



Prepared for:

City of Malibu
23825 Stuart Ranch Road
Malibu, CA 90265-4861

Broad Beach Road Biofiltration Project

Preliminary Design Report

Prepared by:

Geosyntec 
consultants

engineers | scientists | innovators

3415 S. Sepulveda Blvd, Suite 500
Los Angeles, CA 90034

Project Number LA0245

April 2011

TABLE OF CONTENTS

	<u>Page</u>
LIST OF ABBREVIATIONS AND ACRONYMS	v
1. INTRODUCTION	1
1.1 Project Description and Background.....	2
1.2 Project Objectives.....	2
1.3 Terms of Reference	3
2. EXISTING SITE CHARACTERISTICS	4
2.1 General Site Condition and Location	4
2.2 Site Topography	4
2.3 Utilities	5
2.4 Biology	6
2.5 Climate.....	7
2.6 Hardscape and Landscape	7
3. REGULATORY REQUIREMENTS	8
3.1 Water Quality	8
3.2 Environmental Review	9
3.3 Coastal Development Permit.....	9
3.4 Water Use Guidelines.....	10
4. GEOTECHNICAL AND GROUNDWATER INVESTIGATIONS.....	11
4.1 General.....	11
4.2 Purpose and Objectives	11
4.3 Summary of Existing Conditions	11
4.3.1 Surface and Subsurface Conditions	11
4.3.2 Groundwater.....	13
4.3.3 Onsite Wastewater Treatment Systems.....	13
4.4 Findings	13
4.5 Design and Construction Recommendations.....	15
5. HYDROLOGY	16
5.1 General.....	16
5.2 Existing Hydrologic Conditions	16
5.2.1 General.....	16
5.2.2 Drainage Infrastructure and Flow Patterns	16
5.3 Stormwater Quality Design Volume	17

TABLE OF CONTENTS (Cont.)

	<u>Page</u>
5.3.1 Technical Approach	17
5.3.2 Stormwater Quality Design Volume Calculation	18
6. CONCEPTUAL DESIGN ALTERNATIVES	19
6.1 Project Objectives and Stormwater Alternatives Development	19
6.2 BMPs and Stormwater Improvements.....	21
6.2.1 General	21
6.2.2 Biofiltration	21
6.2.3 Vegetated Swales	22
6.2.4 Water Collection, Storage, and Use or Treatment	23
6.2.5 Concrete Pavers.....	23
6.2.6 Retaining and Garden Walls	24
6.2.7 Irrigation System Removal/Replacement	24
6.2.8 Habitat Restoration	24
6.3 Stormwater Alternative 1	25
6.3.1 Stormwater Management Improvements	25
6.3.2 Landscape, Hardscape, and Irrigation.....	26
6.3.3 Parking Considerations	28
6.3.4 Utility Considerations	29
6.3.5 Performance	30
6.3.6 Operation and Maintenance	30
6.4 Stormwater Alternative 2	31
6.4.1 Stormwater Management Improvements	31
6.4.2 Landscape, Hardscape, and Irrigation.....	33
6.4.3 Parking Considerations	33
6.4.4 Utility Considerations	33
6.4.5 Performance	33
6.4.6 Operation and Maintenance	33
7. CONSTRUCTION COST ESTIMATE.....	35
8. DISCUSSION AND RECOMMENDATION.....	36
9. LIMITATIONS.....	37
10. REFERENCES	38

LIST OF TABLES

- Table 5-1 Catchment areas and design capture volume
- Table 6-1 Proposed BMPs and improvements for each alternative per catchment
- Table 6-2 Design Biofilter Volume (Bv) and Biofilter Media Surface Area (A_{media}) for Alternatives 1 and 2
- Table 7-1 Summary of construction cost estimates for Alternatives 1 and 2

LIST OF FIGURES

- Figure 2-1 Location map of project area
- Figure 2-2 Site map of project area
- Figure 2-3 Private irrigation system contributing to dry-weather runoff
- Figure 2-4 Private irrigation piping in storm drain
- Figure 2-5 Unpaved parking strip with potted plants
- Figure 2-6 Cast in place concrete retaining wall with parking apron
- Figure 2-7 Privately constructed waste concrete hardscape
- Figure 2-8 Brick retaining wall
- Figure 2-9 Treated wood retaining wall
- Figure 6-1 Typical biofilter cross-sections and details
- Figure 6-2 Flow diagram for Alternative 1
- Figure 6-3 Flow diagram for Alternative 2
- Figure 6-4 Preliminary Landscape and Biofilter Plan - Key map
- Figure 6-5 – 6-14 Preliminary Landscape and Biofilter Plan – Sheets 1-10

LIST OF APPENDICES

Appendix A	Topography Maps
Appendix B	Utility Maps
Appendix C	Biological Assessment report (draft)
Appendix D	Geotechnical and Groundwater Studies Report
Appendix E	Drainage Maps
Appendix F	Sizing Methodology for Biofilters
Appendix G	Water Usage Calculations
Appendix H	Material Exhibits
Appendix I	Construction Cost Estimates

LIST OF ABBREVIATIONS AND ACRONYMS

BMP	Best Management Practice
CDP	Coastal Development Permit
CEQA	California Environmental Quality Act
ETWU	Estimated Total Water Usage
LACFD	Los Angeles County Fire Department
LCP	Local Coastal Program
LIP	Local Implementation Plan
MAWA	Maximum Applied Water Allowance
MEP	Maximum Extent Practicable
MS4	Municipal Separate Storm Sewer System
MSL	Mean Sea Level
NPDES	National Pollutant Discharge Elimination System
OWTS	Onsite Wastewater Treatment System
PAH	Polycyclic Aromatic Hydrocarbon
PCH	Pacific Coast Highway
PDR	Preliminary Design Report
POC	Pollutant of Concern
SWRCB	State Water Resources Control Board

The Broad Beach Road Biofiltration Project (Project) is funded in part by the City of Malibu (City) and in part by the State Water Resources Control Board (SWRCB) through a Proposition 84 Grant Agreement between the two parties. The contents of this document do not necessarily reflect the views and policies of the State Water Resources Control Board, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

1. INTRODUCTION

The purpose of this report is to present the design basis and the evaluation of design alternatives for the Broad Beach Road Biofiltration Project (Project). This Preliminary Design Report will form the basis for the critical evaluation and selection of the Project design approach.

The Preliminary Design Report (PDR) is intended to document all the relevant studies, evaluations, and calculations for the Broad Beach Road Biofiltration Project and to produce two conceptual design alternatives for the Project. The Project scope of work requires that the PDR include the following:

- Hydrology studies and soils report;
- Groundwater mounding analyses;
- Utility maps and identification of utility interferences;
- Development of two conceptual design alternatives presented at the 10 percent design level;
- Site plans showing proposed improvements, landscaping, and best management practices (BMPs);
- Performance and maintenance for the proposed alternatives;
- Construction cost estimate; and
- Final design recommendations.

This report is presented in 10 sections. Section 1 is this report and Project introduction. Section 2 reviews the existing Project site conditions, including topographic maps and utility maps. Section 3 reviews various regulations and approvals considered in the development of the Project conceptual design. Section 4 presents the results of the soil and groundwater investigation, including the infiltration study and groundwater mounding analysis. Section 5 introduces the Project hydrology evaluation, including a review of site drainage and development of the Project site design capture volume. Section 6 reviews the Project objectives, introduces the proposed BMPs and site improvements, and develops two stormwater improvement alternatives. Section 7 presents construction cost estimates for the two alternatives. Section 8 includes a discussion of the two alternatives, with recommendations. Section 9 defines the

limitations on use of this report. Section 10 presents pertinent references cited in this report.

1.1 Project Description and Background

The city of Malibu was awarded a Proposition 84 grant by the State Water Resources Control Board (SWRCB) for the Broad Beach Road Biofiltration Project. The stated purpose of this grant is for “diverting dry-weather and some stormwater runoff from a series of eight (8) storm drains onto permeable surfaces and into a biofiltration system along a one (1) mile stretch of Broad Beach Road to prevent discharges to Broad Beach.” [SWRCB, 2011]. The City of Malibu has contracted with Geosyntec Consultants to prepare studies, develop design documents, provide community outreach, and support the City during construction of this Project.

The Project includes various stormwater BMPs, landscape, and other improvements to eliminate or greatly reduce dry-weather flows, improve stormwater quality through treatment, reduce erosion and sediment tracking, and possibly capture and use stormwater. Overall, the Project will improve runoff quality and reduce wet weather and dry weather flows to Broad Beach.

1.2 Project Objectives

The Project objectives are:

- Eliminate dry weather flows to the storm drain;
- Reduce wet weather flows to storm drain (as feasible);
- Improve water quality of wet weather flows to storm drain (i.e., storm water treatment, pollutant reduction) to the maximum extent practicable (MEP);
- Reduce potable water use for irrigation (as feasible);
- Restore habitat above Broad Beach Road (as feasible);
- Reduce slope erosion (as feasible); and
- Preserve street and visitor parking.

1.3 Terms of Reference

This report was prepared for the City of Malibu (City) by Geosyntec Consultant Team (Geosyntec) in support of the Broad Beach Road Biofiltration Project in the City of Malibu, California. This work was authorized under Agreement executed on October 27, 2011; this report satisfies Task 1.11 of the scope of services. This report was written by Jan Coward and Patrick Galvin, PE, with senior review conducted by Ken Susilo, PE, in accordance with Geosyntec's quality review procedures.

The City project manager for the Project is senior civil engineer Rob DuBoux, Esq., PE.

The Project is funded in part by the City of Malibu and in part by the State Water Resources Control Board through a Proposition 84 Grant Agreement between the two parties.

2. EXISTING SITE CHARACTERISTICS

2.1 General Site Condition and Location

Broad Beach Road, situated between Broad Beach and Pacific Coast Highway (PCH) in Malibu, California, runs parallel to the coastline with a general orientation within the Project area of southeast to northwest. Broad Beach Road is a paved two-lane residential street providing residents access to their homes along the south side of the road and providing parking and beach access for residents and visitors. A mostly unpaved strip along the northern edge of Broad Beach Road varying in width from 10 to 20 feet provides public parking on the north side of the road. This parking strip is separated from PCH by a vegetated hillside which varies in slope from slightly steep to nearly vertical bluffs where the elevation difference between the two roadways is at its greatest. The Project area is located in the western end of Malibu approximately three miles northwest of Point Dume (see Vicinity Map, Figure 2-1).

The Project drainage area encompasses approximately 4,500 linear feet of Broad Beach Road between PCH and Victoria Point Road and extends for the most part from the center line of Broad Beach Road to the top of the hillside between Broad Beach Road and PCH. The total Project drainage area is 12.3 acres.

The Project area is located at the mouth of Trancas Canyon (see Figure 2-2). Trancas Canyon Creek, which drains the 6,233 acre Trancas Canyon watershed, runs to the east of the Project area culminating in a small disturbed coastal lagoon adjacent to the commercial center at the intersection of Trancas Canyon Road and Pacific Coast Highway. The area north of the Project area and west of Trancas Canyon Road drains to Caltrans-owned catch basins along the northern edge of PCH. The Trancas Canyon watershed drainage is not addressed by this Project. With the exception of one area located on PCH, the drainage from PCH is not addressed by this Project.

2.2 Site Topography

The site topography is fairly consistent along the length of Broad Beach Road varying mainly in the elevation difference between Broad Beach Road and PCH and the steepness of the hillside. The Project area, corresponding to the drainage area, encompasses 12.3 acres, approximately 1.6 acres of which is asphalt and concrete paved roadway and parking area. A topographic survey was performed for the Project. The topographic maps are presented in Appendix A.

Broad Beach Road is paved with asphalt and has two lanes, each lane approximately 10 feet wide. The road is crowned at the center line with a lateral slope of roughly two percent. Thus, storm water runoff that lands on the south side of the road flows toward the private residence drains and storm water from the north side of the road flows to the city-owned catch basins. The roadway undulates but is relatively flat except for the western end which reaches a slope of up to five percent. The stretch of road within the Project area has four low points and the roadway elevation varies from 18 to 64 feet above mean sea level measured at roadway center line.

A shoulder area varying in width from roughly 10 to 20 feet lies on the north side of the road along the entire stretch, separating it from the hillside –this area is used for parking by visitors and residents. This area is mostly unpaved, covered by varying materials including gravel, decomposed granite, compacted dirt, sand, and patches of asphalt and concrete. The parking strip follows the same undulating gradient as the roadway in the longitudinal direction and slopes slightly from the toe of the hillside toward the edge of the roadway pavement.

The hillside that separates the parking area and the shoulder along the south side of PCH is relatively steep and in certain areas nearly vertical. The elevation difference from the top of the hillside to the bottom of the hillside varies between 20 and 60 feet. The vertical bluff sections coincide with where the shoulder along PCH is widened to allow for roadside parking.

The entrances to the properties along the south side of Broad Beach Road generally lie at the same elevation as the roadway, or lower.

Existing drainage patterns are described in *Section 5 Hydrology*.

2.3 Utilities

The major utilities within the Project area consist of storm drains, sanitary sewer, potable water, electricity, communication, and natural gas. In support of the development of this preliminary design, the Geosyntec team performed utility research and located existing utilities in the Project area. This work was done using available utility maps and by requesting utility owners to mark their utilities at the Project site. No independent field verification of utilities was conducted. The utility maps are presented in Appendix B.

2.4 Biology

In support of the development of this preliminary design, the Geosyntec team performed a preliminary Biological Assessment of the Project area. The intention of the Biological Assessment was to provide an objective preliminary evaluation of potential impacts of the Project on existing biological resources. The information presented below is a summary of the conclusions and recommendations from this assessment. The preliminary draft of the Biological Assessment report is presented in its entirety in Appendix C.

Based on review of historic vegetation maps, the site is significantly degraded from its historic condition prior to development of Broad Beach. Field surveys found that the vegetation was heavily invaded by naturalized and planted exotic species. The vegetation classifications described below were determined to best characterize the assessment area.

- *Coastal Bluff Scrub (3.1 acres)* - Coastal bluff scrub consists primarily of native plant species, although exotic invasives are present throughout. This vegetation occurs on the upper, steeper bluff slopes between Pacific Coast Highway and the lower landscaped zone along Broad Beach Road.
- *Ornamental Landscaping (4.2 acres)* - Ornamental landscaping consists primarily of exotic vegetation that has been planted and irrigated, including pines, junipers, eucalyptus, bamboo, bougainvillea, and invasive species such as pampas grass. This vegetation dominates the lower slope of the assessment area along Broad Beach Road.
- *Ornamental Landscaping/Coastal Bluff Scrub (1.1 acre)* - This classification represents an integration of native and planted vegetation, with invasive exotics such as iceplant also present throughout.
- *Ornamental Landscaping (Planted Sycamores) (0.2 acre)* - Planted and irrigated sycamores occupy a localized, small area between Broad Beach Road and artificial terraces upslope. These trees may fall under the protection of the City's Native Tree Protection Ordinance because they are native to California.

In general, the area has relatively few wildlife species present or expected to occur, due to its condition as fragmented habitat surrounded by high-traffic roads, frequent human disturbance, construction noise, and dominance of exotic vegetation. The exotic vegetation provides cover and limited nesting habitat for birds, but few food resources for native wildlife. Certain wildlife species, especially goldfinches and crows, were

frequently observed moving between the assessment area and landscaping on residential properties to the south. After the Project design is further advanced, an additional biological assessment will be conducted to specifically address the proposed activities and their potential biological impact on the final Project areas.

2.5 Climate

The climate characteristics of the site reflect the general Mediterranean climate of central coastal regions of California. This climate regime is characterized by cool, wet winters and warm, dry summers with occasional periods of fog. Although infrequent, Malibu is periodically subjected to intense coastal storms.

The average daytime summer temperatures in the area are usually in the 70s to 80s (Fahrenheit). Nighttime low temperatures during the summer are typically in the high 50s to low 60s, while the winter high temperature tends to be in the 60s. Characteristic of Malibu's marine microclimate, the winter low temperatures are in the low 50s. The annual average rainfall in Malibu is about 20 inches. Winter months tend to be wetter than summer months. The wettest month of the year is January with an average rainfall of about 5 inches.

2.6 Hardscape and Landscape

Many Broad Beach Road residents have created gardens across from their residences on city property. These gardens include many non-native invasive or ornamental plants and shrubs. On several parcels, numerous potted plants are also stored along the roadway. Although this property is owned by the city, many homeowners have installed private irrigation systems plumbed back to their residential water services. Irrigation piping runs under the road and was also observed within existing storm drain pipe. The private irrigation of gardens creates uncontrolled and unmanageable dry-weather flows which have been observed during recent site visits.

Residents have also constructed several garden and retaining walls along the hillside. These walls are constructed of a myriad of materials including cobbles, broken concrete, masonry brick, and cast-in-place concrete. Some walls appear to have served as a means of disposal of waste broken concrete from driveway replacements. The parcel-specific variable hardscape and landscape elements have created an inconsistent environmental theme for the neighborhood.

Examples of existing hardscape, landscape, and irrigation systems are presented in Figures 2-3 through 2-9.

3. REGULATORY REQUIREMENTS

3.1 Water Quality

The City storm drains within the Project area ultimately discharge through private drains to private beaches. After passing through a wave wash mixing zone in the Pacific Ocean, flows reach the Pacific Ocean and a designated Area of Special Biological Significance (ASBS 24). The California Ocean Plan [SWRCB, 2009] defines water quality objectives for ocean waters including all ASBS. Since compliance with Ocean Plan's stringent objectives is not always economically feasible nor in the public interest, the Ocean Plan allows the State Water Board to grant exceptions to its provisions as long as the public interest will be served and beneficial uses are protected.

As part of an application for a general exception to Ocean Plan requirements, Special Protections [SWRCB, 2012] have been proposed to fulfill the state mandate for protection of water quality in ASBS and to address the requirements identified in the Ocean Plan. On March 20, 2012 these Special Protections were recommended by the State Water Board as part of an Ocean Plan Exception. According to these Special Protections, the design storm for treatment control BMPs is defined as follows:

“Design storm – For purposes of these Special Protections, a design storm is defined as the volume of runoff produced from one inch of precipitation per day or, if this definition is inconsistent with the discharger's applicable storm water permit, then the design storm shall be the definition included in the discharger's applicable storm water permit.”

The applicable storm water permit in this case is the Los Angeles County National Pollutant Discharge Elimination System (NPDES) Municipal Storm Sewer Systems (MS4) Permit. Since under this permit the Broad Beach project is not considered a new development or a redevelopment, the permit requires that pollutants in stormwater discharge be reduced to the maximum extent practicable (MEP). In Los Angeles County the 0.75 inch design storm event is generally accepted as equivalent to MEP per the MS4 permit. This is also in compliance with the design storm requirements in the proposed revised MS4 Permit [LA RWQCB, 2012]. Since the one inch event is inconsistent with the applicable permit, the conclusion of this study is that the Broad Beach treatment control BMPs should be designed for the 0.75 inch design storm event.

3.2 Environmental Review

The Project is subject to the requirements of the California Environmental Quality Act (CEQA). CEQA requires that all projects be reviewed and that their environmental impacts be evaluated. The lead agency for the Project is the city of Malibu. On behalf of the city of Malibu, Geosyntec will prepare an Initial Study for the project.

This Project is an environmental improvement project (stormwater quality improvement) and the new constructed facilities will likely be hardscape and landscape improvements and natural water quality treatment facilities such as vegetated swales and biofilters. It is expected that the Initial Study will result in a finding of no impact or no significant impact with mitigation, qualifying the Project for a Negative Declaration or a Mitigated Negative Declaration.

As part of the CEQA process, a Frequently Asked Questions sheet will be published and distributed to the community to inform them of the Project. A public notice will be filed in the local newspaper and a public meeting will be conducted to provide the interested public with the opportunity to comment on the Project plans.

3.3 Coastal Development Permit

The California Coastal Act of 1976 (Div. 20 CA Public Resources Code Sections 30000 et. seq.) was adopted by the California Legislature in 1976 and became effective January 1, 1977. The Coastal Act provides a comprehensive regulatory framework for all new proposed non-exempt “development” (See PRC Sec. 30106 and 30610) within the Coastal Zone of the state of California. Pursuant to Sec. 30500 et. seq. of the Coastal Act each local government is responsible for preparing and adopting a Local Coastal Program (LCP) so as to implement the policies and provisions of the Act within its jurisdictional boundaries. Prior to Certification of an LCP the California Coastal Commission generally retains jurisdiction for the processing of Coastal Development Permits (CDPs) consistent with the Act; following certification of an LCP it becomes the primary responsibility of the Local government to review and approve all new proposed development within the Coastal Zone consistent with the provisions contained within its LCP.

In 2002 the City of Malibu’s Local Coastal Program was approved by the California Legislature and became law. Any new non-exempt development proposed within the City of Malibu must apply for and receive a Coastal Development Permit prior to commencement of development (See 13.3 of the Malibu Local Implementation Plan—“LIP”). The LIP and the Malibu Municipal Code provide the primary regulatory framework for review of new development.

The Project is located within the Coastal Zone in the City of Malibu and does propose new development therein; therefore the Project is governed by the City's Certified Local Coastal Program and is required to obtain a Coastal Development Permit prior to Project commencement in addition to other requisite Project entitlements.

3.4 Water Use Guidelines

The Los Angeles County Department of Public Health has established guidelines [Los Angeles County, 2011] for harvesting of rainwater, stormwater, and urban runoff for outdoor non-potable uses such as irrigation. The guidelines have categorized rainwater harvesting systems into four classes, Tier I – IV, depending on the potential water sources, and provide requirements for minimum water quality standard and treatment processes.

- Tier I – On-site collection of rainwater in rain barrels for on-site use in gravity flow systems.
- Tier II - On-site collection of rainwater in cisterns for on-site use.
- Tier III - On-site or off-site collection of rainwater, stormwater, and urban runoff in cisterns for on-site or off-site use. (Excludes water collected from locations zoned for high use transportation corridors, industrial, agricultural or manufacturing uses).
- Tier IV - On-site or off-site collection of rainwater, stormwater, and urban runoff in cisterns for on-site or off-site use. (Includes water collected from locations zoned for high use transportation corridors, industrial, agricultural or manufacturing uses).

Any rainwater harvesting systems based on storage of runoff from Broad Beach Road in underground cisterns would most likely be regulated under Tier III, due to the presence of urban (dry-weather) runoff generated from irrigation of the hillside.

For Tier III systems, if captured runoff is to be used for spray irrigation, irrigation water must be disinfected by chlorination or an equivalent technology. For drip or sub-surface irrigation, Tier III systems require only pre-screening (sediment filtration) of irrigation water. Project biofilters are anticipated to satisfy pre-screening requirements.

4. GEOTECHNICAL AND GROUNDWATER INVESTIGATIONS

4.1 General

To support the development of the preliminary design, Geosyntec performed geotechnical and groundwater investigations for the Project area. The information presented below is a summary of the investigations and the conclusions and recommendations from the Geotechnical and Groundwater Studies Report [Geosyntec, 2012]. The report in its entirety is included on a CD in Appendix D.

4.2 Purpose and Objectives

The Geotechnical and Groundwater investigations focused on the evaluation of subgrade soils along the Project alignment for the purpose of providing design input. This included assessment of groundwater conditions and infiltration potential. Geosyntec's scope of work consisted primarily of the following tasks:

- Gathering available geotechnical and geologic information;
- Performing a geotechnical field investigation consisting of six hollow-stem auger borings and six Geoprobe soundings;
- Performing a constant head infiltration test in the vadose zone and in saturated zones at the locations of the six Geoprobe soundings;
- Constructing temporary piezometers and monitoring groundwater elevations at select Geoprobe locations;
- Conducting laboratory testing of selected soil samples obtained from the borings and analytical testing of groundwater samples; and
- Conducting geotechnical engineering analysis.

4.3 Summary of Existing Conditions

4.3.1 Surface and Subsurface Conditions

To the north, the site is bounded by a predominantly vegetated bluff slope that extends up to the relict marine terraced platform on which Pacific Coast Highway is located. However, localized portions of the adjacent slope are devoid of vegetation and expose the rilled granular material of the marine terrace bluff. Exploratory borings encountered

artificial fill, Quaternary Terrace deposits, and the Tertiary age Trancas Formation at depth.

Artificial fill deposits were encountered in five of the six explorations along Broad Beach Road. In general, the fill deposits consist of brown sands with varying amounts of gravel and clay. Within the limits of the explorations, artificial fills extended from the ground surface to maximum depths of four feet.

Quaternary-age terrace deposits were encountered within all of the 12 explorations performed for the investigation at the ground surface or underlying the artificial fill. The terrace deposits generally range in composition from brown to reddish brown, clayey to gravelly sand, to light brown to tan, silty sand. Within the older, upper terrace bluff (Qt), densities generally increase with depth from medium dense to very dense.

Along the terrace surface underlying Broad Beach Road, the densities generally ranged from medium dense to dense. A subset of these terrace deposits, identified as the “Beach Sands” or Qb is present at a number of the investigation locations along Broad Beach Road. This deposit identified separately from other terrace deposits due to its characteristic fine sand and relatively low fines content (20 percent).

At the location of Broad Beach Road, the beach sand is typically less than approximately 10 feet thick. Based on information from other investigations between Broad Beach Road and the ocean this thickness increases to 10-15 feet typically.

The Tertiary age Trancas Formation underlies the entire site at depth and was encountered in nine of the explorations –this formation generally consists of a hard, gray fat claystone. Along Broad Beach Road, the Trancas Formation was encountered beneath the terrace deposits at an elevation of +18 feet mean seal level (MSL) at the west end of the Project area and slopes down to an elevation of -5 feet MSL at the east end. It is anticipated that the erosional unconformity between the overlying terrace deposits and the Trancas Formation slopes up to the north beneath Pacific Coast Highway and slopes down towards the beach on the south.

Dozens of single family residences are present along the south side of Broad Beach Road along the Project alignment. Review of numerous foundation reports for these structures indicates that while some are founded on the Trancas formation using deep foundations other structures and appurtenances may be founded on the beach sands using shallow foundations.

4.3.2 Groundwater

The investigations performed by Geosyntec indicate that the groundwater gradient in the Beach Sands is typically from north to south (i.e., toward the ocean). It is expected that water that infiltrates at the surface along Broad Beach Road will flow within the Beach Sands toward the ocean along the sloping unconformity between the Trancas formation and Beach Sand. Additional flow infiltrated by this Project may raise groundwater elevations within the Beach Sand.

The measured static groundwater elevation varied along the alignment of Broad Beach Road from approximately 7.0 to approximately 20.5 ft above MSL. In general, the observed groundwater elevations are assumed to represent a dry-weather condition although “wet year” and “wet-weather” conditions are assumed to be within a few feet of these conditions as indicated by observations. The groundwater elevations recorded remained fairly constant over the monitoring period, suggesting that there is no significant tidal influence at these locations.

In conversations with Broad Beach residents, concerns were expressed regarding making changes that potentially increase infiltration and consequentially raise groundwater levels. Some homes have basements and at least one homeowner has observed water, presumably groundwater, leaking into the basement.

4.3.3 Onsite Wastewater Treatment Systems

Onsite wastewater treatment systems (OWTS), such as septic systems, for the residences along the south side of Broad Beach discharge to leach fields that are in some areas located in the backyards between the homes and the dunes, in the courtyard area between the garage and the house, or between the house and Broad Beach Road. Based on analysis of groundwater samples carried out for this Project, it appears that the locations sampled are generally unaffected by the operation of the OWTS's.

4.4 Findings

The California Department of Transportation (Caltrans) Stormwater Quality Handbook: Project Planning and Design Guide [Caltrans, 2007] and the Los Angeles County Department of Public Works Stormwater Best Management Practice Design and Maintenance Manual [LADPW, 2009] both present guidelines related to the siting of infiltration BMPs. The criterion for selection of an appropriate site for infiltration trenches contained in these documents were used as primary screening criteria for selection of appropriate locations for Project infiltration features.

Based on the results of the investigations and evaluations, from a geotechnical viewpoint, the proposed stormwater best management practices and streetscape improvements are feasible as long as direct infiltration is not included as a Project feature. While infiltration rates in some areas are within the acceptable ranges, the following design criteria restrict the use of infiltration:

- The shallow groundwater and a shallow confining layer will impose significant constraints on the geometry of infiltration facilities.
- Typically the invert of infiltration features would be approximately five feet below grade, which in areas of shallow groundwater would violate the criteria of a 10-foot separation from groundwater provided in Caltrans [2007] and CASQA [2003].
- Dozens of OWTS are potentially present within 50 feet of the proposed infiltration facilities. Operation of infiltration facilities within 100 feet of septic system or a leach field violates the Caltrans [2007] criteria.
- Structural foundations are present within 100 feet down gradient of the location of the proposed features. This violates the Caltrans [2007] criteria. Infiltration will produce an increase in groundwater elevations (however minor or temporary) in the beach sand unit where some unknown number of these foundations is located. Evaluations indicate that, for some areas, there is potential for liquefaction in the current groundwater configuration and an increased risk for liquefaction under mounded groundwater conditions. This is of particular concern for foundations within the beach sand. The impact on individual structures is difficult to assess given that they are so numerous and have such a variety of foundation systems and soil conditions.

The following proposed Project components are feasible from a geotechnical perspective:

- Biofiltration with underdrains and impermeable geo-membranes;
- Permeable pavements with no infiltration to subgrade; and
- Vegetated swales.

The following proposed Project components are not feasible from a geotechnical perspective:

- Biofiltration including infiltration; and
- Permeable pavements with infiltration to subgrade.

Limited equilibrium slope stability analyses indicate that existing slopes are stable under current conditions and are not a constraint on Project design in their current configuration.

With the stated limitations on infiltration and given the presence of only minimally liquefiable deposits along the alignment of the proposed BMPs, liquefaction of subgrade soils is not a constraint on the design of proposed drainage features and appurtenant structures.

4.5 Design and Construction Recommendations

The Geotechnical and Groundwater Studies Report includes geotechnical recommendations for proposed construction in the following areas:

- (1) Drainage features, including biofiltration features and permeable pavements;
- (2) Foundation design; and
- (3) Earthwork.

A copy of the Geotechnical and Groundwater Studies Report is included as Appendix D.

5. HYDROLOGY

5.1 General

This section presents an analysis of the existing Project area hydrologic conditions and is intended to:

- Describe the existing hydrologic conditions including drainage infrastructure, catchment boundaries, soils, climate, and flow pattern; and
- Present the hydrologic basis for proposed stormwater BMPs.

5.2 Existing Hydrologic Conditions

5.2.1 General

The watershed associated with the Project site is roughly bounded on the north by the top of the hillside along the south side of PCH and on the south by the center line of Broad Beach Road, and has a total area of 12.3 acres. The watershed encompasses approximately 4,500 feet of Broad Beach Road. The total impervious area is estimated to be 1.5 acres consisting mainly of the asphalt pavement on Broad Beach Road area and PCH; however, there are also patches of concrete and asphalt along the roadside parking strip. There are eight catchment areas and ten City catch basins within the Project area. Drainage maps showing the catchment boundaries, drainage infrastructure, flow patterns, and pervious and impervious areas are presented in Appendix E.

5.2.2 Drainage Infrastructure and Flow Patterns

Broad Beach Road has local depressions and is crowned so that runoff from the northern half of the roadway flows toward the hillside, and runoff from the southern half flows toward the homes where it is typically collected in trench drains at the top or bottom of each resident's driveway. Hillside runoff (in which gullies and surface erosion were observed) and roadway runoff comeingle on the mostly unpaved roadside parking strip to the north. The parking area is typically at its lowest elevation closest to the roadway. This directs the surface runoff along the road edge towards the catch basins.

The catch basins for Catchments 1 to 7 are located along the north side of Broad Beach Road are recessed into the hillside with a local depression in the area immediately in front of the inlet. Catchment 8 drains to a storm drain inlet, and although technically not a catch basin, it is referred to such in this report (see Appendix E).

As shown in Appendix E, within the vicinity of the low point of Catchment 5A there are three City catch basins; CB5A, CB5B, and CB5C. The outfalls from all three catch basins feed to the same storm drain. CB5A drains Catchment 5A. CB5B receives only flow from a non-City-owned storm drains that run down the hillside and no direct runoff from the Project area. CB5C drains only an area of a few hundred square feet of the southern half of Broad Beach Road.

The catch basin curb inlets typically have approximately 17 inch openings with varying widths. The distance from inlet invert to catch basin bottom varies from 2 to 4 feet.

Runoff from PCH and adjacent roadside areas flows toward slope drain inlets on both sides of PCH. With one exception, slope drains along the southern side of PCH drop directly into the catch basins along the northern side of Broad Beach Road. These flows are conveyed in Caltrans-owned buried pipes (slope drains) to the below-grade catch basins. As this is not part of the City MS4, it is not addressed by this Project. From the catch basins, water flows through storm drain pipes that cross under Broad Beach Road and tie into private storm drains at the residential property lines prior to discharge to the outfall points on the ocean side of the homes.

The exception to the description above is one slope drain in the western end of the Project area that drains 0.6 acres of PCH, including the road shoulder. This drain daylight at the bottom of the embankment slope; runoff from PCH comingles with surface runoff from Broad Beach Road prior to entering the catch basin.

Delineation of the eight catchment boundaries was carried out based on the following information:

- Topographic maps based on a survey performed for the Project;
- Topographic data (GIS) and aerial photos from Los Angeles County; and
- Field observations and measurements.

5.3 Stormwater Quality Design Volume

5.3.1 Technical Approach

The stormwater quality design volume per catchment was calculated using the methodology described in the Los Angeles County Department of Public Works' *Development Planning for Stormwater Management, A Manual for the Standard Urban Stormwater Mitigation Plan, Appendix A, Volume and Flow Rate Calculations*, issued

on September 2002. The design storm event is the 0.75 inch 24-hour storm event which complies with the sizing requirements in the Los Angeles County NPDES MS4 Permit for structural and treatment control BMPs for new development and redevelopment projects. This is consistent with the recommendations in the *City of Malibu Local Coastal Program Local Implementation Plan* and in the Special Protections of the proposed General Exception to the Ocean Plan. Although the Project is a storm water quality improvement project and does not formally qualify as new development or redevelopment, this design criterion was selected for the Project.

The catchments correspond to the tributary areas for the catch basins.

The runoff coefficient curve for the pervious surfaces within the tributary area was selected based on soil maps from Los Angeles County Department of Public Works Water Resources Division. The soils in the Malibu area are identified as soil ID No. 038 [Los Angeles County GIS Data Portal, 2011].

5.3.2 Stormwater Quality Design Volume Calculation

Stormwater Quality Design Volume (SWQDV) was calculated using the following equation:

$$SWQDV (ft^3) = (2,722.5 ft/acre) * [(A_I)(0.9) + (A_P + A_U)(C_U)]$$

Where:

A_C = Catchment Total Area (acres) = $A_I + A_P$

A_I = Impervious Area (acres)

A_P = Pervious Area (acres)

A_U = Contributing Undeveloped Upstream Area (acres)

C_U = Undeveloped Runoff Coefficient (-)

Values for A_I , and A_P were determined using the available topographic maps and aerial photos. A_I includes all paved area and A_P includes the remaining area. A_U was determined to be zero for all catchments. C_U was assigned the value of 0.1 based on the runoff coefficient curve for soil no. 038 [LADPW, 2006]. The calculated design volumes are presented in Table 5-1.

6. CONCEPTUAL DESIGN ALTERNATIVES

This section begins with a review of the Project objectives and a discussion of how those objectives are satisfied. Following this, each proposed stormwater BMP or improvement is presented. Finally, two stormwater alternatives are developed and described in detail.

6.1 Project Objectives and Stormwater Alternatives Development

As stated in Section 1, the goals for the Project are to:

1. Eliminate dry-weather flows to the storm drain;
2. Reduce wet weather flows to storm drain (as feasible);
3. Improve water quality of wet weather flows to storm drain (i.e., storm water treatment, pollutant reduction) to the maximum extent practicable (MEP);
4. Reduce potable water use for irrigation (as feasible);
5. Restore habitat above Broad Beach Road (as feasible);
6. Reduce slope erosion (as feasible); and
7. Preserve street and visitor parking.

In addition, feedback from the residents has indicated a preference that the constructed project should not create or perpetuate the existing condition of highly variable parking and landscape/hardscape elements. The Project should be consistent with the rustic natural environment that currently exists along portions of Broad Beach Road. Therefore, we have created an additional objective (new Objective 8) which is to ensure that proposed improvements are consistent with the neighborhood landscape theme of a rustic natural environment.

To address these objectives, Geosyntec developed two stormwater management alternatives. A discussion of each objective and how it is satisfied by the alternatives is provided below.

Objective 1: Eliminate dry-weather flows to the storm drain. It is assumed that the primary dry-weather flows that occur within the Project area are related to irrigation runoff. All the residences are located on the south side of Broad Beach Road and any residential runoff from irrigation, pavement cleaning, car washing, etc. is captured by

private drains owned by each residence. Many residents have installed separate private irrigation systems on the north side of the street, on city of Malibu property and within the Project area. To eliminate dry-weather flows, these irrigation systems will be removed and city-operated water-efficient irrigation will be installed in place of these private systems. High-water-use ornamental and exotic plants will be removed and replaced with drought-tolerant native species, reducing the need for frequent irrigation during the dry season.

Objective 2: Reduce wet-weather flows to storm drain (as feasible). This objective is focused on water storage, use, and/or infiltration as a means of reducing discharge to the storm drains. Alternative 2 includes a water use option to reduce wet-weather flow. The soil and groundwater investigation specifically recommended no infiltration for this project, primarily due to the proximity to OWTS, low depth to groundwater, and concern for water intrusion in basements; therefore, infiltration is not considered an option for wet-weather flow reduction.

Objective 3: Improve water quality of wet-weather flows to storm drain (i.e., storm water treatment, pollutant reduction) to the MEP. This objective is met by several proposed Project elements. First, the roadway parking strip is proposed to be paved using concrete interlocking pavers. The construction of these pavers will not enhance stormwater infiltration (see Objective 2 above) but will reduce tracking of sediment from the currently soil/gravel parking strip to the proposed paved parking strip. Second, the parking strip area between the road and the toe of the embankment would be regraded to direct stormwater sheet flow away from the road and to vegetated swales located at the toe of the embankment. Vegetated swales will provide stormwater quality improvement. Third, garden walls (slough walls) and retaining walls are planned for various areas along the toe of the embankment, reducing erosion from the hillside and improving stormwater quality. Fourth, biofilters are proposed to treat wet-weather flows prior to discharge to the existing catch basins. Fifth, for Alternative 2, stormwater capture, storage, and use for irrigation are proposed. This provides a viable use option for a portion of the Project stormwater, if site conditions warrant use for irrigation. If site conditions do not support irrigation, the water will be discharged to and treated by the proposed biofilters, improving stormwater quality prior to discharge.

Objective 4: Reduce potable water use for irrigation (as feasible). This objective is satisfied by the removal of the numerous privately-owned irrigation systems on city property and installing a city-managed low water use irrigation system. The removal of non-native exotic plant species and replacement with native drought tolerant species also reduces potable water use for irrigation. Finally, for Alternative 2, captured

stormwater is proposed to be used to replace potable water, for a portion of the Project area irrigation needs.

Objective 5: Restore habitat above Broad Beach Road (as feasible). The Project budget will support removal of invasive and non-native exotic species for portions of the Project area and planting of native species in areas disturbed by construction. These plantings will provide partial habitat restoration of the areas above Broad Beach Road, reducing water usage and reducing hillside erosion.

Objective 6: Reduce slope erosion (as feasible). As stated under Objective 5 above, the partial habitat restoration included in the Project will reduce slope erosion. The proposed garden walls and retaining walls will further reduce slope erosion.

Objective 7: Preserve street and visitor parking. Currently, the only visitor parking available for beach-goers or residential visitors is along the north side of Broad Beach Road. The proposed storm water improvements (i.e., swales and biofilters) have been set back from the road such that the parallel parking opportunities along the full stretch of Broad Beach Road are unchanged.

