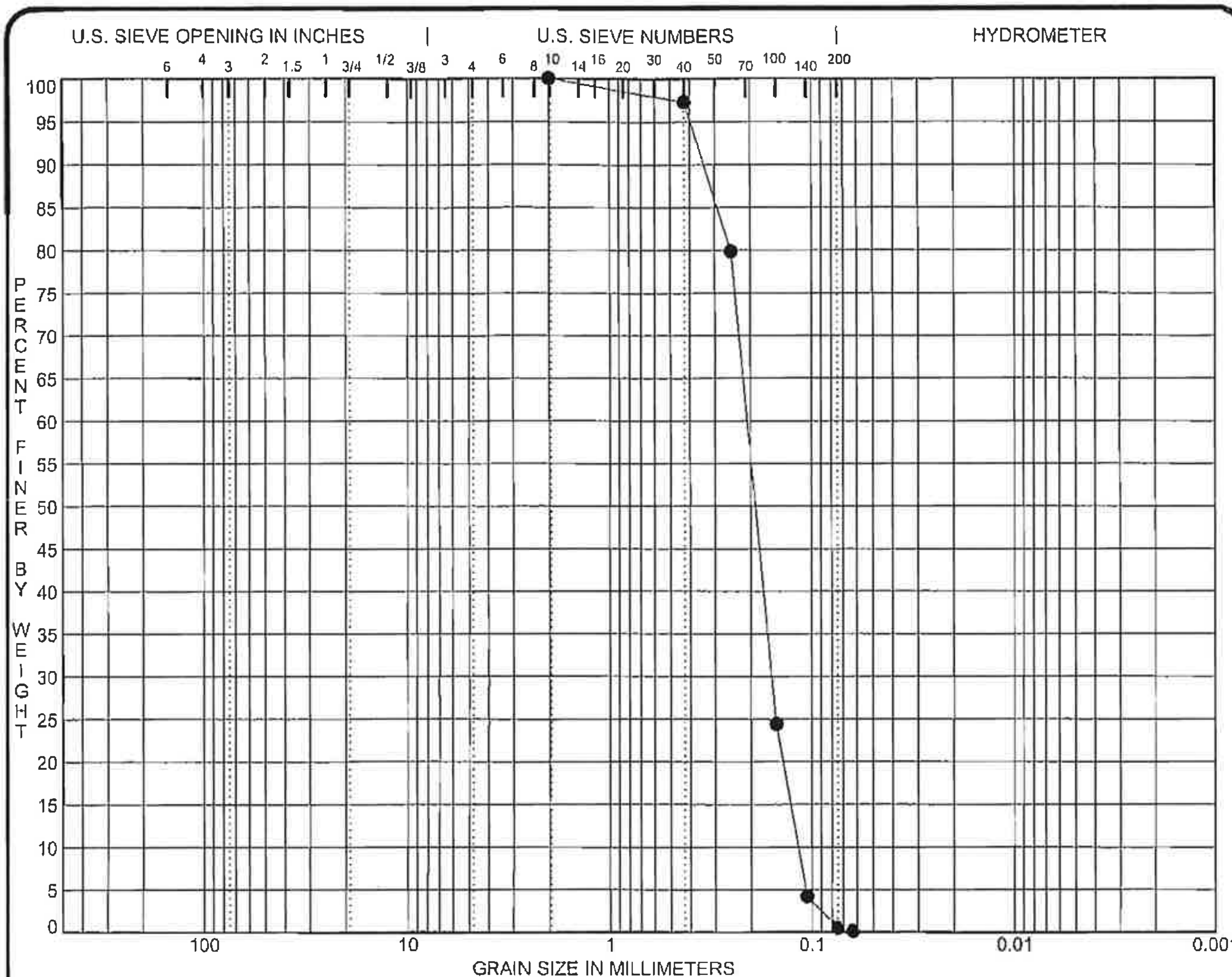

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● P1 0' Depth	SKIMMER BOX BASKET (Material retained in Skimmer Box)					1.02	1.8

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● P1	2.00	0.21	0.158	0.1171	0.0	99.5	0.5	

NO. 4	NO. 10	NO. 40	NO. 60	NO. 100	NO. 140	NO. 200	NO. 230
	100.0	97.3	79.9	24.4	4.2	0.5	0.1

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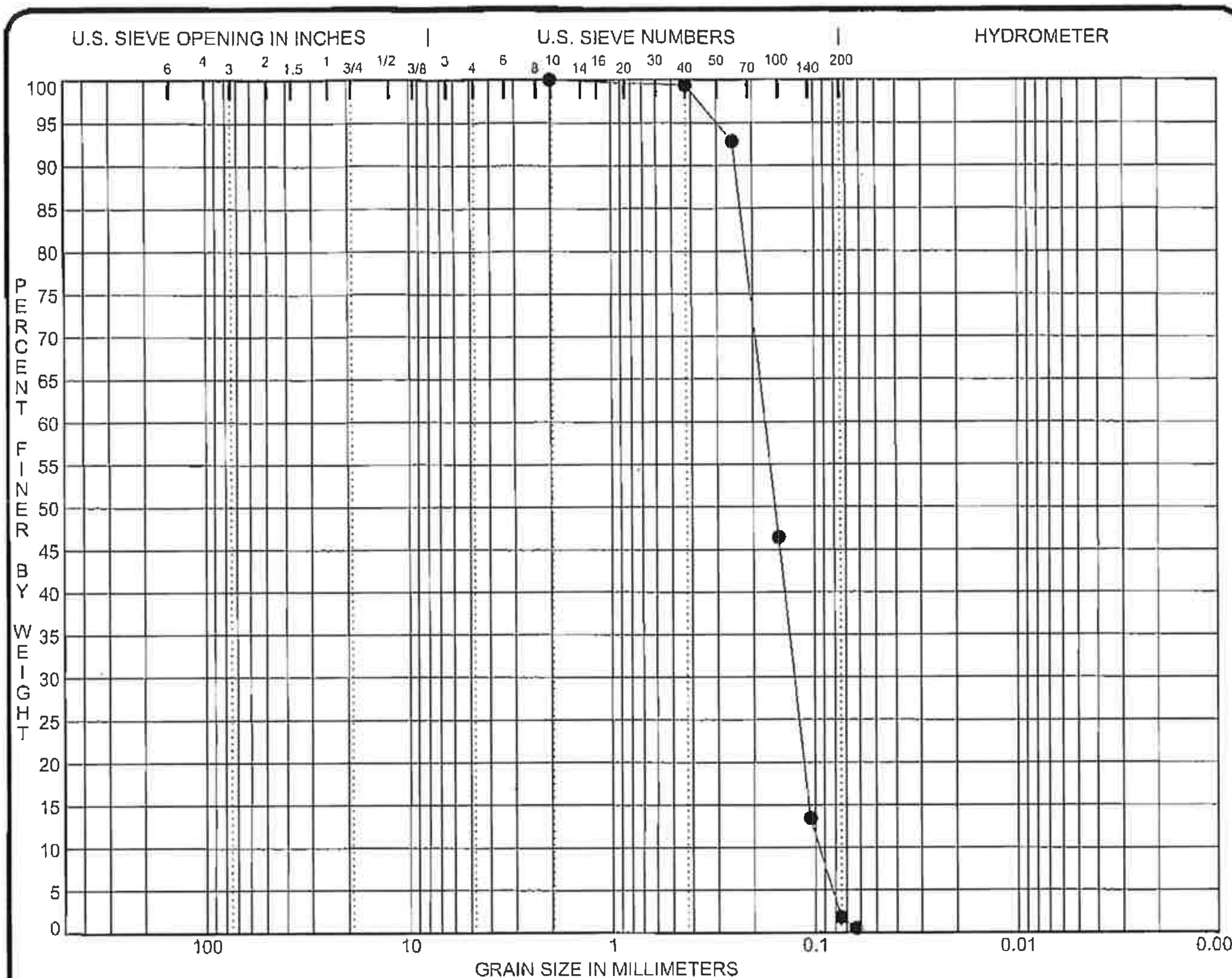

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
● P1	**SKIMMER BOX RESERVOIR (Material passing Skimmer Box Basket)**					**0.95**	**1.8**
0' Depth							

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● P1	**2.00**	**0.17**	**0.126**	**0.0958**	**0.0**	**98.2**	**1.8**	

NO. 4	NO. 10	NO. 40	NO. 60	NO. 100	NO. 140	NO. 200	NO. 230
	100.0	**99.3**	**92.8**	**46.4**	**13.4**	**1.8**	**0.5**

Client: **SUNTREE TECHNOLOGIES**
798 CLEARLAKE ROAD
COCOA FLORIDA 32922

Client No: **34184-004-01**

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Project: **SUSPENDED SOILS RETENTION TESTING**
FOR GRATE INLET SKIMMER BOX
ROCKLEDGE, FLORIDA