Objective 8: Proposed Project improvements should preserve and enhance the rustic landscape/hardscape theme for the neighborhood. This objective is met by the proposed landscape and hardscape elements. The landscape architect has developed a rural neighborhood theme which is carried through all the proposed stormwater improvements including pavers, garden and retaining walls, vegetated swales, biofilters, and plantings.

6.2 BMPs and Stormwater Improvements

6.2.1 General

This section provides descriptions of the proposed stormwater BMPs and stormwater improvements and identifies how they would function to meet the Project objectives. An overview of proposed BMPs and improvements to be included in each alternative is presented in Table 6-1.

6.2.2 Biofiltration

Biofiltration systems will be used as the primary treatment control BMP for treatment of stormwater and dry-weather runoff from the Project area. Biofiltration systems, sometimes referred to as bioretention systems, are landscaped shallow depressions that capture and filter stormwater and dry-weather runoff. These facilities function as soil-

and plant-based filtration devices that remove pollutants through a variety of physical, biological, and chemical treatment processes. Biofilters typically consist of a surface ponding area, mulch layer, planting soils, and plantings. As water flows across the plantings and passes down through the organic-rich planting soil, pollutants are filtered, adsorbed, and biodegraded by the soil and plants. These systems provide a fairly high level of treatment. Because infiltration is unacceptable for this Project, biofilters will be designed with a lower impermeable membrane and a perforated underdrain to collect the treated water. The underdrain will connect to a collector pipe which will convey the treated water to a nearby catch basin. The outlet of the collector pipe in the catch basin will be located to facilitate sampling of biofilter effluent. Alternatively, an access point will be installed along the collector pipe to allow for effluent sampling. Typical cross-sections and details for the biofilters proposed for Broad Beach are shown in Figure 6-1.

Where sediment, trash and debris is expected in site runoff and a vegetated swale is not provided for water pretreatment, a pretreatment forebay will be included upstream of the biofilters. A forebay will reduce the rate of clogging of the biofilter and facilitate maintenance.

For this Project, the biofilters will not be designed to retain and infiltrate water - most water will flow through the filters and be discharged. However, low flows (i.e., dry-weather flows) may be partially or fully retained in the filter media. These relatively small water volumes are expected to be ultimately reduced by evapotranspiration.

The Project biofilters are designed to capture and treat the design capture volume during a storm event. A description of the biofilter sizing methodology for this Project is included in Appendix F. The calculated values for the required biofilter media surface area (A_{media}) for the two alternatives described later in this section are presented in Table 6-1.

6.2.3 Vegetated Swales

At present, stormwater flows off the embankment and towards a low elevation flow line between the street and the parking strip. The area between the edge of road pavement and the toe of the embankment will be graded to cause stormwater to flow off the road and off the parking strip to the embankment toe. A vegetated swale will be installed along the embankment toe, parallel to the road and will convey stormwater to storage or biofilter treatment facilities. Vegetated swales are an effective stormwater pretreatment BMP to filter out trash, debris, and coarse sediments - they also provide aesthetic enhancement for the area. The installation of vegetated swales will reduce pollutant loading and clogging on the downstream biofilters, extending the biofilter media life.

Vegetated swales are sloped and are not designed to pond water. Therefore, infiltration of water through vegetated swales is insignificant and it should not be necessary to install impermeable liners under the swales.

6.2.4 Water Collection, Storage, and Use or Treatment

Stormwater runoff can be collected in below-ground enclosed storage facilities (cisterns) and used for landscape irrigation, as required. Runoff would be conveyed in swales and gravity drain into systems of vaults, tanks, or pipes to store the water until needed. When needed, the water can be pumped from the underground storage and conveyed in pressurized pipes for use in drip irrigation. Drip irrigation is selected as the most viable use option. This site would be classified as a Tier III system under Los Angeles County requirements for rainwater and stormwater harvesting systems. Drip irrigation requires only sediment filtration prior to water use. Spray irrigation requires water disinfection, which adds an unattractive level of complexity to this stormwater use application.

If stored water cannot be used for landscape irrigation due to lack of irrigation water demand, the water would be pumped and discharged to biofilters after the storm peak had passed and the surface stormwater had been filtered and discharged. In this way, the biofilters can be used to filter stored water during times when the filters are otherwise not in use.

Local residents have expressed concern regarding underground storage of stormwater and the potential for leakage and infiltration of this water, possibly exacerbating a high groundwater condition in the neighborhood. Should stormwater storage be implemented, various technologies such as impermeable lining systems could be employed to provide additional assurance against leakage of stored water.

6.2.5 Concrete Pavers

The majority of the parking strip that runs parallel to Broad Beach Road is unpaved – the existing surface varies, including sand, soil, decomposed granite, and various types of gravel. This parking strip is commonly used for parking by residential visitors, workers, and beachgoers. Surface erosion of the unpaved parking surfaces can reduce stormwater quality. Sediment tracking from parking areas to the roadway mobilizes sediment and can reduce stormwater quality. This condition is exacerbated by muddy and wet conditions during storm events. The installation of pavers from the edge of road to form an approximately 10 foot wide parking strip is proposed. Pavers would provide a uniform surface for parking and greatly reduce erosion and sediment tracking. Paver selection and design will be made to reduce stormwater infiltration to the extent

possible. In any event, the minor infiltration through paver system is expected to be significantly less than the existing condition where stormwater infiltrates through unpaved ground.

6.2.6 Retaining and Garden Walls

Retaining walls (structural walls) and garden walls (non-structural slough walls) are proposed for various locations along the hillside. The walls fulfill three purposes. First, installation of walls in designated locations will allow for the embankment to be cut back, opening up needed areas for biofilter installation. Second, the walls reduce soil erosion and sloughing from the hillside, which is a key contributor to sediment in stormwater. Third, the installation of walls creates a uniform hardscape theme across the neighborhood. Existing retaining walls are not engineered, are often ineffective for erosion reduction, and are constructed of a myriad of materials including cobbles, broken concrete, masonry brick, and cast-in-place concrete.

6.2.7 Irrigation System Removal/Replacement

A key element to reducing or eliminating dry-weather flows is the removal of privately-owned irrigation systems on the north side of the road. Although this property is owned by the city, homeowners have installed private irrigation systems plumbed back to their water services and have created private gardens and landscapes on city property. The private irrigation of gardens creates uncontrolled and unmanageable dry-weather flows which have been observed during recent site visits. Private systems would be removed and replaced with water-efficient low-volume irrigation controlled by city-controlled, automated evapotranspiration controllers. Water would be provided by the city and water use would be managed by the city. We recognize the communication efforts that will be required to implement the removal of these private irrigation systems. An estimate of annual water use for Broad Beach Road irrigation is provided in Appendix G.

6.2.8 Habitat Restoration

As mentioned above, many Broad Beach Road residents have created gardens across from their residences on city property. These gardens include many non-native invasive or ornamental plants and shrubs, most which require frequent irrigation. To reduce irrigation requirements and reduce the erosion potential, high water-demand ornamental plants and shrubs within 20 feet of the toe of embankment slope would be removed and replaced with more drought-tolerant, native species plants and shrubs. This will allow the city to manage irrigation (and reduce or eliminate dry-weather flows) and reduce potable water use on the hillside. Areas disturbed by construction will be revegetated

with appropriate species. Other ornamental or exotic species will be removed, depending on proximity to the roadway and the plant-specific water consumption requirements. The creation of a more uniform native species plant/shrub environment furthers the objective of creating a more uniform landscape theme for the neighborhood. Again, we recognize the communication efforts that will be required to implement the removal of nonnative species that were planted by residents.

6.3 Stormwater Alternative 1

Stormwater Alternative 1 is comprised of a combination of BMPs and improvements including stormwater conveyance and treatment BMPs, retaining and garden walls, parking strip pavers, irrigation, and landscape improvements. Alternative 1 is differentiated from Alternative 2 in that Alternative 1 contains no stormwater storage or use options – in Alternative 1, all stormwater up to the design storm event is captured, treated, and discharged. A flow diagram illustrating the stormwater management principles for Alternative 1 is presented in Figure 6-2. In the subsections below, the specific application of these BMPs and improvements are addressed, as are issues related to parking, utilities, and operation and maintenance. The general layout and features of Alternative 1 are shown on Figures 6-4 through 6-14.

6.3.1 Stormwater Management Improvements

For Catchments 2 to 7 runoff will be collected from the road, parking strip and embankment and transported in vegetated swales that drain to biofilters located upstream of the catch basins. The swales will provide pretreatment while primary treatment will occur in the biofilters.

The swales will run along the toe of the hillside slope intercepting hillside runoff. The parking area will be regraded such that both the road and the parking area drain toward the swales. The swales will serve to channelize flow to the biofilters and will widen at the biofilters entrance to create sheet flow into the biofilter.

Biofilters will be located between the toe of the slope and the paved parking area. In some cases cuts will be made into the hillside to create more available filter area. Filtered water will be collected in underdrains that connect to collector pipes, discharging to the existing catch basins, or to the storm drains if more feasible. When the ponding capacity of the biofilters is exceeded, overflow will occur over a weir located at the end of the biofilter closest to the catch basin and then surface flow to the catch basin inlet. The top of weir elevation will be the same as the water surface elevation corresponding to the biofilter design ponding depth.

Locating adequately sized biofilters in Catchment 1 and the eastern part (east of CB8) of Catchment 8 was not deemed feasible due to lack of area and other logistical constraints such as utilities, parking, and steep slopes. For these two catchments, runoff is diverted to other areas where adequate area for treatment is available.

Runoff from Catchment 1 is diverted via gravity flow from catch basin CB1 to a biofilter in Catchment 2. The diversion structure will be designed to divert low flows while during high runoff events (in excess of design storm) water will overflow to catch basin CB1.

Runoff from Catchment 8 will be captured in a new wet sump adjacent to storm drain inlet CB8 and pumped to a biofilter in the western end of Catchment 8. The wet sump will be designed to receive and pump flows up to the design storm – events in excess of the design storm will overflow to CB8. A submersible pump can be used for this application. Noise levels outside of the sump are expected to be imperceptible to residents.

In general, the biofilters are sized for the design capture volume generated in their immediate tributary area. However, the biofilters in Catchment 2 and 8 are sized for both direct catchment runoff as well as the diverted runoff from other areas.

The proposed stormwater system improvements do not significantly alter the existing drainage patterns. Hillside and roadway runoff patterns are generally unchanged; however, regrading of the Broad Beach Road parking strip will concentrate flow along the toe of the slope instead of along the road pavement edge. Biofilters and swales are sited in order to maintain flood paths to existing catch basins.

6.3.2 Landscape, Hardscape, and Irrigation

Alternative 1 includes construction of garden and retaining walls and parking strip pavers, removal/modification of some of the existing garden and retaining walls, removal of all private irrigation systems and replacement with city-controlled, water-efficient irrigation systems, and replacement of exotic, ornamental, and invasive plant species. This alternative also includes replanting in areas disturbed by construction. The general plan indicating the Project areas where hardscape, irrigation, and planting improvements will be made is shown on Figures 6-4 through 6-14.

Selective plant material will be removed from the Project area to help create consistent landscape theme, reduce irrigation water use, and facilitate Coastal Bluff Scrub Habitat Restoration. The specific criteria applied to each area to determine which existing ornamental, exotic, or invasive plant species should be replaced are as follows:

- Invasive plant species will be removed from the first 20 feet of the Project slopes and parkway to the extent practical;
- Vegetation will be removed from existing utility setbacks;
- Vegetation will be removed from Project improvement areas including biofilter areas, vegetated swales, retaining walls, garden walls, parking areas, and concrete swales and gutters;
- Vegetation will be removed in locations where conflicts occur with the proposed slope irrigation improvements and proper system operations;
- Native vegetation that constitutes a high fire risk per Los Angeles County Fire Department Fuel Modification Plan will be removed;
- Trees with invasive roots will be removed that are located within 10 feet of proposed Project retaining walls, garden walls, and biofiltration areas; and
- Selective ornamental vegetation that is high water use will be removed.

The proposed irrigation system for the Project will be a low water use system featuring a smart weather based controller combined with low volume drip, bubbler and overhead rotary stream spray heads. The smart controller will allow for daily automatic adjustments to the watering schedule based on real time weather data. Flow sensing devices allow for system shut-down and delays in response to rain events and system failures. Low volume point to point irrigation using drip and bubbler systems provide for maximum water use efficiency. Rotary stream heads provide additional water savings with 30% increased efficiency over traditional spray heads. The estimated total water usage (ETWU) for the Project is approximately 740,000 gallons per year. This represents about 50% of the maximum applied water allowance (MAWA) for the proposed design.

Feedback from a conversation with one of the Broad Beach homeowners indicates that some of the existing irrigation systems may have been installed to serve as fire protection. This has not been confirmed but the need for fire protection will be evaluated during the design phase and more information will be solicited from the Broad Beach homeowners. The final design will comply with existing code and fuel modification requirements including the following:

- All proposed landscape and irrigation improvements will be implemented per the Los Angeles County Fire Department (LACFD) Fuel Modification Plan

Guidelines [LACFD, 2011] to create the desired defensible space around all combustible structures in a fire environment.

- All proposed landscape improvement plant species are subject to LACFD approval and will be inherently fire resistant and spaced appropriately.
- Existing native vegetation and ornamental plantings within the project fuel modification zones will be modified by thinning and removal of species constituting a high fire risk (refer to the LACFD Undesirable Plant List).
- Routine fuel modification maintenance will be regularly performed in all zones. Maintenance includes irrigation, pruning, thinning and annual removal of weeds, dead materials and other undesirable flammable vegetation required to keep the area in a fire safe condition. (Refer to the LACFD Fuel Modification Plan Maintenance and Long Term Maintenance sections)

The proposed planting for the Project will consist of native and drought tolerant grass species for the biofilter areas and vegetated swales. This vegetation provides water quality improvements for Project runoff and creates a distinct theme for the Project parkway. The slope planting will consist of a combination of drought-tolerant shrubs to enhance the existing plant material to create a more consistent landscape theme combined with Coastal Bluff Scrub species to facilitate native slope habitat restoration.

The proposed hardscape improvements for the project will include an interlocking concrete paver parking area, concrete veneer retaining walls and dry stacked boulder garden/slough walls. These elements will be installed throughout the project construction limits creating a consistent rural neighborhood theme and materials palette for the project. Miscellaneous existing garden/slough walls will be removed and either omitted or replaced with project theme walls as needed to construct the proposed biofiltration areas and vegetated swales. Existing retaining walls that are required due to existing grade and are structurally sound will remain and be enhanced with the project theme veneer so that all walls are consistent.

A plant palette exhibit and a materials exhibit for pavers and wall veneers are included in Appendix H. The exhibits present several different options.

6.3.3 Parking Considerations

The proposed improvements will allow for parallel parking along the entire stretch of roadway within the Project boundaries, similar to the current-day parking locations.

The installation of pavers will improve parking conditions in several areas where the surface is uneven due to ditches and erosion.

6.3.4 Utility Considerations

Existing utilities have been identified both by review of historical maps and by marking on Broad Beach Road by the utility owners. The preliminary design of BMPs and improvements has been developed in consideration of all known utilities and no significant utility conflicts are known. Prior to construction of the Project, the city of Malibu's contractor will be required to mark and locate all utilities within the Project area and to field verify locations of utilities that could be threatened by the work.

Los Angeles County owns a sewer line that runs along Broad Beach Road, between the road edge and the embankment. A sewage pumping station is located in Catchment 1. In some areas, this sewer line will be located under the proposed location of parking strip pavers. The depth of this utility will need to be verified to ensure it is protected during grading and subgrade improvement work.

The Gas Company owns a gas line that also runs parallel to the road between the sewer line and the road. Similar to the sewer line, this gas line will be under the parking strip where pavers are proposed. The depth of this utility will also need to be field verified to ensure it is protected during construction.

There are electrical transformers owned by Southern California Edison located along the north side of Broad Beach Road within the Project area. Electrical laterals traverse the parking area. We have not identified any significant conflicts between the electrical lines and the proposed construction. Locations and depths can be verified prior to construction. Vegetation will need to be removed around the existing transformers.

Charter Communications owns communications lines that primarily run along the south side of the road, outside of the Project area. We have identified several communications lines that cross the road to roadside amplifier boxes. These crossings are within the Project area but do not pose a conflict for the proposed work.

The Los Angeles County Waterworks owns a water main that is located near the road centerline and provides water to residents and to two hydrants located along the north side of the road within the Project area. These water supply lines are marked and do not pose a conflict for the proposed work. During design, coordination with the local fire department will be required to identify parking restrictions in front of fire hydrants. Currently, there are no posted parking restrictions in this area; however, we expect that

the fire department may impose parking prohibitions in certain areas to ensure emergency hydrant access.

No telephone utilities were identified in the Project area.

6.3.5 Performance

The proposed configuration of treatment control BMPs and improvements will be designed to treat 100% of the runoff generated within the Project tributary area for storm events equal to or less than the design storm. Using vegetated swales and biofilters, pollutant removal treatment effectiveness is predicted to be medium to high. It is our expectation that, barring an unforeseen water line break, all dry-weather runoff will be treated by the biofilter system. Dry-weather runoff should be substantially reduced or even eliminated by the removal of private irrigation systems and the installation of new water efficient irrigation with smart controllers. Other than irrigation runoff, there are no other known sources of dry-weather runoff within the Project area.

Retaining walls, garden walls, and parking strip pavers will all reduce erosion and sediment transport in runoff. Pavers will also reduce sediment tracking from the parking strip to the roadway. New plantings of native species will also reduce erosion.

Potable water use will be reduced by elimination of the numerous private irrigation systems and installation of new water-efficient irrigation and smart irrigation controllers.

6.3.6 Operation and Maintenance

The following is a description of anticipated operation and maintenance requirements for the proposed BMPs and improvements.

Vegetated swales will require periodic removal of accumulated trash and debris. Removal of accumulated sediment and revegetation may also be required. Weed removal, trimming, and pruning are also necessary. Vegetated swales will require some minimal irrigation during dry months.

Biofilters will require periodic removal of accumulated trash and debris. If sediment removal is required, replacement of mulch and vegetation may also be necessary. Occasional pruning of shrubs and cleanup of leaves and organic waste may be required. Periodic replacement or addition of planting material and mulch will be needed to sustain the biofilter's treatment effectiveness. Minimal biofilter irrigation will be

needed, especially during dry months. Irrigation needs will significantly diminish after plants become established.

Irrigation system maintenance will include periodic inspections of system performance and verification that dry weather flows are eliminated. Damaged sprinkler piping, sprinkler heads, and drip emitters will require replacement. Verification of proper operation of irrigation controllers will be required. The total water usage for the first year is estimated at 740,000 gallons. The yearly cost for this water usage is roughly \$5,500 based on current water rates (see water usage and cost calculations in Appendix G). Water usage, and consequentially water costs, can be reduced after plants are established.

Areas that have been revegetated due to replacement of inappropriate species or in areas disturbed by construction will require inspection and landscape maintenance to ensure that plants are properly established and the plant health is sustained.

The wet sump in Catchment 8 and the pumping system will require periodic inspection and verification of proper operation. Pump maintenance will be minimal. Electricity to run this pump represents a trivial expense.

6.4 Stormwater Alternative 2

Stormwater Alternative 2 has many common elements to Alternative 1. The primary difference between the alternatives is that Alternative 2 includes collection and storage of runoff in underground cisterns. The collected water from the two proposed cisterns can be pumped for irrigation use or pumped to biofilters for treatment after the storm peak has passed. This storage and off-peak treatment permits more efficient use of the biofilters and results in a smaller Project biofilters footprint. In the subsections below, the proposed BMPs and improvements are presented. A flow diagram illustrating the stormwater management principles for Alternative 2 is presented in Figure 6-3. The general layout and features of Alternative 2 are shown on Figures 6-4 through 6-14.

6.4.1 Stormwater Management Improvements

As previously stated, stormwater management BMPs and improvements for Alternative 2 are similar to Alternative 1. However, Alternative 2 collects surface runoff from Catchment 1, part of Catchment 2, and Catchment 8 and stores this water in two underground stormwater cisterns. The cisterns are proposed to be constructed of a system of buried pipe that functions like a storage tank and is specifically manufactured for underground water storage. One cistern is located within Catchment 8 – all the runoff from Catchment 8 drains to swales, flows to a drain inlet, and is conveyed to the

cistern. The total storage for the Catchment 8 cistern is 520 cubic feet. When storage capacity is exceeded, runoff will overflow to the existing storm drain inlet. Refer to Figure 6-5 for the proposed location of the storage system.

Stormwater in Catchment 1 and the western portion of Catchment 2 is captured in swales and gutters and flows to two drain inlets that are routed to a cistern located in Catchment 2, for storage. The total storage for this cistern is 2,080 cubic feet. Refer to Figures 6-11 and 6-12 for the proposed location of the storage system. When storage capacity is exceeded, runoff will overflow to the existing storm drain outfall from catch basins CB1 and CB2.

Residents have expressed concern that underground water storage facilities could leak, causing groundwater mounding and potentially exacerbating a high water table condition under their homes. If the manufactured cistern system is not determined to be sufficiently reliable for water storage, a system of synthetic liners can be considered to provide additional assurance that the water storage systems do not leak and infiltrate water to the subsurface.

Each of the two cisterns will be constructed with a wet sump to evacuate the stored water. Stored water can either be directed to biofilters located in Catchments 2 and 7 or water can be used for landscape irrigation. Each wet sump would be fitted with two pumps, one for landscape (a higher pressure, higher flow application) and one for water transfer to the biofilters (a lower pressure, lower flow application). Submersible pump noise is expected to be imperceptible to residents. Pumps would be controlled by a smart stormwater controller that assesses the volume of water in the cisterns, evaluates current climatic conditions and the forecast for future storms, assesses the need for irrigation based on evapotranspiration data, and controls each pump appropriately.

For portions of Catchment 2 and Catchments 3-7, the BMPs and improvements proposed are the same as Alternative 1. Refer to Figures 6-4 through 6-14 for details.

The Project benefits of stormwater storage are that there is approximately 2,600 cubic feet (approximately 19,500 gallons) of stored water available for irrigation. If irrigation is not needed, which is often the case in the winter, the water can be stored and discharged to the biofilters after the storm peak as passed, allowing the biofilters to be used more efficiently and resulting in a reduced area footprint for the biofilters. The reduced biofilter area for Alternative 2 is nearly 1,900 square feet (refer to Table 6-1) less than Alternative 1. The layout of Alternative 2 increases vegetated swale length by approximately 300 linear feet.

6.4.2 Landscape, Hardscape, and Irrigation

Landscape elements are similar between Alternatives 1 and 2. Hardscape elements are similar between the Alternatives with the exception that Alternative 2 has a smaller Catchment 2 retaining wall, due to the smaller biofilter area required. Alternative 2 has the same irrigation plan as Alternative 1 supplemented by an additional parallel drip irrigation system to support the use of stored stormwater. To avoid cross connection concerns, it is necessary to have completely independent irrigation systems supplied by potable water and supplied by stormwater.

6.4.3 Parking Considerations

There is no difference between Alternative 1 and Alternative 2 with regard to parking on Broad Beach Road.

6.4.4 Utility Considerations

The utility considerations unique to Alternative 2 are related to the underground storage of stormwater. Stormwater from Catchment 1 and a portion of Catchment 2 will be stored in a large diameter buried pipe located in Catchment 2. The pipe will require an excavation of up to approximately eight feet in depth. We have considered the need for shoring during this installation. The pipe location should not conflict with any existing utilities. For Catchment 8, the underground storage pipe installation will require an excavation to a depth of approximately six feet. This will likely require shoring, careful location of the adjacent sewer line, and ultimately replacement of the toe-of-slope swale.

6.4.5 Performance

Stored stormwater that is used for irrigation represents a net reduction in discharge to the ocean. That is consistent with the Project objectives. Furthermore, the stored water used for irrigation replaces potable water. The proposed storage systems have a capacity to store roughly one-third of the total design capture volume for the Project area. The performance of vegetated swales, biofilters, and landscape and hardscape elements is similar to Alternative 1.

6.4.6 Operation and Maintenance

The operation and maintenance items for Alternative 2 are similar to Alternative 1 with a few minor exceptions. The parallel drip irrigation system for stormwater irrigation use would require periodic maintenance. The submersible pumps found in the cisterns

would require periodic inspection and occasional maintenance. The cost of electricity for pumping is considered trivial.

The total water usage for the first year is estimated at 715,000 gallons: 625,000 gallons for slope vegetation and 90,000 gallons for biofilter and swale vegetation.

Potable water use would be reduced for Alternative 2, due to use of stored water for irrigation. The cisterns will store approximately 2,600 cubic feet with equates to approximately 19,500 gallons. Water from the cisterns will be used to irrigate the biofilters and the vegetated swales. Although difficult to predict how much stormwater will substitute for potable water, we believe it is reasonable to expect that stormwater use for irrigation may replace between 5 and 10 percent of potable water use.

The yearly average cost for water usage is estimated to vary between \$4,400 and \$5,200 based on current water rates (see water usage and cost calculations in Appendix G). Assuming that 50% of the irrigation demand for the biofilters and vegetated swales is supplied by cistern water, the yearly average cost is estimated to be \$4,800, roughly \$700/yr less than Alternative 1. The amount of irrigation water for biofilters and vegetated swales supplied by cistern water can potentially reach 100%; however, this is unlikely since the demand will be greatest during dry periods when supply is low. These costs represent water usage for the first year. Water usage, and consequentially water costs, can be reduced after plants are established.

7. CONSTRUCTION COST ESTIMATE

Cost estimates were developed for the two proposed design alternatives for this 10 percent design level. The estimates represent solely contractor costs and do not include oversight, independent testing, construction management, or documentation. A 20 percent contingency was applied to each estimate. For this conceptual design, the costs were not escalated to spring of 2013, the predicted construction start date.

The following is a list of the various cost resources used in the development of the cost estimates:

- The Geosyntec team's experience on similar projects;
- Cost data for two recent, similar projects constructed in Malibu;
- Vendor quotes; and
- RS Means cost guide.

Through an iterative process the scope of construction was modified (reduced) in order to generally meet the Grant construction budget which is \$1,675,836. Estimated construction costs correspond only to the improvements in the Project area that fall within the limits of construction on Figures 6-6 and 6-11, unless otherwise noted on the figures.

The estimate of construction costs for the two alternatives are:

Alternative 1 - \$1,625,000

Alternative 2 - \$1,688,000

A summary table of the primary cost items is presented in Table 7-1. Detailed cost estimates are presented in Appendix I.

8. DISCUSSION AND RECOMMENDATION

Alternatives 1 and 2 both generally satisfy the Project objectives. Each alternative eliminates or at least substantially reduces dry-weather flows. Both alternatives reduce erosion and sediment tracking through hardscape and landscape improvements. Both alternatives provide stormwater treatment and associated improvements in water quality for water discharged to Broad Beach. Both alternatives provide habitat restoration and reductions in potable water use related to planting of drought tolerant species. Both alternatives include consistent hardscape and landscape themes and carry these themes throughout the Project area.

The stormwater management elements that are different between the two alternatives are:

1. Reduction of potable water for irrigation; and
2. Volume of water discharged to Broad Beach.

Alternative 2 is a partial capture and treat alternative. Alternative 2 provides storage for approximately one-third of the design capture volume of runoff and either uses that water for irrigation or treats the stored water after the storm has passed, allowing for more efficient use of biofilters. This capture and use strategy reduces potable water needed for irrigation and reduces the volume of treated water discharged to Broad Beach. The capture and use strategy is progressive and demonstrates leadership and innovation by the city of Malibu.

The challenges related to Alternative 2 are that water storage and use adds additional cost, as compared to Alternative 1. The need for pumping systems increases the Project complexity and maintenance costs are also slightly higher (primarily related to maintaining a separate irrigation system). Finally, there may be a perception by the local residents that there is a risk of stormwater leakage from the cisterns, potentially causing undesirable infiltration.

Geosyntec believes both Alternatives are viable and attractive stormwater management approaches for Broad Beach Road. However, Geosyntec believes that Alternative 2 goes further to meet the goals of the grant by promoting a greater reduction of wet weather flow to the storm drain and by reducing potable water use for irrigation; Geosyntec therefore recommends Alternative 2.

9. LIMITATIONS

This Preliminary Design Report was developed in accordance with the scope of work, purpose, terms, and conditions described in the Terms of Reference, described in Section 1.

The conclusions contained in this investigation are based on the conditions as observed by Geosyntec personnel and as reported by relevant agencies and other named sources at the time the investigation was performed.

No warranty, expressed or implied, is made regarding the professional opinions expressed in this report or concerning the completeness of the data presented to us. If actual conditions are found to differ from those described in the report, or if new information regarding the site is obtained, Geosyntec should be notified and additional recommendations, if required, will be provided.

Geosyntec is not liable for any use of the information contained in this report by persons other than the City of Malibu as intended for the subject Project.

10. REFERENCES

California Coastal Commission [2002] City of Malibu Local Coastal Program Local Implementation Plan, California Coastal Commission.

Caltrans [2007], “Stormwater Quality Handbook: Project Planning and Design Guide”, California Department of Transportation.

CASQA [2003] Stormwater Best Management Practice Handbook: New Development and Redevelopment, California Stormwater Quality Association.

Geosyntec [2012] Geotechnical and Groundwater Studies Report, Geosyntec Consultants.

Grossman, Marshall and Marlene, Broad Beach Road homeowners [2012], meeting February 15 2012, City of Los Angeles.

LACFD [2011] Fuel Modification Plan Guidelines, Los Angeles County Fire Department.

LADPH [2011] Guidelines for Harvesting Rainwater, Stormwater, & Urban Runoff for Outdoor Non-potable Uses, Los Angeles County Department of Public Health.

LADPW [2002] Development Planning for Stormwater Management, A Manual for the Standard Urban Stormwater Mitigation Plan, Los Angeles County Department of Public Works.

LADPW [2006] Hydrology Manual, Los Angeles County Department of Public Works.

LADPW [2009] Stormwater Best Management Practice Design and Maintenance Manual for Publically Maintained Storm Drain Systems, Los Angeles County Department of Public Works.

Los Angeles County GIS Data Portal [2011], Shape (SHP) file, County of Los Angeles.

LA RWQCB [2012] Staff Working Proposal for Provisions Regarding Minimum Control Measures, Los Angeles Regional Water Quality Control Board.

Stormwater Best Management Practice Design and Maintenance Manual for Publically Maintained Storm Drain Systems, Los Angeles County Department of Public Works.

SWRCB [2009], California Ocean Plan, State Water Resources Control Board.

SWRCB [2012], Draft. State Water Resources Control Board Resolution No. 2012-.
Approving Exceptions to the California Ocean Plan for Selected Discharges
into Areas of Special Biological Significance, Including Special Protections for
Beneficial Uses, and Certifying a Program Environmental Impact Report, State
Water Resources Control Board.

SWRCB [2011], Proposition 84 Areas of Special Biological Significance (ASBS)
Grant Program Grant Agreement between the State Water Resources Control
Board, and City of Malibu, Broad Beach Road Biofiltration, Agreement no. 10-
411-550, State Water Resources Control Board.

TABLES

Table 5-1. Areas and Stormwater Quality Design Volume per Catchment

Catchment No.	Catchment Section	A _C (ac)	A _I (ac)	A _P (ac)	A _U (ac)	C _U (-)	SWQDv (ft ³)
1		2.34	0.53	1.81	0	0.1	1788
2	west	0.57	0.05	0.53	0	0.1	254
	east	1.61	0.15	1.46	0	0.1	766
3		0.75	0.09	0.66	0	0.1	395
4		1.48	0.11	1.37	0	0.1	644
5A	west	0.85	0.10	0.75	0	0.1	457
	east	1.70	0.13	1.57	0	0.1	734
6		1.08	0.11	0.96	0	0.1	534
7	west	0.76	0.09	0.67	0	0.1	406
	east	0.31	0.03	0.28	0	0.1	145
8		0.82	0.13	0.69	0	0.1	514
Total		12.27	1.51	10.75			6637

Table 6-1. Proposed BMPs and Improvements for each Alternative per Catchment

Catchment No.	Biofilters	Vegetated Swales (incl. grading)	Water Storage and Use or Treatment	Concrete Pavers	Retaining and Garden Walls	Irrigation System Removal/Replacement	Habitat Restoration
1			Alt. 2	Both Alt.	Both Alt. ¹	Both Alt.	Both Alt.
2	Both Alt.	Both Alt.	Alt. 2	Both Alt.	Both Alt.	Both Alt.	Both Alt.
3	Both Alt.	Both Alt.		Both Alt.	Both Alt.	Both Alt.	Both Alt.
4	Both Alt.	Both Alt.		Both Alt.	Both Alt.	Both Alt.	Both Alt.
5A	Both Alt.	Both Alt.		Both Alt.	Both Alt.	Both Alt.	Both Alt.
6	Both Alt.	Both Alt.		Both Alt.	Both Alt.	Both Alt.	Both Alt.
7	Both Alt.	Both Alt.		Both Alt.	Both Alt.	Both Alt.	Both Alt.
8	Alt. 1	Alt. 2	Alt. 2	Both Alt.	Both Alt.	Both Alt.	Both Alt.

¹ Walls are not proposed for Catchment 1. However, a concrete swale along the slope will function as a slough wall.

Table 6-2. Design Biofilter Volume (B_v) and Biofilter Media Surface Area (A_{media}) for Alternatives 1 and 2

Catchment No.	Catchment Section	Alternative 1		Alternative 2	
		B_v (ft ³)	A_{media} (ft ²)	B_v (ft ³)	A_{media} (ft ²)
1					
2	west	3063	1541		
	east	1149	541	1149	541
3		593	326	593	326
4		966	448	966	448
5A	west	685	334	685	334
	east	1101	560	1101	560
6		801	365	801	365
7	west	608	268	608	268
	east	218	107	218	107
8	west	771	350		
Total		9956	4840	6122	2949

Table 7-1. Summary of Construction Cost Estimates for Alternatives 1 and 2

Total Construction Costs	Alt. 1	Alt. 2	Notes
Biofilters	\$159,000	\$96,000	
Vegetated Swale	\$31,000	\$34,000	
Planting of Slope	\$38,000	\$38,000	
Irrigation	\$150,000	\$156,000	
Walls (new and existing)	\$169,000	\$116,000	
Concrete Interlocking Pavers	\$528,000	\$527,000	
Diversion and Storage Structures - Catchment 2	\$3,000	\$124,000	Alt. 1 does not include storage
Diversion and Storage Structures - Catchment 8	\$43,000	\$77,000	Alt. 1 does not include storage
Maintenance of planting and irrigation	\$8,000	\$8,000	3 month maintenance period
Demolition of hardscape/landscape	\$34,000	\$34,000	
<i>SUBTOTAL 1</i>	<i>\$1,163,000</i>	<i>\$1,210,000</i>	
Mobilization & Demobilization	\$116,000	\$121,000	10% of Subtotal 1
Bonds	\$35,000	\$36,000	3% of Subtotal 1
Traffic Control	\$20,000	\$20,000	
SWPPP	\$20,000	\$20,000	
<i>SUBTOTAL 2</i>	<i>\$1,354,000</i>	<i>\$1,407,000</i>	
Contingency	\$271,000	\$281,000	20% of Subtotal 2
Total Construction Cost	\$1,625,000	\$1,688,000	

FIGURES

Figure 2-1. Vicinity map of Project area

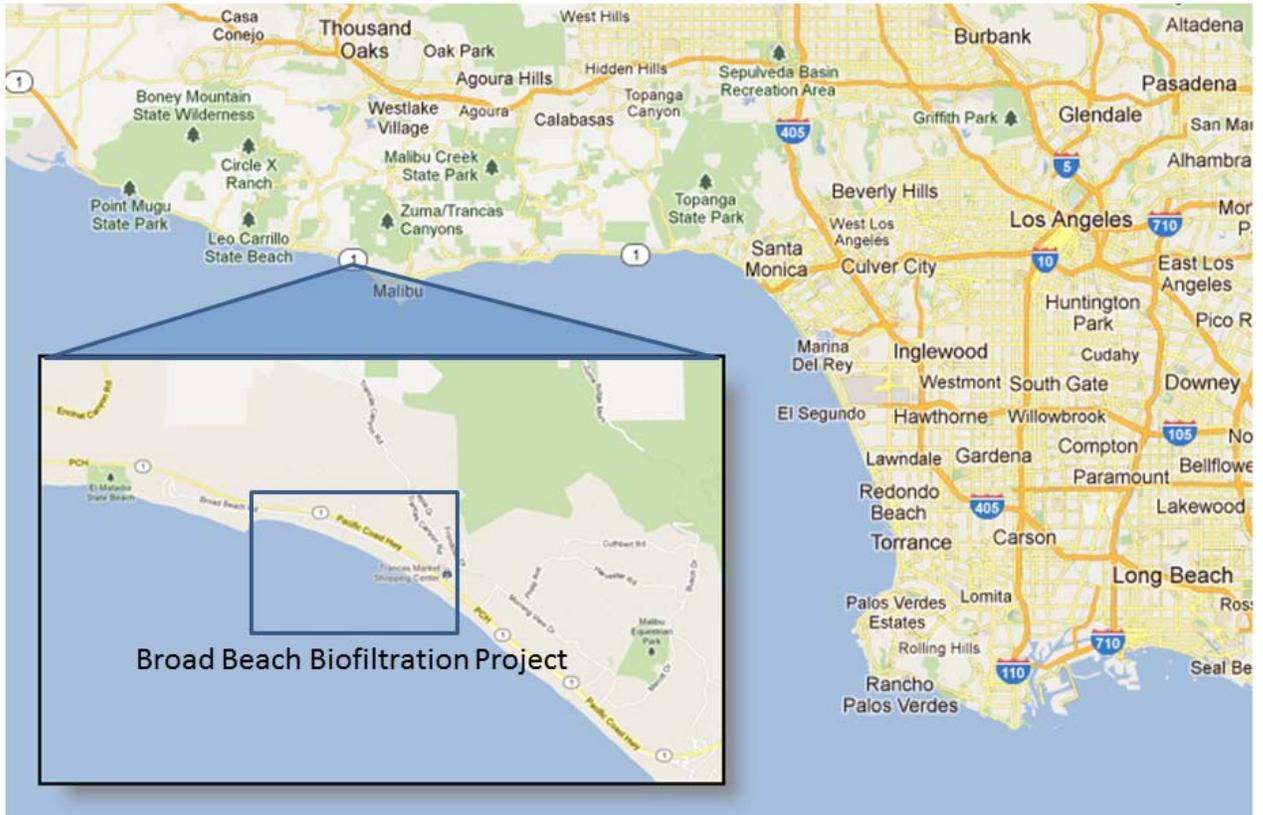


Figure 2-2. Location map of Project area



Figure 2-3. Private irrigation system contributing to dry-weather runoff



Figure 2-4. Private irrigation piping in storm drain



Figure 2-5. Unpaved parking strip with potted plants



Figure 2-6. Cast in place concrete retaining wall with parking apron



Figure 2-7. Privately constructed waste concrete hardscape



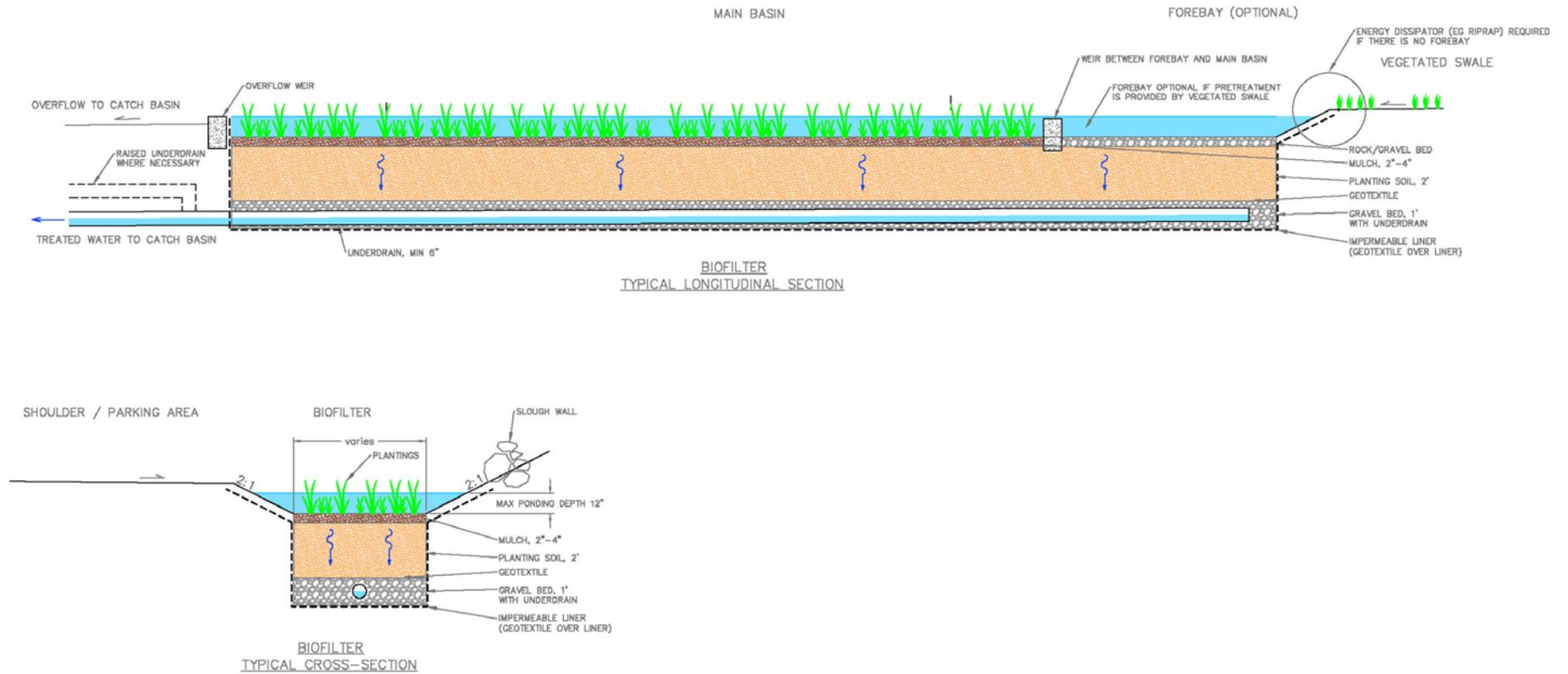
Figure 2-8. Brick retaining wall



Figure 2-9. Treated wood retaining wall



Figure 6-1. Typical biofilter cross-sections and details



DETAILS ARE NOT TO SCALE

Figure 6-2. Flow diagram for Alternative 1

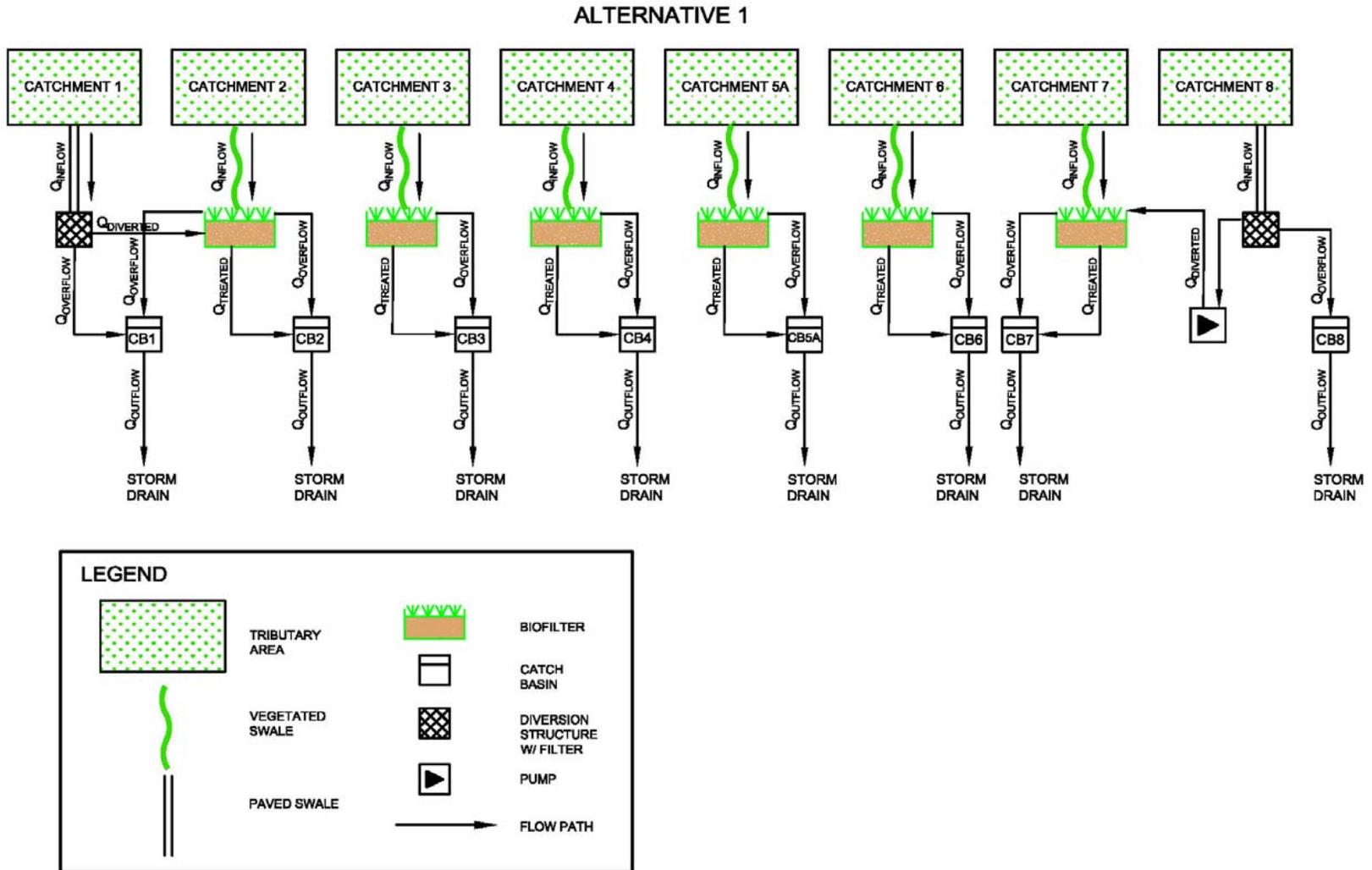
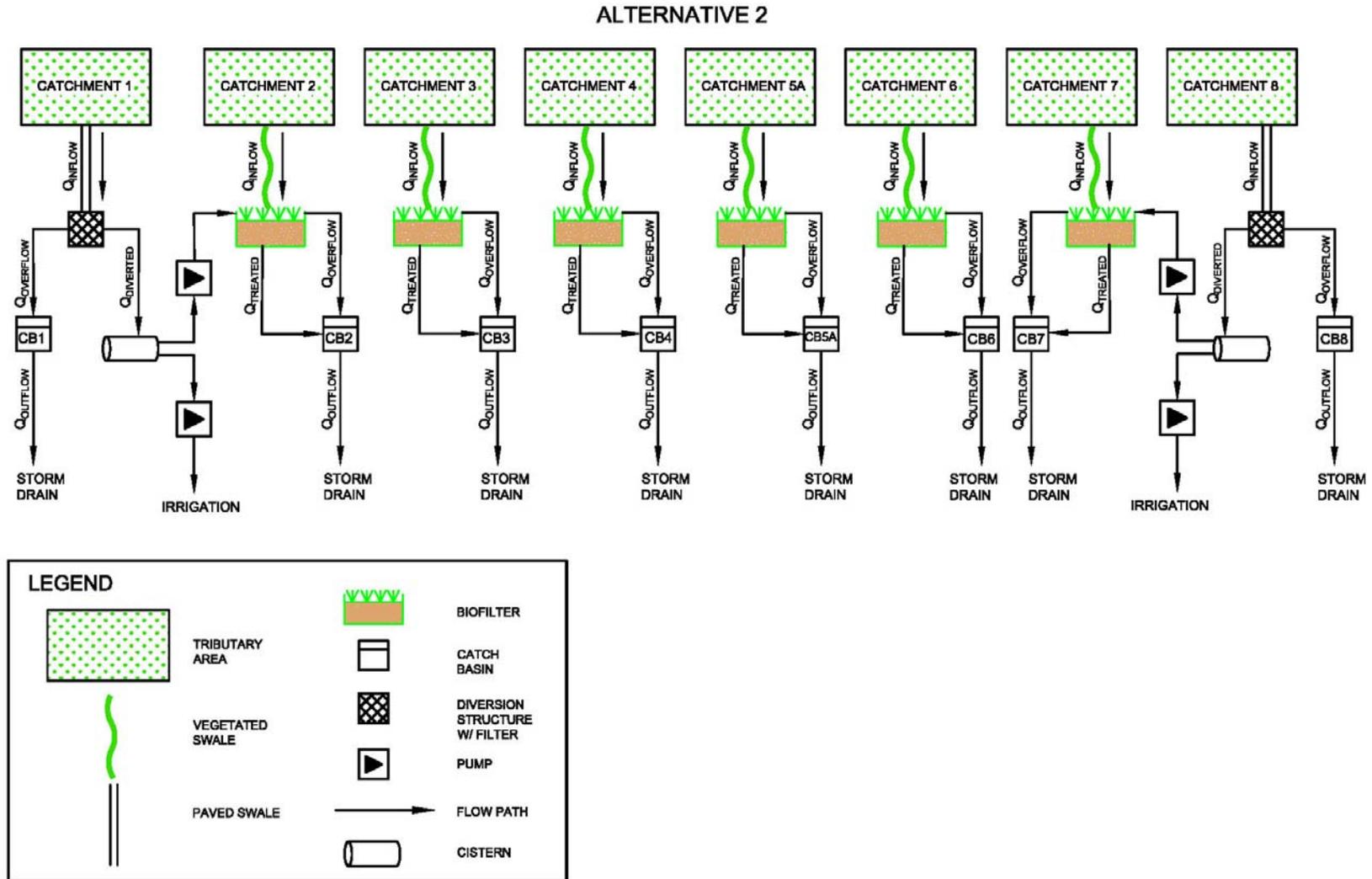
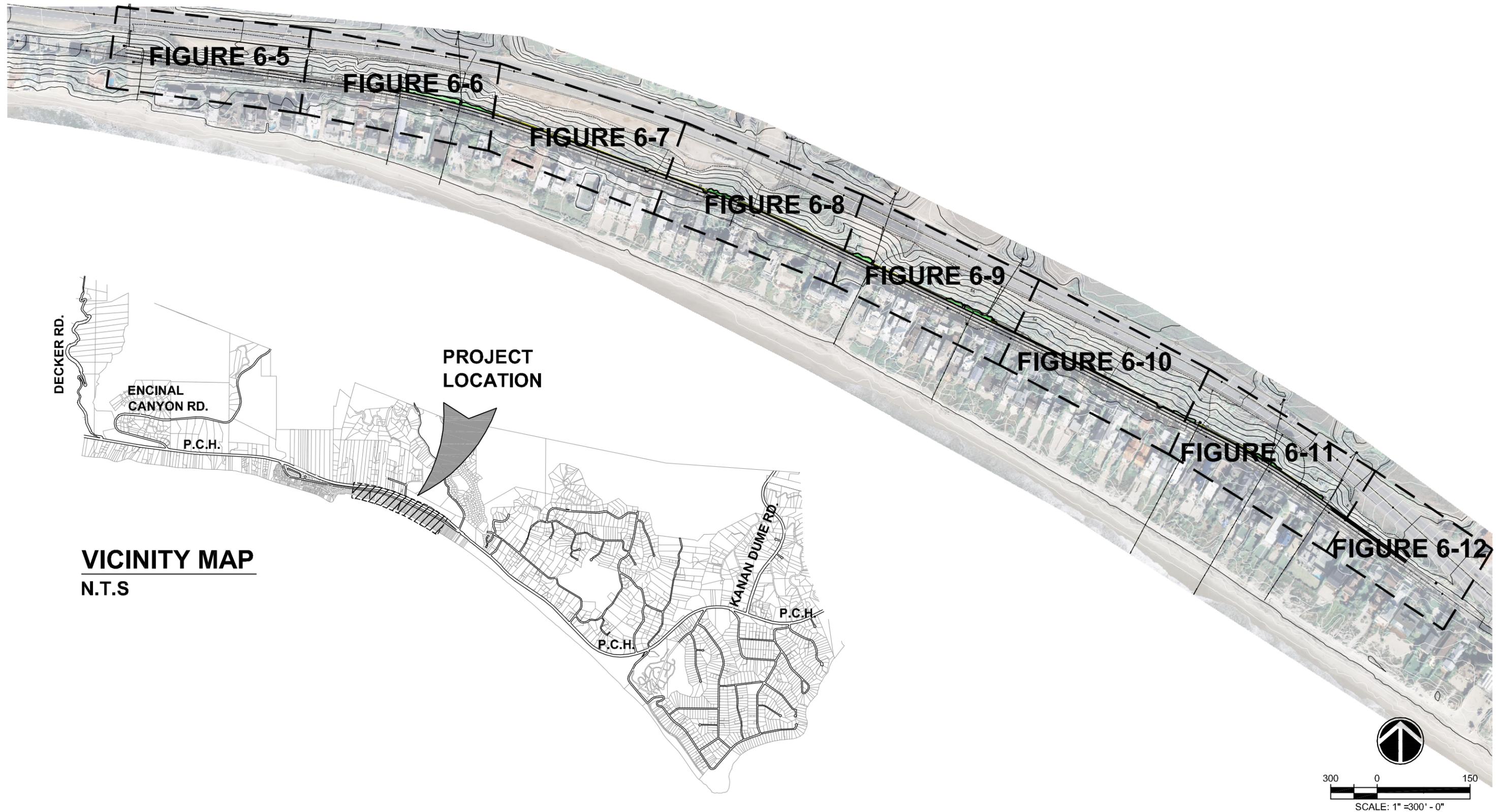


Figure 6-3. Flow diagram for Alternative 2





VICINITY MAP
N.T.S



LNDG JOB # 2341-01



Client:
City of Malibu
DEPARTMENT OF PUBLIC WORKS
23825 STUART RANCH ROAD
MALIBU, CA 90265
PHONE: 310.456.2489

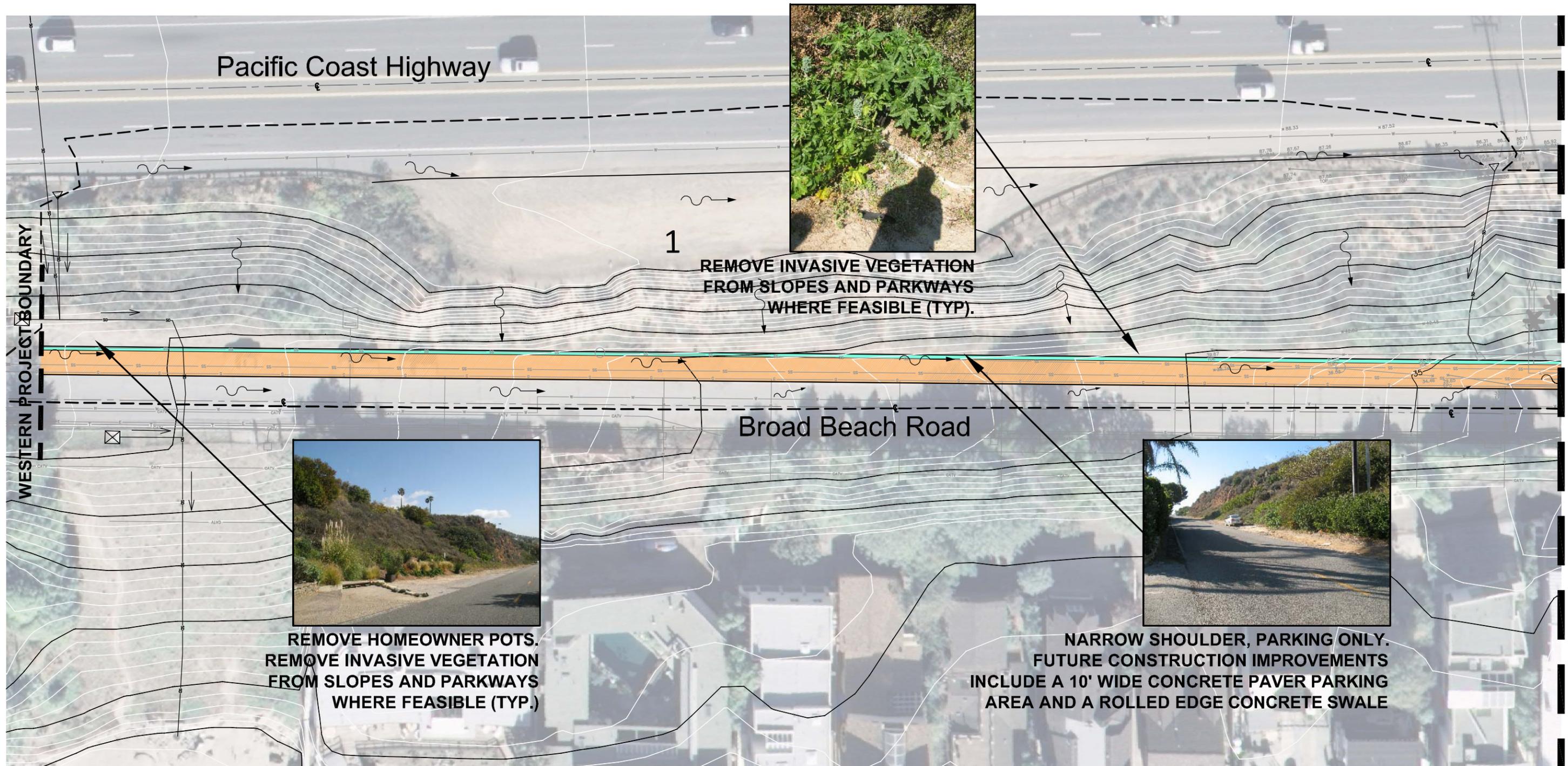


Broad Beach Road Biofiltration Project

Preliminary Landscape & Biofilter Plan

Preliminary Design - Not for Construction

Figure 6-4

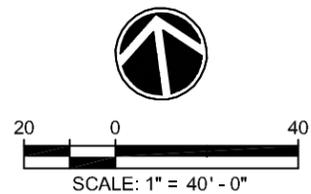


FUTURE CONSTRUCTION IMPROVEMENTS

(These areas are to be completed under separate funding at a later date)

-  10' Wide Concrete Paver Parking Area
-  Rolled Edge Concrete Swale
-  Concrete Swale

NOTE: Selective vegetation removal and site clean-up shall occur within the entire project boundary as part of this construction scope-of-work and budget.



LNDG JOB # 2341-01



Client:
City of Malibu
 DEPARTMENT OF PUBLIC WORKS
 23825 STUART RANCH ROAD
 MALIBU, CA 90265
 PHONE: 310.456.2489



Broad Beach Road Biofiltration Project

Preliminary Landscape & Biofilter Plan

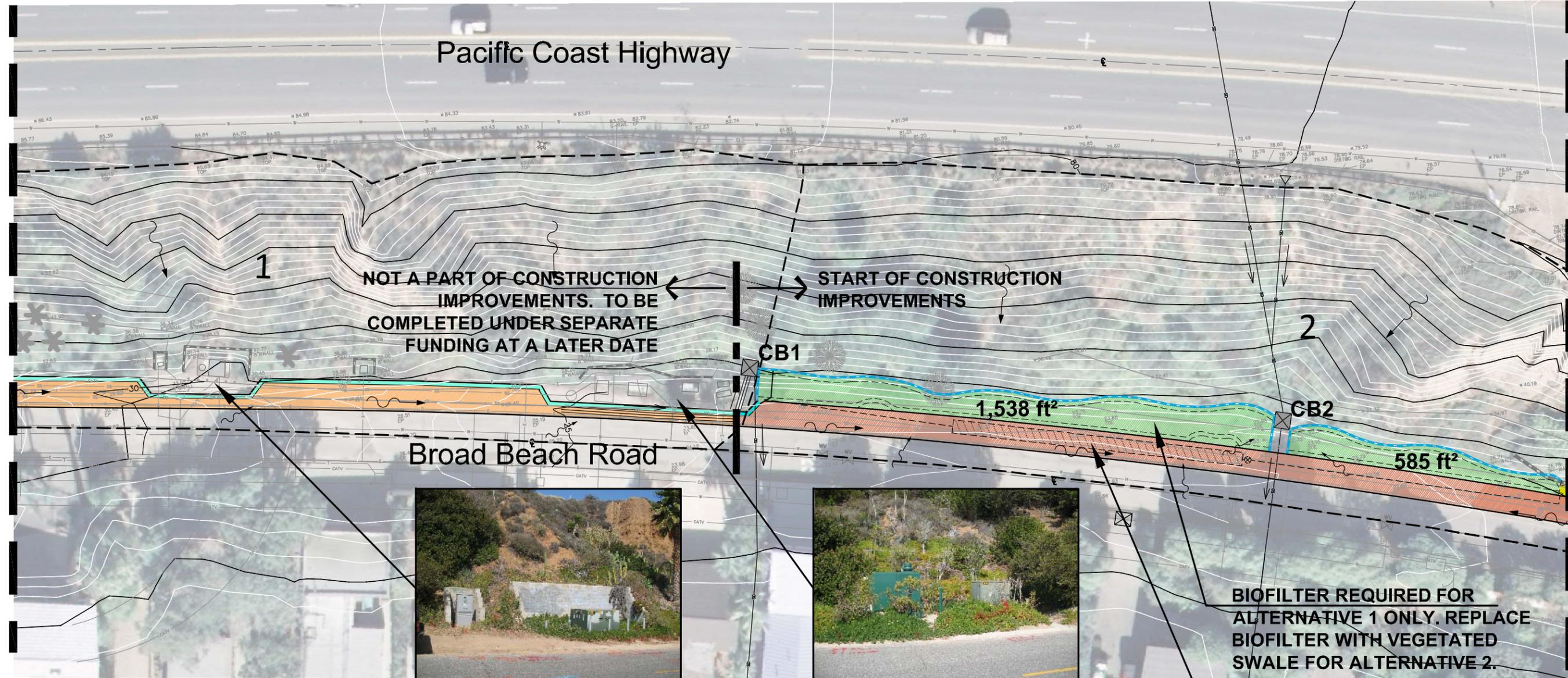
Preliminary Design - Not for Construction

Figure 6-5

MATCHLINE SEE FIGURE 6-6

MATCHLINE SEE FIGURE 6-5

MATCHLINE SEE FIGURE 6-7



EXISTING UTILITIES, REMOVE EXISTING VEGETATION FROM UTILITY SETBACKS (TYP.)



SEWER LIFT STATION, REMOVE EXISTING VEGETATION FROM UTILITY SETBACKS (TYP.)

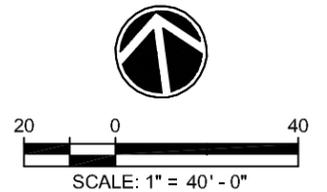
LEGEND:

- 10' Wide Concrete Paver Parking Area
- Rolled Edge Concrete Swale
- Vegetated Biofilter
- Vegetated Swale
- Alternative 2 Storage Tank
- Wall
- Catchment Area Boundary
- Existing Catch Basin

FUTURE CONSTRUCTION IMPROVEMENTS
(These areas are to be completed under separate funding at a later date)

- 10' Wide Concrete Paver Parking Area
- Rolled Edge Concrete Swale
- Concrete Swale

NOTE: Selective vegetation removal and site clean-up shall occur within the entire project boundary as part of this construction scope-of-work and budget.



L. Newman Design Group, Inc.
 • Landscape Architecture
 • Planning
 • Horticulture
 • Biological Restoration
 91100 15th Colfax • Suite 100
 Westlake Village, CA 91362-3302
 Phone: (818) 991-5055 • Fax: (818) 991-5478
 Email: lndg@lndg.com

Geosyntec consultants
 engineers | scientists | innovators

Client:
City of Malibu
 DEPARTMENT OF PUBLIC WORKS
 23825 STUART RANCH ROAD
 MALIBU, CA 90265
 PHONE: 310.456.2489



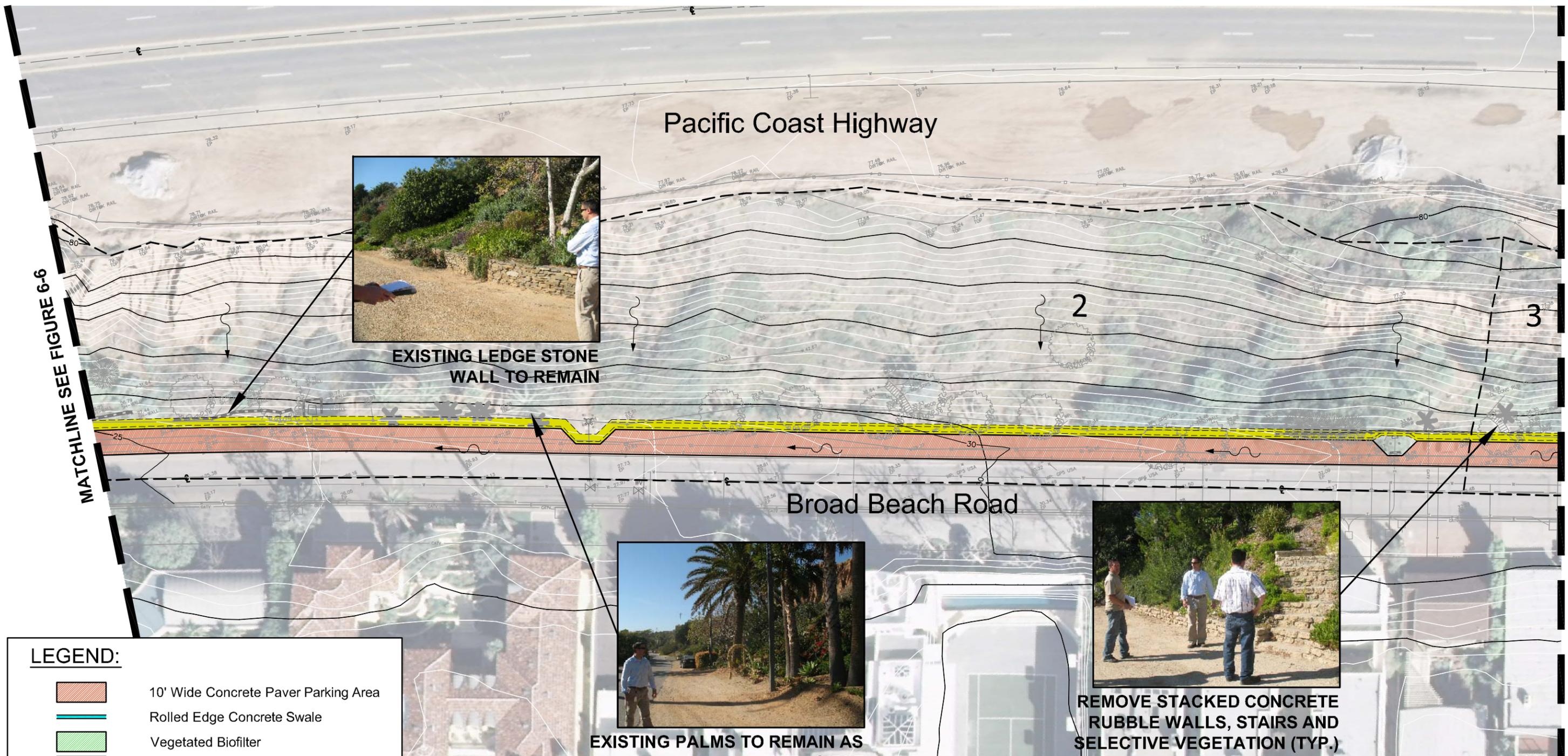
Broad Beach Road Biofiltration Project

Preliminary Landscape & Biofilter Plan

Preliminary Design - Not for Construction

Figure 6-6

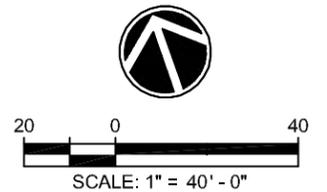
LNDG JOB # 2341-01



LEGEND:

	10' Wide Concrete Paver Parking Area
	Rolled Edge Concrete Swale
	Vegetated Biofilter
	Vegetated Swale
	Alternative 2 Storage Tank
	Wall
	Catchment Area Boundary
	Existing Catch Basin

NOTE: Selective vegetation removal and site clean-up shall occur within the entire project boundary as part of this construction scope-of-work and budget.



Client:
City of Malibu
 DEPARTMENT OF PUBLIC WORKS
 23825 STUART RANCH ROAD
 MALIBU, CA 90265
 PHONE: 310.456.2489



Broad Beach Road Biofiltration Project

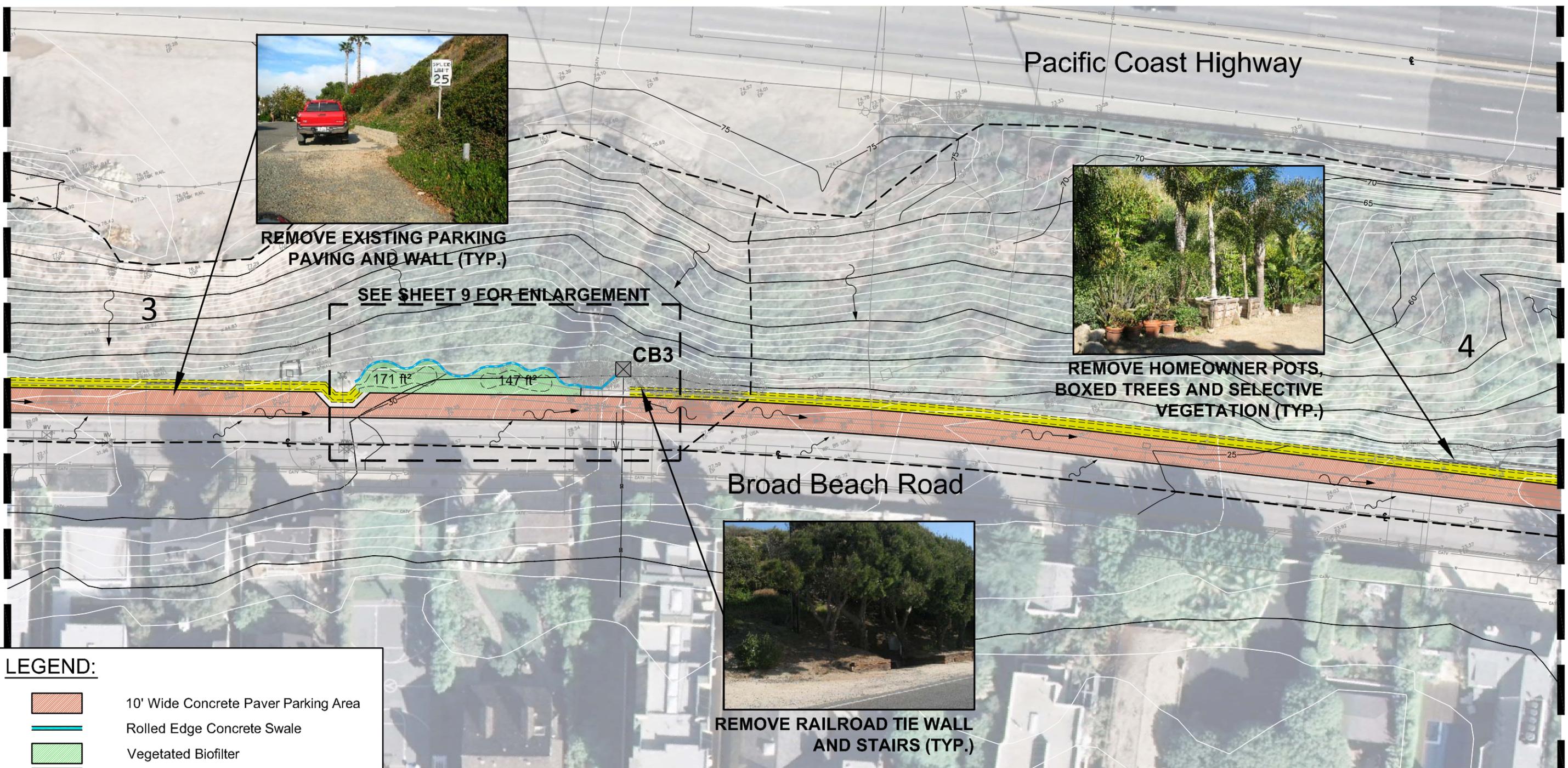
Preliminary Landscape & Biofilter Plan

Preliminary Design - Not for Construction

Figure 6-7

MATCHLINE SEE FIGURE 6-7

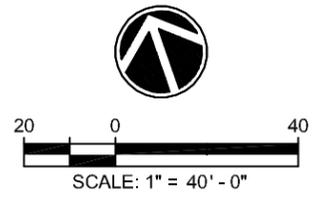
MATCHLINE SEE FIGURE 6-9



LEGEND:

-  10' Wide Concrete Paver Parking Area
-  Rolled Edge Concrete Swale
-  Vegetated Biofilter
-  Vegetated Swale
-  Alternative 2 Storage Tank
-  Wall
-  Catchment Area Boundary
-  Existing Catch Basin

NOTE: Selective vegetation removal and site clean-up shall occur within the entire project boundary as part of this construction scope-of-work and budget.



L. Newman Design Group, Inc.
 • Landscape Architecture
 • Planning
 • Horticulture
 • Biological Restoration
 91100 14th Street • Suite 100
 Westlake Village, CA 91362-3800
 Phone: (818) 991-5055 • Fax: (818) 991-5478
 Email: lndg@lndg.com

Geosyntec consultants
 engineers | scientists | innovators

Client:
City of Malibu
 DEPARTMENT OF PUBLIC WORKS
 23825 STUART RANCH ROAD
 MALIBU, CA 90265
 PHONE: 310.456.2489

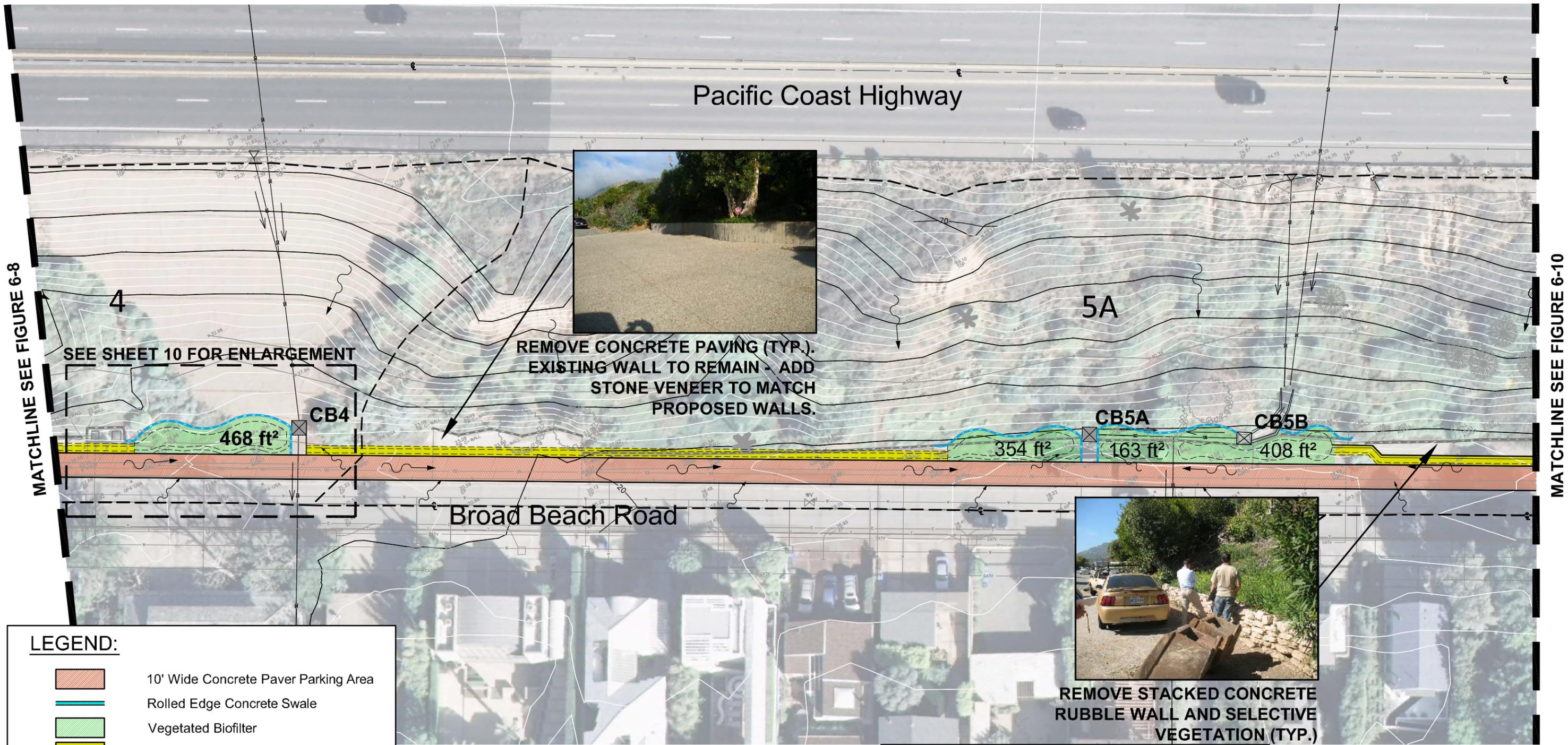


Broad Beach Road Biofiltration Project

Preliminary Landscape & Biofilter Plan

Preliminary Design - Not for Construction

Figure 6-8



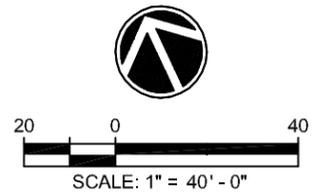
MATCHLINE SEE FIGURE 6-8

MATCHLINE SEE FIGURE 6-10

LEGEND:

- 10' Wide Concrete Paver Parking Area
- Rolled Edge Concrete Swale
- Vegetated Biofilter
- Vegetated Swale
- Alternative 2 Storage Tank
- Wall
- Catchment Area Boundary
- Existing Catch Basin

NOTE: Selective vegetation removal and site clean-up shall occur within the entire project boundary as part of this construction scope-of-work and budget.



Client:
City of Malibu
 DEPARTMENT OF PUBLIC WORKS
 23825 STUART RANCH ROAD
 MALIBU, CA 90265
 PHONE: 310.456.2489



Broad Beach Road Biofiltration Project

Preliminary Landscape & Biofilter Plan

Preliminary Design - Not for Construction

Figure 6-9

Pacific Coast Highway

Broad Beach Road



REMOVE EXISTING WALL AND SELECTIVE VEGETATION (TYP.)

5A

6

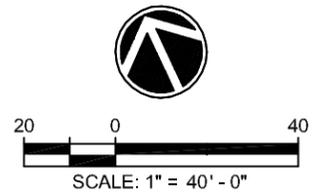
MATCHLINE SEE FIGURE 6-9

MATCHLINE SEE FIGURE 6-11

LEGEND:

-  10' Wide Concrete Paver Parking Area
-  Rolled Edge Concrete Swale
-  Vegetated Biofilter
-  Vegetated Swale
-  Alternative 2 Storage Tank
-  Wall
-  Catchment Area Boundary
-  Existing Catch Basin

NOTE: Selective vegetation removal and site clean-up shall occur within the entire project boundary as part of this construction scope-of-work and budget.