SOIL GRADATION CURVES

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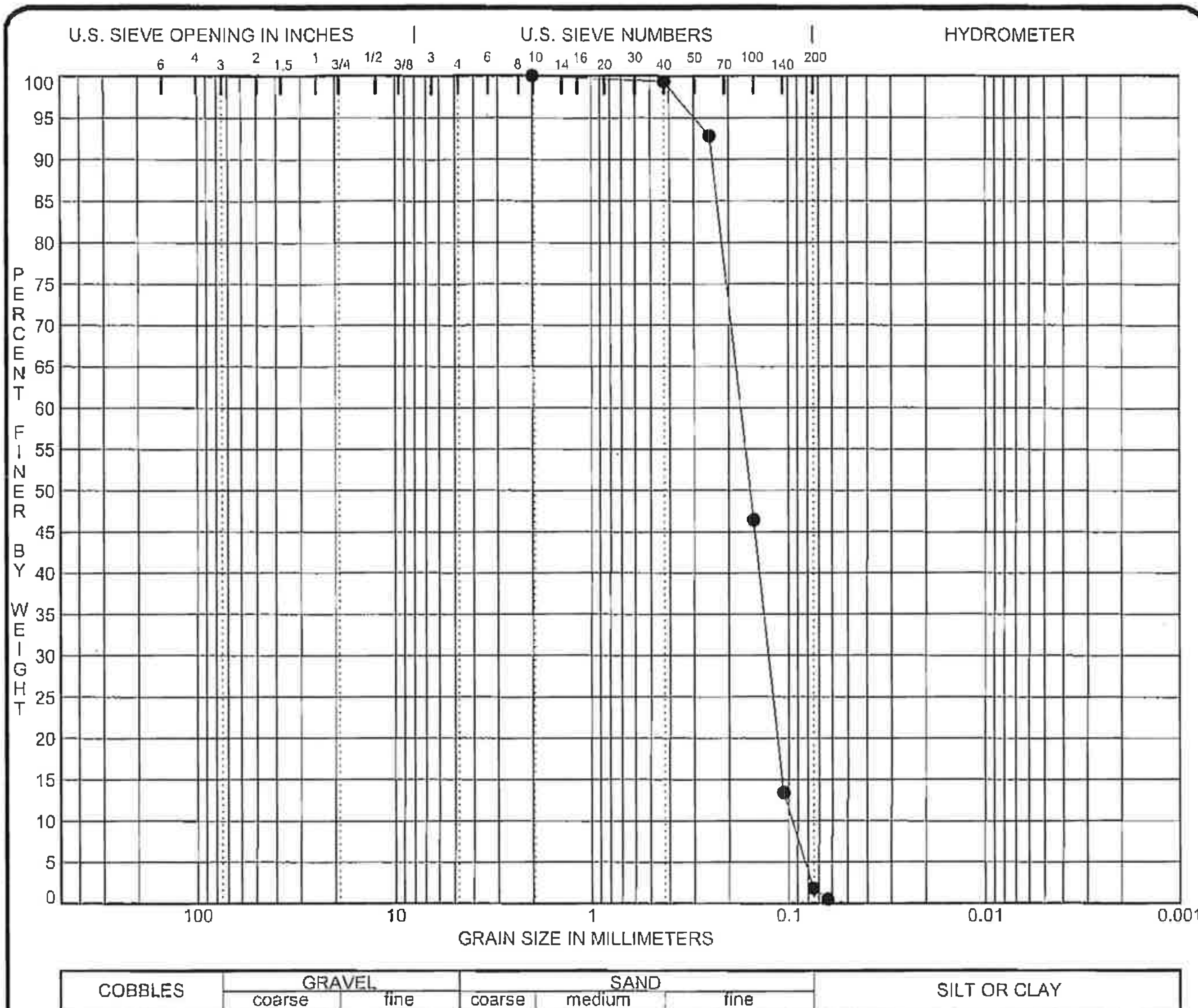

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	P1	SKIMMER BOX RESERVOIR (Material passing Skimmer Box Basket)					0.95	1.8
	0' Depth							

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	P1	2.00	0.17	0.126	0.0958	0.0	98.2	1.8	

NO. 4	NO. 10	NO. 40	NO. 60	NO. 100	NO. 140	NO. 200	NO. 230
	100.0	99.3	92.8	46.4	13.4	1.8	0.5

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Universal Engineering Sciences, Inc.
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Photo No. 1: Curb Inlet Basket test bed