Broad Beach Road Biofiltration Project

Preliminary Landscape & Biofilter Plan

Preliminary Design - Not for Construction

Figure 6-10

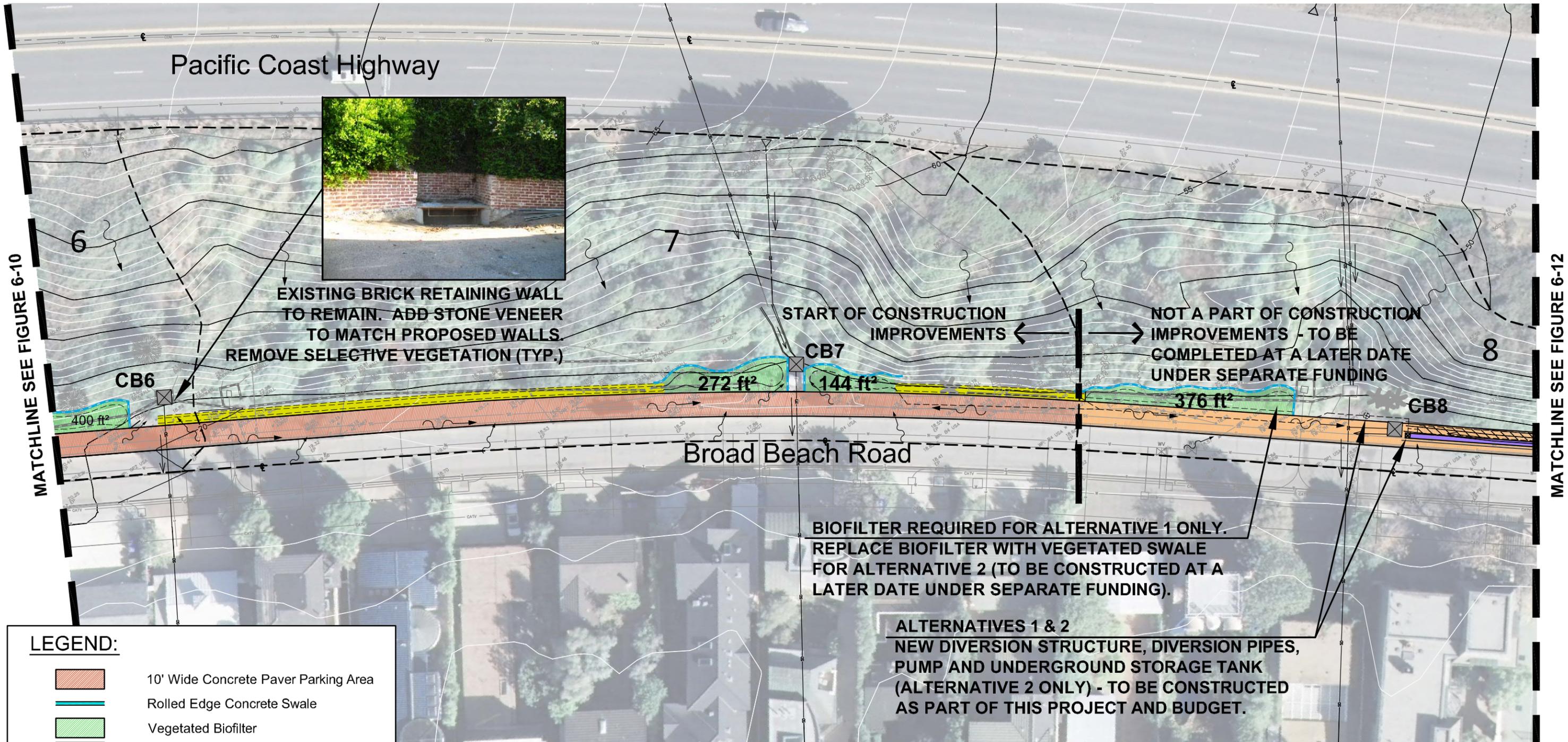


LNDG JOB # 2341-01



Client:
City of Malibu
 DEPARTMENT OF PUBLIC WORKS
 23825 STUART RANCH ROAD
 MALIBU, CA 90265
 PHONE: 310.456.2489





MATCHLINE SEE FIGURE 6-10

MATCHLINE SEE FIGURE 6-12

LEGEND:

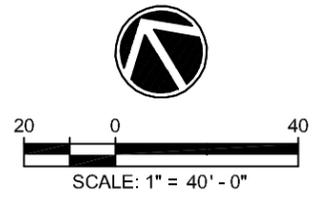
- 10' Wide Concrete Paver Parking Area
- Rolled Edge Concrete Swale
- Vegetated Biofilter
- Vegetated Swale
- Alternative 2 Storage Tank
- Wall
- Catchment Area Boundary
- Existing Catch Basin

FUTURE CONSTRUCTION IMPROVEMENTS

(These areas are to be completed under separate funding at a later date)

- 10' Wide Concrete Paver Parking Area
- Rolled Edge Concrete Swale
- Concrete Swale

NOTE: Selective vegetation removal and site clean-up shall occur within the entire project boundary as part of this construction scope-of-work and budget.



Client:
City of Malibu
 DEPARTMENT OF PUBLIC WORKS
 23825 STUART RANCH ROAD
 MALIBU, CA 90265
 PHONE: 310.456.2489



Broad Beach Road Biofiltration Project

Preliminary Landscape & Biofilter Plan

Preliminary Design - Not for Construction

Figure 6-11

MATCHLINE SEE FIGURE 6-11

Pacific Coast Highway



NARROW SHOULDER, PARKING ONLY.
FUTURE CONSTRUCTION
IMPROVEMENTS INCLUDE A 10' WIDE
CONCRETE PAVER PARKING AREA
WITH A CENTER CONCRETE SWALE

NEW UNDERGROUND STORAGE TANK
TO BE CONSTRUCTED AS PART OF
THIS PROJECT AND BUDGET.

EASTERN PROJECT BOUNDARY

Broad Beach Road

FUTURE CONSTRUCTION IMPROVEMENTS

(These areas are to be completed under separate funding at a later date)

-  10' Wide Concrete Paver Parking Area
-  Rolled Edge Concrete Swale
-  Concrete Swale

NOTE: Selective vegetation removal and site clean-up shall occur within the entire project boundary as part of this construction scope-of-work and budget.



20 0 40
SCALE: 1" = 40' - 0"



LNDG JOB # 2341-01



Client:
City of Malibu
DEPARTMENT OF PUBLIC WORKS
23825 STUART RANCH ROAD
MALIBU, CA 90265
PHONE: 310.456.2489

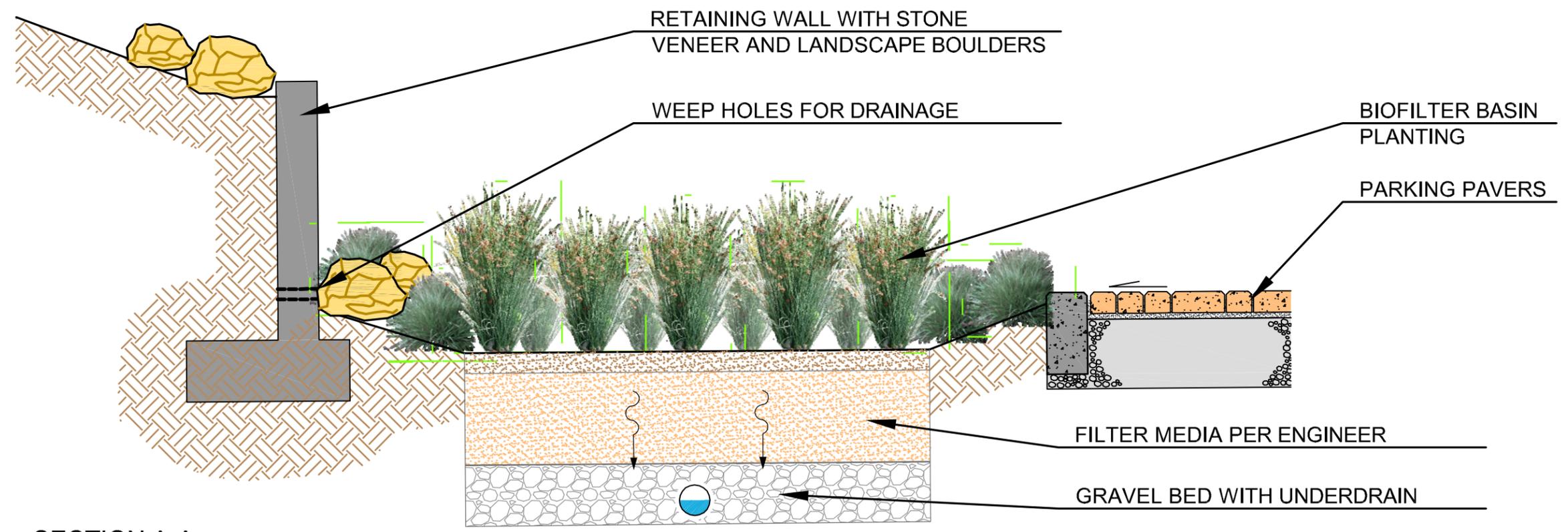
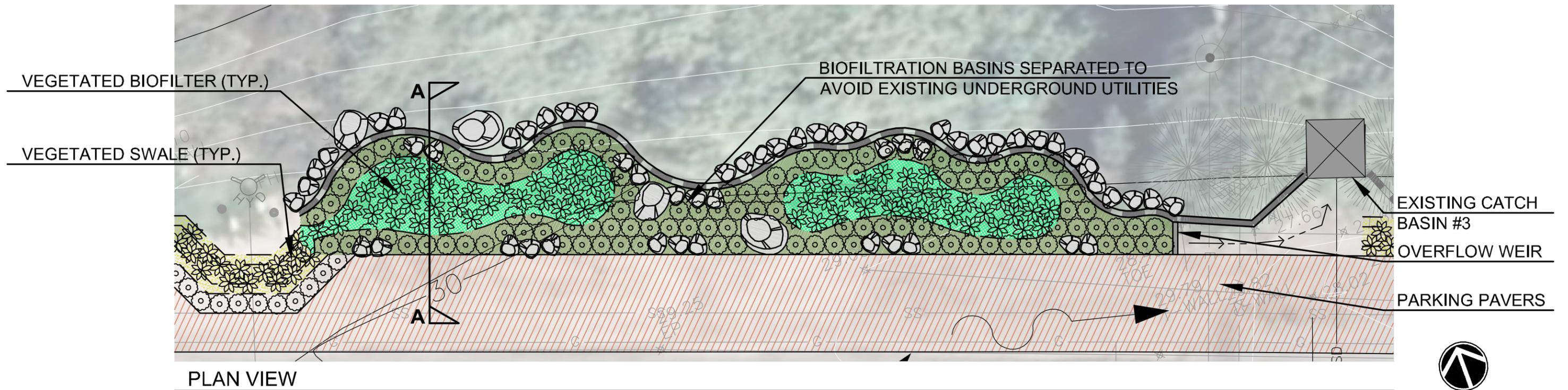


Broad Beach Road Biofiltration Project

Preliminary Landscape & Biofilter Plan

Preliminary Design - Not for Construction

Figure 6-12



Broad Beach Road Biofiltration Project

Preliminary Landscape & Biofilter Plan

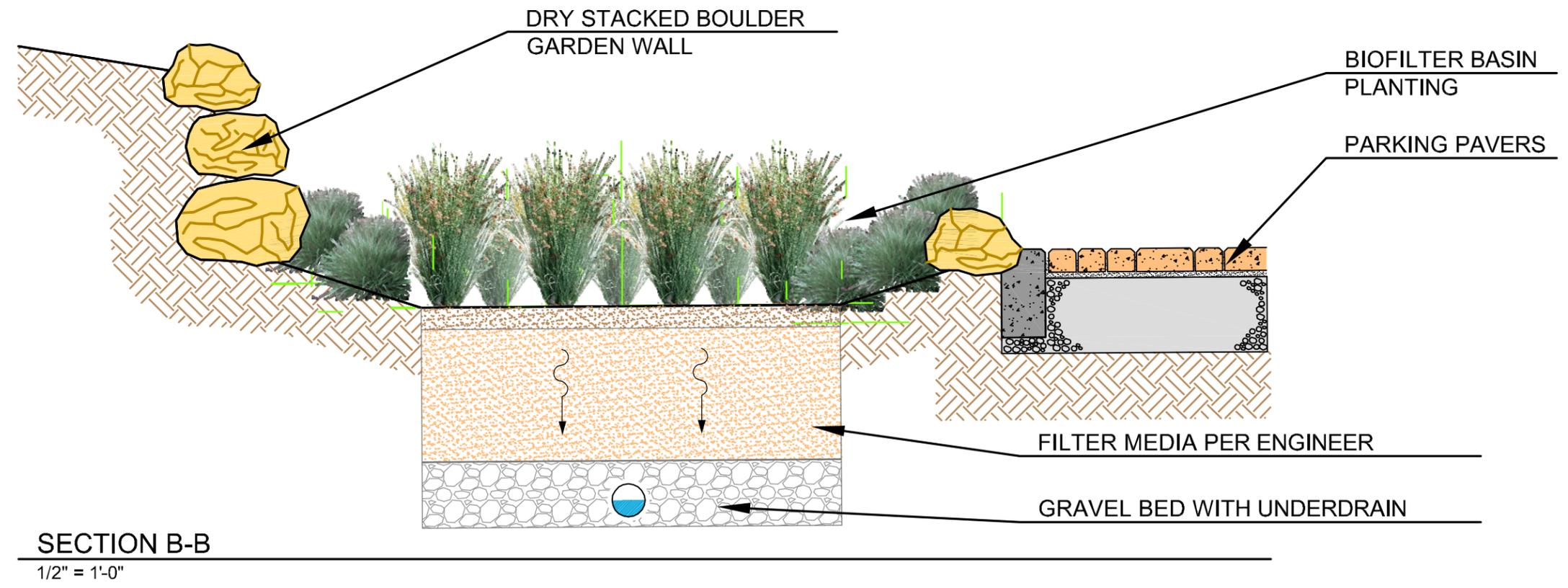
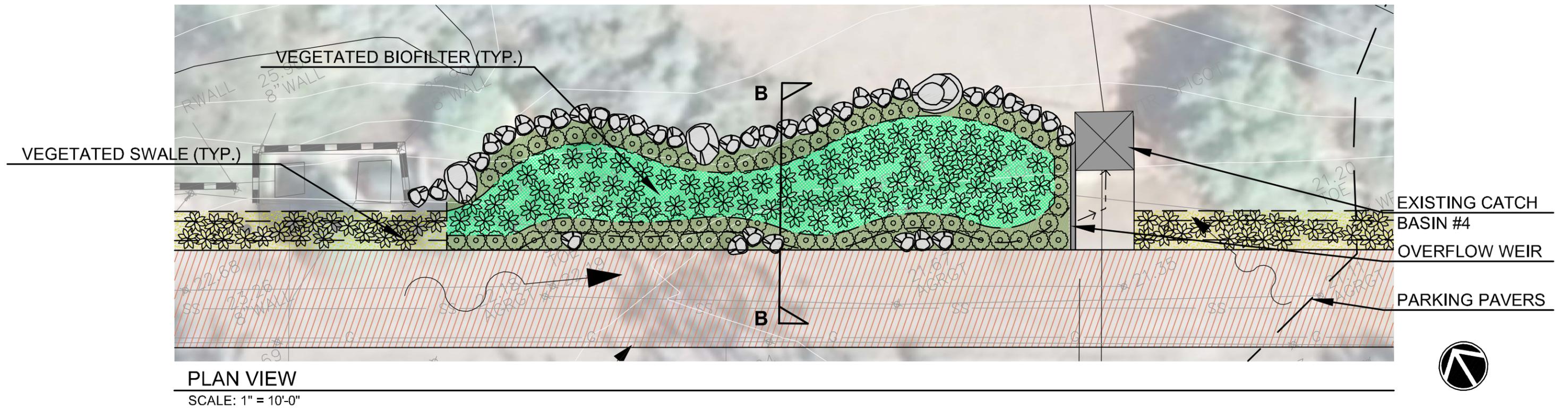
Preliminary Design - Not for Construction

Figure 6-13



Client:
City of Malibu
 DEPARTMENT OF PUBLIC WORKS
 23825 STUART RANCH ROAD
 MALIBU, CA 90265
 PHONE: 310.456.2489

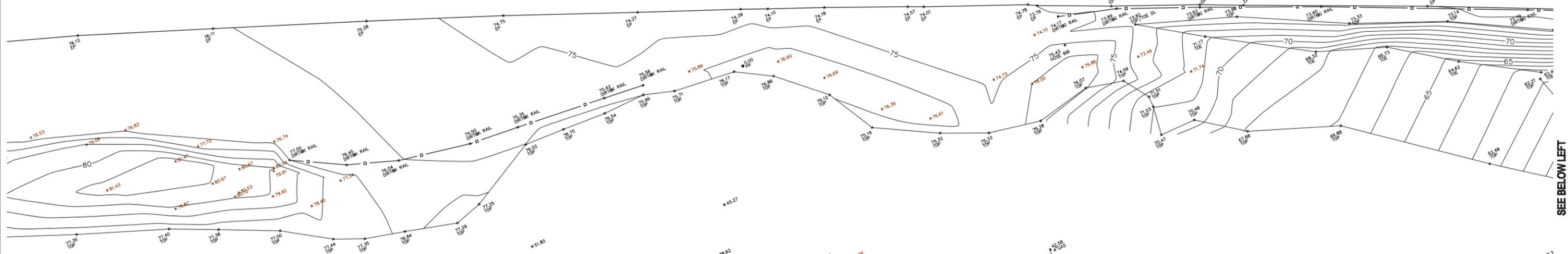




APPENDIX A

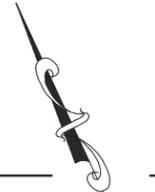
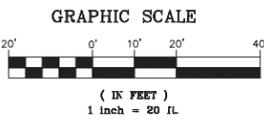
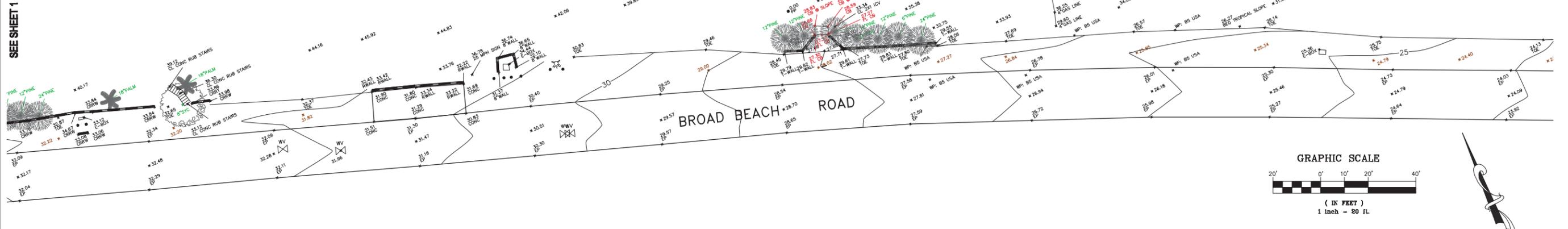
TOPOGRAPHY MAPS

PACIFIC COAST HIGHWAY

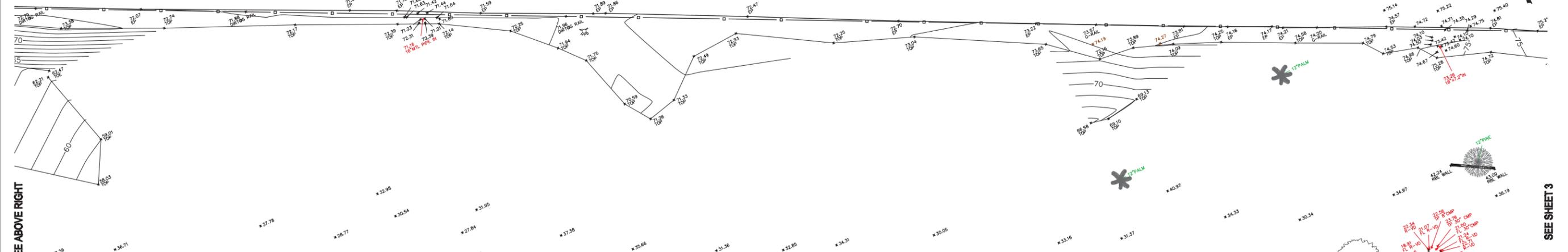


SEE SHEET 1

SEE BELOW LEFT

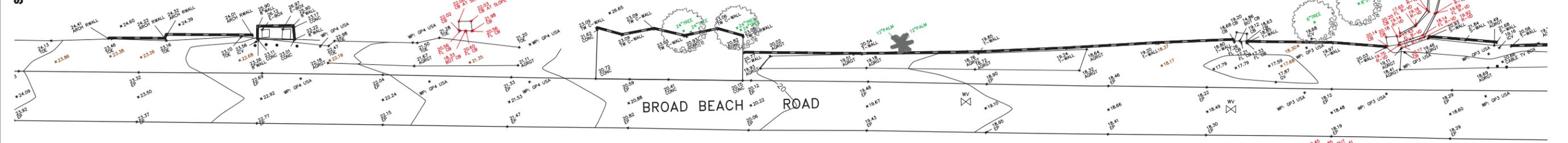


PACIFIC COAST HIGHWAY



SEE ABOVE RIGHT

SEE SHEET 3



LEGEND (SEE SHEET 4)

PREPARED FOR: **CITY OF MALIBU**

PREPARED BY: **Lund and Associates Engineering, Inc.**
Civil Engineering/Lead Surveying/Lead Planning

28212 Kelly Johnson Park, Ste. 115
Van Nuys, California 91355
(818) 744-3984

DATE: 11/14/2011

SCALE: 1" = 20'

W.O.: _____

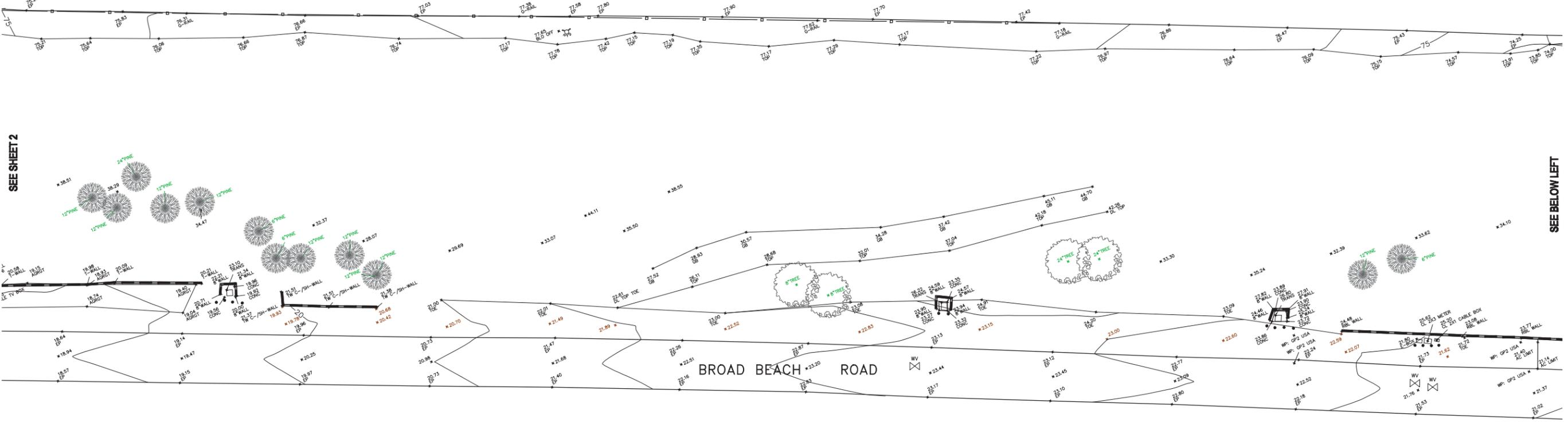
SHEET 2 OF 4 SHEETS

NO.	REVISION	DATE	CHK'D BY

PACIFIC COAST HIGHWAY

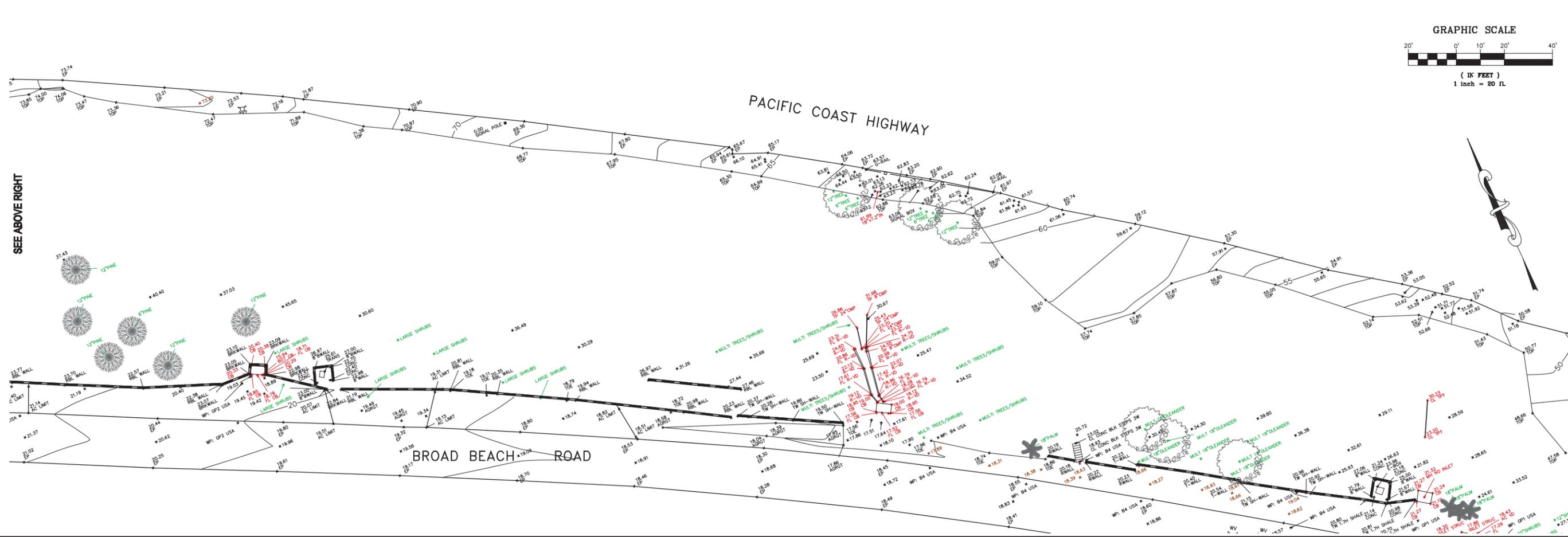
LEGEND

(SEE SHEET 4)



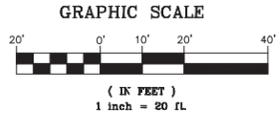
SEE SHEET 2

SEE BELOW LEFT



SEE ABOVE RIGHT

SEE SHEET 4



DATE: 11/14/2011
 SCALE: 1"=20'
 SHEET 3 OF 4 SHEETS

28212 Kelly Johnson Hwy, Ste. 115
 Valencia, California 91355
 (661) 244-3984

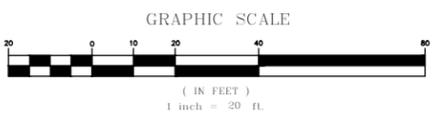
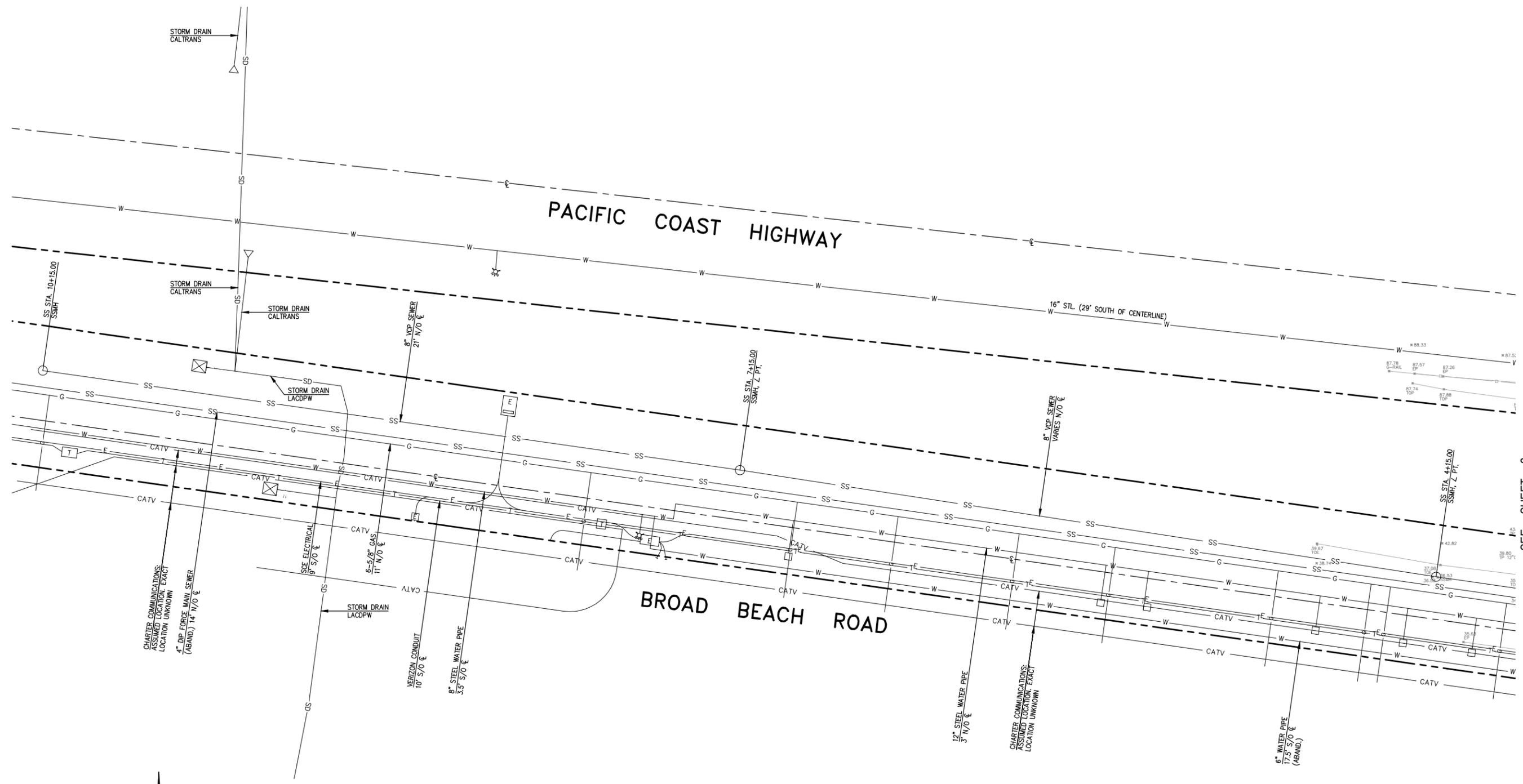
PREPARED BY:
 Lund and Associates Engineering, Inc.
 Civil Engineering/Land Surveying/Land Planning

NO.	REVISION	DATE	CHKD BY

PREPARED FOR:
 CITY OF MALIBU

APPENDIX B

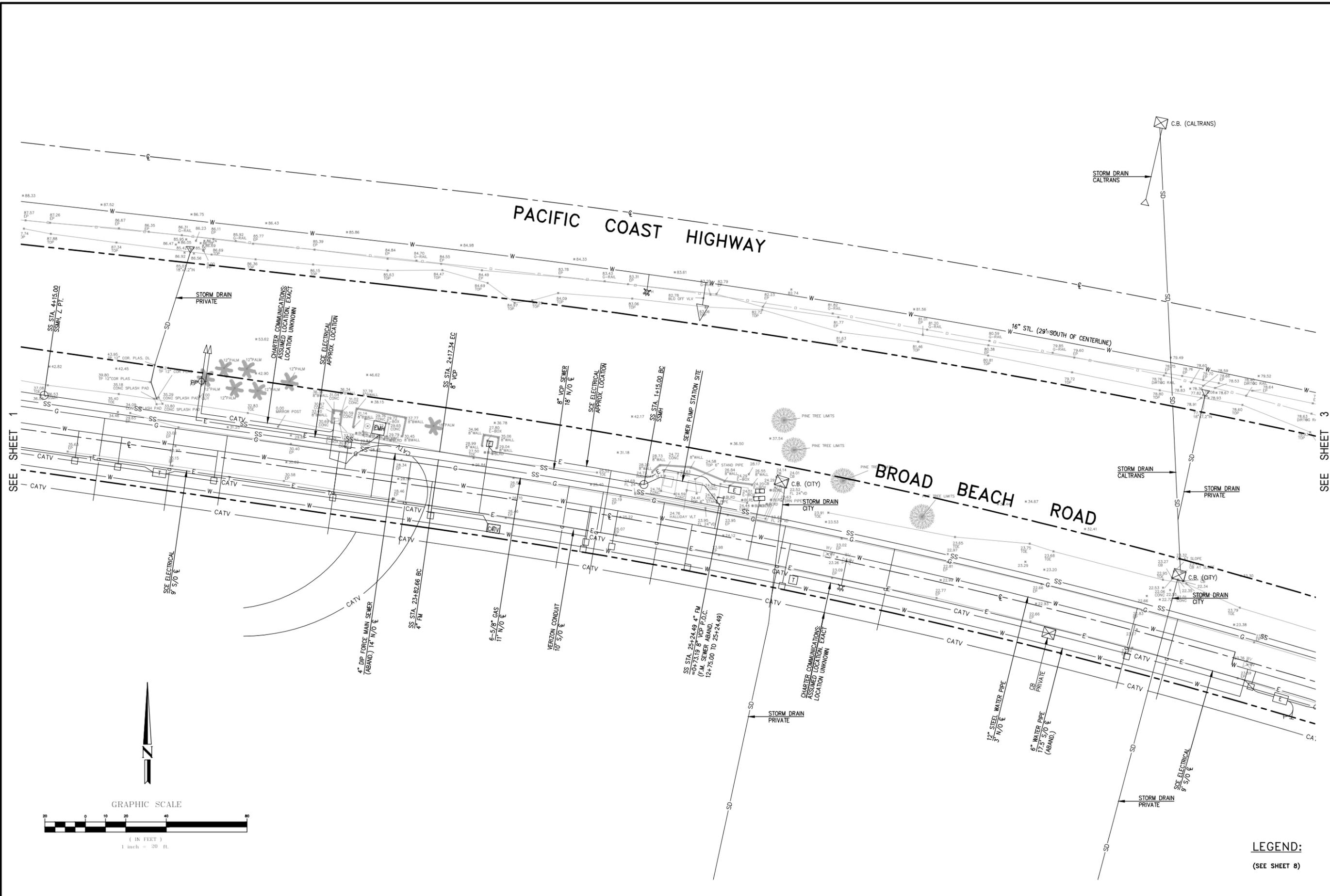
UTILITY BASE MAPS



LEGEND:
(SEE SHEET 8)

SEE SHEET 2

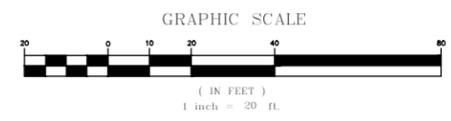
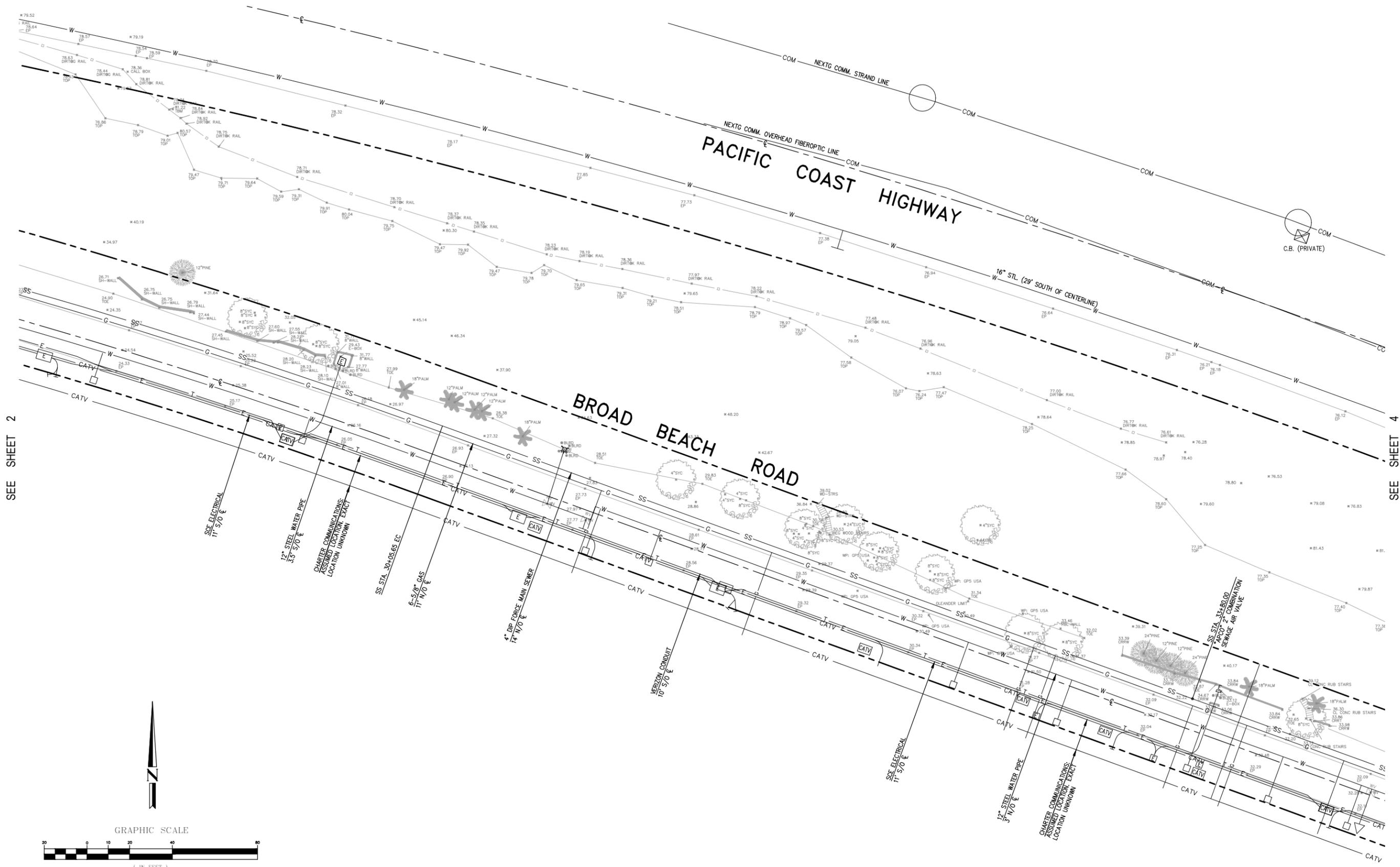
PREPARED FOR: **CITY OF MALIBU**
 DATE: _____
 REVISION: _____
 CHECKED BY: _____
 NO.: _____
 LUND and Associates Engineering, Inc.
 Civil Engineering/Land Surveying/Land Planning
 28212 Katy Johnson Pkwy, #115
 Venice, California 91355
 (611) 294-3384
 SCALE: 1"=20'
 DATE: 3/7/2012
 SHEET 1 OF 8 SHITS