Photo No. 2: Grate Inlet Skimmer Box test bed, upper tier

Photo No. 3: Grate Inlet Skimmer Box test bed, lower tier

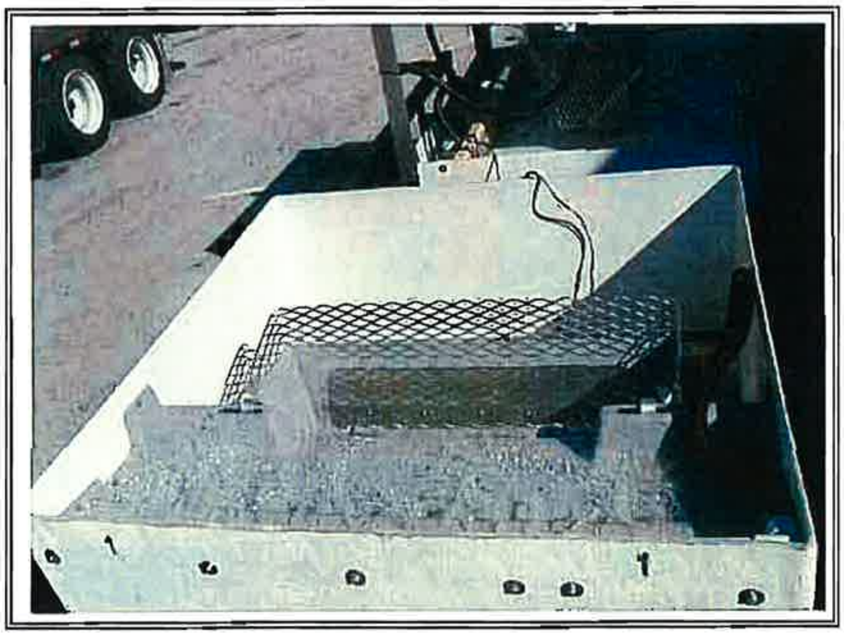

Photo No. 4: Water flowing into Curb Inlet

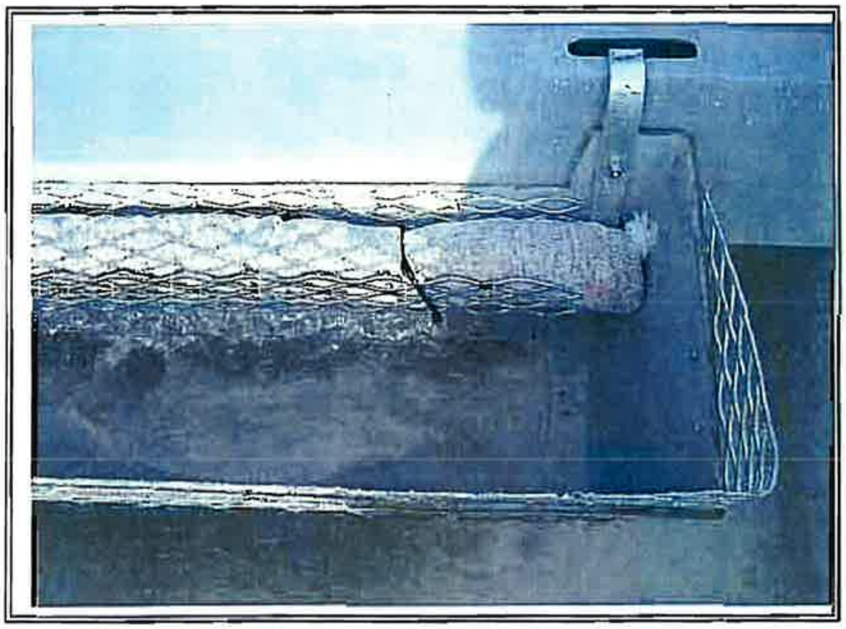

Photo No. 5: Curb Inlet hook hanging in slot on test bed

Photo No. 6: Blue RTV Silicon placed around edge of Skimmer Box

Photo No. 7: Silica sand being placed into top tier of Skimmer Box testing bed

Photo No. 8: Approximately one minute left until completion of Skimmer Box test

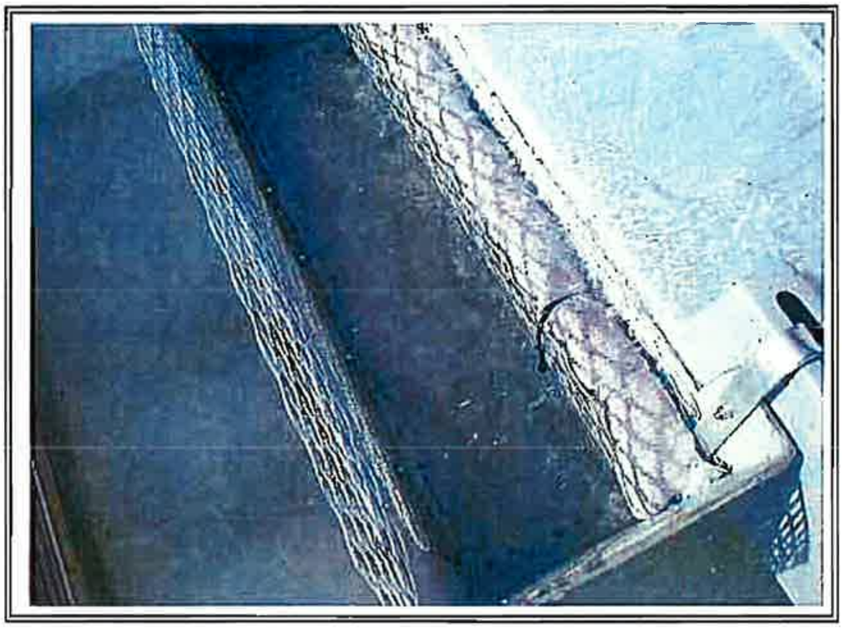

Photo No. 11: Curb Inlet Basket just prior to end of testing

Photo No. 12: Sand in the Curb Inlet testing bed reservoir being washed into a container prior sieve analysis

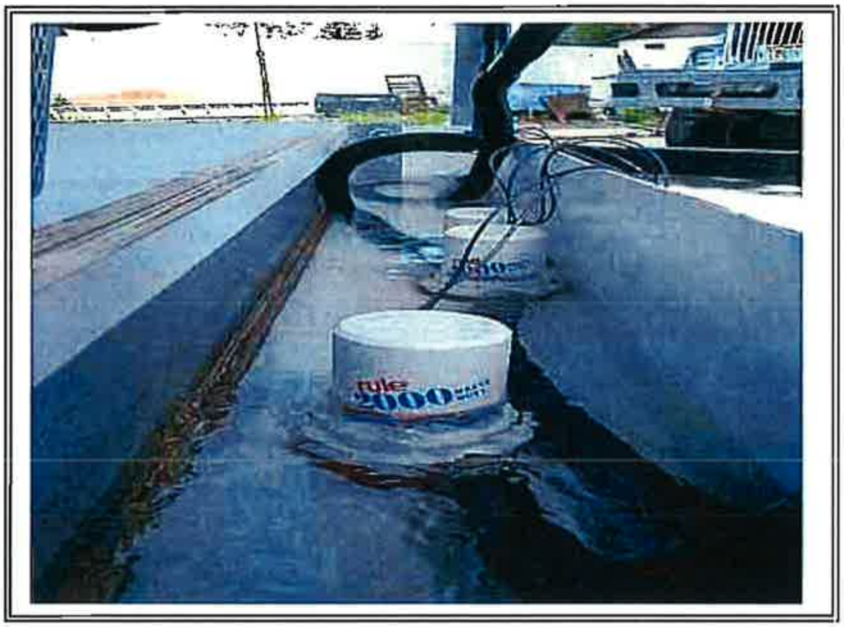

Photo No. 13: Pumps for Grate Inlet Skimmer Box test bed

Photo No. 14: Sand left in lower tier of Skimmer Box test bed being washed into a container for sieve analysis

Evaluation of the Performance of Four Catch Basin Inserts in Delaware Urban Applications

Marianne Walch, Randall Cole and Wendy Polasko
Delaware Department of Transportation NPDES Program
P.O. Box 778, Dover, DE 19930

Dwight Walters and William Frost
KCI Technologies, Inc.
Newark, DE 19713

Patrick DiNicola and Ron Gneo
RK&K Consulting Engineers
Baltimore, MD 21217

Introduction

Catch basin inserts are becoming more widely used as stormwater best management practices (BMPs). A variety of commercial devices are available. Most are designed to remove trash, sediments and hydrocarbons to varying degrees from stormwater runoff that enters the catch basins. They are a relatively easy and inexpensive retrofit, particularly for older, existing drainage systems where end-of-pipe treatment technologies may be impractical or prohibitively expensive. However, until recently, few catch basin insert filters have had performance data collected under actual field conditions.

The Delaware Department of Transportation (DelDOT) is investigating the performance of four different types of inlet protection devices in urbanized areas of northern Delaware. We are evaluating and comparing the performance of these inserts with respect to their ability to remove sediment and hydrocarbons from stormwater runoff, as well as their maintenance requirements in different applications. Monitoring will continue year-round over a two- to three-year period, in order to incorporate data from varying seasonal and rainfall conditions.

Methods

The catch basin inserts being tested are

1. UltraDrainguard® Oil and Sediment Model (UltraTech International, Inc.) – an X-TEX geotextile sock and skirt that fits the size of the inlet opening.
2. HydroKleen® (Hydro Compliance Management, Inc.) – a two-chambered system consisting of a presettling sediment chamber and a filtration chamber containing one activated carbon and two cellulose filters.
3. DrainPac® (United Stormwater, Inc.) – an HDPE support basket and polypropylene filter liner custom-sized to fit the inlet.
4. Flo-Gard+Plus® (Kristar Enterprises, Inc.) – a support basket and removable polypropylene filter liner, plus a silicate oil-adsorbent filter medium in floatable bags.

The devices were installed in three different locations, with different land use types and varying pollutant loads. These include the service station drainage areas of a rest area on Interstate Rt. 95 near Newark; Drummond North, a residential subdivision in Newark; and a commercial parking area on the Wilmington Riverfront (Table 1). Photographs of each insert are included in Figure 1.

To determine the effectiveness of the catch basin inserts, we are comparing data from wet-weather samples collected at the outfalls of both protected and nearby unprotected (control) runs of inlets. Criteria for a qualifying storm event are a 72-hour dry period preceding and at least 0.1 inch of rainfall during the storm. First flush and flow-weighted composite stormwater samples are analyzed for the following water quality parameters: suspended and dissolved solids, pH, chemical and biological oxygen demand, nutrients, chloride, oil and grease, petroleum hydrocarbons, BTEX, phenolics, PAHs, heavy metals, and indicator bacteria. Only first flush samples are being collected for the Flo-Gard+Plus® inserts. In addition, we inspect all of the inserts on a regular basis; when cleaning or replacement occurs, the sediment and other solids collected in the filters are weighed, characterized as to content, and samples are taken for chemical analysis. This allows us to estimate the total sediment and nutrient load removed by the filters.

The inserts were installed at various times during the past year (Table 1). The drainage pipes and catch basins were cleaned before installation of the inserts.

Results

At the time of this writing, data were available from six wet weather events for the DrainPac® units and one event each for the HydroKleen® and Flo-Gard Plus® units.

HydroKleen®: The HydroKleen® catch basin inserts were selected for the service plaza site because of their multilayer filter design for removing hydrocarbons and other dissolved organics. Baseline monitoring data collected for the past year from the I-95 service plaza show that metals, petroleum hydrocarbons and PAHs are major stormwater contaminants there.

The single set of data from wet weather samples collected from the HydroKleen®-protected run of inlets do not show much protective effect for most of the parameters we measured (Table 2). However, we do not draw any conclusions from this single sampling event, because of the variability of the data. Additional samples collected during the next year or two may clarify this.

The filters were replaced immediately before water quality sampling began, after about nine months of service. The originally white cellulose filters were thoroughly blackened, indicating that the media was saturated with adsorbed hydrocarbons (Figure 2). Little sediment had accumulated in the sedimentation chambers of the inserts; even after nine months most of the chambers had less than an inch of sediment in them. It is not clear whether this is due primarily to a very low sediment and debris load coming from this part of the service plaza or to resuspension and failure to collect the sediment that does enter the units.

DrainPac®: The Drummond North subdivision in which the DrainPac® catch basin inserts were installed lies within the White Clay Creek watershed, an urban area facing TMDL restrictions for nutrients, bacteria, and biology and habitat. This is an older single-family home community, with numerous trees, so the inserts were expected to collect leaves and yard debris, especially during the fall months.

Wet weather data from the DrainPac®-protected catch basins have been highly variable (Table 2). Concentrations of most parameters measured in first flush samples collected from the protected run of inlets were frequently higher than in samples from the untreated control (Table 2). This difference, however, generally was not statistically significant (Wilcoxon signed rank test, $p>0.05$). Contaminant concentrations in composite samples also were not significantly different between treated and control runs. The lack of difference in this case may be explained by the observation that much of the water flowing into the catch basins appears to bypass the DrainPac® filters. The catch basins in this community, like many in Delaware, are grated curb inlets (Figure 3), and, because in our trial the

DrainPac® units do not extend under the curb opening, water that flows into the curb opening does not get treated. For this type of inlet it is clearly desirable to have a BMP that extends under this opening in order that most of the water is not bypassed.

The DrainPac® units, despite the relatively large size of the filter bag, filled up rapidly in this tree-lined community, particularly during the autumn leaf fall (Figure 4). They were cleaned at two-month intervals. However, in this case the units should probably be cleaned more often to prevent resuspension of the collected debris, which may also have contributed to the lack of observed difference in treated and untreated contaminant concentrations. Stenstrom (1999) also demonstrated that DrainPac inserts bypassed much flow once they had accumulated debris.