LEGEND:
 (SEE SHEET 8)

SEE SHEET 2

SEE SHEET 4



LEGEND:
 (SEE SHEET 8)

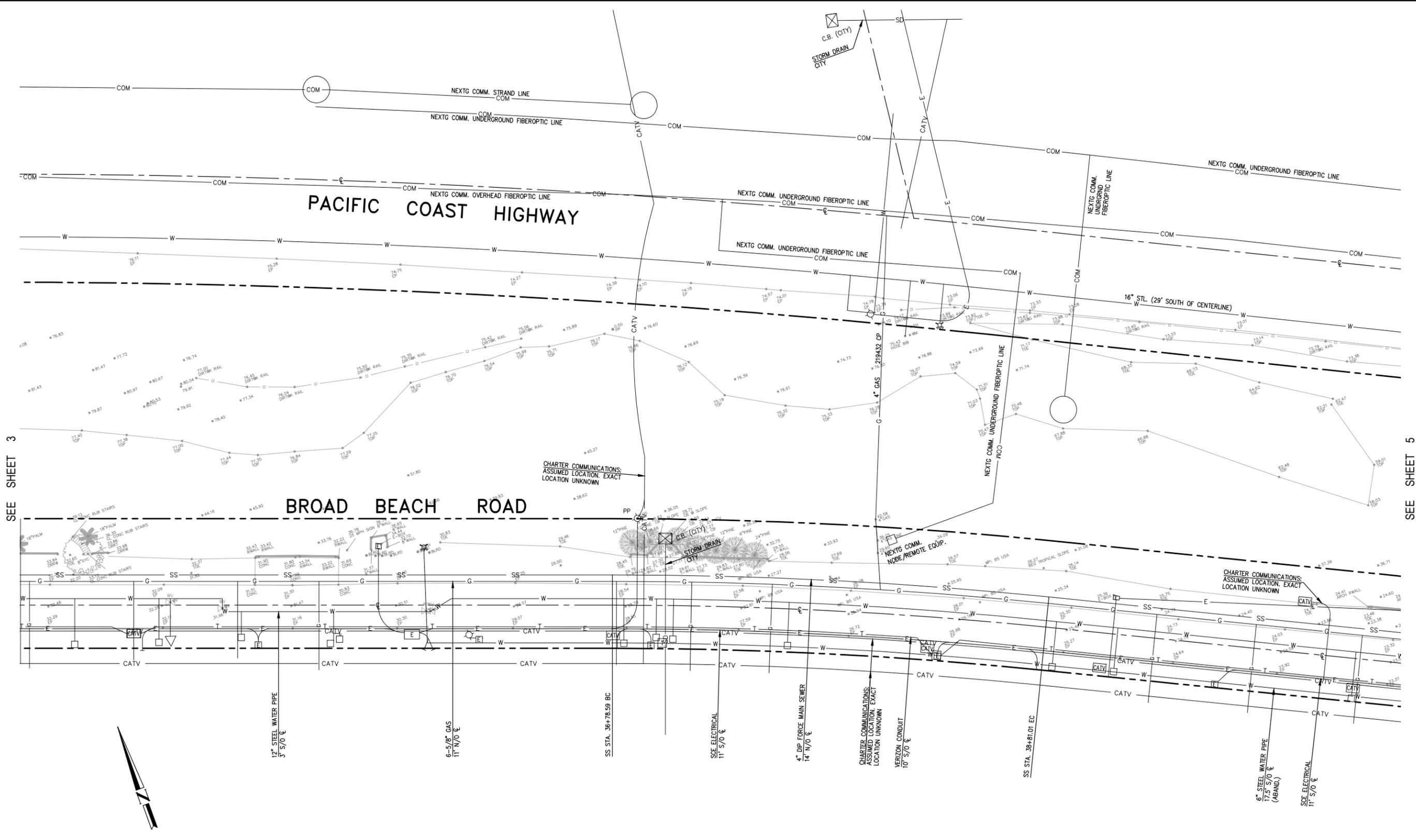
DATE: 3/7/2012 SCALE: 1"=20' SHEET 3 OF 8 SHTS

W.D.:

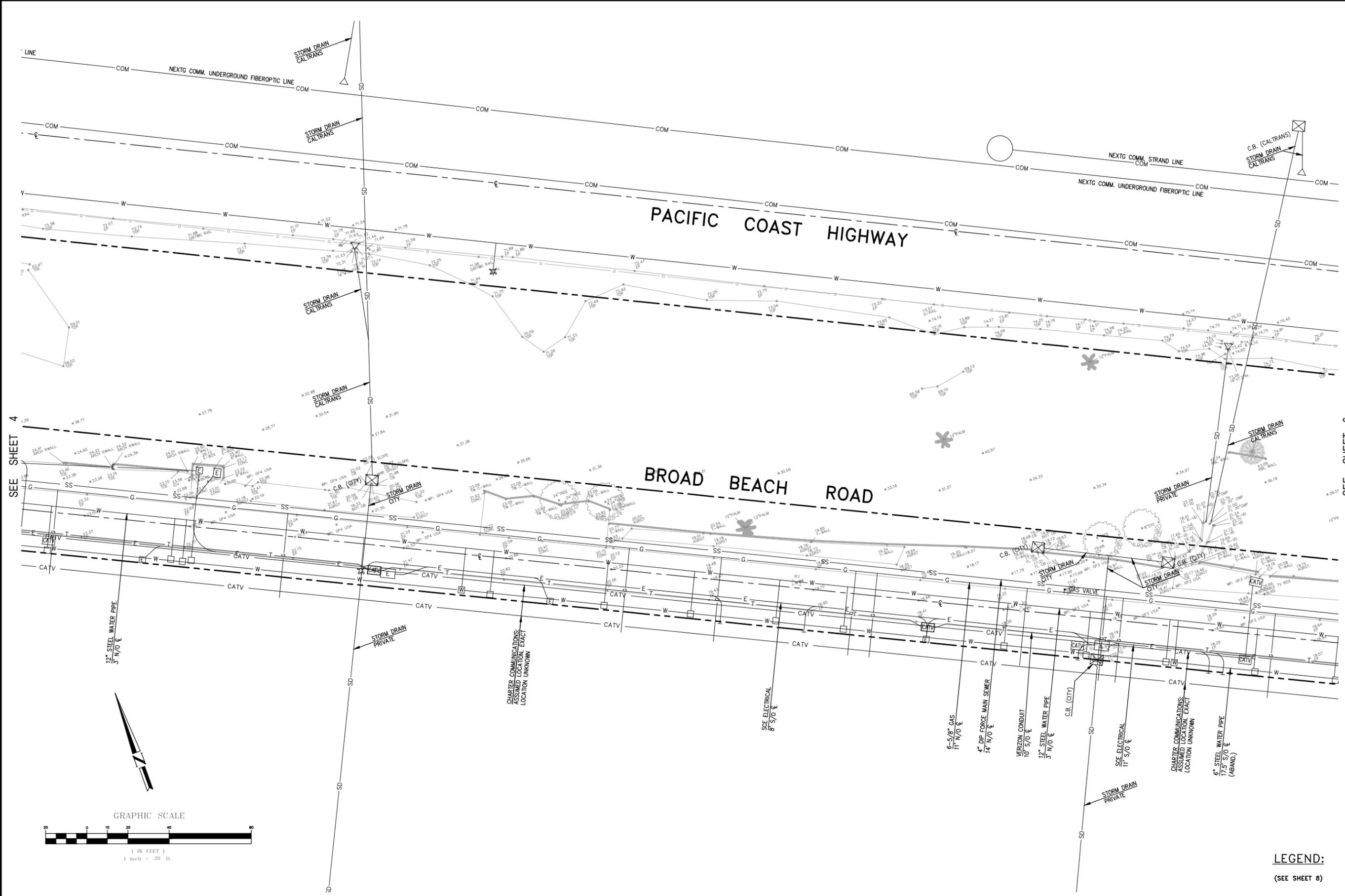
18212 Hwy. 101, Suite 111, Malibu, California 91355
 Lund and Associates Engineering, Inc.
 Civil Engineering/Land Surveying/Land Planning
 (818) 294-3884

NO.	REVISION	DATE	CHKD BY

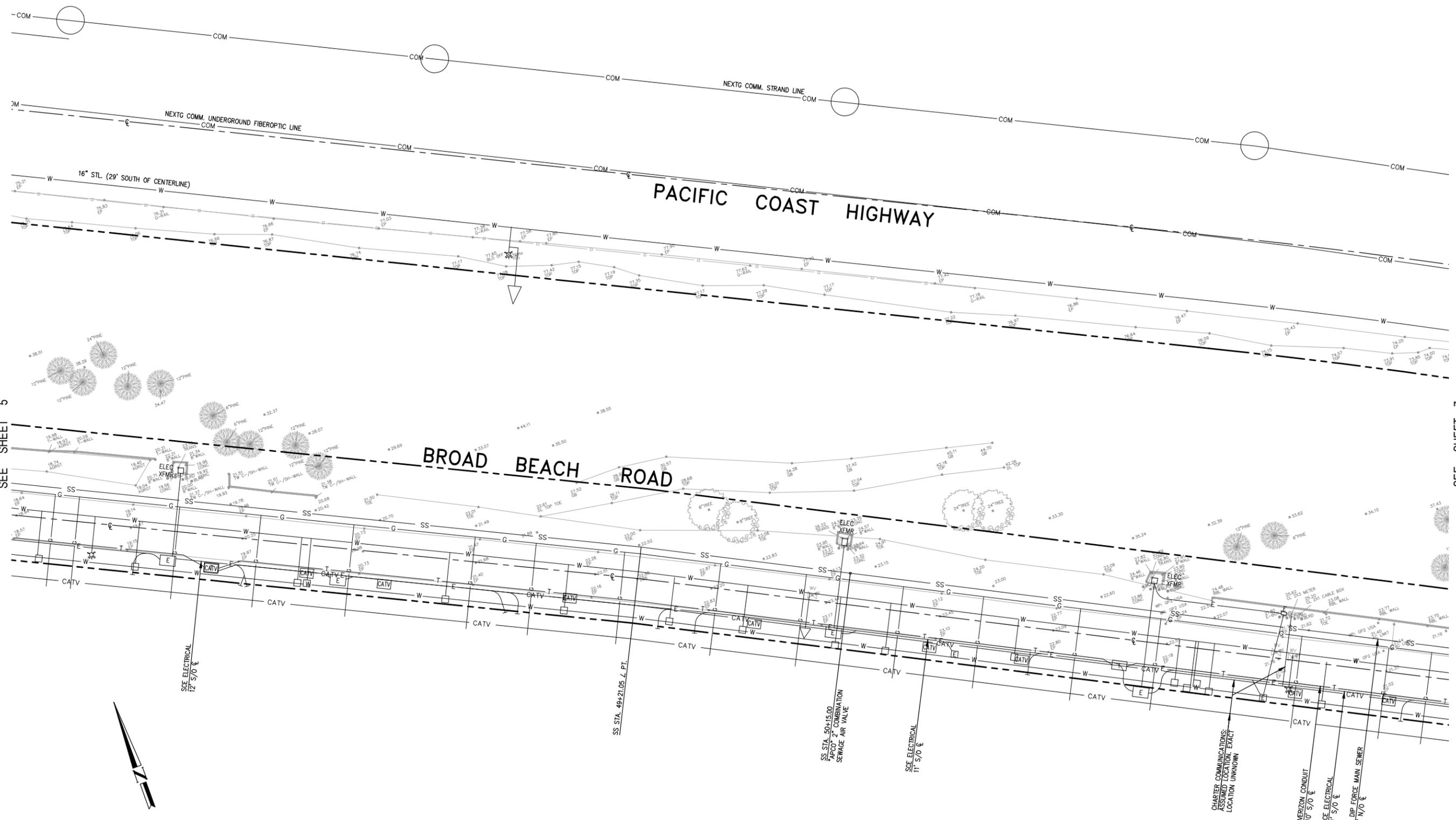
PREPARED FOR:
CITY OF MALIBU



LEGEND:
 (SEE SHEET 8)

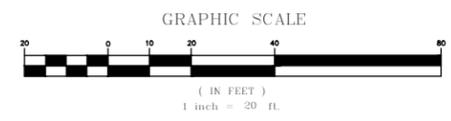


LEGEND:
 (SEE SHEET 8)



SEE SHEET 5

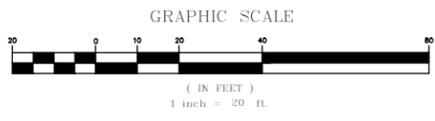
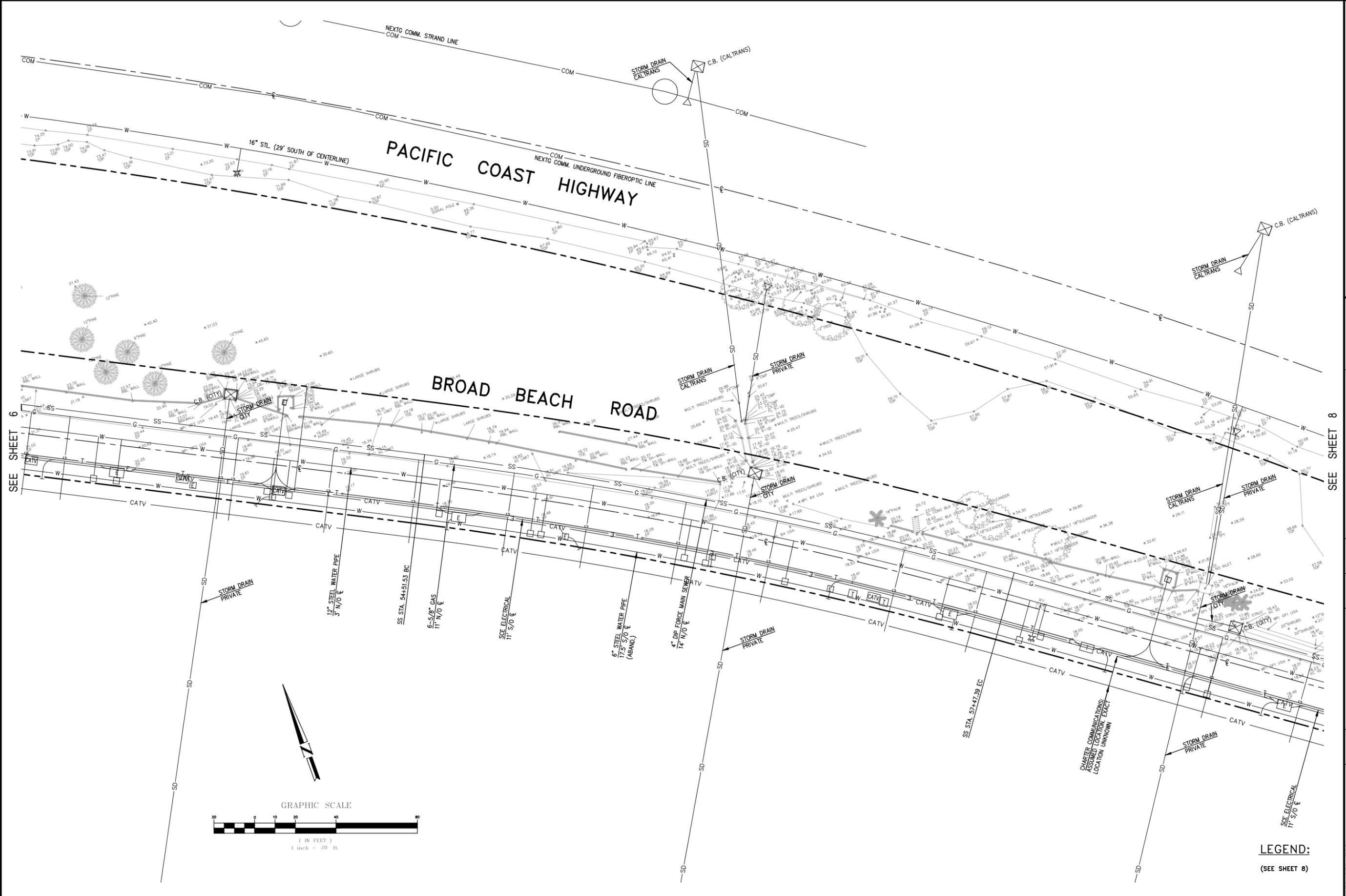
SEE SHEET 7



LEGEND:
 (SEE SHEET 8)

PREPARED FOR: **CITY OF MALIBU**
 DATE: **3/7/2012**
 SCALE: **1"=20'**
 SHEET **6** OF **8** SHITS
 W.D.:
 LUND and Associates Engineering, Inc.
 Civil Engineering/Land Surveying/Land Planning
 28212 Kelly Johnson Pkwy., #115
 Malibu, California 91355
 (818) 294-3884

NO.	REVISION	DATE	CHKD BY



LEGEND:
(SEE SHEET 8)

SEE SHEET 6

SEE SHEET 8

PREPARED FOR: CITY OF MALIBU

DATE: 3/7/2012

SCALE: 1"=20'

W.D.:

NO.:

REVISION:

CHKD BY:

DATE:

18212 Malibu Avenue, #115, Venice, California 91355 (611) 294-3894

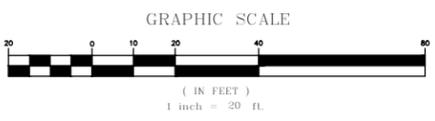
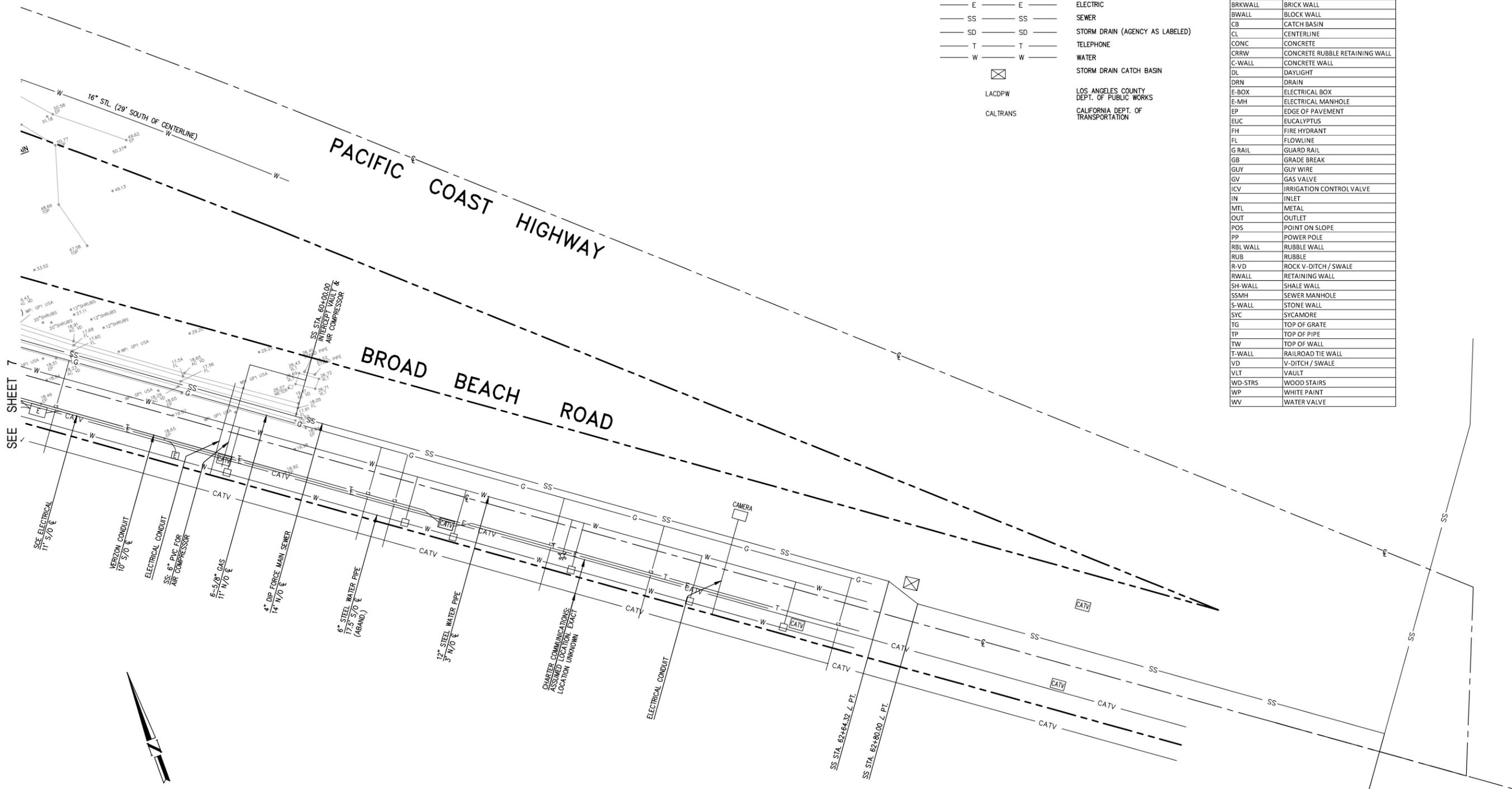
Lund and Associates Engineering, Inc.
Civil Engineering/Land Surveying/Land Planning

BROAD BEACH ROAD UTILITY SURVEY

SHEET 7 OF 8 SHTS

LEGEND

— CATV —	CATV	CABLE TELEVISION	AC	ASPHALT CONCRETE
— COM —	COM	COMMUNICATIONS	AGRGT	AGGREGATE
— G —	G	GAS	BLRD	BOLLARD
— E —	E	ELECTRIC	BOT	BOTTOM
— SS —	SS	SEWER	BRKWALL	BRICK WALL
— SD —	SD	STORM DRAIN (AGENCY AS LABELED)	BWALL	BLOCK WALL
— T —	T	TELEPHONE	CB	CATCH BASIN
— W —	W	WATER	CL	CENTERLINE
☒		STORM DRAIN CATCH BASIN	CONC	CONCRETE
LACDPW		LOS ANGELES COUNTY DEPT. OF PUBLIC WORKS	CRRW	CONCRETE RUBBLE RETAINING WALL
CALTRANS		CALIFORNIA DEPT. OF TRANSPORTATION	C-WALL	CONCRETE WALL
			DL	DAYLIGHT
			DRN	DRAIN
			E-BOX	ELECTRICAL BOX
			E-MH	ELECTRICAL MANHOLE
			EP	EDGE OF PAVEMENT
			EUC	EUCALYPTUS
			FH	FIRE HYDRANT
			FL	FLOWLINE
			G RAIL	GUARD RAIL
			GB	GRADE BREAK
			GUY	GUY WIRE
			GV	GAS VALVE
			ICV	IRRIGATION CONTROL VALVE
			IN	INLET
			MTL	METAL
			OUT	OUTLET
			POS	POINT ON SLOPE
			PP	POWER POLE
			RBL WALL	RUBBLE WALL
			RUB	RUBBLE
			R-VD	ROCK V-DITCH / SWALE
			RWALL	RETAINING WALL
			SH-WALL	SHALE WALL
			SSMH	SEWER MANHOLE
			S-WALL	STONE WALL
			SYC	SYCAMORE
			TG	TOP OF GRATE
			TP	TOP OF PIPE
			TW	TOP OF WALL
			T-WALL	RAILROAD TIE WALL
			VD	V-DITCH / SWALE
			VLT	VAULT
			WD-STRS	WOOD STAIRS
			WP	WHITE PAINT
			WV	WATER VALVE



BENCHMARK
 MALIBU (2008) 78.578 LACO BM TAG IN CONC PAD W SIDE 13M(43') S/O CL PACIFIC COAST Y 11715
 23.951 HWY & 88M(282') E/O CL LA HERRAN RD @ CALL BOX 575

APPENDIX C

BIOLOGICAL ASSESSMENT

Biological Assessment



Broad Beach Biofiltration Project

Prepared For: Geosyntec Consultants, Inc.
Los Angeles, CA

Prepared By: Edith Read, PhD
E Read and Associates, Inc.
Orange, CA

DRAFT
January 8, 2012

TABLE OF CONTENTS

1	ASSESSMENT LOCATION	4
2	PROJECT DESCRIPTION.....	4
3	PURPOSE AND SCOPE OF THIS BIOLOGICAL ASSESSMENT	6
4	METHODS	6
	FIELD SURVEY.....	6
	DATA REVIEW.....	7
5	RESULTS AND DISCUSSION	7
	TOPOGRAPHY	7
	SOILS	7
	FIRE HISTORY	8
	VEGETATION	8
	WILDLIFE.....	16
	SENSITIVE SPECIES	18
	SENSITIVE HABITATS	19
6	IMPACT ANALYSIS	20
7	CONCLUSIONS AND RECOMMENDATIONS	22
8	REFERENCES	24

List of Figures

FIGURE 1.	BIOLOGICAL ASSESSMENT LOCATION	5
FIGURE 2A.	VEGETATION TYPES – EAST SECTION	9
FIGURE 2B.	VEGETATION TYPES – CENTER SECTION	10
FIGURE 2C.	VEGETATION TYPES – WEST SECTION.....	11
FIGURE 3.	SITE PHOTOGRAPHS.....	12

List of Tables

TABLE 1.	NATIVE AND NATURALIZED EXOTIC PLANT SPECIES OBSERVED	13
TABLE 2.	COMMON WILDLIFE SPECIES OBSERVED AND WITH POTENTIAL TO OCCUR	17

List of Appendices

APPENDIX A. SPECIAL STATUS PLANT SPECIES RECORDED FROM THE PROJECT REGION 26

APPENDIX B. SPECIAL STATUS WILDLIFE SPECIES RECORDED FROM THE PROJECT REGION..... 35

1 ASSESSMENT LOCATION

This Biological Assessment covers an area between Broad Beach Road and Pacific Coast Highway (PCH), about nine miles west of the City of Malibu (City), Los Angeles County, California (Figure 1). The area encompasses 11 acres and about 3700 feet of length parallel to Broad Beach Road. This acreage is larger than the area of direct disturbance anticipated for construction of the proposed biofiltration project (Project), which is expected to occur within and immediately adjacent to the shoulder of Broad Beach Road. The road shoulder is heavily used for public and visitor parking.

2 PROJECT DESCRIPTION

The Project objective is to reduce stormwater and dry-weather runoff, with associated pollutant loadings, from Broad Beach Road to the City's storm drain inlets or catch basins (Geosyntec Consultants, 2011). These inlets are part of the City's Municipal Separate Storm Sewer System (MS4). The City storm drains connect to private drains. Flow ultimately discharges through private beaches, passing through a wave wash mixing zone before reaching a designated Area of Special Biological Significance (ASBS 24). This section is just upcoast from Zuma Beach, one of Los Angeles County's most popular public beaches.

The biofiltration systems will be located upstream and adjacent to ten City-owned storm drain inlets along Broad Beach Road. The systems will use a combination of runoff capture, bioretention, evapotranspiration, and infiltration to treat dry-weather and stormwater runoff for multiple pollutants of concern. These pollutants of concern include copper, zinc, oil, grease, and polyaromatic hydrocarbons.

The Project will also incorporate permeable pavement into current public parking areas to help reduce runoff volumes and further promote infiltration. Minor habitat restoration will also be provided for some of the slopes above Broad Beach Road, with the goal of replacing and controlling invasive species with native vegetation.

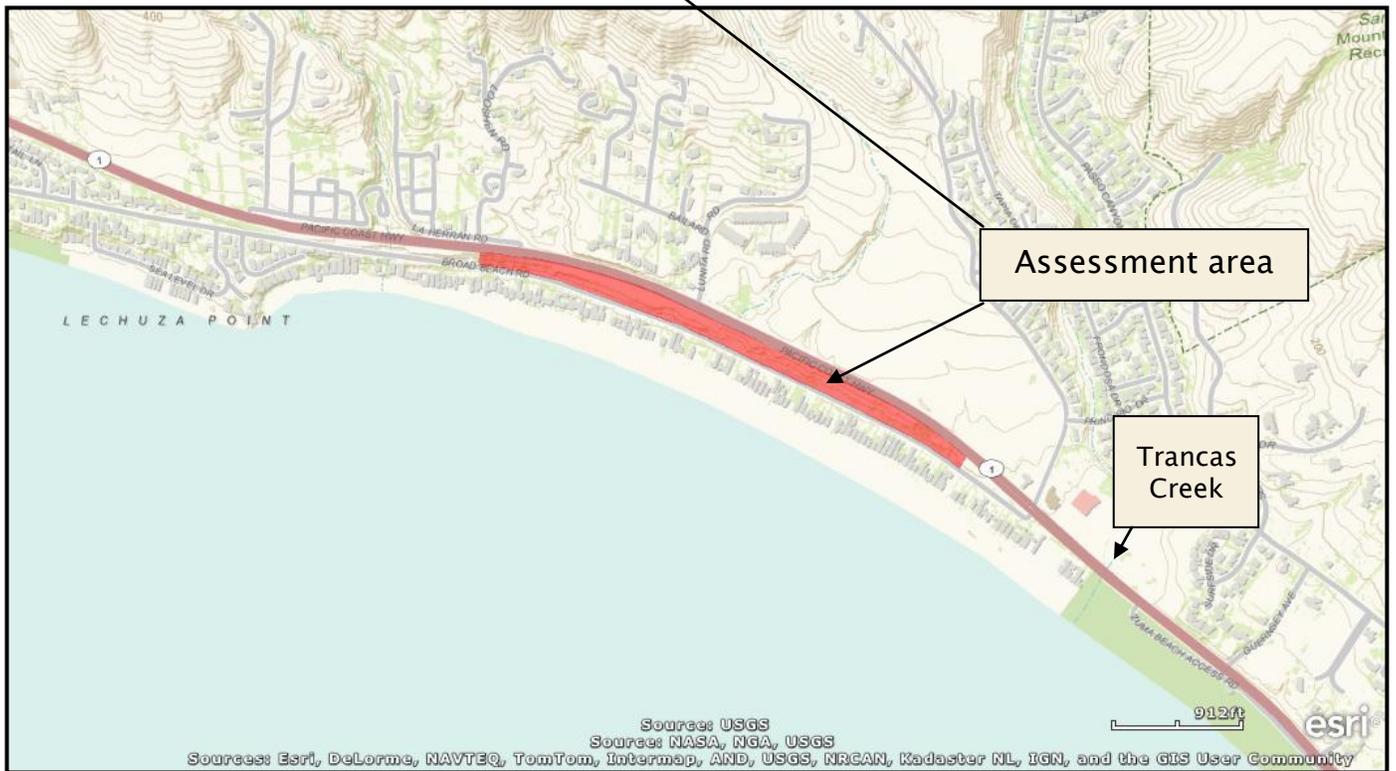
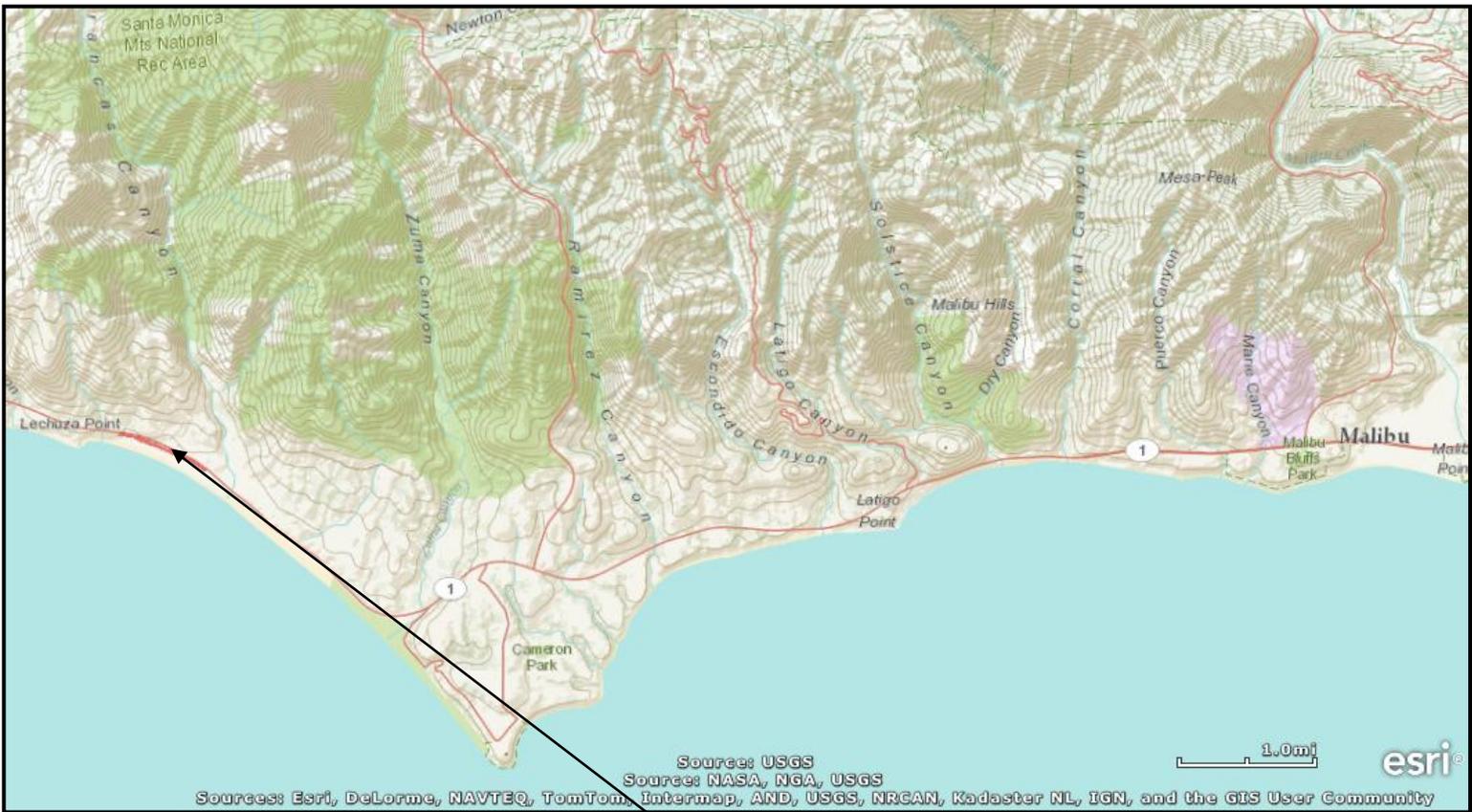


Figure 1. Biological Assessment Location

3 PURPOSE AND SCOPE OF THIS BIOLOGICAL ASSESSMENT

This Biological Assessment is intended to assist decision-makers and the public with objective evaluation of potential impacts of the Project on biological resources, whether beneficial, adverse, or both. This Assessment is also intended to comply with specific City requirements for the content of Biological Assessments (City of Malibu, 2004), and be utilized in preparation of environmental documentation under the California Environmental Quality Act (CEQA).

As of this Draft, design of the Project is ongoing. Therefore, in order to ensure that the Project avoids (or at least minimizes) adverse impacts to biological resources, this assessment encompasses a larger geographic area than will likely be directly impacted by Project construction, operation, or maintenance. Recommended measures for the Project to avoid or minimize adverse biological impacts are provided.

4 METHODS

Field Survey

The assessment area was surveyed on November 16 and December 29, 2011. The entire perimeter of the area was walked. Wildlife species were recorded as direct observation or sign (e.g. tracks, burrows). Native and naturalized plant species observed were recorded. Planted and landscaped vegetation was mapped, but because ornamental taxa can include a wide variety of nursery cultivars, and are generally of little relevance to assessment of indigenous biological resources, these taxa were not inventoried. Other field observations included surface soils (relevant to sensitive species evaluation), wetland indicators, streambed indicators, and disturbance. Vegetation community data and other features relevant to the assessment were transcribed into Geographic Information System (GIS) software. This software was used to produce maps, calculate acreages, and calculate proximity of the assessment area to off-site resources (ESHA).

Data Review

Records of the California Natural Diversity Database (CNDDDB) of special status species, and the California Native Plant Society's Inventory of Rare and Endangered Plants, were searched and evaluated for possible occurrence of sensitive species in the assessment area. Fire history was interpreted from maps prepared by staff of the Santa Monica Mountains National Recreation Area. Locations and extent of environmentally sensitive areas relative to the assessment area were based on City maps. Historical vegetation conditions were evaluated based on topographic and vegetation maps produced by the Wieslander surveys of the late 1920s–early 1930s.

5 RESULTS AND DISCUSSION

Topography

The assessment area is located in an un-numbered section of the United States Geological Survey (USGS) Point Dume 7.5' quadrangle. Elevations range from about 14 feet above mean sea level (MSL) at the lowest section of Broad Beach Road to about 75 feet MSL at the highest section along Pacific Coast Highway. Most of the assessment area consists of a steep, south-facing bluff below Pacific Coast Highway, with shallow gradients limited to a cleared narrow shoulder along Broad Beach Road and a cleared turnout area along Pacific Coast Highway.

Soils

A soil map available online from the Natural Resources Conservation Service (USDA–NRCS, 2008) was reviewed and not found to accurately represent surface conditions observed at the detailed scale of this assessment. Surface soils were observed to be typical of coastal bluffs along this part of the Malibu coast, with coarse gravels and cobbles loosely embedded in a matrix of sand and silt. All areas appeared to be well-drained, without development of wetland conditions despite extensive irrigation. The bluff slopes are readily eroded.

Fire History

Fire history maps available online (UCLA Stunt Ranch, 2009) document incidents in the Santa Monica Mountains beginning in 1925. A review of these maps indicates that the earliest recorded fire for the general region was the Malibu Fire of 1935, which surrounded the assessment area to the northwest and northeast but did not burn past the current alignment of Pacific Coast Highway. The next fire in the region was the Sherwood/Zuma fire of 1956, but again Pacific Coast Highway served as a fuel break. Finally, the Trancas Fire of 1978 extended into the assessment area. Pacific Coast Highway again served as a fuel break for later fires that would have otherwise naturally progressed into the area, particularly the Pacific Fire of 2003.

Vegetation

Figures 2A, 2B, and 2C show vegetation types in the assessment area. Figure 3 provides photographs representing site conditions. Table 1 provides a list of plant species observed.

The site is significantly degraded from its historic condition prior to development of Broad Beach. A review of historic topographic and vegetation maps (Wieslander 1920, 1934) indicates that Broad Beach Road followed the same alignment as a section of Pacific Coast Highway in 1920. The bluff slope area is shown as “barren” on a vegetation map that was created *circa* 1934, a category that was defined as “practically devoid” of vegetation (Wieslander, undated). No trees are shown as a historic vegetation type in the assessment area. Based on documentation of adjacent vegetation types it can be assumed that “sparse” vegetation on the bluff slope would have consisted of at least two species that have persisted to date: lemonadeberry (*Rhus integrifolia*) and California sagebrush (*Artemisia californica*). A third species common in this historic period was seacliff buckwheat (*Eriogonum parvifolium*), but this species appears to have been largely replaced by ashy-leaved buckwheat (*Eriogonum cinereum*) in the current vegetation types described below.



Figure 2A. Vegetation Types - East Section



Figure 2B. Vegetation Types – Center Section



Figure 2C. Vegetation Types – West Section

View west from Broad Beach



View east from Broad Beach Road



Above: planted sycamore grove mapped on Figure 2C. Associated with non-native vegetation (eucalyptus, pampas grass).

Below: view northeast from Broad Beach Road, showing coastal bluff scrub on the upper slopes and ornamental vegetation on the lower slopes. Flowering shrub is bougainvillea, a planted ornamental that is not invasive but requires irrigation.

View west from Pacific Coast Highway

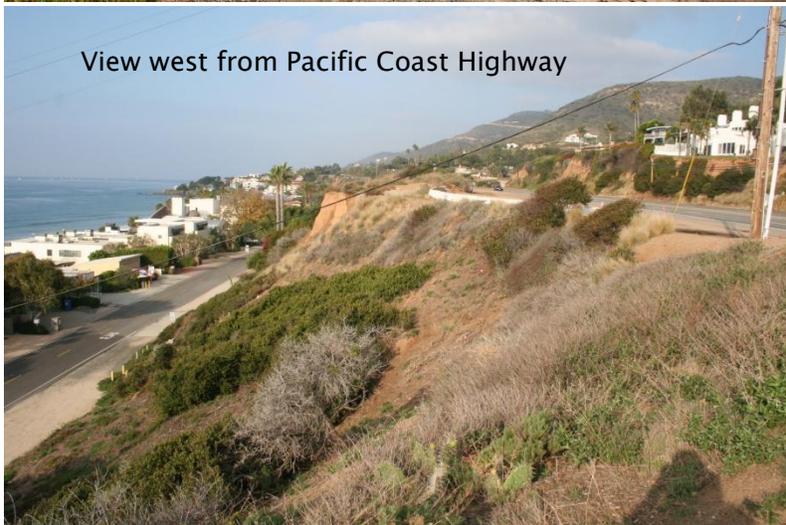


Figure 3. Site Photographs

Table 1. Native and Naturalized Exotic Plant Species Observed

Latin Name ([*] = exotic species)	Common Name
DICOTS	
Aizoaceae	Fig-Marigold Family
<i>Carpobrotus</i> sp.*	sea fig
<i>Mesembryanthemum</i> cf. <i>nodiflorum</i> L.*	slender-leaved iceplant
Anacardiaceae	Sumac Family
<i>Malosma laurina</i> (Nutt.) Abrams	laurel sumac
<i>Rhus integrifolia</i> (Nutt.) Brewer & S. Watson	lemonadeberry
<i>Schinus molle</i> L.*	Peruvian pepper tree
Apiaceae	Carrot Family
<i>Foeniculum vulgare</i> Mill.*	fennel
Asteraceae	Sunflower Family
<i>Ambrosia psilostachya</i> DC.	western ragweed
<i>Artemisia californica</i> Less.	California sagebrush
<i>Baccharis pilularis</i> DC.	coyote brush
<i>Coreopsis gigantea</i> (Kellogg) H.M. Hall	giant coreopsis
<i>Encelia californica</i> Nutt.	coast sunflower
<i>Hazardia squarrosa</i> (Hook. & Arn.) Greene var. <i>grindelioides</i> (DC) W.D. Clark	saw-toothed goldenbush
<i>Heterotheca grandiflora</i> Nutt.	telegraph weed
<i>Lessingia filaginifolia</i> (Hook. & Arn.) M.A. Lane	California-aster
Cactaceae	Cactus Family
<i>Opuntia ficus-indica</i> (L.) Miller*	Indian fig cactus
<i>Opuntia littoralis</i> (Engelm.) Cockerell	coastal prickly pear
<i>Isomeris arborea</i> Nutt.	bladderpod
Chenopodiaceae	Goosefoot Family
<i>Atriplex lentiformis</i> (Torr.) S. Watson	saltbush
<i>Atriplex semibaccata</i> R. Br.*	Australian saltbush
<i>Salsola tragus</i> L.*	Russian thistle, tumbleweed
Convolvulaceae	Morning Glory Family
<i>Convolvulus arvensis</i> L.*	field bindweed
Euphorbiaceae	Spurge Family
<i>Euphorbia terracina</i> L.*	terracina spurge
Fabaceae	Pea Family
<i>Lotus scoparius</i> (Nutt.) Ottley	deerweed, California broom
Geraniaceae	Geranium Family
<i>Erodium cicutarium</i> (L.) L'Her.*	red-stem filaree
Lamiaceae	Mint Family
<i>Salvia mellifera</i> E. Greene	black sage
Myrtaceae	Myrtle Family
<i>Eucalyptus</i> sp.*	eucalyptus
Platanaceae	Sycamore Family
<i>Platanus racemosa</i> Nutt.	western sycamore (planted)

Table 1 -- continued

Polygonaceae*Eriogonum cinereum* Benth.*Eriogonum fasciculatum* Benth. var. *fasciculatum**Nicotiana glauca* Graham***Salicaceae***Salix lasiolepis* Benth.**MONOCOTS****Liliaceae***Yucca whipplei* Torrey**Poaceae***Arundo donax* L.**Avena fatua* L.**Bromus diandrus* Roth**Cortaderia selloana* (Schultes) Asch. & Graebner**Cynodon dactylon***Leymus condensatus* (C. Presl) A. Love*Pennisetum setaceum* (Forssk.) Chiov.***Buckwheat Family**

ashy-leaved buckwheat

California buckwheat

tree tobacco

Willow Family

arroyo willow

GRASSES AND ALLIES**Lily Family**

Whipple's yucca

Grass Family

giant reed

common wild oats

ripgut brome

pampas grass

Bermuda grass

giant rye

fountain grass, bristlegrass

In classifying the vegetation types we attempted to follow the current Manual of California Vegetation (Sawyer et al., 2009), but found that the vegetation was so heavily invaded by naturalized and planted exotic species that strict adherence to this classification system was not possible. The vegetation classifications described below were determined to best characterize the assessment area.

Coastal Bluff Scrub (3.1 acres)

Coastal bluff scrub consists primarily of native plant species, although exotic invasives (especially fountain grass, *Pennisetum setaceum*) are present throughout. This vegetation occurs on the upper, steeper bluff slopes between Pacific Coast Highway and the lower landscaped zone along Broad Beach Road. Native shrub species include ashy-leaved buckwheat (*Eriogonum cinereum*), California sagebrush (*Artemisia californica*), California brittlebush (*Encelia californica*), coyote brush (*Baccharis pilularis*), lemonadeberry (*Rhus integrifolia*), and laurel sumac (*Malosma laurina*).

Coastal Bluff Scrub (Revegetated Slope) (0.2 acre)

This vegetation type is confined to a small area of steep bluff below Pacific Coast Highway (Figure 2B), and is associated with a short section of the highway that appears to have been repaired. Density and uniformity of the shrub vegetation, along with erosion control material (straw rolls) are evidence of intentional revegetation. The dominant species is native (ashy-leaved buckwheat).

Ornamental Landscaping (4.2 acres)

Ornamental landscaping consists primarily of exotic vegetation that has been planted and irrigated. As can be seen from the photographs in Figure 3, this vegetation dominates the lower slope of the assessment area along Broad Beach Road. This vegetation includes invasive species such as pampas grass (*Cortaderia selloana*). No attempt was made here to identify and list all of the planted ornamental species and nursery cultivars, but examples include pines, junipers, eucalyptus, bamboo, bougainvillea, plumbago, pepper trees, and myoporum.

Ornamental Landscaping/Coastal Bluff Scrub (1.1 acre)

This classification represents an integration of native and planted vegetation, with invasive exotics such as iceplant (*Carpobrotus* sp., *Mesembryanthemum* sp.) also present throughout. Where present, fragmented stands of native vegetation typically consist of lemonadeberry and/or laurel sumac.

Ornamental Landscaping (Planted Sycamores) (0.2 acre)

Planted and irrigated sycamores (*Platanus racemosa*) occupy a localized, small area between Broad Beach Road and artificial terraces upslope (Figure 2C). Trunk diameters of these trees range in size from four to eight inches at breast height (dbh). Examples of these trees are shown in the photographs in Figure 3. Despite being planted, and arguably not native to the area since there is no historical evidence of trees at this site, these trees probably fall under the protection of the City's Native

Tree Protection Ordinance because they are native to California. This Ordinance does not distinguish between indigenous and planted trees.

Arroyo Willow

One willow was observed on a slope in the center section of the site (see mapped location, Figure 2B). The willow is associated with a localized zone of high moisture, most likely irrigation. No streambed or wetland indicators were observed at this location.

Cleared (2.2 acres)

Cleared areas are devoid of vegetation. These areas are confined to a strip along the north shoulder of Broad Beach Road (1.2 acres) and south shoulder of Pacific Coast Highway (1.0 acre).

Wildlife

Table 2 lists wildlife species observed during the surveys and with potential to occur in the assessment area. In general the area has relatively few wildlife species present or expected to occur, due to its condition as fragmented habitat surrounded by high-traffic roads, frequent human disturbance, construction noise, and dominance of exotic vegetation. The exotic vegetation provides cover and limited nesting habitat for birds, but few food resources for native wildlife. Certain wildlife species, especially goldfinches and crows, were frequently observed moving between the assessment area and landscaping on residential properties to the south. No raptor nests or woodrat middens were observed in the vegetation during the survey. Regular trimming of most of the vegetation along Broad Beach Road likely precludes nesting by raptors. However, nocturnal roosting by certain raptors such as owls is possible. While we did not observe any evidence of a roost site (e.g. pellets, fecal material), open fields north of Pacific Coast Highway provide significant off-site foraging opportunities and therefore the potential for the taller, denser stands of trees on site to support roosting by raptors cannot be dismissed completely.

Table 2. Common Wildlife Species Observed and With Potential to Occur

Latin Name	Common Name	Occurrence
Insects		
<i>Danaus plexippus</i>	monarch butterfly	observed
Birds		
Note: any number of migratory birds may be observed during the year. Only the more common are listed in the "potential" category here.		
<i>Aphelocoma californica</i>	western scrub jay	observed
<i>Bubo virginianus</i>	great horned owl	potential
<i>Buteo jamaicensis</i>	red-tailed hawk	potential
<i>Calypte anna</i>	Anna's hummingbird	observed
<i>Carduelis psaltria</i>	lesser goldfinch	observed
<i>Carduelis tristis</i>	American goldfinch	observed
<i>Carpodacus mexicanus</i>	house finch	observed
<i>Corvus brachyrhynchos</i>	American crow	observed
<i>Dendroica coronata</i>	yellow-rumped warbler	observed
<i>Falco sparverius</i>	American kestrel	potential
<i>Mimus polyglottos</i>	northern mockingbird	observed
<i>Pipilo crissalis</i>	California towhee	observed
<i>Psaltiriparus minimus</i>	bushtit	potential
<i>Sayornis nigricans</i>	black phoebe	potential
<i>Tyto alba</i>	barn owl	potential
<i>Zonotrichia leucophrys</i>	white-crowned sparrow	potential
Reptiles		
<i>Elgaria multicarinata webbi</i>	alligator lizard	potential
<i>Eumeces skiltonianus</i>	western skink	potential
<i>Sceloporus occidentalis</i>	western fence lizard	observed
<i>Uta stansburiana hesperis</i>	side-blotched lizard	potential
Mammals		
<i>Canis latrans</i>	coyote	potential
<i>Didelphis virginiana</i>	Virginia opossum	potential
<i>Mephitis mephitis</i>	striped skunk	potential
<i>Peromyscus maniculatus</i>	deer mouse	potential
<i>Procyon lotor</i>	raccoon	potential
<i>Spermophilus beecheyi</i>	California ground squirrel	potential
<i>Sylvilagus audubonii</i>	Audubon's cottontail	potential
<i>Thomomys bottae</i>	valley pocket gopher	potential

Sensitive Species

Appendices A and B list all of the special status plant and wildlife species recorded for the project region. Databases of sensitive species are searched by 7.5' USGS topographic quadrangles, and therefore the "project region" defined for the purpose of the database search and this assessment includes Point Dume as well as surrounding quadrangles. We also added quadrangles upcoast (Point Mugu) and downcoast (Topanga) to thoroughly evaluate potential for species specifically associated with habitats along the immediate coast.

Plants

A total of 35 special status plant taxa were reviewed for this assessment (Appendix A). None of the species are known to occur in the assessment area and none were determined to have high potential to occur. Reasons for this determination vary with species and ranges from lack of suitable habitat (e.g. salt marsh) to a decades-old history of highly disturbed conditions on the site.

Wildlife

A total of 48 special status wildlife taxa were reviewed for this assessment (Appendix B). There are no records of any special status species occurring in or adjacent to the assessment area. One special status species was concluded to have moderate potential to occur on the upper slopes of the assessment area within coastal bluff scrub vegetation: coast horned lizard (*Phrynosoma blainvillii*), a California Species of Special Concern. Species of Special Concern are generally those whose populations are declining or are otherwise vulnerable. The intent of the California Department of Fish and Game for these species is to halt or reverse the decline of these populations before they are reduced to threatened or endangered status.

Regardless of listing status, or whether vegetation is native or non-native, all native birds have State and Federal protection while nesting. Nesting season varies by species, year, and location, but in general the season can begin around mid-February

and end in late July. If potential roost or nest trees are to be removed or trimmed, the City of Malibu requires surveys for nesting raptors during the period February 15–July 30. The City also requires surveys for wintering raptors during the period of December 1 – February 15.

An individual of one special status species, the monarch butterfly (*Danaeus plexippus*), was observed flying over the coastal scrub vegetation in the assessment area during the November 2011 survey. There are no CNDDDB records of winter roost trees on the site, although some records in the CNDDDB are suppressed. Of the records available, known winter roosting locations for the monarch butterfly in the Point Dume region consist of eucalyptus groves that are more mature, more dense, and more numerous than occur in the assessment area. Considering these factors plus frequent human disturbance and no evident nectar sources, the potential for trees on the site to serve as winter roosting habitat for monarchs is considered low.

Sensitive Habitats

Vegetation Communities. There are no CNDDDB records of sensitive habitats within or adjacent to the assessment area (CDFG–CNDDDB, 2012).

ESHA. One drainage north of the assessment area is mapped as an Environmentally Sensitive Habitat Area (ESHA) by the City of Malibu. This drainage is shown on Figure 2B. It extends north from Pacific Coast Highway, beginning about 84 feet north from the edge of the assessment area and about 200 feet upslope from the shoulder of Broad Beach Road.

While it may be possible to eliminate exotic species and restore the assessment area to native habitat, we do not believe the site would qualify for sensitive habitat status or designation as ESHA. Restoration would be of value to some native wildlife (especially birds and insects), but this value is unlikely to qualify for ESHA designation. The isolated and fragmented condition of this site, discontinuous with off-site habitat and separated from an existing ESHA by a major highway where wildlife crossing is hazardous, significantly reduces its overall habitat value.

Marine Resources. Off-shore resources with special status, as shown on the City of Malibu's ESHA Overlay Maps, consist of Pismo Clam Habitat and Kelp Beds. In addition, off-shore marine habitat has been designated as Area of Special Biological Significance (ASBS) #24 by the California State Water Resources Control Board. All of these designations are outside of the assessment area but may indirectly benefit from water quality improvements expected from the Project.

Wetlands and Streambeds. No wetlands or streambeds are present in the assessment area. No "blue-line" streambed features mapped by the USGS are located in the assessment area. Certain existing storm drain inlets are connected to a "V"-ditch, rock-lined ditch, or swale, but these are features constructed in uplands for drainage purposes and are not associated with any existing or historical streambed feature.

6 IMPACT ANALYSIS

The Broad Beach Biofiltration Project is still in the design phase as of this Draft. Therefore this impact analysis makes the following assumptions, based on the project description provided to date (Geosyntec Consultants, 2011):

1. Construction of all biofiltration systems, located upstream and adjacent to ten City-owned storm drain inlets along Broad Beach Road, will primarily disturb ornamental landscaping, but may also disturb some native coastal bluff scrub vegetation consisting of lemonadeberry and laurel sumac stands that extend into the landscaping and construction zone, and planted sycamores.
2. Temporary impacts from construction staging and grading will be limited to Broad Beach Road and existing cleared areas (road shoulder).
3. Quality of runoff from Broad Beach Road into City storm drains will improve as result of the Project.
4. Areas disturbed by construction will be revegetated with native plant species and exotic species removed.

Vegetation and Sensitive Plant Species

Impacts to native vegetation communities are not expected to be significant. No special status plant species are expected to occur within areas directly or indirectly impacted by the Project. Impacts to planted sycamores would not be biologically significant, but the City has requirements for protection of “native” trees. Our recommendations for addressing these requirements are discussed in Section 7. Removal of exotic vegetation, especially highly invasive species such as pampas grass and iceplant, would be expected to benefit the surrounding habitat. The significance of this benefit is probably limited, with species re-invading from outside the Project limits, unless the City and/or the California Department of Transportation (CalTrans) undertake a program of removing invasive exotics throughout the assessment area.

Wildlife and Sensitive Animal Species

The Project is not expected to impact listed threatened, endangered, or rare wildlife species. The only special status animal species identified as having moderate potential to occur in the assessment area is coast horned lizard (Species of Special Concern), but if present it would likely be found only on the upper slopes. Limitation of Project disturbance to cleared and landscaped zones along Broad Beach Road would not be expected to impact this species.

The Project is not expected to interfere with, or impact, wildlife movement or movement corridors. No evidence of the site functioning as a corridor for wildlife movement was observed during the surveys for this assessment. Frequent human presence and disturbance, in addition to proximity to heavily traveled roads, significantly reduces the potential for the site to serve as a wildlife corridor.

The Project has potential to disturb nesting and/or roosting bird species, including raptors. Our recommendations for addressing these impacts are discussed in Section 7.

Sensitive Habitats

The Project is expected to improve quality of runoff from Broad Beach Road into City storm drains and therefore have a beneficial effect on marine resources. The significance of this benefit has not been quantified, but baseline conditions and measurements of Project effectiveness are planned (Geosyntec Consultants, 2011).

The Project will not impact any designated ESHA, or any area potentially meeting the definition of ESHA. Removal of invasive exotics within the construction zone, especially those with seeds dispersed by air or birds (e.g., pampas grass), will help reduce the probability of these species invading the designated ESHA north of Pacific Coast Highway.

7 CONCLUSIONS AND RECOMMENDATIONS

No significant constraints or barriers to Project implementation were identified in this assessment. However, while the Project is expected to have a net beneficial effect on biological resources due to improvement of water quality and removal of some invasive vegetation, there is potential for temporary adverse impacts from construction unless the following measures are implemented. The extent of these temporary impacts will depend on season and extent to which construction is likely to disturb or require removal of vegetation, including planted sycamore trees, vegetation that supports common bird species while nesting, or trees that serve as nesting or roosting sites for raptors. The following measures can address these potential impacts:

1. Planted Sycamore Trees. The sycamores on site are planted, heavily trimmed, and relatively immature. These factors plus their proximity to frequent human disturbance significantly reduces their biological value. If removal of one or more of these trees cannot be avoided, or protection zones around the trees cannot be avoided, we recommend requesting a waiver from the City's native tree protection ordinance. If a waiver cannot be obtained, the City requires preparation of a Native Tree Protection plan by a qualified

biologist or resource expert. Required content of this plan is described in the City's Local Implementation Plan, Chapter 5.

2. Nesting Birds (other than raptors). Construction outside of the nesting season (generally mid-February to July 31) would avoid impacts to nesting birds. While human activity along Broad Beach Road is such that nesting in adjacent landscaping seems unlikely, certain species such as Anna's hummingbird and house finch are well-adapted to urban environments and therefore the potential for nesting cannot be dismissed entirely. If construction within the nesting season cannot be avoided, we recommend that a survey for nesting birds be conducted by a qualified biologist prior to construction, in coordination with the City's biologist. The survey may need to be repeated one or more times depending on expected duration of construction. If an active nest is found, the nest area must be avoided until young have fledged and left the nest. The "buffer" zone around the nest, within which no construction or disturbance can occur will depend on species and recommendations of the City/monitoring biologist.

3. Nesting or Roosting Birds (Raptors). No raptor nests or evidence of roosting were observed during surveys for this assessment, but the extent to which the Project may (or may not) impact trees of sufficient size or structure to become occupied by a raptor as a roost or nest site from the date of this writing until construction is not known at this time. Once the Project disturbance footprint is known, the City may require surveys for nesting or wintering raptors prior to construction. Surveys for nesting raptors must be conducted during the period of February 15-July 30, and surveys for wintering raptors must be conducted during the period of December 1 - February 15. At a minimum, the City requires that each raptor survey be conducted for two hours between dawn and 10:00 am on five occasions with at least one week between surveys. We recommend that the raptor surveys include surveys for nesting or roosting owls, such that at least three of the raptor surveys should be conducted during

the period immediately before nightfall, in addition to the morning surveys. If a raptor nest or roost site is found, protection measures appropriate for the species and site conditions should be developed by a qualified biologist in coordination with the City biologist.

4. Removal of Vegetation. Vegetation removed as part of the Project should be replaced *where feasible* (see below) with native species appropriate for the site conditions. For example, if a “bioswale” is installed as a design feature, native shrub species that have potential to block runoff would not be appropriate, but herbaceous species including grasses and wildflowers may be suitable. Ideally, other vegetation temporarily disturbed or removed during construction should be replaced with coastal bluff scrub species, but this measure may not prove practical in the long term, especially in the presence of irrigation and continual influx of invasive exotics from the Caltrans right-of-way. An exotics removal and native revegetation plan should be prepared by a qualified biologist familiar with effective methods of removing exotics, the local native flora, and the expected “as-built” condition of areas to be revegetated. Revegetation with natives should include practical considerations of long-term maintenance, capabilities of entities responsible for this maintenance, fuel modification zones, and potential for wildfire. It is possible that removal of invasive exotics alone would significantly improve habitat values of the assessment area and facilitate expansion of existing native species from the surrounding area.

8 REFERENCES

California Department of Fish and Game – California Natural Diversity Database, 2012. Database search for sensitive plants, wildlife, and communities January, 2012.

City of Malibu, 2004. Biological Studies Required for Review of Development Projects. November 24, 2004.

Geosyntec Consultants, Inc., 2011. Project Assessment and Evaluation Plan (PAEP) for Broad Beach Road Biofiltration Project. Final Draft, November 28, 2011.

Sawyer, J.O., T. Keeler–Wolf, and J.M. Evens, 2009. A Manual of California Vegetation. Second Edition. California Native Plant Society and California Department of Fish and Game, Sacramento, California.

United States Department of Agriculture, Natural Resources Conservation Service, 2008. Soil Survey Data, Version 10, January 4, 2008: websoilsurvey.nrcs.usda.gov

University of California at Los Angeles, Stunt Ranch Santa Monica Mountains Reserve, 2009. Fire history maps online: <http://stuntranch.ucnrs.org/index.php/map/fire-history>

Wieslander, A.E., 1920. Topographic map of the Triunfo Pass quadrangle: vtm.berkeley.edu

Wieslander, A.E., 1934. Vegetation map and plot data for the Triunfo Pass quadrangle: vtm.berkeley.edu

Wieslander, A.E., undated. Manual of Field Instructions for Vegetation Type Map of California: available online at vtm.berkeley.edu.

APPENDIX A. SPECIAL STATUS PLANT SPECIES RECORDED FROM THE PROJECT REGION

Appendix A

Evaluation of Special Status Plant Species Recorded From the Project Region

Common Name <i>Latin Name</i>	Status			Habitat	Elevation Range, Life Form, and Reproductive Period	Potential Occurrence on the Project Site
	Federal	State	CNPS			
Braunton's milk-vetch <i>Astragalus brauntonii</i>	FE	none	1B.1	Closed-cone conif, chaparral, coastal sage, v&f grassland/ recent burns or disturbed areas-usually carbonate soils.	4-640m PH March-July	Low Potential. Soil within potential impact area not present; nearest known historical coastal location is Malibu Lagoon.
Ventura marsh milk-vetch <i>Astragalus pycnostachyus</i> var. <i>lanosissimus</i>	FE	CE	1B.1	Coastal salt marsh	1-35m PH June-October	Not expected. Habitat absent.
coastal dunes milk-vetch <i>Astragalus tener</i> var. <i>titi</i>	FE	CE	1B.1	Moist, sandy depressions of coastal bluffs or dunes.	1-50m AH March-May	Low potential. Suitable habitat not observed during surveys; no records (recent or historical) from project vicinity.
Coulter's saltbush <i>Atriplex coulteri</i>	none	none	1B.2	Coastal bluff scrub, coastal dunes, coastal scrub, valley and foothill grasslands	3-460m PH(s) March-Oct	Low Potential. Nearest known historical location is on bluffs within City of Malibu.

Common Name <i>Latin Name</i>	Status			Habitat	Elevation Range, Life Form, and Reproductive Period	Potential Occurrence on the Project Site
	Federal	State	CNPS			
Parish's brittle scale <i>Atriplex parishii</i>	none	none	1B.1	Alkali meadows, vernal pools, chenopod scrub, playas; typically on drying alkali flats with fine soils.	25-1900m AH June-October	Not expected; no suitable habitat on site.
Malibu baccharis <i>Baccharis malibuensis</i>	none	none	1B.1	Chaparral, coastal scrub, cismontane woodland, riparian woodland.	150-305 m S (d) August	Low potential. Vegetation on site not typical of the species. Not observed during surveys.
Round-leaved filaree <i>California macrophyllum</i>	none	none	1B.1	Cismontane woodland, valley and foothill grassland; clay soils	15-1200m AH March-May	Low potential. Vegetation on site not typical of the species.
Slender mariposa lily <i>Calochortus clavatus</i> var. <i>gracilis</i>	none	none	1B.2	Chaparral, coastal scrub, grassland.	360-1000m PH(b) March	Low potential. Habitat potentially impacted by the project is not typical of the species.
Plummer's mariposa lily <i>Calochortus plummerae</i>	none	none	1B.2	Coastal scrub, chaparral, grassland, cismontane woodland.	100-1700m PH (b) May-July	Low potential. Habitat potentially impacted by the project is not typical of the species.

Common Name <i>Latin Name</i>	Status			Habitat	Elevation Range, Life Form, and Reproductive Period	Potential Occurrence on the Project Site
	Federal	State	CNPS			
southern tarplant <i>Centromadia parryi</i> ssp. <i>australis</i>	none	none	1B.1	Marsh margins, vernal mesic grassland, vernal pools.	0-425 m AH May-November	Not expected. Habitat not present on site.
Orcutt's pincushion <i>Chaenactis glabriuscula</i> var. <i>orcuttiana</i>	none	none	1B.1	Sandy substrate in coastal bluff scrub, coastal dunes.	0-100 m AH January-August	Low potential. Highly disturbed conditions and planted vegetation likely precludes occurrence. Nearest location record is historical (1898) from an unmapped area referred to as "South Beach".
salt marsh bird's beak <i>Chloropyron maritimum</i> ssp. <i>maritimum</i>	FE	CE	1B.2	Coastal salt marsh and dunes.	0-30 m AH(h) May-October	Not expected. Habitat not present on site.
San Fernando Valley spineflower <i>Chorizanthe parryi</i> ssp. <i>fernandiha</i>	FC	CE	1B.1	Coastal scrub; associated with open, sandy soil habitats.	150-1035 m AH April-June	Low Potential. Conditions on site are not typical of the species; no occurrence records for the Santa Monica Mountains.
Parry's spineflower <i>Chorizanthe parryi</i> ssp. <i>parryi</i>	none	none	1B.1	Chaparral and coastal scrub; associated with sandy or rocky openings.	40 – 1705m AH Apr-Jun	Low Potential. Highly disturbed conditions and planted vegetation likely precludes occurrence. Nearest location record is historical (1957) from Latigo Canyon – no records from project vicinity.
Santa Susana tarplant <i>Deinandra minthornii</i>	none	CR	1B.2	Chaparral and coastal scrub; associated with sandstone outcroppings and rocky areas.	280-760m S (d) July-November	Not expected. Habitat not present on site.

Common Name <i>Latin Name</i>	Status			Habitat	Elevation Range, Life Form, and Reproductive Period	Potential Occurrence on the Project Site
	Federal	State	CNPS			
dune larkspur <i>Delphinium parryi</i> ssp. <i>blochmaniae</i>	none	none	1B.2	Coastal dunes, chaparral (maritime)	0-200m PH April-May	Not Expected. Suitable habitat not present on site.
Norris's beard moss <i>Didymodon norrisii</i>	none	none	2.2	Cismontane woodland; lower montane coniferous forest (mesic, rocky)	600-1973m Moss	Not Expected. Suitable habitat not present on site.
beach spectaclepod <i>Dithyrea maritima</i>	none	CT	1B.1	Coastal dunes, coastal scrub on sea shores and sandy places near the shore.	3-50m PH March-May	Not Expected. Suitable habitat not present on site.
Blochman's dudleya <i>Dudleya blochmaniae</i> ssp.	none	none	1B.1	Coastal bluff scrub, coastal scrub, chaparral and grasslands; often associated with clay or serpentinite soils.	5-450m PH April-June	Low Potential. Soils typically associated with the species not present.
Agoura Hills dudleya <i>Dudleya cymosa</i> ssp. <i>agourensis</i>	FT	none	1B.2	Chaparral, cismontane woodland/ rocky, volcanic soils.	200-500m. PH May-June	Not Expected. Suitable habitat not present on site.

Common Name <i>Latin Name</i>	Status			Habitat	Elevation Range, Life Form, and Reproductive Period	Potential Occurrence on the Project Site
	Federal	State	CNPS			
Marcescent dudleya <i>Dudleya cymosa</i> ssp. <i>marcescens</i>	FT	CR	1B.2	Chaparral; occurs on the lower reaches of sheer volcanic cliffs and canyon walls near perennial streams.	150-520m. PH April-July	Not Expected. Suitable habitat not present on site.
Santa Monica dudleya <i>Dudleya cymosa</i> ssp. <i>ovatifolia</i>	FT	none	1B.2	Chaparral on shaded, rocky north-facing slopes; associated with Conejo volcanic outcrops, rocky sites.	150-1675m PH March-June	Not Expected. Suitable habitat not present on site.
Many-stemmed dudleya <i>Dudleya multicaulis</i>	none	none	1B.2	Chaparral, coastal scrub, valley and foothill grassland (clay)	15-790m PH April-July	Not Expected. Suitable habitat not present on site.
Conejo dudleya <i>Dudleya parva</i>	FT	none	1B.2	Coastal scrub, valley and foothill grassland (clay or volcanic)	60-450m PH May-June	Low Potential. Site conditions not typical of the species.
Verity's dudleya <i>Dudleya verityi</i>	FT	none	1B.2	Volcanic outcrops in chaparral, cismontane woodland, coastal scrub.	60-120m PH May-June	Not Expected. Suitable habitat not present on site.

Common Name <i>Latin Name</i>	Status			Habitat	Elevation Range, Life Form, and Reproductive Period	Potential Occurrence on the Project Site
	Federal	State	CNPS			
Conejo buckwheat <i>Eriogonum crocatum</i>	none	CR	1B.2	Chaparral, coastal scrub, valley and foothill grassland (rocky volcanic)	50-580m PH April-July	Not Expected. Suitable habitat not present on site.
Coulter's goldfields <i>Lasthenia glabrata</i> ssp. <i>coulteri</i>	none	none	1B.1	Coastal salt marshes, playas, vernal pools	1-1220 m AH February-June	Not Expected. Suitable habitat not present.
Ojai navarretia <i>Navarretia ojaiensis</i>	none	none	1B.1	Openings in chaparral, coastal scrub, grassland.	275-620 m AH May-July	Low Potential. Site conditions not typical of the species.
Peninsular nolina <i>Nolina cismontana</i>	none	none	1B.2	Chaparral, coastal scrub (sandstone or gabbro substrate)	140-1275m S(e) May-July	Low Potential. Site conditions not typical of the species.
California Orcutt grass <i>Orcuttia californica</i>	FE	CE	1B.1	Vernal pools within chaparral, valley and foothill grasslands.	15-660m AH April-August	Not Expected. Suitable habitat not present on site.

Common Name <i>Latin Name</i>	Status			Habitat	Elevation Range, Life Form, and Reproductive Period	Potential Occurrence on the Project Site
	Federal	State	CNPS			
Lyon's pentachaeta <i>Pentachaeta lyonii</i>	FE	CE	1B.1	Chaparral, valley and foothill grasslands. Ecotonal edges and cleared areas	30-630m AH March-August	Not Expected. Suitable habitat not present on site.
chaparral ragwort <i>Senecio aphanactis</i>	none	none	2.2	Drying alkaline flats in cismontane woodland, coastal scrub.	15-1800m AH January-April	Not Expected. Suitable habitat not present on site.
salt spring checkerbloom <i>Sidalcea neomexicana</i>	none	none	2.2	Alkaline and mesic sites in chaparral, coastal sage scrub, lower montane coniferous forest, Mojavean desert scrub, playas.	15-1530 m PH March-June	Not Expected. Suitable habitat not present on site.
estuary seablite <i>Suaeda esteroa</i>	none	none	1B.2	Coastal salt marshes	0-5 m PH May-January	Not Expected. Suitable habitat not present on site.
Sonoran maiden fern <i>Thelypteris puberula var. sonorensis</i>	none	none	2.2	Meadows and seeps	50-610m RH January-September	Not Expected. Suitable habitat not present on site.

SOURCES:

1. California Department of Fish and Game, Natural Diversity Database (CNDDDB), January 2012. Record search of the following USGS quadrangles: Calabasas, Malibu Beach, Newbury Park, Point Dume (project quadrangle), Point Mugu, Thousand Oaks, Topanga, Triunfo Pass.
2. California Native Plant Society Inventory of Rare and Endangered Plants.

STATUS KEY:

Federal

FE: Federally Endangered
 FT: Federally Threatened

State

CE: State Endangered
 CT: State Threatened
 CR: State Rare

CNPS

List 1B: Plants rare, threatened, or endangered in California and elsewhere.

List 2: Plants rare, threatened, or endangered in California but more common elsewhere.

Threat Ranks:

.1 : Seriously Threatened in California
 .2 : Fairly Threatened in California

LIFE FORM KEY:

AH: Annual Herb
 PH: Perennial Herb
 RH: Rhizomatous Herb
 S: Shrub
 (b): bulb
 (d): deciduous
 (e): evergreen
 (h): hemi parasitic

Appendix B. Special Status Wildlife Species Recorded From the Project Region

Appendix B

Evaluation of Special Status Wildlife Species Recorded From the Project Region

Common Name <i>Latin Name</i>	Status		Habitat Requirements	Potential Occurrence on the Project Site
	Federal	State		
INVERTEBRATES				
Santa Monica shieldback katydid <i>Agalothorax longipennis</i>	--	SA	Chaparral and canyon stream bottom vegetation; can inhabit introduced iceplant and native chaparral plants.	Low Potential ; patches of iceplant present but no chaparral or stream bottom vegetation. Nearest record of occurrence is from 1975 near the entrance to Big Rock (Piedra Gorda) Canyon, about 15 air miles east of the project site -- the two individuals reported from this location were collected, so current population status is unknown.
Sandy beach tiger beetle <i>Cicindela hirticollis gravida</i>	--	SA	Clean, dry, light-colored sand in upper beach zones adjacent to non-brackish water; e.g. dune depressions.	Not Expected ; no suitable habitat on site.

Common Name <i>Latin Name</i>	Status		Habitat Requirements	Potential Occurrence on the Project Site
	Federal	State		
senile tiger beetle <i>Cicindela senilis frosti</i>	--	SA	Marine shoreline; dried salt pans.	Not Expected ; no suitable habitat on site.
globose dune beetle <i>Coelus globosus</i>	--	SA	Coastal dunes.	Not Expected ; no suitable habitat on site.
Monarch butterfly (wintering sites) <i>Danaus plexippus</i>	--	SA	Winter roost sites located in wind-protected tree groves, with nectar and water sources nearby.	Low potential ; tree groves present (all non-native) but are not wind-protected and nectar sources not observed; tree trimming reduces habitat value; individual fliers may be observed occasionally (one observed during survey) but no roosting populations observed during surveys. Project location not reported in numerous available records from Point Dume area, but details of some records have been suppressed by CNDDB.

Common Name <i>Latin Name</i>	Status		Habitat Requirements	Potential Occurrence on the Project Site
	Federal	State		
Trask shoulderband <i>Helminthoglypta traskii traskii</i>	--	SA	Only habitat information in region is from collection record in La Jolla Canyon, Santa Monica Mtns – algae covered rock under waterfall.	Not Expected ; for what is known of habitat associations, there no suitable habitat on site.
wandering (saltmarsh) skipper <i>Panoquina errans</i>	--	SA	Coastal salt marshes.	Not Expected ; no suitable habitat on site.
Gertsch's socalchemmis spider <i>Socalchemmis gertschi</i>	--	SA	No information available	Low potential ; only records are from Topanga Canyon area.
Santa Monica grasshopper <i>Trimerotropis occidentiloides</i>	--	SA	Hillsides, dirt trails in chaparral; known only from the Santa Monica Mountains.	Low potential ; habitat on site not suitable, based on limited habitat information about the species; no records from project vicinity.

Common Name <i>Latin Name</i>	Status		Habitat Requirements	Potential Occurrence on the Project Site
	Federal	State		
mimic tryonia (California brackishwater snail) <i>Tryonia imitator</i>	--	SA	Coastal lagoons, estuaries, salt marshes.	Not Expected; no suitable habitat on site.
FISH				
Tidewater goby <i>Eucyclogobius newberryi</i>	FE	SSC	Shallow lagoons and lower coastal stream reaches with salinities from brackish to fresh.	Not Expected; no aquatic habitat on site.
Arroyo chub <i>Gila orcutti</i>	--	SSC	Slow-moving or backwater sections of warm to cool streams with mud or sand substrates.	Not Expected; no aquatic habitat on site.
Steelhead rainbow trout (SoCal DPS) <i>Oncorhynchus mykiss</i>	FE	SSC	Coastal seasonal to perennial streams with suitable cobble for spawning	Not Expected; no aquatic habitat on site.
REPTILES				

Common Name <i>Latin Name</i>	Status		Habitat Requirements	Potential Occurrence on the Project Site
	Federal	State		
Silvery legless lizard <i>Anniella pulchra pulchra</i>	--	SSC	Sandy or loose loamy soils under sparse vegetation; soil moisture essential.	Low Potential ; poor quality habitat on site; nearest records of occurrence are from the Simi Hills and Thousand Oaks.
Coastal whiptail <i>Aspidoscelis tigris stejnegeri</i>	--	SA	Deserts and semiarid habitats with sparse vegetation, open areas; woodlands and riparian areas; firm soil, sandy or rocky.	Low potential ; vegetation and substrate highly disturbed and mostly planted/heavily irrigated. No records of occurrence in project area.
San Bernardino ringneck snake <i>Diadophis punctatus modestus</i>	--	SA	Woodlands, grassland, chaparral, and scrub habitats; often found in mesic areas under rocks, logs, and debris.	Low potential ; only mesic areas on site are due to irrigation; no records of occurrence in project area.

Common Name <i>Latin Name</i>	Status		Habitat Requirements	Potential Occurrence on the Project Site
	Federal	State		
western pond turtle <i>Emys marmorata</i>	--	SSC	Streams, ponds, freshwater marshes, and lakes.	Not Expected; no suitable habitat on or adjacent to site.
California mountain kingsnake (San Diego population) <i>Lampropeltis zonata pulchra</i>	--	SSC	Occurs in riparian woodlands, and the adjacent chaparral and coastal sage scrub vegetation; associated with rock outcrops.	Low Potential; thought to be restricted to the San Gabriel and San Jacinto Mountains, but there is a record of occurrence at Stunts Ranch in the Santa Monica Mountains; no records from project area.
coast horned lizard <i>Phrynosoma blainvillii</i>	--	SSC	Relatively open grasslands, scrublands, and woodlands with fine, loose soil; requires open areas for sunning and abundant supply of ants and other insects.	Moderate Potential. Marginal quality habitat in coastal scrub vegetation on the upper slopes. No sign or food resources observed during site surveys, and while most records of occurrence in the Point Dume quadrangle are in upper Latigo canyon, there is one historical (1966) record of occurrence at Point Dume State Beach.