UltraDrainguard®: UltraDrainguard® inserts were installed in both the I-95 service plaza and the Drummond North subdivision (Table 1). These inserts are appealing because of their relatively low initial cost and ease of installation. However, the smaller bag size compared to other inserts may make their maintenance more burdensome in areas with heavy debris or sediment loads. At the service plaza, these units have collected primarily trash, sand (in winter), grass clippings (in summer), and some leaves. They have been able to go for a number of months between cleanings at this site. The UltraDrainguard® filters were not installed in the Drummond North community until mid-Winter 2004. At the time this paper was written, no wet weather data had yet been collected.

Flo-Gard Plus®: Flo-Gard® inserts also were not installed until late Winter 2004. Initial wet weather data suggest that sediment and oils are removed by the units (Table 2), although more storm events will need to be sampled to determine if this difference is significant.

Discussion and Conclusions

This study was designed to collect stormwater quality data from field installations of catch basin inserts. Thus, the water samples collected represent actual discharge to the stormwater system, including untreated bypass flow. The study will provide information not only on the effectiveness of various inlet protection devices in removing runoff pollutants, but also on their practicality in terms of maintenance issues and cost. Results will help DelDOT in its efforts to select BMPs that are appropriate for particular sites, land uses or stormwater quality problems in the state.

The limited data that we have collected so far on these catch basin inserts point out the variability in wet weather data, as well as in pollutant loads and the effectiveness of the inserts at removing those contaminants. Other studies have also demonstrated considerable variability in field results. DeMaria et al. (2003) have discussed the challenges in acquiring good field data in this type of study. A Navy Environmental Leadership Program study found a 17-95% range of removal efficiencies for DrainPac inserts (NELP, 2002). A study performed by the Interagency Catch Basin Insert Committee found that a variety of catch basin inserts showed little removal of suspended solids, partially due to scouring from relatively small storms (ICBIC, 1995). A recent CalTrans study of highway BMP retrofits included several types of drain inlet inserts. The inserts performed poorly compared to other BMP types, generally providing less than 10% reduction in the concentration of most constitutents. This study concluded that drain inlet inserts are best suited for gross solids removal (Currier et al., 2001; Taylor, 2002).

Lee (2000) and Taylor (2000) claim that storm drain inserts of all kinds generally perform poorly in field tests due to limited contact time between the water and sorptive media, resuspension of material removed by the filters, and requirements for close monitoring and frequent maintenance. They also conclude that inserts do little to remove dissolved contaminants and are bested suited for removing trash and other gross pollutants.

Catch basin inserts are attractive retrofits because of the relative ease and low cost of installation. Ultimately, however, their cost effectiveness is determined by the frequency with which they must be maintained. Our study and others have demonstrated that for many applications a very high frequency of cleaning is necessary to keep the inserts from clogging and bypassing stormwater flows, as well as resuspending captured material. Inserts may not be practical for large drainage areas or for areas with high levels of leaves or debris that can plug them.

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Table 1. Summary of types of catch basin inserts evaluated in this study.

Insert Type	Location	Land Use Drained	Date Installed	No. of Units	Monitoring
HydroKleen®	I-95 Service Plaza	Gas station and vehicle (primarily truck) parking	July 2003	8	Wet weather and sediment
UltraDrainguard®	I-95 Service Plaza	Gas station and vehicle parking	Aug. 2003	19	Sediment only
	Drummond North subdivision	Residential	Dec. 2003	26	Wet weather and sediment
DrainPac®	Drummond North subdivision	Residential	June 2003	21	Wet weather and sediment
FloGard Plus®	Wilmington Riverfront	Commercial parking	Feb. 2004	7	Wet weather

Figure 1. Photographs of installed catch basin inserts. (a) HydroKleen units at the I-95 service plaza; (b) UltraDrainguard filters at the service plaza; (c) DrainPac inserts in Drummond North subdivision; (d) FloGard Plus units at the Wilmington Riverfront.

Table 2. Comparison of first flush (FF) and flow-weighted composite concentrations of selected chemical parameters in stormwater samples from control and insert-protected inlet runs. "ND" indicates a non-detect value.

	TSS, mg/L				Oil & Grease				TPH				COD			
	FF		Composite		FF		Composite		FF		Composite		FF		Composite	
Insert/Storm Event	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*
DrainPac																
9/22/2003	11	17	22	19	ND	ND	ND	ND	ND	ND	ND	ND	86	139	100	80
10/14/2003	161	222	112	51	ND	ND	ND	ND	ND	ND	ND	ND	103	313	60	36
11/19/2003	52	266	149	138	ND	7.4	5.3	8.7	ND	ND	ND	ND	89	189	79	64
11/24/2003	31	85	17	22	ND	ND	7.1	7.0	ND	ND	ND	7.0	117	445	54	59
2/3/2004	2140	476	150	151	ND	ND	ND	ND	ND	ND	ND	ND	64	294	118	97
3/16/2004	59	43	31	51	ND	ND	ND	ND	ND	ND	ND	ND	70	100	42	44
HydroKleen																
3/16/2004	132	188	31	57	ND	14.0	6.1	ND	ND	9.9	6.1	ND	313	674	82	132
Flo-Gard Plus																
3/5/2004	468	136			8.3	ND			ND	ND			287	220		