Common Name <i>Latin Name</i>	Status		Habitat Requirements	Potential Occurrence on the Project Site
	Federal	State		
two-striped garter snake <i>Thamnophis hammondi</i>	--	SSC	In or near permanent fresh water.	Not Expected; no suitable habitat on site.
AMPHIBIANS				
arroyo toad <i>Anaxyrus californicus</i>	FE	SSC	Washes, intermittent streams, rivers.	Not expected; no habitat on site.
California red-legged frog <i>Anaxyrus californicus</i>	FT	SSC	In or near permanent deep water.	Not expected; no habitat on site.
BIRDS				
Cooper's hawk (nesting) <i>Accipiter cooperi</i>	--	WL	Dense stands of live oaks and riparian woodlands.	Not expected to nest on site due to lack of suitable nesting habitat; species may be observed occasionally foraging over the site; no raptor nests observed in October and December 2011 surveys.
tri-colored blackbird (nesting colony) <i>Agelaius tricolor</i>	--	SSC	Emergent marsh near open water.	Not expected; habitat absent.

Common Name <i>Latin Name</i>	Status		Habitat Requirements	Potential Occurrence on the Project Site
	Federal	State		
southern California rufous-crowned sparrow (nesting) <i>Aimophila ruficeps canescens</i>	--	WL	Coastal sage scrub and sparse mixed chaparral; steep rocky hillsides with patches of grasses and forbs.	Low potential; species may be observed occasionally as a forager but is not expected to nest on site due to frequent disturbance of habitat; no records of nest sites in project area.
golden eagle (nesting & wintering) <i>Aquila chrysaetos</i>	--	WL; CFP	Mountains, deserts, and open country.	Low potential; species may be observed occasionally as a forager; not expected to nest on site; no raptor nests observed during October and December 2011 surveys.
burrowing owl (burrow sites & some wintering sites) <i>Athene cunicularia</i>	--	SSC	Grasslands and open scrub.	Not Expected; no suitable habitat present on site and no occurrences of this species in project area.

Common Name <i>Latin Name</i>	Status		Habitat Requirements	Potential Occurrence on the Project Site
	Federal	State		
ferruginous hawk (wintering) <i>Buteo regalis</i>	--	WL	Open grasslands, sagebrush flats, desert scrub, low foothills and edges of pinyon-juniper vegetation.	Not expected to nest on site due to lack of suitable nesting habitat; species may be observed occasionally foraging over the site; no raptor nests observed in October and December 2011 surveys.
western snowy plover (nesting) <i>Charadrius alexandrinus nivosus</i>	FT (Pacific coastal population) MNBMC	SSC (Pacific coastal and interior populations)	Sandy ocean beaches and around the drying margins of lagoons; nests on sparsely vegetated sandy or gravelly habitats, on dry mud flats, or on dirt dikes and fills.	Not Expected; no suitable habitat on site.
Belding's savannah sparrow <i>Passerculus sandwichensis beldingi</i>	--	SE	Pickleweed on and around margins of tidal flats.	Not expected; no suitable habitat on site.

Common Name <i>Latin Name</i>	Status		Habitat Requirements	Potential Occurrence on the Project Site
	Federal	State		
California brown pelican (nesting colony and communal roosts) <i>Pelecanus occidentalis californicus</i>	--	CFP	Coastal islands.	Not expected; no suitable habitat on site.
California gnatcatcher <i>Polioptila californica</i>	FT	CSC	Coastal sage scrub in areas of flat or gently sloping terrain.	Not Expected, no suitable habitat present on site and no occurrences of this species in project area.
light-footed clapper rail <i>Rallus longirostris levipes</i>	FE	SE	Salt marshes.	Not Expected; no suitable habitat on site.
bank swallow (nesting) <i>Riparia riparia</i>	--	ST	Colonial nester; primarily in riparian and lowland habitats west of desert; known to nest in coastal bluff habitats.	Low potential; no records from project site and nesting unlikely due to frequent disturbance; nearest record is from 1907 in the bluffs above the historical "Port Los Angeles" long wharf; thought to be extirpated as a breeder in southern California.

Common Name <i>Latin Name</i>	Status		Habitat Requirements	Potential Occurrence on the Project Site
	Federal	State		
California least tern (nesting colony) <i>Sterna antillarum browni</i>	FE	CE, CFP	Marine and estuarine shores with nearby lagoons or lacustrine waters.	Not Expected; no suitable habitat on site.
Least Bell's vireo (nesting) <i>Vireo bellii pusillus</i>	FE	SE	Riparian vegetation with extensive willows below 2,000 ft.	Not Expected; no suitable habitat on site.

Common Name <i>Latin Name</i>	Status		Habitat Requirements	Potential Occurrence on the Project Site
	Federal	State		
MAMMALS				
pallid bat <i>Antrozous pallidus</i>	--	SSC	Deserts, grasslands, shrublands, woodlands, and forests; prefers rocky outcrops, cliffs, and crevices with access to open habitats for foraging; roosts highly sensitive to disturbance.	Low potential; poor quality roosting habitat on site; nearest record of occurrence is from the Simi Hills.
spotted bat <i>Euderma maculata</i>	--	SSC	Deserts, scrublands, chaparral, and coniferous woodlands.	Low potential; may occur as infrequent forager, limited roosting habitat present on site; no records from project area.

Common Name <i>Latin Name</i>	Status		Habitat Requirements	Potential Occurrence on the Project Site
	Federal	State		
western mastiff bat <i>Eumops perotis</i>	--	SSC	Primarily arid lowlands and coastal basins with rugged, rocky terrain, along with suitable crevices for day-roosts.	Low potential; may occur as infrequent forager, limited roosting habitat present on site; nearest location record is from the Paramount ranch area of the Santa Monica Mountains.
western red bat <i>Lasiurus blossevillii</i>	--	SSC	Roosts primarily in trees, 2-40' above ground.	Low potential; may occur as infrequent forager, limited roosting habitat present on site; nearest location records are from the Paramount and Strauss ranch areas of the Santa Monica Mountains.
hoary bat <i>Lasiurus cinereus</i>	--	SA	Open habitats or habitat mosaics with access to trees for cover & open areas or edges for feeding	Low potential; may occur as infrequent forager, limited roosting habitat present on site; nearest location record is from the Strauss ranch area of the Santa Monica Mountains.

Common Name <i>Latin Name</i>	Status		Habitat Requirements	Potential Occurrence on the Project Site
	Federal	State		
California leaf-nosed bat <i>Macrotus californicus</i>	--	SSC	Deserts and palm oases.	Not expected; nearest reported location is from a cave in Canoga Park area.
south coast marsh vole <i>Microtus californicus stephensi</i>	--	SSC	Tidal marshes in LA, Orange and Southern Ventura Counties	Not Expected; no suitable habitat on site.
western small-footed myotis <i>Myotis ciliolabrum</i>	--	SA	Uplands near water; seeks cover in caves, buildings, mines, and crevices.	Low potential; may occur as infrequent forager, limited roosting habitat present on site. No records of occurrence in project area.
Yuma myotis <i>Myotis yumanensis</i>	--	SA	Open forests and woodlands with water sources, over which to forage; maternity colonies occur in caves, crevices, mines, and buildings.	Low potential; may occur as infrequent forager, limited roosting habitat present on site. No records of occurrence in project area.

Common Name <i>Latin Name</i>	Status		Habitat Requirements	Potential Occurrence on the Project Site
	Federal	State		
San Diego desert woodrat <i>Neotoma lepida intermedia</i>	--	SSC	Chaparral and coastal sage scrub.	Low potential; no sign observed during surveys; nearest location record is from the west side of Pepperdine University.
southern California saltmarsh shrew <i>Sorex ornatus salicornicus</i>	--	SSC	Coastal salt marsh.	Not Expected; no suitable habitat on site.
American badger <i>Taxidea taxus</i>	--	SA	Drier open stages of shrub, forest, and herbaceous habitats with friable soils.	Low potential; no burrows observed during surveys; no records from project area.

SOURCE: California Department of Fish and Game, Natural Diversity Database (CNDDDB), January 2012. Record search of the following USGS quadrangles: Calabasas, Malibu Beach, Newbury Park, Point Dume (project quadrangle), Point Mugu, Thousand Oaks, Topanga, Triunfo Pass.

NOTES: For most wildlife taxa only resident populations are tracked by the CNDDDB. In some cases (primarily birds), the CNDDDB only tracks certain parts of the species range or life history. The area or life stage is indicated in parenthesis after the common name.

STATUS CODES:

Federal -- U.S. Fish and Wildlife Service

FE: Federally-listed Endangered Species

FT: Federally-listed Threatened Species

FC: Candidate Species for Federal listing

State -- California Department of Fish and Game

SE: State-listed Endangered Species

ST: State-listed Threatened Species

CFP: California Fully Protected Species

SSC: California Species of Special Concern

WL: CDFG Watch List

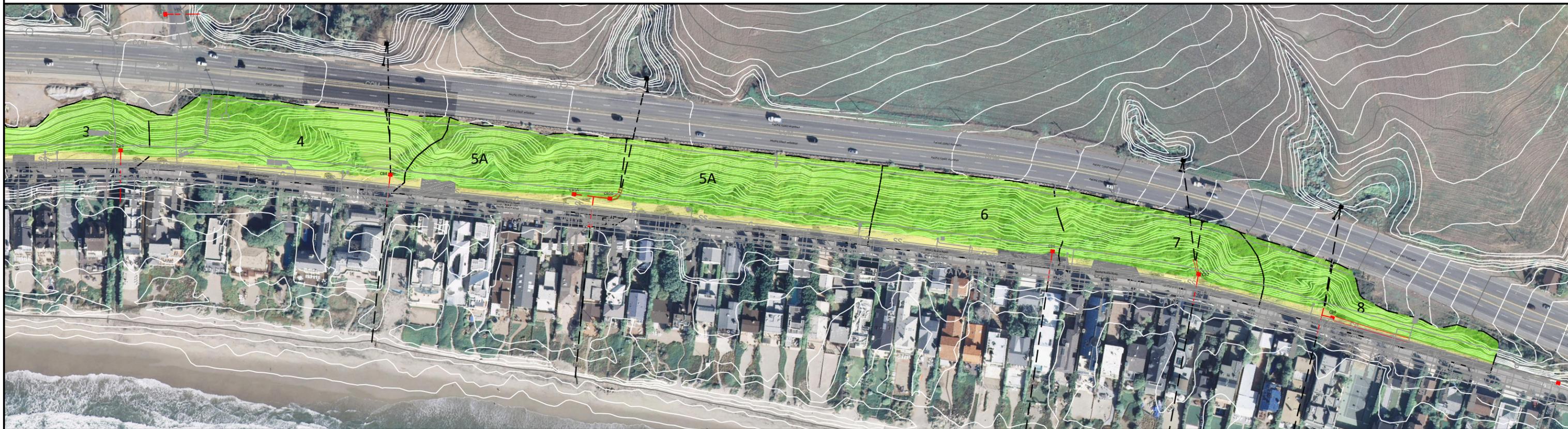
SA: California Special Animal. These species have no official federal or state status, but are tracked by the CNDDDB due to their rarity.

APPENDIX D

**GEOTECHNICAL AND GROUNDWATER
STUDIES REPORT
(CD)**

APPENDIX E

DRAINAGE MAPS

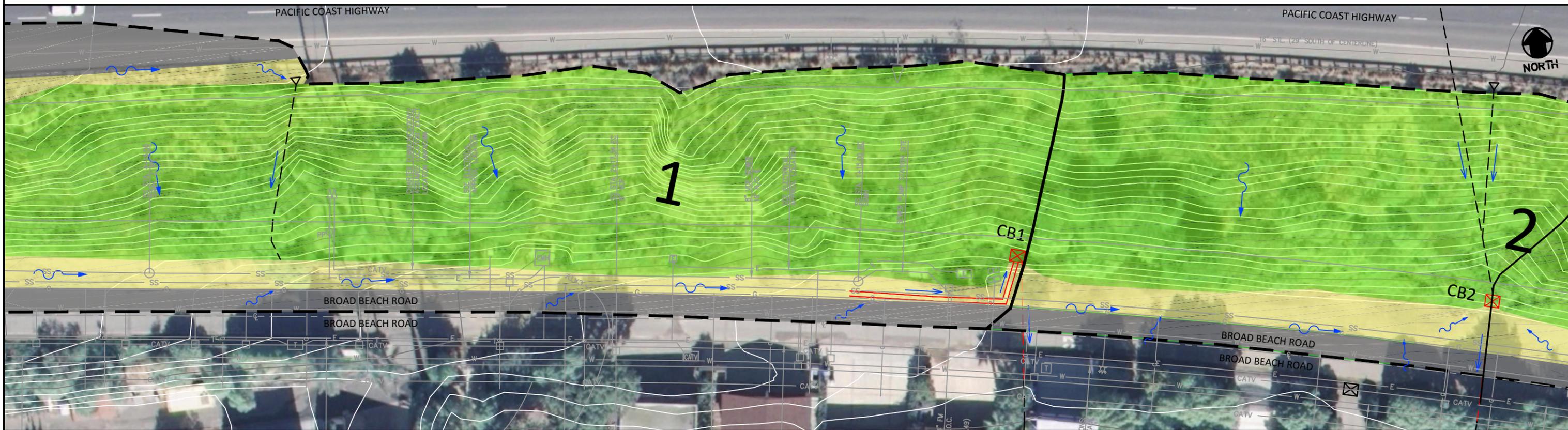
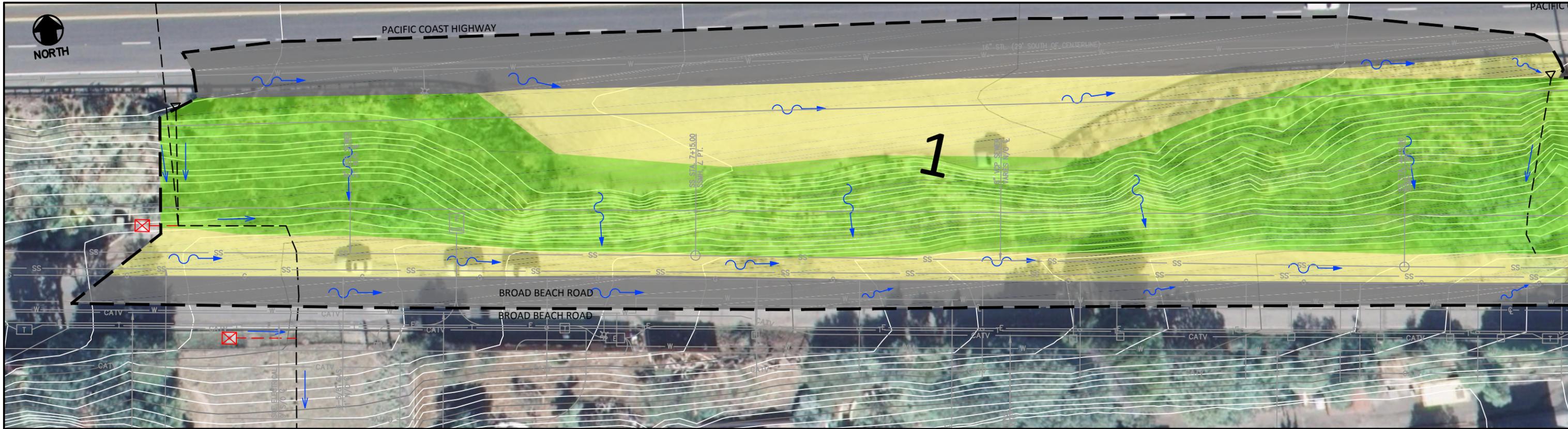


LEGEND

- CATCHMENT BOUNDARY
- HILLSIDE
- ROADSIDE SHOULDER (UNPAVED)
- PAVED AREA (ROADWAY AND SHOULDER)
- CATCH BASIN (CITY-OWNED)
- STORM DRAIN PIPE (CITY-OWNED)
- STORM DRAIN PIPE (NOT CITY-OWNED)
- PAVED DITCH/SWALE
- WALL

250 125 0 250 500

PROJECT: BROAD BEACH ROAD BIOFILTRATION PROJECT	
TITLE: DRAINAGE MAP OVERVIEW - CATCHMENTS	
PREPARED FOR: CITY OF MALIBU, DEPT. OF PUBLIC WORKS 23825 STUART RANCH ROAD MALIBU, CA 90265 PHONE: 310.456.2489	DESIGNED BY: REVIEWED BY: DATE: MAR 2012 DRAWING: DR-0
PREPARED BY: GEOSYNTEC CONSULTANTS 3415 S. SEPULVEDA BLVD., SUITE 500 LOS ANGELES, CA 90034 PHONE: 310.957.6100	DRAWN BY: APPROVED BY: PROJ. NO.: LA 0254



LEGEND

- CATCHMENT BOUNDARY
- HILLSIDE
- ROADSIDE SHOULDER (UNPAVED)
- PAVED AREA (ROADWAY AND SHOULDER)
- FLOW DIRECTION - SURFACE RUNOFF
- FLOW DIRECTION - PIPE / SWALE FLOW
- CATCH BASIN (CITY-OWNED)
- STORM DRAIN PIPE (CITY-OWNED)
- STORM DRAIN PIPE (NOT CITY-OWNED)
- PAVED DITCH/SWALE
- WALL

50 25 0 50 100
SCALE IN FEET

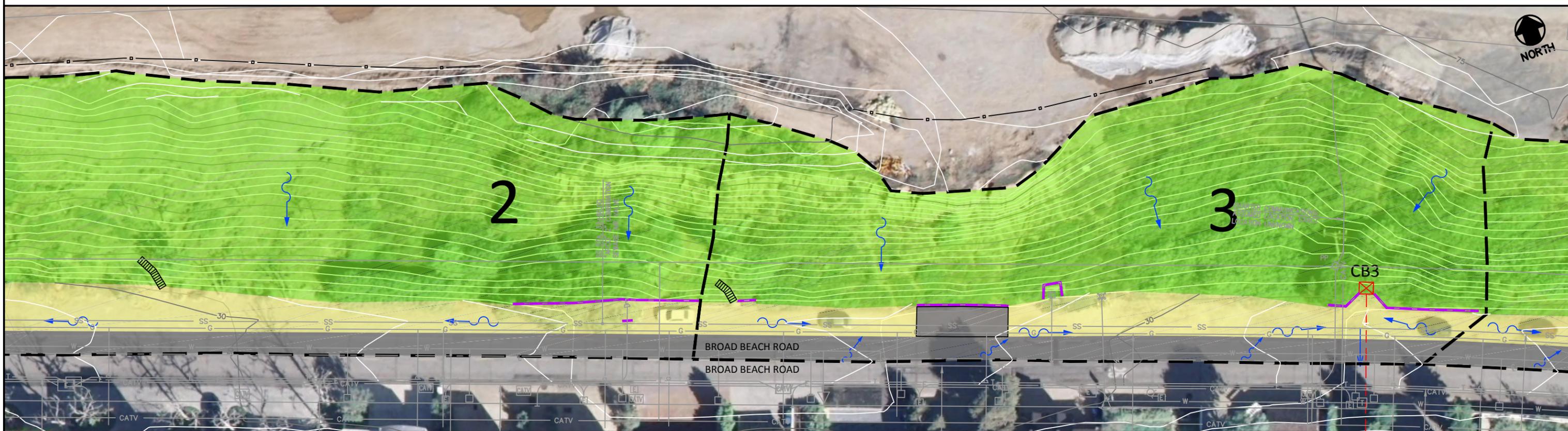
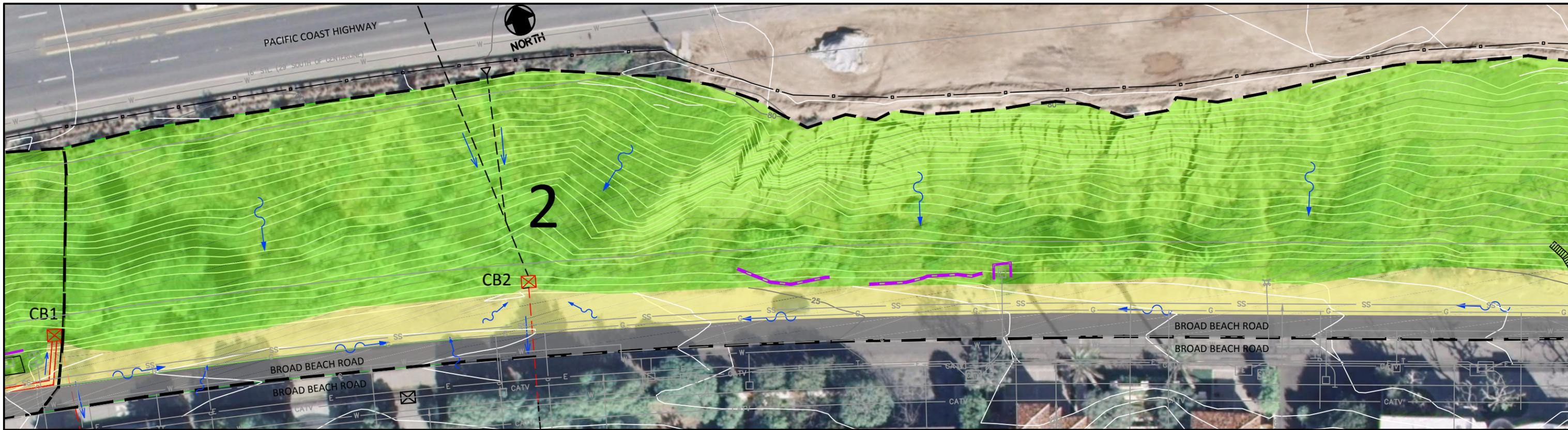
PREPARED FOR:
 CITY OF MALIBU, DEPT. OF PUBLIC WORKS
 23825 STUART RANCH ROAD
 MALIBU, CA 90265
 PHONE: 310.456.2489

PREPARED BY:
Geosyntec consultants
 GEOSYNTEC CONSULTANTS
 3415 S. SEPULVEDA BLVD., SUITE 500
 LOS ANGELES, CA 90034
 PHONE: 310.957.6100

PROJECT:
BROAD BEACH ROAD BIOFILTRATION PROJECT

TITLE:
**DRAINAGE MAP
CATCHMENT 1**

DESIGNED BY:	REVIEWED BY:	DATE: MAR 2012	DRAWING: DR-1
DRAWN BY:	APPROVED BY:	PROJ. NO.: LA 0254	



LEGEND

	CATCHMENT BOUNDARY		CATCH BASIN (CITY-OWNED)
	HILLSIDE		STORM DRAIN PIPE (CITY-OWNED)
	ROADSIDE SHOULDER (UNPAVED)		STORM DRAIN PIPE (NOT CITY-OWNED)
	PAVED AREA (ROADWAY AND SHOULDER)		PAVED DITCH/SWALE
	FLOW DIRECTION - SURFACE RUNOFF		WALL
	FLOW DIRECTION - PIPE / SWALE FLOW		

50 25 0 25 50 100
SCALE IN FEET

PREPARED FOR:
 CITY OF MALIBU, DEPT. OF PUBLIC WORKS
 23825 STUART RANCH ROAD
 MALIBU, CA 90265
 PHONE: 310.456.2489

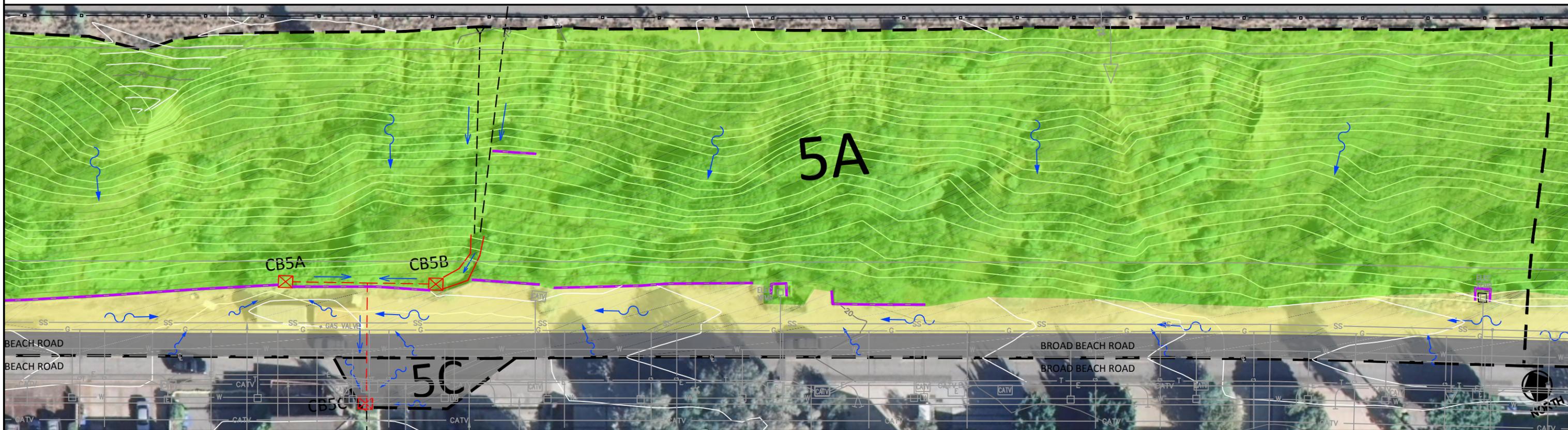
PREPARED BY:
Geosyntec
 consultants
engineers | scientists | designers

GEOSYNTEC CONSULTANTS
 3415 S. SEPULVEDA BLVD., SUITE 500
 LOS ANGELES, CA 90034
 PHONE: 310.957.6100

PROJECT:
BROAD BEACH ROAD BIOFILTRATION PROJECT

TITLE:
**DRAINAGE MAP
CATCHMENTS 2 & 3**

DESIGNED BY:	REVIEWED BY:	DATE: MAR 2012	DRAWING: DR-2
DRAWN BY:	APPROVED BY:	PROJ. NO.: LA 0254	

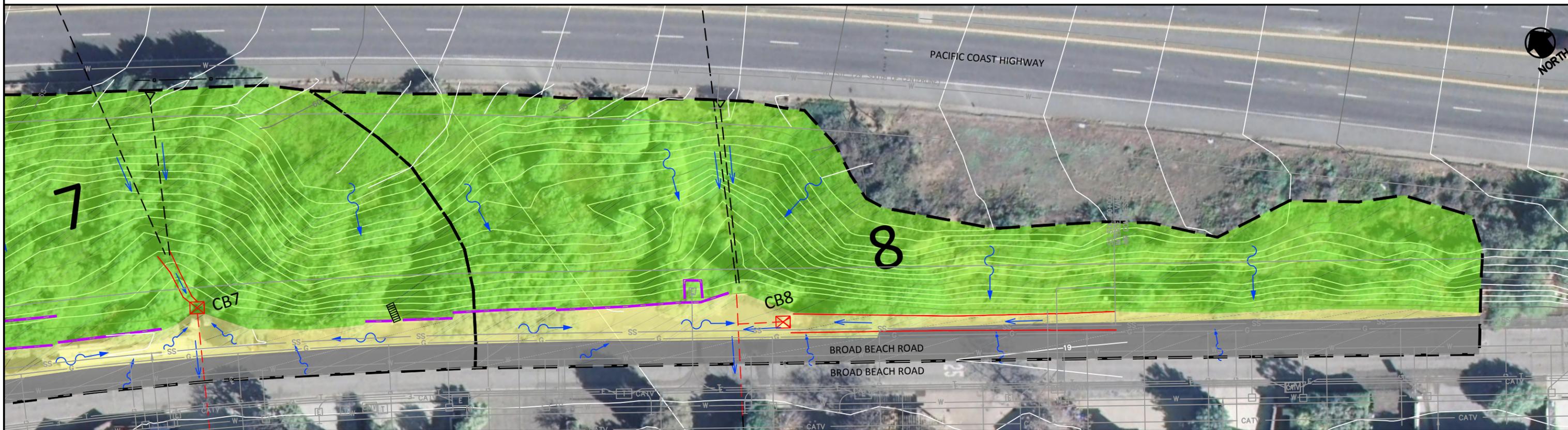
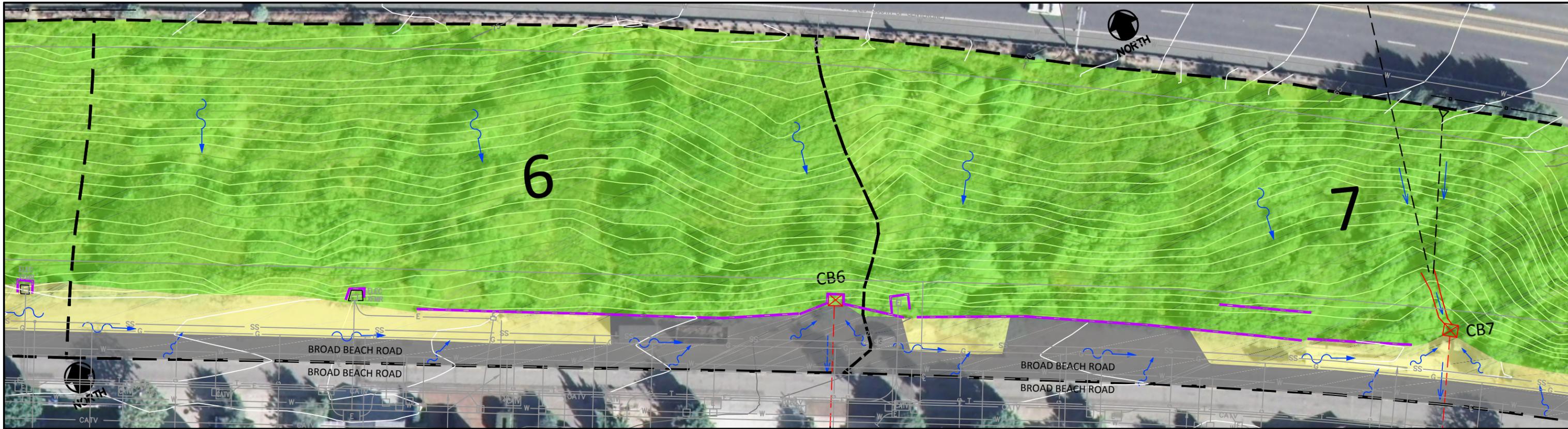


LEGEND

- CATCHMENT BOUNDARY
- HILLSIDE
- ROADSIDE SHOULDER (UNPAVED)
- PAVED AREA (ROADWAY AND SHOULDER)
- FLOW DIRECTION - SURFACE RUNOFF
- FLOW DIRECTION - PIPE / SWALE FLOW
- CATCH BASIN (CITY-OWNED)
- STORM DRAIN PIPE (CITY-OWNED)
- STORM DRAIN PIPE (NOT CITY-OWNED)
- PAVED DITCH/SWALE
- WALL

50 25 0 50 100
SCALE IN FEET

PROJECT: BROAD BEACH ROAD BIOFILTRATION PROJECT									
<p>PREPARED FOR:</p> <p>CITY OF MALIBU, DEPT. OF PUBLIC WORKS 23825 STUART RANCH ROAD MALIBU, CA 90265 PHONE: 310.456.2489</p>	<p>TITLE: DRAINAGE MAP CATCHMENTS 4, 5A & 5C</p>								
<p>PREPARED BY:</p> <p>GEOSYNTEC CONSULTANTS 3415 S. SEPULVEDA BLVD., SUITE 500 LOS ANGELES, CA 90034 PHONE: 310.957.6100</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 25%;">DESIGNED BY:</td> <td style="width: 25%;">REVIEWED BY:</td> <td style="width: 25%;">DATE: MAR 2012</td> <td style="width: 25%;">DRAWING: DR-3</td> </tr> <tr> <td>DRAWN BY:</td> <td>APPROVED BY:</td> <td>PROJ. NO.: LA 0254</td> <td></td> </tr> </table>	DESIGNED BY:	REVIEWED BY:	DATE: MAR 2012	DRAWING: DR-3	DRAWN BY:	APPROVED BY:	PROJ. NO.: LA 0254	
DESIGNED BY:	REVIEWED BY:	DATE: MAR 2012	DRAWING: DR-3						
DRAWN BY:	APPROVED BY:	PROJ. NO.: LA 0254							



LEGEND

- CATCHMENT BOUNDARY
- HILLSIDE
- ROADSIDE SHOULDER (UNPAVED)
- PAVED AREA (ROADWAY AND SHOULDER)
- FLOW DIRECTION - SURFACE RUNOFF
- FLOW DIRECTION - PIPE / SWALE FLOW
- CATCH BASIN (CITY-OWNED)
- STORM DRAIN PIPE (CITY-OWNED)
- STORM DRAIN PIPE (NOT CITY-OWNED)
- PAVED DITCH/SWALE
- WALL

50 25 0 50 100
SCALE IN FEET

PREPARED FOR:
 CITY OF MALIBU, DEPT. OF PUBLIC WORKS
 23825 STUART RANCH ROAD
 MALIBU, CA 90265
 PHONE: 310.456.2489

PREPARED BY:
Geosyntec
 consultants
 3415 S. SEPULVEDA BLVD., SUITE 500
 LOS ANGELES, CA 90034
 PHONE: 310.957.6100

PROJECT:
BROAD BEACH ROAD BIOFILTRATION PROJECT

TITLE:
**DRAINAGE MAP
CATCHMENTS 6, 7 & 8**

DESIGNED BY:	REVIEWED BY:	DATE: MAR 2012	DRAWING: DR-4
DRAWN BY:	APPROVED BY:	PROJ. NO.: LA 0254	

APPENDIX F

SIZING METHODOLOGY FOR BIOFILTERS

Biofilter facilities with underdrains shall be designed to capture and treat the design capture volume. Since these systems commonly have a relatively high media filtration rate and shallow depth, they are typically capable of filtering a significant portion of the design capture volume during a storm event. For sizing of the Broad Beach Road biofilters a simplified routing approach is utilized that accounts for the portion of the design capture volume that is filtered during the storm event. Design biofilter surface area (A_{design}) was calculated using the following equation:

$$A_{design} = \frac{Bv}{d_p + d_{eff}}$$

Where:

A_{design}	=	design biofilter surface area (ft ²)
A_{media}	=	biofilter media surface area (ft ²)
Bv	=	biofilter design volume (ft ³) = 1.5 * SWQDv
$SWQDv$	=	stormwater quality design volume (ft ³)
d_p	=	design ponding water depth (ft)
d_{eff}	=	effective storage depth water in biofilter media (ft)
	=	$n_{media} * l_{media}$
n_{media}	=	media porosity (biofilter media = 25%, gravel = 30%)
l_{media}	=	media depth

A_{design} represents the water surface area at a ponding depth equal to half of design ponding water depth. A_{media} represents the biofilter media surface area which will be smaller than A_{design} when the sides are sloped. Values for A_{design} were calculated per catchment and where relevant per catchment section. Catchments where the catch basins receive flow from both east and west have been divided into two sections. The biofilters on each side of the catch basin were sized for their respective tributary areas.

Design maximum allowed ponding drawdown time is 48 hours. Ponding drawdown time is calculated as the design ponding depth divided by the design percolation rate (P_{design}). The target saturated hydraulic conductivity (K_{sat}) for the biofilter media is 5 inches per hour. The media K_{sat} will decline over time but will still have capacity to drain the pond within the period required to avoid vector control issues and to restore

hydraulic capacity for subsequent storms. To account for this reduction in filtration capacity, a factor of safety of 2.0 is applied such that P_{design} is 2.5 inches per hour. Design ponding depth varies between 9 and 12 inches.

APPENDIX G

WATER USAGE CALCULATIONS

Broad Beach Road Biofiltration Project

WATER BUDGET CALCULATIONS

(Based upon Project Survey Site Plan)

PREPARED FOR:

City of Malibu
 Department of Public Works
 23825 Stuart Ranch Road
 Malibu, CA 90265
 DATE: March 7, 2012
 LNDG # 2341-01

PREPARED BY:

L. Newman Design Group, Inc.
 31300 Via Colinas, Suite 104
 Westlake Village, CA 91362-3924

HYDROZONE INFORMATION TABLE

Hydrozone	Plant Water Use Type	Plant Factor (PF)	Irrigation Type and Efficiency (IE)	Hydrozone Area (HA)	(PF x HA) / IE
1	LW	0.2	Drip – 0.90	18,000	4,000
2	LW	0.3	Rotator – 0.75	54,675	21,870
Totals				72,675	25,870

EQUATIONS & DEFINITIONS

$$\text{MAWA (Maximum Applied Water Allowance)} = (ET_o)(0.62) [(0.7 \times LA) + (0.3 \times SLA)]$$

$$\text{ETWU (Estimated Total Water Usage)} = (ET_o)(0.62) [(PF \times HA / IE) + SLA]$$

LEGEND

ET _o	=	Evapotranspiration Rate
PF	=	Plant Factor
HA	=	Hydrozone Area
IE	=	Irrigation Efficiency
LA	=	Landscape Area
SLA	=	Special Landscape Area

REFERENCE EVAPOTRANSPIRATION (ET_o) TABLE (Comparable Climate)

County			City					Region				
Los Angeles			Malibu					Coastal Valleys and Plains				
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
1.86	2.24	3.72	4.80	5.27	5.70	5.58	5.27	4.20	3.41	2.40	1.86	46.30

MAXIMUM APPLIED WATER ALLOWANCE (MAWA)

$$MAWA = (ET_o) (0.62) [(0.7 \times LA) + (0.3 \times SLA)]$$

$$MAWA = (46.3) (0.62) [(0.7 \times 72,675) + (0.3 \times 0)]$$

$$\boxed{MAWA = 1,460,346 \text{ GPY}}$$

ESTIMATED TOTAL WATER USAGE (ETWU)

$$ETWU = (ET_o) (0.62) [(PF \times HA / IE) + SLA]$$

$$ETWU = (46.3) (0.62) [(25,870) + 0]$$

$$\boxed{ETWU = 742,625 \text{ GPY}}$$

WATER SAVINGS

$$\% \text{ Savings} = [(MAWA - ETWU) / MAWA] \times 100$$

$$\% \text{ Savings} = [(1,460,346 - 742,625) / 1,460,346] \times 100$$

$$\boxed{\% \text{ Savings} = 49.15\%}$$

REFERENCES

Current data has been compiled from the following references:

1. **CIMIS** (California Irrigation Management Information System)
www.cimis.water.ca.gov
2. **State of California Department of Water Resources** (California Code of Regulations, Title 23, Section 490-495, Model Water Efficient Landscape Ordinance)
<http://www.water.ca.gov/wateruseefficiency/docs/MWEL09-10-09.pdf>
3. **WUCOLS** (Water Use Classification of Landscape Species)
http://www.water.ca.gov/pubs/conservation/a_guide_to_estimating_irrigation_water_needs_of_landscape_plantings_in_california_wucols/wucols00.pdf

**All Alternatives
Summary of Water Usage Costs**

Month	Alt 1 (\$)	Alt 2 (0%) (\$)	Alt 2 (50%) (\$)	Alt 2 (100%) (\$)
Jan				
Feb	\$399	\$383	\$358	\$333
Mar				
Apr	\$674	\$639	\$591	\$550
May				
Jun	\$1,349	\$1,290	\$1,192	\$1,094
Jul				
Aug	\$1,387	\$1,321	\$1,211	\$1,101
Sep				
Oct	\$1,090	\$1,034	\$942	\$869
Nov				
Dec	\$616	\$592	\$553	\$513
Total	\$5,516	\$5,259	\$4,846	\$4,460

Alternative 1 - 100% treatment (no storage)
Calculation of Water Usage Costs

ETWU_{pot} = Estimated total potable water usage (gallons)

UC₁ = Tier 1 unit cost (\$/unit¹) = \$4.60

UC₂ = Tier 2 unit cost (\$/unit¹) = \$5.36

UC₃ = Tier 3 unit cost (\$/unit¹) = \$7.66

T_{w1} = Tier 1 threshold, winter (units)² = 60

T_{w2} = Tier 2 threshold, winter (units)² = 120

T_{w3} = Tier 3 threshold, winter (units)² = 210

T_{s1} = Tier 1 threshold, summer (units)² = 90

T_{s2} = Tier 2 threshold, winter (units)² = 180

T_{s3} = Tier 3 threshold, winter (units)² = 300

V_{tot} = Total potable water usage (units)

V_x = Potable water usage per tier level x (gal)

C_x = Cost per tier level x (\$) = V_x * UC_x

C_{serv} = Service charge (\$)

C_{tot} = Total cost (\$)

Month	ETWU _{pot} (gal/1m)	V _{tot} (units/2m)	V ₁ (units)	V ₂ (units)	V ₃ (units)	C ₁ (\$)	C ₂ (\$)	C ₃ (\$)	C _{serv} ³ (\$)	C _{tot} (\$)
Dec	29833									
Jan	29833	80	60	20	0	\$138	\$106	\$0	\$155	\$399
Feb	35928									
Mar	59667	128	60	60	8	\$138	\$322	\$60	\$155	\$674
Apr	76989									
May	84528	216	60	60	96	\$138	\$322	\$735	\$155	\$1,349
Jun	91425									
Jul	89500	242	90	90	62	\$276	\$482	\$474	\$155	\$1,387
Aug	84528									
Sep	67365	203	90	90	23	\$276	\$482	\$177	\$155	\$1,090
Oct	54694									
Nov	38495	125	90	35	0	\$276	\$185	\$0	\$155	\$616
Total	742785	993	450	354	189	\$1,243	\$1,900	\$1,445	\$929	\$5,516

1. One unit = 100 cu.ft. = 748 gal

2. The first 30 units are included in the service charge. Winter = Dec - May, Summer = June - Nov.

3. Service charge for 1 1/2 inch water meter.

Assumptions:

All unit costs and service costs are based on Tiered Rate Schedule for Malibu effective 01/01/2012.