	TKN				NO2/NO3				Total P				Total Zinc			
	FF		Composite		FF		Composite		FF		Composite		FF		Composite	
Insert/Storm Event	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*	*Control*	*Treated*
DrainPac																
9/22/2003	1.40	2.00	1.30	1.30	3.15	2.75	1.49	1.69	0.40	0.40	0.59	0.35	0.009	0.010	0.007	0.008
10/14/2003	1.46	3.93	1.29	0.89	2.26	2.29	1.05	0.63	0.37	0.80	0.35	0.23	0.016	0.029	0.008	0.008
11/19/2003	1.50	2.00	0.54	0.57	2.31	0.00	0.00	0.84	0.60	0.56	0.37	0.24	0.018	0.010	0.008	0.009
11/24/2003	1.16	2.40	1.11	1.43	0.25	0.32	0.19	0.21	0.18	0.96	0.27	0.20	0.007	0.071	0.008	0.011
2/3/2004	3.87	3.16	7.65	1.96	2.03	1.75	ND	ND	0.11	0.30	0.52	0.26	0.056	0.201	0.155	0.120
3/16/2004	0.67	1.93	1.09	0.93	2.49	2.24	1.17	1.07	0.18	0.19	0.16	0.11	0.048	0.053	0.047	0.043
HydroKleen																
3/16/2004	9.58	118	5.53	12.50	2.15	1.5	ND	ND	0.35	7.71	0.41	0.98	0.354	0.666	0.168	0.243
Flo-Gard Plus																
3/5/2004													0.262	0.325		

Figure 2. Used cellulose (front) and activated carbon (back) filters removed from HydroKleen inserts after nine months service.

Figure 3. UltraDrainguard-protected inlet showing water flow bypassing the filter and entering the curb opening.

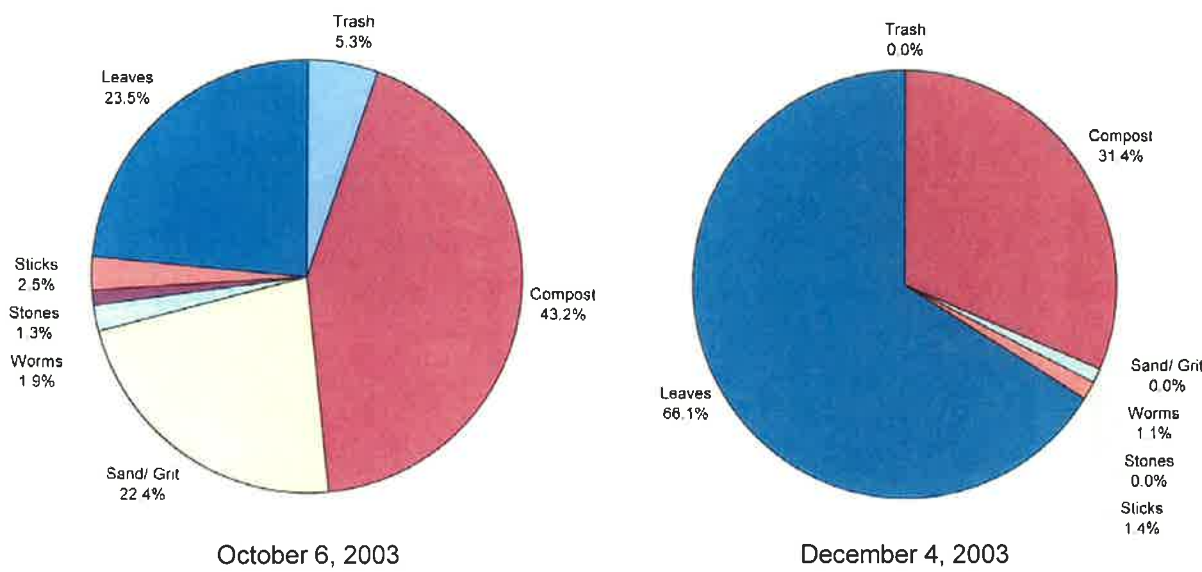

Figure 4. Mean percent volume of contents removed from DrainPac filter bags at two different times, showing the preponderance of leaves and other organic debris.