Alternative 2 - Treatment and Reuse (partial storage)

Calculation of Water Usage Costs - 0% of Water for Hydrozone 1 from Cistern

ETWU_{pot} = Estimated total potable water usage (gallons)

UC₁ = Tier 1 unit cost (\$/unit¹) = \$4.60

UC₂ = Tier 2 unit cost (\$/unit¹) = \$5.36

UC₃ = Tier 3 unit cost (\$/unit¹) = \$7.66

T_{w1} = Tier 1 threshold, winter (units)² = 60

T_{w2} = Tier 2 threshold, winter (units)² = 120

T_{w3} = Tier 3 threshold, winter (units)² = 210

T_{s1} = Tier 1 threshold, summer (units)² = 90

T_{s2} = Tier 2 threshold, winter (units)² = 180

T_{s3} = Tier 3 threshold, winter (units)² = 300

V_{tot} = Total potable water usage (units)

V_x = Potable water usage per tier level x (gal)

C_x = Cost per tier level x (\$) = V_x * UC_x

C_{serv} = Service charge (\$)

C_{tot} = Total cost (\$)

Month	ETWU _{pot} (gal/1m)	V _{tot} (units/2m)	V ₁ (units)	V ₂ (units)	V ₃ (units)	C ₁ (\$)	C ₂ (\$)	C ₃ (\$)	C _{serv} ³ (\$)	C _{tot} (\$)
Dec	28757									
Jan	28757	77	60	17	0	\$138	\$91	\$0	\$155	\$383
Feb	34632									
Mar	57514	123	60	60	3	\$138	\$322	\$24	\$155	\$639
Apr	74212									
May	81478	208	60	60	88	\$138	\$322	\$675	\$155	\$1,290
Jun	88126									
Jul	86271	233	90	90	53	\$276	\$482	\$407	\$155	\$1,321
Aug	81478									
Sep	64935	196	90	90	16	\$276	\$482	\$121	\$155	\$1,034
Oct	52721									
Nov	37106	120	90	30	0	\$276	\$161	\$0	\$155	\$592
Total	715987	957	450	347	160	\$1,243	\$1,860	\$1,227	\$929	\$5,259

1. One unit = 100 cu.ft. = 748 gal

2. The first 30 units are included in the service charge. Winter = Dec - May, Summer = June - Nov.

3. Service charge for 1 1/2 inch water meter.

Assumptions:

All unit costs and service costs are based on Tiered Rate Schedule for Malibu effective 01/01/2012.

Alternative 2 - Treatment and Reuse (partial storage)

Calculation of Water Usage Costs - 50% of Water for Hydrozone 1 from Cistern

ETWU_{pot} = Estimated total potable water usage (gallons)

UC₁ = Tier 1 unit cost (\$/unit¹) = \$4.60

UC₂ = Tier 2 unit cost (\$/unit¹) = \$5.36

UC₃ = Tier 3 unit cost (\$/unit¹) = \$7.66

T_{w1} = Tier 1 threshold, winter (units)² = 60

T_{w2} = Tier 2 threshold, winter (units)² = 120

T_{w3} = Tier 3 threshold, winter (units)² = 210

T_{s1} = Tier 1 threshold, summer (units)² = 90

T_{s2} = Tier 2 threshold, winter (units)² = 180

T_{s3} = Tier 3 threshold, winter (units)² = 300

V_{tot} = Total potable water usage (units)

V_x = Potable water usage per tier level x (gal)

C_x = Cost per tier level x (\$) = V_x * UC_x

C_{serv} = Service charge (\$)

C_{tot} = Total cost (\$)

Month	ETWU _{pot} (gal/1m)	V _{tot} (units/2m)	V ₁ (units)	V ₂ (units)	V ₃ (units)	C ₁ (\$)	C ₂ (\$)	C ₃ (\$)	C _{serv} ³ (\$)	C _{tot} (\$)
Dec	26989									
Jan	26989	72	60	12	0	\$138	\$65	\$0	\$155	\$358
Feb	32503									
Mar	53977	116	60	56	0	\$138	\$298	\$0	\$155	\$591
Apr	69648									
May	76468	195	60	60	75	\$138	\$322	\$577	\$155	\$1,192
Jun	82707									
Jul	80966	219	90	90	39	\$276	\$482	\$297	\$155	\$1,211
Aug	76468									
Sep	60942	184	90	90	4	\$276	\$482	\$28	\$155	\$942
Oct	49479									
Nov	34824	113	90	23	0	\$276	\$122	\$0	\$155	\$553
Total	671961	898	450	330	118	\$1,243	\$1,772	\$902	\$929	\$4,846

1. One unit = 100 cu.ft. = 748 gal

2. The first 30 units are included in the service charge. Winter = Dec - May, Summer = June - Nov.

3. Service charge for 1 1/2 inch water meter.

Assumptions:

All unit costs and service costs are based on Tiered Rate Schedule for Malibu effective 01/01/2012.

Alternative 2 - Treatment and Reuse (partial storage)

Calculation of Water Usage Costs - 100% of Water for Hydrozone 1 from Cistern

ETWU_{pot} = Estimated total potable water usage (gallons)

UC₁ = Tier 1 unit cost (\$/unit¹) = \$4.60

UC₂ = Tier 2 unit cost (\$/unit¹) = \$5.36

UC₃ = Tier 3 unit cost (\$/unit¹) = \$7.66

T_{w1} = Tier 1 threshold, winter (units)² = 60

T_{w2} = Tier 2 threshold, winter (units)² = 120

T_{w3} = Tier 3 threshold, winter (units)² = 210

T_{s1} = Tier 1 threshold, summer (units)² = 90

T_{s2} = Tier 2 threshold, winter (units)² = 180

T_{s3} = Tier 3 threshold, winter (units)² = 300

V_{tot} = Total potable water usage (units)

V_x = Potable water usage per tier level x (gal)

C_x = Cost per tier level x (\$) = V_x * UC_x

C_{serv} = Service charge (\$)

C_{tot} = Total cost (\$)

Month	ETWU _{pot} (gal/1m)	V _{tot} (units/2m)	V ₁ (units)	V ₂ (units)	V ₃ (units)	C ₁ (\$)	C ₂ (\$)	C ₃ (\$)	C _{serv} ³ (\$)	C _{tot} (\$)
Dec	25220									
Jan	25220	67	60	7	0	\$138	\$40	\$0	\$155	\$333
Feb	30373									
Mar	50441	108	60	48	0	\$138	\$258	\$0	\$155	\$550
Apr	65085									
May	71458	183	60	60	63	\$138	\$322	\$479	\$155	\$1,094
Jun	77289									
Jul	75661	204	90	90	24	\$276	\$482	\$187	\$155	\$1,101
Aug	71458									
Sep	56949	172	90	82	0	\$276	\$438	\$0	\$155	\$869
Oct	46238									
Nov	32543	105	90	15	0	\$276	\$82	\$0	\$155	\$513
Total	627936	839	450	302	87	\$1,243	\$1,622	\$666	\$929	\$4,460

1. One unit = 100 cu.ft. = 748 gal

2. The first 30 units are included in the service charge. Winter = Dec - May, Summer = June - Nov.

3. Service charge for 1 1/2 inch water meter.

Assumptions:

All unit costs and service costs are based on Tiered Rate Schedule for Malibu effective 01/01/2012.

**Alternative 1 - 100% treatment (no storage)
Calculation of ETWU**

Hydrozone information table¹

Hydrozone	Plant Water Use Type	Plant Factor (PF)	Irrigation Type and Efficiency (IE)	Hydrozone Area (HA)	(PF x HA) / IE
1	LW	0.2	Drip – 0.90	18,000	4,000
2	LW	0.3	Rotator – 0.75	54,675	21,870
			Totals	72,675	25,870

ET₀ = Reference evapotranspiration (in)

ETWU = Estimated total water usage (gallons) = $ET_0 * 0.62 * [(PF * HA / IE) + SLA]$

SLA = Special Landscape Area¹ = 0

Month	ET ₀ ¹ (in)	ETWU (gal/1m)
Jan	1.86	29833
Feb	2.24	35928
Mar	3.72	59667
Apr	4.80	76989
May	5.27	84528
Jun	5.70	91425
Jul	5.58	89500
Aug	5.27	84528
Sep	4.20	67365
Oct	3.41	54694
Nov	2.40	38495
Dec	1.86	29833
Total	46.31	742785

1. Reference: Water Budget Calculations [LNDG, 2012]

**Alternative 2 - Treatment and Reuse (partial storage)
Calculation of ETWU**

Hydrozone information table¹

Hydrozone	Plant Water Use Type	Plant Factor (PF)	Irrigation Type and Efficiency (IE)	Hydrozone Area (HA)	(PF x HA) / IE
1	LW	0.2	Drip – 0.90	13,800	3,067
2	LW	0.3	Rotator – 0.75	54,675	21,870
Totals				68,475	24,937

ET₀ = Reference evapotranspiration (in)

ETWU = Estimated total water usage (gallons) = ET₀ * 0.62 * [(PF * HA / IE) + SLA]

ETWU_{pot,0} = Potable water usage based on 0% of hydrozone 1 irrigated by stored water

ETWU_{pot,50} = Potable water usage based on 50% of hydrozone 1 irrigated by stored water

ETWU_{pot,100} = Potable water usage based on 100% of hydrozone 1 irrigated by stored water

SLA = Special Landscape Area¹ = 0

Month	ET ₀ (in)	ETWU (gal/1m)	ETWU _{pot,0} (gal/1m)	ETWU _{pot,50} (gal/1m)	ETWU _{pot,100} (gal/1m)
Jan	1.86	28757	28757	26989	25220
Feb	2.24	34632	34632	32503	30373
Mar	3.72	57514	57514	53977	50441
Apr	4.80	74212	74212	69648	65085
May	5.27	81478	81478	76468	71458
Jun	5.70	88126	88126	82707	77289
Jul	5.58	86271	86271	80966	75661
Aug	5.27	81478	81478	76468	71458
Sep	4.20	64935	64935	60942	56949
Oct	3.41	52721	52721	49479	46238
Nov	2.40	37106	37106	34824	32543
Dec	1.86	28757	28757	26989	25220
Total	46.31	715987	715987	671961	627936

1. Reference: Water Budget Calculations [LNDG, 2012]

EFFECTIVE 01/01/2012

Malibu Tiered Rate Schedule			Summer	June 1 to November 30		
2962		FCS \$.693	QSC \$1.74	2962 Bill Code W09, I09, F09		
Meter size	Billing Units	Allowance	Service Chg	Water Usage Tier	Range	Charge
3/4 X 1	1	10	\$25.81 (\$51.62)	Conservation	30	\$4.603
				Normal	60	\$5.361
				Excessive	100	\$7.657
1 inch	2	20	\$51.62 (\$103.24)	Conservation	60	\$4.603
				Normal	120	\$5.361
				Excessive	200	\$7.657
1 1/2 inch	3	30	\$77.43 (\$154.86)	Conservation	90	\$4.603
				Normal	180	\$5.361
				Excessive	300	\$7.657
2 inch	5	50	\$129.05 (\$258.10)	Conservation	150	\$4.603
				Normal	300	\$5.361
				Excessive	500	\$7.657
2 1/2 inch	7	70	\$180.67 (\$361.34)	Conservation	210	\$4.603
				Normal	420	\$5.361
				Excessive	700	\$7.657
3 inch	11	110	\$283.91 (\$567.82)	Conservation	330	\$4.603
				Normal	660	\$5.361
				Excessive	1100	\$7.657
4 inch	17	170	\$438.77 (\$877.54)	Conservation	510	\$4.603
				Normal	1020	\$5.361
				Excessive	1700	\$7.657
6 inch	33	330	\$851.73 (\$1,703.46)	Conservation	990	\$4.603
				Normal	1980	\$5.361
				Excessive	3300	\$7.657
8 inch	53	530	\$1367.93 (\$2,735.86)	Conservation	1590	\$4.603
				Normal	3180	\$5.361
				Excessive	5300	\$7.657
10 inch	77	770	\$1,987.37 (\$3,974.74)	Conservation	2310	\$4.603
				Normal	4620	\$5.361
				Excessive	7700	\$7.657
12 inch	100	1000	\$2,581.00 (\$5,162.00)	Conservation	3000	\$4.603
				Normal	6000	\$5.361
				Excessive	10000	\$7.657

EFFECTIVE 01/01/2012

Malibu Tiered Rate Schedule			Winter	December 1 to May 31		
2962		FCS \$.693	QSC \$1.74	2962 Bill Code W09, I09, F09		
Meter size	Billing Units	Allowance	Service Chg	Water Usage Tier	Range	Charge
3/4 X 1	1	10	\$25.81 (\$51.62)	Conservation	20	\$4.603
				Normal	40	\$5.361
				Excessive	70	\$7.657
1 inch	2	20	\$51.62 (\$103.24)	Conservation	40	\$4.603
				Normal	80	\$5.361
				Excessive	140	\$7.657
1 1/2 inch	3	30	\$77.43 (\$154.86)	Conservation	60	\$4.603
				Normal	120	\$5.361
				Excessive	210	\$7.657
2 inch	5	50	\$129.05 (\$258.10)	Conservation	100	\$4.603
				Normal	200	\$5.361
				Excessive	350	\$7.657
2 1/2 inch	7	70	\$180.67 (\$361.34)	Conservation	140	\$4.603
				Normal	280	\$5.361
				Excessive	490	\$7.657
3 inch	11	110	\$283.91 (\$567.82)	Conservation	220	\$4.603
				Normal	440	\$5.361
				Excessive	770	\$7.657
4 inch	17	170	\$438.77 (\$877.54)	Conservation	340	\$4.603
				Normal	680	\$5.361
				Excessive	1190	\$7.657
6 inch	33	330	\$851.73 (\$1,703.46)	Conservation	660	\$4.603
				Normal	1320	\$5.361
				Excessive	2310	\$7.657
8 inch	53	530	\$1367.93 (\$2,735.86)	Conservation	1060	\$4.603
				Normal	2120	\$5.361
				Excessive	3710	\$7.657
10 inch	77	770	\$1,987.37 (\$3,974.74)	Conservation	1540	\$4.603
				Normal	3080	\$5.361
				Excessive	5390	\$7.657
12 inch	100	1000	\$2,581.00 (\$5,162.00)	Conservation	2000	\$4.603
				Normal	4000	\$5.361
				Excessive	7000	\$7.657

APPENDIX H

MATERIAL EXHIBITS

COASTAL BLUFF SCRUB SLOPE RESTORATION
& SLOPE ENHANCEMENT AREAS



Atriplex lentiformis
(Saltbush)



Erigeron cinereum
(Ashy-Leaved Buckwheat)



Yucca whipplei
(Our Lord's Candle)



Encelia californica
(California Brittlebush)



Rhus integrifolia
(Lemonadeberry)



Baccharis pilularis
(Coyote Brush)



Mimulus spp.
(Monkey Flower)



Mesembryanthemum nodiflorum
(Slender-leaved Iceplant)



Ceanothus spp.
(Wild Lilac)



Agave attenuata
(Foxtail Agave)



Aloe arborescens
(Tree Aloe)



Opuntia littoralis
(Coastal Prickly Pear)

BIOSWALE & BIOFILTRATION AREAS



Juncus acutus
(Spiny Rush)



Scirpus californicus
(California Bulrush)



Juncus patens
(Rush)



Scirpus cernuus
(Fiber Optic Grass)



Carex nudata
(California Black Flowering Sedge)



Carex spissa
(San Diego Sedge)



LNDG JOB # 2341-01



engineers | scientists | innovators

Client:
City of Malibu
DEPARTMENT OF PUBLIC WORKS
23825 STUART RANCH ROAD
MALIBU, CA 90265
PHONE: 310.456.2489



Broad Beach Road Biofiltration Project

Plant Palette Exhibit

*Preliminary Design - Not for Construction



Existing Broad Beach Road Garden / Slough Wall
(Dry Stacked River Rock / Cobble)



Shadow Rock
(El Dorado Stone)



Bluffstone
(El Dorado Stone)



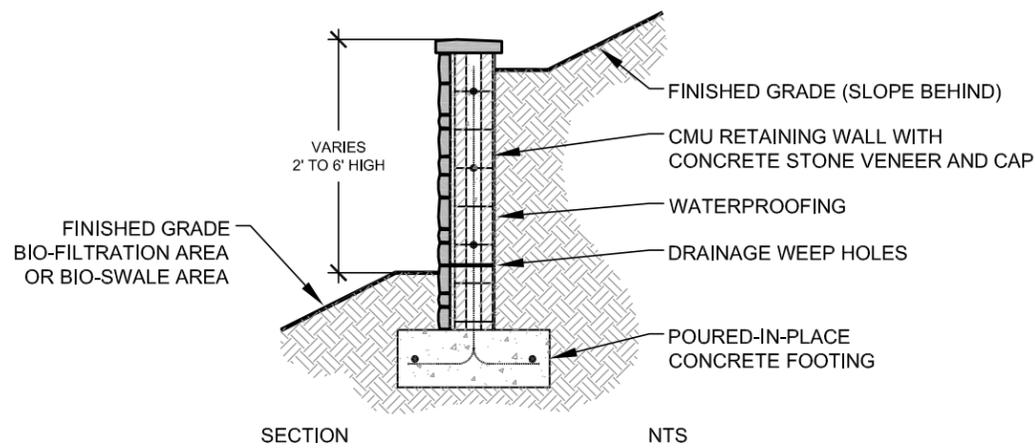
Rustic Ledge
(El Dorado Stone)



Existing Broad Beach Road Stone Retaining Wall
(Rustic Ledgestone)



Bio-swale Boulders & Cobble
(Legacy Park, Malibu)



SECTION NTS
Concrete Stone Veneer Garden / Slough & Retaining Wall



Existing Broad Beach Road Retaining Wall - to Remain
(Face with Project Theme Stone Veneer)



Existing Broad Beach Road Retaining Wall - to Remain
(Face with Project Theme Stone Veneer)



Multi-weave Pattern



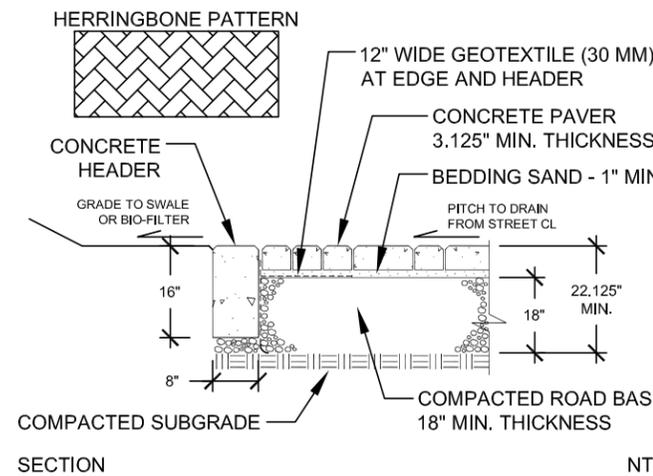
Ashlar Rectangle Pattern
(Tumbled Edge)



Herringbone Pattern



Ashlar Rectangle & Square Pattern
(Tumbled Edge)



SECTION NTS
Concrete Paver on Aggregate Base



Concrete Parking Pavers
(Spirent Office Building, Calabasas)



Rolled Edge Concrete Swale
(North Ranch, Thousand Oaks)



Concrete Pavers
(Paramount Ranch Estates, Agoura Hills)



Client:
City of Malibu
DEPARTMENT OF PUBLIC WORKS
23825 STUART RANCH ROAD
MALIBU, CA 90265
PHONE: 310.456.2489



Broad Beach Road Biofiltration Project

Materials Exhibit

*Preliminary Design - Not for Construction

APPENDIX I

CONSTRUCTION COST ESTIMATES

Alternatives 1 and 2

CONSTRUCTION COSTS - SUMMARY

Site Name: Broad Beach Road
 Site Location: Malibu, CA

Total Construction Costs	Alt. 1	Alt. 2	Notes
Biofilters	\$ 159,000	\$ 96,000	
Vegetated Swale	\$ 31,000	\$ 34,000	
Planting of Slope	\$ 38,000	\$ 38,000	
Irrigation	\$ 150,000	\$ 156,000	
Walls	\$ 169,000	\$ 116,000	
Concrete Interlocking Pavers	\$ 528,000	\$ 527,000	
Diversion and Storage Structures - Catchment 2	\$ 3,000	\$ 124,000	Alt. 1 does not include storage
Diversion and Storage Structures - Catchment 8	\$ 43,000	\$ 77,000	Alt. 1 does not include storage
Maintenance of planting and irrigation	\$ 8,000	\$ 8,000	3 month maintenance period
Demolition of hardscape/landscape	\$ 34,000	\$ 34,000	
SUBTOTAL 1	\$ 1,163,000	\$ 1,210,000	
Mobilization & Demobilization	\$ 116,000	\$ 121,000	10% of Subtotal 1
Bonds	\$ 35,000	\$ 36,000	3% of Subtotal 1
Traffic Control	\$ 20,000	\$ 20,000	
SWPPP	\$ 20,000	\$ 20,000	
SUBTOTAL 2	\$ 1,354,000	\$ 1,407,000	
Contingency	\$ 271,000	\$ 281,000	20% of Subtotal 2
Total Construction Cost	\$ 1,625,000	\$ 1,688,000	

Alternative 1

TOTAL CONSTRUCTION COSTS

Site Name:

Broad Beach Road

Site Location:

Malibu, CA

Total Construction Costs	Unit	Unit Cost
Biofilters	SF	\$ 159,000
Vegetated Swale	LF	\$ 31,000
Planting of Slope	SF	\$ 38,000
Irrigation	LS	\$ 150,000
Walls	LS	\$ 169,000
Concrete Interlocking Pavers	LS	\$ 528,000
Diversion Structures	LS	\$ 46,000
Maintenance of planting and irrigation (3 months)	LS	\$ 8,000
Demolition of hardscape/landscape	LS	\$ 34,000
SUBTOTAL 1		\$ 1,163,000
Mobilization & Demobilization		\$ 116,000
Bonds	LS	\$ 35,000
Traffic Control	LS	\$ 20,000
SWPPP	LS	\$ 20,000
SUBTOTAL 2		\$ 1,354,000
Contingency (20%)		\$ 271,000
Total Construction Cost		\$ 1,625,000

Note: Costs rounded to the nearest \$1,000

Alternative 1

CONSTRUCTION COSTS

DEMOLITION

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Existing slope irrigation & conflicting/invasive planting	LS	\$ 25,000.00	1	\$ 25,000
Trees	EA	\$ 500.00	12	\$ 6,000
Rubble and garden walls	CY	\$ 30.00	111	\$ 3,333
Total Facility Base Cost				\$ 34,333

Assumptions:

Assumed 1000 feet of wall and an average wall cross-section of 3 sq ft.

Pavement demolition included paver costs

Alternative 1

CONSTRUCTION COSTS

BIOFILTERS

Biofilter unit media surface area (SF): 200
 Biofilter total media surface area (SF): 5000

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Excavation	CY	\$ 12.00	44	\$ 533
Haul/Dispose of Excavated Material	CY	\$ 20.00	44	\$ 889
Basin Liner	SF	\$ 2.30	650	\$ 1,495
Geotextile	SF	\$ 0.60	850	\$ 510
Anchor Trench	LF	\$ 8.00	100	\$ 800
Drain Gravel Layer	CY	\$ 50.00	7	\$ 370
Underdrain	LF	\$ 15.00	50	\$ 750
Engineered Planting Media	CY	\$ 40.00	15	\$ 593
Bark Mulch	SY	\$ 8.00	22	\$ 178
Planting of biofilter	SF	\$ 0.75	200	\$ 150
Planting of side slopes	SF	\$ 0.75	135	\$ 101
Facility Unit Cost	SF	\$ 32		\$ 6,369
Total Facility Base Cost				\$ 159,230

Assumptions:

Based on a biofilter with a media surface area = 200 ft² and dimensions 5' x 40'

Alternative 1

CONSTRUCTION COSTS

VEGETATED SWALES

Swale unit length (LF): 200
Swale total length (LF): 2400

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Excavation	CY	\$ 12.00	59	\$ 711
Level & Tilling	SY	\$ 1.00	89	\$ 89
Haul/Dispose of Excavated Material	CY	\$ 20.00	59	\$ 1,185
Planting	SF	\$ 0.75	800	\$ 600
Facility Unit Cost	LF	\$ 13		\$ 2,585
Total Facility Base Cost				\$ 31,022

Assumptions:

Based on a swale length of 200 ft.

=> average width = 4' from top slope to top slope

Alternative 1

CONSTRUCTION COSTS

PARKING AREA PAVERS

Paver surface area (SF): 31410

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Excavation	CY	\$ 12.00	2908	\$ 34,900
AC/Concrete cut	LF	\$ 1.00	3141	\$ 3,141
Soil Disposal	CY	\$ 20.00	2908	\$ 58,167
Pavement demo and removal	CY	\$ 20.00	175	\$ 3,490
Rough grading	SY	\$ 1.00	3490	\$ 3,490
Subgrade prep	SF	\$ 0.50	31410	\$ 15,705
Parking area concrete pavers	SF	\$ 12.00	31410	\$ 376,920
Concrete header	LF	\$ 5.00	6306	\$ 31,530
Concrete curb and gutter	LF	\$ 20.00	37	\$ 740
Concrete ribbon gutter	LF	\$ 15.00	0	\$ -
Total Facility Base Cost	SF			\$ 528,083

Assumptions:

Area of pavement to be removed assumed to be 4386 LF * 3 ft

Pavement thickness assumed to be 6"

Included header along both sides of pavers (hillside and roadside)

Alternative 1

CONSTRUCTION COSTS

PLANTING

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Planting - hillside	SF	\$ 0.75	50305	\$ 37,729
Total Facility Base Cost				\$ 37,729

Assumptions:

Alternative 1

CONSTRUCTION COSTS

IRRIGATION

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Irrigation network - slope area	SF	\$ 1.00	50305	\$ 50,305
Irrigation network - biofilter and swale	SF	\$ 1.00	18000	\$ 18,000
Water meters and hot taps	LS	\$ 80,000.00	1	\$ 80,000
Electrical for rotary controllers and meters	LS	\$ 2,000.00	1	\$ 2,000
Total Facility Base Cost				\$ 150,305

Assumptions:

Alternative 1

CONSTRUCTION COSTS

PLANTING AND IRRIGATION MAINTENANCE

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Planting - slope	SF/3 months	\$ 0.12	50305	\$ 6,037
Planting - biofilters and swales	SF/3 months	\$ 0.12	18000	\$ 2,160
Total Facility Base Cost				\$ 8,197

Assumptions:

For a 3 month period

Alternative 1

CONSTRUCTION COSTS

WALLS

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Slough walls with stone veneer	LF	\$ 100	600	\$ 60,000
Slough walls with boulders and cobble	ton	\$ 50	500	\$ 25,000
Retaining walls (3 - 4 ft)	LF	\$ 125	250	\$ 31,250
Retaining walls (5 - 6 ft)	LF	\$ 250	150	\$ 37,500
Veneer of existing walls	LS	\$ 15,000	1	\$ 15,000
Total Facility Base Cost				\$ 168,750

Assumptions:

Alternative 1

CONSTRUCTION COSTS

DIVERSION STRUCTURE CATCHMENT 1

Diversion of runoff from Catchment 1 to biofilter in Catchment 2 (west)

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Low-flow diversion weir in existing concrete V-ditch	LS	\$ 500.00	1	\$ 500
Diversion swale	LF	\$ 1.00	20	\$ 20
PVC/PP Standpipe (for overflow)	LS	\$ 500.00	1	\$ 500
Overflow pipe and trench	LF	\$ 50.00	20	\$ 1,000
Tie-in to existing catch basin / storm drain (overflow)	LS	\$ 500.00	1	\$ 500
Total Facility Base Cost				\$ 2,520

Assumptions:

Alternative 1

CONSTRUCTION COSTS

DIVERSION STRUCTURE CATCHMENT 8

Diversion of runoff from Catchment 8 (east) to biofilter in Catchment 7

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Excavation	CY	\$ 12.00	28	\$ 335
Haul/Dispose of Excavated Material	CY	\$ 20.00	25	\$ 502
Catch Basin (small) with flat grate	LS	\$ 1,200.00	1	\$ 1,200
Basin with Pump	LS	\$ 27,000	1	\$ 27,000
Pressure pipe and trench	LF	\$ 60	50	\$ 3,000
Collector pipe and trench (from biofilter to CB7)	LF	\$ 50.00	120	\$ 6,000
Electrical	LS	\$ 5,000	1	\$ 5,000
Total Facility Base Cost				\$ 43,037

Assumptions:

Alternative 2

TOTAL CONSTRUCTION COSTS

Site Name:

Broad Beach

Site Location:

Malibu, CA

Total Construction Costs	Unit Cost
Biofilters	\$ 96,000
Vegetated Swale	\$ 34,000
Planting of Slope	\$ 38,000
Irrigation	\$ 156,000
Walls	\$ 116,000
Concrete Interlocking Pavers	\$ 527,000
Storage and diversion structures - Catchment 2	\$ 124,000
Storage and diversion structures - Catchment 8	\$ 77,000
Maintenance of planting and irrigation (3 months)	\$ 8,000
Demolition of hardscape/landscape	\$ 34,000
SUBTOTAL 1	\$ 1,210,000
Mobilization & Demobilization	\$ 121,000
Bonds	\$ 36,000
Traffic Control	\$ 20,000
SWPPP	\$ 20,000
SUBTOTAL 2	\$ 1,407,000
Contingency (20%)	\$ 281,000
Total Construction Cost	\$ 1,688,000

Note: Costs rounded to the nearest \$1,000

Alternative 2

CONSTRUCTION COSTS

DEMOLITION

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Existing slope irrigation & conflicting/invasive planting	LS	\$ 25,000.00	1	\$ 25,000
Trees	EA	\$ 500.00	12	\$ 6,000
Rubble and garden walls	CY	\$ 30.00	111	\$ 3,333
Total Facility Base Cost				\$ 34,333

Assumptions:

Assumed 1000 feet of wall and an average wall cross-section of 3 sq ft.

Alternative 2

CONSTRUCTION COSTS

BIOFILTERS

Biofilter unit media surface area (SF): 200

Biofilter total media surface area (SF): 3000

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Excavation	CY	\$ 12.00	44	\$ 533
Haul/Dispose of Excavated Material	CY	\$ 20.00	44	\$ 889
Basin Liner	SF	\$ 2.30	650	\$ 1,495
Geotextile	SF	\$ 0.60	850	\$ 510
Anchor Trench	LF	\$ 8.00	100	\$ 800
Drain Gravel Layer	CY	\$ 50.00	7	\$ 370
Underdrain	LF	\$ 15.00	50	\$ 750
Engineered Planting Media	CY	\$ 40.00	15	\$ 593
Bark Mulch	SY	\$ 8.00	22	\$ 178
Planting of biofilter	SF	\$ 0.75	200	\$ 150
Planting of side slopes	SF	\$ 0.75	135	\$ 101
Facility Unit Cost	SF	\$ 32		\$ 6,369
Total Facility Base Cost				\$ 95,538

Assumptions:

Based on a biofilter with a media surface area = 200 ft² and dimensions 5' x 40'

Alternative 2

CONSTRUCTION COSTS

VEGETATED SWALES

Swale unit length (LF): 200
Swale total length (LF): 2600

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Excavation	CY	\$ 12.00	59	\$ 711
Level & Tilling	SY	\$ 1.00	89	\$ 89
Haul/Dispose of Excavated Material	CY	\$ 20.00	59	\$ 1,185
Planting	SF	\$ 0.75	800	\$ 600
Facility Unit Cost	LF	\$ 13		\$ 2,585
Total Facility Base Cost				\$ 33,607

Assumptions:

Based on a swale length of 200 ft.

=> average width = 4' from top slope to top slope

Alternative 2

CONSTRUCTION COSTS PARKING AREA PAVERS

Paver surface area (SF): 31410

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Excavation	CY	\$ 12.00	2908	\$ 34,900
AC/Concrete cut	LF	\$ 1.00	3141	\$ 3,141
Haul/Dispose of Excavated Material	CY	\$ 20.00	2908	\$ 58,167
Pavement demo and removal	CY	\$ 20.00	175	\$ 3,490
Rough grading	SY	\$ 1.00	3490	\$ 3,490
Subgrade prep	SF	\$ 0.50	31410	\$ 15,705
Parking area concrete pavers	SF	\$ 12.00	31410	\$ 376,920
Concrete header	LF	\$ 5.00	6306	\$ 31,530
Concrete curb and gutter	LF	\$ 20.00	0	\$ -
Concrete ribbon gutter	LF	\$ 15.00	0	\$ -
Total Facility Base Cost	SF			\$ 527,343

Assumptions:

Area of pavement to be removed assumed to be 4400 LF * 3 ft

Pavement thickness assumed to be 6"

Alternative 2

CONSTRUCTION COSTS

PLANTING

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Planting - hillside	SF	\$ 0.75	50305	\$ 37,729
Total Facility Base Cost				\$ 37,729

Assumptions:

Alternative 2

CONSTRUCTION COSTS

IRRIGATION

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Irrigation network - slope area	SF	\$ 1.00	50305	\$ 50,305
Irrigation network - biofilter and swale	SF	\$ 1.00	13800	\$ 13,800
Drip irrigation system (2 separate lines)	LS	\$ 5,000.00	2	\$ 10,000
Water meters and hot taps	LS	\$ 80,000.00	1	\$ 80,000
Electrical for rotary controllers and meters	LS	\$ 2,000.00	1	\$ 2,000
Total Facility Base Cost				\$ 156,105

Assumptions:

Alternative 2

CONSTRUCTION COSTS

PLANTING AND IRRIGATION MAINTENANCE

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Planting - slope	SF/3 months	\$ 0.12	50305	\$ 6,037
Planting - biofilters and swales	SF/3 months	\$ 0.12	15800	\$ 1,896
Total Facility Base Cost				\$ 7,933

Assumptions:

For a 3 month period

Alternative 2

CONSTRUCTION COSTS

WALLS

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Slough walls with stone veneer	LF	\$ 100	600	\$ 60,000
Slough walls with boulders and cobble	ton	\$ 55	500	\$ 27,500
Retaining walls (3 - 4 ft)	LF	\$ 125	110	\$ 13,750
Retaining walls (5 - 6 ft)	LF	\$ 250	0	\$ -
Veneer of existing walls	LS	\$ 15,000	1	\$ 15,000
Total Facility Base Cost				\$ 116,250

Assumptions:

Alternative 2

CONSTRUCTION COSTS

UNDERGROUND STORAGE SYSTEM - CATCHMENT 2

Detention storage for runoff from Catchments 1 and 2 (west)

Storage pipe length (LF): 110

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Excavation	CY	\$ 12.00	239	\$ 2,862
Shoring	LS	\$ 8,000.00	1	\$ 8,000
Storage pipe complete	LS	\$ 36,000.00	1	\$ 36,000
Pipe installation	LS	\$ 3,200.00	1	\$ 3,200
Bedding and fill	CY	\$ 60.00	125	\$ 7,504
Backfill with excavated soil	CY	\$ 40.00	60	\$ 2,385
Haul/Dispose of Excavated Material	CY	\$ 20.00	179	\$ 3,577
Geotextile	SY	\$ 0.60	396	\$ 238
Basin with Pump	LS	\$ 27,000.00	1	\$ 27,000
Pressure pipe and trench	LF	\$ 60	140	\$ 8,400
Additional pump for irrigation	LS	\$ 2,500.00	1	\$ 2,500
Electrical	LS	\$ 5,000.00	1	\$ 5,000
Controllers	LS	\$ 10,000.00	1	\$ 10,000
Total Facility Base Cost				\$ 116,666

Assumptions:

Based on use of Contech's Duromaxx SRPE Pipe (Diam. 60")

Alternative 2

CONSTRUCTION COSTS

UNDERGROUND STORAGE SYSTEM - CATCHMENT 8

Detention storage for runoff from Catchments 8

Storage pipe length (LF): 75

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Excavation	CY	\$ 12.00	89	\$ 1,067
Shoring	LS	\$ 5,200.00	1	\$ 5,200
Storage pipe complete	LS	\$ 10,100.00	1	\$ 10,100
Pipe installation	LS	\$ 2,400.00	1	\$ 2,400
Bedding and fill	CY	\$ 60.00	53	\$ 3,188
Backfill with excavated soil	CY	\$ 40.00	30	\$ 1,185
Repaving excavated area	SF	\$ 4.00	640	\$ 2,560
Haul/Dispose of Excavated Material	CY	\$ 20.00	59	\$ 1,184
Geotextile	SY	\$ 0.60	1840	\$ 1,104
Basin with Pump	LS	\$ 27,000.00	1	\$ 27,000
Pressure pipe and trench	LF	\$ 60	40	\$ 2,400
Additional pump for irrigation	LS	\$ 2,500.00	1	\$ 2,500
Electrical	LS	\$ 5,000.00	1	\$ 5,000
Controllers	LS	\$ 10,000.00	1	\$ 10,000
Total Facility Base Cost				\$ 74,888

Assumptions:

Based on use of Contech's Duromaxx SRPE Pipe (Diam. 36")

Asphalt to be removed 6" thick

Alternative 2

CONSTRUCTION COSTS

DIVERSION STRUCTURE CATCHMENTS 1 AND 2

Diversion of runoff from Catchments 1 and 2 (west) to storage in Catchment 2 (west)

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Excavation	CY	\$ 12.00	9	\$ 111
Haul/Dispose of Excavated Material	CY	\$ 20.00	8	\$ 167
Catch Basin (small) with flat grate	LS	\$ 1,200.00	2	\$ 2,400
Diversion pipe and trench (from catch basins to tank)	LF	\$ 50.00	100	\$ 5,000
Total Facility Base Cost				\$ 7,678

Assumptions:

Alternative 2

CONSTRUCTION COSTS

DIVERSION STRUCTURE CATCHMENT 8

Diversion of runoff from Catchment 8 to storage tank in Catchment 8

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Excavation	CY	\$ 12.00	28	\$ 335
Haul/Dispose of Excavated Material	CY	\$ 20.00	25	\$ 502
Catch Basin (small) with flat grate	LS	\$ 1,200.00	1	\$ 1,200
Diversion pipe and trench (from catch basin to tank)	LF	\$ 50.00	10	\$ 500
Total Facility Base Cost				\$ 2,537

Assumptions: