ORANGE COUNTY COASTKEEPER

The Villa Park Substation SmartScape Project

A Model for Sustainable Landscape Design and Management

Final Report
Prepared for Southern California Edison

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Abstract

The Villa Park Substation SmartScape Project: A Model for Sustainable Landscape Design and Management is a joint project between Southern California Edison and Orange County Coastkeeper. The project, located at Southern California Edison's Villa Park substation in the City of Orange, converted 3 acres of conventional turf into a resource efficient landscape that is designed to serve as a model for other SCE facilities, commercial spaces, and residential parcels.

The project features drought-tolerant plant design, cutting-edge technology and sustainable landscape management practices that reduce maintenance costs, conserve water, reduce carbon emissions, mitigate storm water runoff, and increase soil carbon sequestration. A two-year monitoring study following the landscape installation evaluated and verified the outcomes of the project goals and objectives.

Purpose of Report

The purpose of this report is two-fold: firstly, to document the project's findings, and secondly, to document best practices, lessons learned, and recommendations for the ongoing management of this project and for replicated installations at other Southern California Edison facilities, businesses, and homes.

Project Goals

1. Use advanced technology and design to develop a resource efficient, sustainable landscape, reducing resources by 50%.
2. Develop a resource efficient landscape with achievable objectives, metrics, and technologies that are replicable for other sites.
3. Develop a landscape that is diverse, resource efficient, and aesthetically pleasing for the next 100 years.

Objectives and Results

Primary objectives

- To reduce maintenance costs by 40%. Actual reduction in maintenance costs was 50%.
- To reduce irrigation by 50%. Actual reduction in irrigation was 48.6%. (However, it should be noted that during precipitation fell short by 44% of average [13"] during the two-year monitoring period. If the site received average rainfall, then actual reduction in irrigation would have been 63.8%.)
- To reduce carbon footprint by 60%. Actual reduction in carbon emissions was 54%.
- To capture and mitigate 100% of onsite storm water drainage. Actual storm water captured and mitigated was 100%.
- To increase soil carbon sequestration by 300%. Actual increase in carbon sequestration was 25%.

Secondary objectives

- Gasoline and diesel consumption by outdoor power equipment and hauling vehicles was reduced by 66%. (A conventional landscape would have used 620 gallons of gasoline and/or diesel over a two-year period; SmartScape used 212 gallons.)
- The use of herbicides, pesticides, and fungicides was reduced by 87%. (A conventional landscape would have used 15 gallons of herbicides, pesticides, and fungicides; Smartscape used 1 gallon.)
- The use of fertilizers was reduced by 85%. (A conventional landscape would have used 3,440 pounds of fertilizers; SmartScape used 400.)
- Observed avian life onsite increased by 200%.
- Microorganisms present in the soil increased by 800%.
- Water and sewer costs were reduced by 50%.
- An onsite composting facility was developed to recycle onsite nutrients and reduce carbon emissions from hauling away debris. No positive results were achieved because of the high content of brown waste (i.e., biodegradable waste that is primarily carbon based, such as twigs, dry leaves, and sawdust) present in the facility. It is recommended that a "starter" quantity of approximately 10 cubic yards of immature composted green waste (i.e., biodegradable waste that is high in nitrogen, such as tree trimmings and weeds) be introduced to the facility as it becomes available.

Recommendations

1. Continue to monitor and evaluate results to ensure ongoing, long-term cost management and ecological benefits.
2. Quantify and monetize the site's functionality by monitoring and measuring water quality benefits.
3. SmartScape Storm Water Quality Enhancement System: Due to diminishing rainfall, the potential functionality of the landscape design may be underutilized. Conduct a two-part study to (1) determine the feasibility of capturing the entire 34-acre facility's storm water runoff and conveying it into the SmartScape system, and (2) capturing and treating North Tustin Street and East Taft Avenue's storm water runoff.
4. Carbon Emissions Study: Conduct a study to assess the feasibility of capturing and sequestering up to 20 pounds of carbon in the top two cubic feet of site soils (1,250 tons of carbon sequestration).
5. Implement educational outreach and marketing programs to demonstrate the site's positive environmental and community impacts.
6. Implement similar resource efficient landscapes at other SCE facilities. Replicate the technologies, design elements, and management practices.

II. Project Summary

Background

In 2007, Southern California Edison ("Edison") collaborated with Orange County Coastkeeper ("Coastkeeper") on the Orange County Nurseries Water Quality Improvement Project with the intent to improve the water quality of agricultural discharges from 112 wholesale nurseries on Edison property during dry weather and storm events. Coastkeeper staff identified pollutants, developed the *Water Quality Field Guide for Nurseries*, and offered free Best Management Practices (BMPs) consultations and training to operators.

In an effort to build on the success of this partnership, Edison asked Coastkeeper to consider other collaborative opportunities that would demonstrate the company's long-standing commitment to the environment. Coastkeeper recommended a landscape renovation for a substation facility, which could serve as a model for resource efficient landscape projects within the company and beyond. Coastkeeper assembled a team of experts including landscape architects Stivers and Associates and Clark and Green and Associates and landscape contractors Harvest Landscape Enterprises ("project team").

About the Site

During Phase I (research and development), the project team vetted several Edison facilities as potential sites for the project, and selected the Villa Park substation for its ample street-facing square footage and high-traffic, high-visibility location.

The substation is located at 1934 East Taft Avenue, at the intersection of North Tustin Street in the City of Orange. The project extends 700 feet east on Taft Avenue and 1,750 feet south on North Tustin, draining at a grade of .5% to the intersection. The existing 2.88 acre landscape consisted primarily of grass turf with several dozen trees. A security wall, varying in height from 7' to 10' throughout the property's perimeter, separates the substation facility from the street-facing landscape. Both East Taft Avenue and North Tustin Street have high rates of pedestrian and vehicular traffic.

III. Scope of Work

The mission of the Villa Park Substation SmartScape Project was to develop an aesthetically pleasing model for resource efficient landscapes appropriate to the climate of Orange County, California with the following goals:

1. To reduce resources by 50% by using advanced landscape technology.
2. To develop achievable objectives, metrics, and technologies that are replicable at other Edison facilities, businesses, and residential parcels.
3. To develop a sustainable landscape that is biologically diverse, resource efficient, and aesthetically pleasing for the next 100 years.

During Phase II (planning, design, and development) of the project, the following primary objectives were established:

- To reduce maintenance by 40%.
- To reduce irrigation by 50%.
- To reduce carbon footprint by 60%.
- To capture and mitigate 100% of site storm water drainage.
- To increase soil carbon sequestration by 300%.

During the construction and monitoring phase, the following secondary objectives emerged:

- Reduced gasoline and diesel use.
- Reduced herbicide use.
- Reduced fertilizer use.
- Increased avian wildlife.
- Increased soil microbiology.
- Reduced water and sewer cost.
- Develop onsite compost greenwaste facility.

Limits of Scope

American Disability Act (ADA) Compliance

There are four vehicular entries into the Villa Park substation facility, each of which intersects a concrete walkway in the City of Orange's public right-of-way. The City requested that SCE upgrade the sidewalks and entry aprons to achieve compliance with the American Disability Act. It was agreed between Edison and Coastkeeper that this was not within the scope of the project.

Rodent Control

Prior to construction, SCE noted that the site is commonly inhabited by rabbits and squirrels, which would potentially pose a challenge for the new project. Vector control on the site would not be included in the scope of the project.

Water Cost

The cost of water during construction and for landscape management was not included in the scope of the project.

Water Quality Testing

Water quality, volume and infiltration testing was not a part of the scope of work.

Project Timeline

Phase I: Research and Development (late 2009)

Research and development was conducted in the areas of landscape maintenance costs, infrastructure and utilities, Low Impact Development (LID) feasibility, irrigation, and vegetation to establish opportunities and constraints, goals, and objectives.

Phase II: Project Planning, Conceptual Design, and Design Development (October 2009 through January 2010)

The project team prepared alternative conceptual site plan diagrams, photo imagery boards, and preliminary landscape construction cost estimates.

Phase III: Landscape Construction (February 2010 through April 2010)
Activities during this project phase included demolition, grading, trenching, irrigation and drainage installation, back fill of trenches, soil compaction, and installation of top soil, plants, and miscellaneous items.

Phase IV: Landscape Management and Monitoring (April 2010 through August 2013)
A two-year monitoring program analyzed and verified the goals and objectives of the project, which will continue to be maintained by Harvest Landscape Enterprises through August of 2013.

IV. Methodology

The degree to which goals and objectives were achieved are best understood within the context of the specific methods and frameworks that guided the research, planning, design, construction, management, and monitoring of the project.

Scientific Approach

A scientific approach was intrinsic to the full scope of the project. In particular, the project team used the scientific method in developing project goals and objectives, conducting research, developing hypotheses (i.e., conceptual designs), testing hypotheses (e.g., construction), analyzing data (e.g., two-year monitoring program), and presenting results. This framework enabled a rich, pragmatic model for analysis, planning, and evaluation.

Landscape Design Theory

Historically, most landscape design in an urban context has been based on achieving qualitative outcomes such as aesthetic or social-behavioral impacts. Quantitative, functional outcomes—such as environmental and economic impacts—are secondary priorities.

The project presents a significant departure from conventional landscape design, development and management. Rather than prioritizing qualitative outcomes over quantitative ones, the project embodies a new design paradigm wherein both sets of outcomes are on equal basis and designed to be sustainable for the next 100 years, the life of the landscape. In comparison with the site's previous landscape, built in 1973, the prioritization of aesthetics resulted in a dysfunctional, inefficient landscape by 2003.

Furthermore, conventional landscapes have been historically designed as inanimate commodities, maintained using methods that preserve an invariable appearance for many years. In contrast, the SmartScape project is an organic, dynamic, functional ecosystem that was designed to mimic nature. The predominance of California native plants onsite, for instance, requires less water, fertilizers, herbicides, and fungicides, and provide habitat for wildlife, which in turn, play a role in the health and proper functioning of the ecosystem. Other design elements such as bioswales and hydrozoning benefit from natural hydrologic processes. In this way, the project inherently provides a number of environmental services that conventional, maintenance-intensive landscapes do not.

Design-Build Continuum

Design-build is a streamlined construction method in which both design services and construction services are delivered by a single entity, bound by one contract. Unlike the more traditional practice of enlisting a designer and construction contractor successively, the design-build method (1) helps ensure that goals and objectives are precise and prioritized at every stage of project management, (2) reduces the project schedule by integrating the design and construction phases, and (3) ultimately minimizes risk on the part of the client because one party is held accountable for the success of the project.

The design-build team for this project is comprised of Orange County Coastkeeper (Coastkeeper), Clark and Green Associates (Clark and Green), Stivers and Associates Inc. (Stivers), and Harvest Landscape Enterprises, Inc. (Harvest).

Qualitative and Quantitative Analysis

An intensive quality assurance and quality control program was carried out during Phase III (construction) and Phase IV (management and monitoring). Project landscape architects were onsite daily to ensure exemplary implementation. During the two-year landscape management phase, project landscape architects also conducted monthly inspections to monitor, record, and adapt best management practices. At the end of the landscape management phase, site soils, irrigation, vegetation and best practices were tested and analyzed to verify effectiveness and results.

V. Analyses of Site Conditions

The following discussion summarizes research, discoveries, analysis, and objectives in six areas:

1. Landscape Maintenance Costs
2. Infrastructure and Utilities
3. Soils
4. Low Impact Development Feasibility
5. Irrigation
6. Vegetation

The project team performed extensive research, testing, inventory, and analysis to understand existing site conditions, identify opportunities and constraints, and develop conceptual ideas and design objectives.

Landscape Maintenance Cost Analysis

Research Objectives, Background and Challenges

The pre-existing landscape was largely comprised of Kikuyu turf grass and 61 trees, including Carrotwood and Melaleuca, and irrigated with a conventional pump system. The project team characterized the site as a typical, conventional utility landscape that basically serves as an aesthetic buffer between the electrical facilities and the surrounding community. The landscape was in poor condition, likely due to maintenance specifications that were appropriate. The degraded state posed a challenge in developing a valid cost analysis. In addition, the project team was unable to obtain the previous landscape contractors' contractual scope of work and fee for services, which would have served as vital baseline data for the development of goals and objectives.

Pre-existing landscape at the Villa Park substation.

Findings

In lieu of accurate site-specific data, the project team resorted to developing a scope of work and fee for services by assessing a landscape similar in design, vegetation, irrigation, drainage, soil conditions, and urban exposure. The team projected a 40% decrease in operations and maintenance costs for the SmartScape project. Harvest Landscape Enterprises developed an estimate and was allotted an annual management budget of $35,000 over the two-year management and monitoring period.

Infrastructure and Utilities Analysis

Research Objectives

The project team worked with Southern California Edison and the City of Orange to determine the location and setback requirements for site's underground, overhead, adjacent structures, wet and dry utilities. According to Edison's requirements for towers, power lines, underground conduit, and perimeter walls, vegetation (particularly trees) shall not be located in a way that obstructs emergency access, site security, and maintenance of the facility. The City of Orange's municipal zoning code has setback requirements that pertained to the site as well. Wet utilities include storm drainage, drainage devices, potable water mains, meters, and existing irrigation system.

Testing, Inventory, and Observations

The project team ascertained Edison's setback criteria, and located existing electrical facilities including power lines, towers, and electrical conduit. In addition, site structures including the perimeter masonry wall, retainer walls, steel mesh fences, gates, paving, and towers, were located, measured, and verified per plan. Site storm drainage was documented including the inlets inside Edison property immediately adjacent the perimeter masonry wall. Inventory included storm drainage inlets, location of conduits, and outlets in project area and into street storm sewer system. City street facilities, pedestrian side walks, cross-walks, bus stops, light posts, meters, and street trees were located and verified on the plan.

Findings and Analysis

The project area receives storm water drainage (volume unknown) from Edison's facilities. Storm drain lines are shallow and will intersect surface drainage features. Edison's "landscape design criteria" restricts trees from within 10' of power lines' "drip lines" and 100' from tower footings; however, variances will be considered. Site features, perimeter walls, and city-owned facilities were found generally per plan with only minor plan modifications required.

Opportunities and Constraints

The project area is a narrow corridor between the substation facility and the public right-of-way. Setback requirements for existing facilities and utilities will have significant impact on landscape design, particularly with regard to tree location. In a high-flow event, some of Edison's storm water will overflow via the 5 existing pipes into the site's proposed bioswales.

Design Objectives

Based on the research, observations, and analysis described above, the following design objectives were proposed for the project:

1. Protect existing utility infrastructure such as underground electrical ducts, drain lines from inner facility, water meters and possibly, existing irrigation mainline.
2. Drain 5 existing storm water overflow pipes into proposed bioswales.
3. Where substation facility drains directly to street (10 locations), save and protect drain pipe. Repair malfunctioning pipe on a time and materials cost basis.

Soils Analysis

Research Objectives

Soil itself is a dynamic functioning ecosystem and is the basis for all healthy, sustainable landscapes. The project team's research objectives with regard to soil are to determine existing soil types onsite, their characteristics, agronomic suitability, infiltration potential, and the necessary modifications to maximize environmental benefits. The primary objective is to develop a deep "living soil"—that is, soil with a diverse mix of microorganisms, providing a healthy environment for plant growth, water infiltration and carbon sequestration.

Testing, Inventory, and Observations

Soils were tested at 7 sites to a depth of 12" for agronomic suitability and to identify necessary soil modifications. In addition, carbon content, type, texture, and depths were also studied. Soil test #3 was taken in a fill soil. Soils in sites 1-6, were tested again at 24”-35” depths to determine content only. At 5 fill locations, soils were probed to a depth of 40” to determine texture and moisture content. All fill locations ranged in depths from 2’ to 7’above the primary grade (approximately 6” above sidewalk surface) and constituted approximately 25% of the total project area.

U.S. Department of Agriculture soil surveys indicated there are three soil types on site: Modjeska (a deep, well-drained soil characterized by slow to medium runoff and moderate permeability[1]), Myford (a moderately well-drained soil that allows medium to rapid runoff with very slow permeability[2]), and Sorrento (a very deep, well-drained soil that allows negligible to medium runoff and has moderate to moderately slow permeability[3]). Soil surveys also indicated sub-soils to a depth of 3’ drain slowly; however, subsoils at a depth of approximately 5’ are better draining clay at .2” per hour.

Findings and Analysis

The soils in the top 12 inches have good infiltration with average ranges in elements, pH, salinity, fertility, organic and carbon content. With some modifications the soil can be made more suitable for healthy, sustainable vegetation growth. However, soils at depths between 12” and 36” (except for fill soils at test location #3) have poor infiltration (approximately 1” an hour) due to higher clay content and generally lower ranges in elements, pH, salinity, fertility, organic and carbon content. Probing of fill indicates soils are consistently “sandy gravelly loam” to a depth of 40”. Findings also indicate that most of the site soils have the characteristics of Myford soil, a “very slowly permeable” sub-soil, which restricts root growth and drainage.

Opportunities and Constraints

Due to the high clay content in soils below a depth of 12”, rooting depth will be constrained, which will in turn reduce healthy plant growth, water infiltration, and carbon sequestration. However, fill soils, with modification, are ideal to achieve overall project objectives.

Design Objectives

Based on the research, observations, and analysis described above, the following design objectives were proposed for the project:

1. At soil testing locations 1-6, excavate soils to a depth of 7’ to observe soil texture, permeability and determine level of better draining soils. If more favorable drainage is found in sub-surface soils, utilize those locations as potential retention areas to drain the site. Supplement locations with conveyance and retention devices. (Note: Prior to developing this design objective, soils were excavated to a depth of 7’, and at all sites, a clay sub-soil with better drainage was found at depths between 32” and 38”.)

[1] U.S. Department of Agriculture website, https://soilseries.sc.egov.usda.gov/OSD_Docs/M/MODJESKA.html
[2] U.S Department of Agriculture website, https://soilseries.sc.egov.usda.gov/OSD_Docs/M/MYFORD.html
[3] U.S. Department of Agriculture website, https://soilseries.sc.egov.usda.gov/OSD_Docs/S/SORRENTO.html

2. In areas where practical, scarify soils to a depth of 36" and amend per soils report. Surface drainage should be conveyed in bioswales supplemented with composite drains and/or sandy loam filled infiltration trenches. Drain to suitable infiltration areas per locations 1-6.
3. Move fill soils to adjacent areas, forming mounds to articulate swales and to provide for plant species that prefer drier, well drained soils. In the lower parts of swales, plant species that prefer more moist, clay soils. Amend all mounded soils per soils report.

Low Impact Development Feasibility

Research Objectives

Low Impact Development (LID) refers to a land planning and engineering approach to managing storm water runoff. LID design mimics natural hydrologic processes to conserve, store, and infiltrate storm water onsite. The project team sought to identify opportunities for incorporating LID features to maximize site infiltration, reduce runoff, improve water quality, and provide passive irrigation for vegetation. Design features should be simple, easily maintained, durable enough to withstand loads from emergency vehicles, and have applicability for both surface and sub-surface areas.

Inventory and Observations

The inner substation facility drains at a 1% grade primarily toward North Tustin Street. At the perimeter wall, facility storm water drains into nine catch basins that convey it to street gutters. At 5 catch basins there is a 6"overflow pipe that conveys water to grass areas in the project landscape. In the alcoves of the perimeter wall there are approximately fifty 4" diameter drain slots that convey storm water onto surface of the project landscape. The volume of water that enters the landscape project from the substation facility is unknown.

Approximately 25% of the site has sandy loam fill soils, at depths ranging from 2' to 6'. These fill areas have been graded into geometric berms and planted with grass. The soils for the remainder of the site consist of sandy loam over clay in depths of 6" to 12". The depth of clay soils is unknown. There is positive sheet flow drainage from the project perimeter walls to street sidewalk at a grade of approximately 2%. No area drains were observed in the existing project landscape. Alcoves have berms that drain to the perimeter walls where it then drains slowly (at a rate of 1% per minute) to city streets. Soils in the alcoves immediately adjacent to the walls are moist sandy loam over wet clay, which have slow surface drainage to the street.

Opportunities and Constraints

The sandy loam soils are well aerated, have good drainage, and relative to clay, convey higher amounts of water to vegetation. With organic amendments, deep sandy loam soils are ideal for healthy plant growth. However, in approximately 75% of the site, the sandy loam is shallow and lays over a deep clay pan, which will result in water perching over the clay, limiting root and biological activity. In addition, the drainage in the alcoves has a longer residence time due to the slow soil drainage, the berm, and run-off from the facility.

Design Objectives

1. Use Contech design software to develop a maximally efficient storm water

management system.

2. Near the soil testing locations (6 total), identify better draining soils below clay pan. If better drainage is found, develop areas into sub-surface detention basins. Use Contech storm water products to capture, convey, detain, and infiltrate water into lower sub-soils.
3. Use some of the sandy loam fill soils to form bio-swales and filtration trenches. Bottom of swales should be comprised of clay with sandy loam forming the side berms. Place composite drains in bio-swales to direct water to detention/infiltration areas. Plant the berms with vegetation that thrive on dry, sandy loam soil, and bottoms of the swales with grasses that thrive on moist to wet soils.
4. Divert storm water overflow from substation facility to bioswales. Intercept storm water sheet flow across city sidewalk with composite drains.
5. Use structural soils and detention devices for sub-surface storm water capture in alcoves and in emergency vehicle access locations. Grow vegetation in structural soils.

Irrigation Analysis

Research Objectives

With experts estimating that up to 60% of urban water use in California is used for landscape irrigation, an analysis of site irrigation was crucial in meeting the conservation and efficiency goals of the project. AB 1881, the Water Conservation in Landscaping Act of 2006[4], provides an appropriate framework for meeting these goals, although the project site is not required to comply. The project team sought to assess the water needs for the substation facility, the water needs for the landscape, and which components of the existing irrigation system, if any, may be utilized for the new landscape installation.

Testing, Inventory, and Observations

Site irrigation components, makes, models, and conditions were identified and verified. The existing controllers were early model Irritrol controllers, which did not operate on a schedule. The site has low water pressure (55 psi) and once had an irrigation pump that was missing at the time of inventory.

There are two relatively new water meters on Tustin Ave. One 2" meter services the entire site including the landscape and the substation facility within the perimeter walls. In addition, there is an unused 2" water meter at the same location.

The site's water use records for the previous 5 years were ascertained from the City of Orange and are as follows:

[4] AB 1881 (2006, Laird), http://www.water.ca.gov/wateruseefficiency/docs/ab_1881_bill.pdf

Year	Water Use (in acre feet)
2009	12.75 AF (projected)
2008	11.33 AF
2007	16.05 AF
2006	12.76 AF
2005	14.31 AF

Findings and Analysis

The existing irrigation system is in poor condition. Levels of efficiency, distribution, and uniformity are very low. Irrigation mainline appears to be intact and salvageable for project. One potable water meters serves the entire site including the substation facility. The irrigation system does not have a separate meter.

Opportunities and Constraints

The existing water meter can be used for irrigation only. The entire site, including the landscape area, historically uses an average of 13.44 AFY (acre feet of water per year). Low water pressure could be addressed by installing a pump. However, this would increase both cost (approximately $15,000) and carbon emissions.

Design Objectives

1. Determine potable water flow and volume requirements for substation facilities. If water requirements are met with the one existing 2" water meter, use the other meter to measure irrigation. Metering water usage separately will reduce Edison's annual sewage fees.
2. Separate Edison's annual de-ionized water requirements from overall water use and calculate landscape water needs.
3. Protect existing utility infrastructure, such as underground electrical dusts and drain lines servicing substation facility, water meters, and irrigation mainline.
4. In lieu of installing a pump, use TORO Precision® Series nozzles, low-psi spray, low-precipitation spray and rotary heads, and drip irrigation.
5. Install drip irrigation on sandy loam filled slopes and berms where dominated with native and drought tolerant vegetation. Place trees on separate drip system.
6. Utilize advanced controllers with soil moisture sensors (SMS), designed to detect soil moisture levels in the root zones. If the designated water content exceeds the setting, an irrigation event is bypassed.

Vegetation Analysis

Research Objectives

Inspect existing vegetation to determine, species, size, health condition and the potential for existing vegetation to remain part of the proposed Resource Efficient Landscape. Objectives are to keep vegetation that is in good health, has vigor and is the right tree for the right location.

Testing, Inventory, Observations

The original landscape plans were produced in 1973, by landscape architecture firm Courtland

Paul and Arthur Beggs & Associates. The plans indicated 254 trees were used consisting four tree species. In addition, two shrub species were used as hedges, one vine species was used on all the walls, and approximately 125,600 square feet of blue grass sod was used as the lawn. The lawn extended from the sidewalk to the perimeter walls.

Each tree onsite was inspected, photographed, and inventoried by an International Society of Arboriculture-certified arborist who assessed trees' health condition, vigor, and risk to the public (although risk was not registered on the inventory). Of the original 254 trees only 61 remained at the time of inventory. Where decay was suspected, an 8" probe was used to test for firmness of the wood. Defects and disease, including the bacterial disease fireblight that was found to affect all pear trees onsite, were photographed and noted. Adjacent to the project site on Tustin Avenue there is a city-owned King Palm in a tree well, and on East Taft Avenue there are city-owned evergreen pear trees in tree wells.

The originally specified blue grass was largely replaced by Kikuyu grass, a hardy, vigorous, weedy grass that goes slightly dormant in the winter, has a thick thatch, and grows by rhizomes. All of the ficus vines on the wall had been replaced with *Ampelopsis brevipedunculata* (Porcelain Berry), which is dying in many of the locations on the wall receiving much sunlight.

Findings and Analysis

All the trees on the site range from dead to fair condition. Nine trees are dead and need immediate removal. The coral trees' limbs are brittle and readily break. The pear trees are all affected by firelight, a contagious bacterial disease. In addition, 3 coral trees and approximately 24 pear trees adjacent to the perimeter wall have limbs that can provide access into the substation facility, posing a security risk. All 61 trees onsite have decay, and combined with the aforementioned characteristics, collectively pose a moderate to high risk to the public.

Design Objectives

- Remove all trees and Kikuyu grass.
- Plant appropriate "California Friendly" vegetation.

VI. Project Implementation

The following discussion summarizes project implementation according to the proposed design objectives developed during the research, planning, and development phases of the project. Project implementation is discussed in six areas:

1. Landscape Maintenance Costs
2. Infrastructure and Utilities
3. Soils
4. Low Impact Development (LID)
5. Irrigation
6. Vegetation

Infrastructure & Utilities

Due to the poor condition of existing vegetation, all the trees and the weedy Kikuyu grasses were demolished and composted. Proposed vegetation was installed per the city's setback requirement from the public right-of-way and Edison's setback requirement for the towers, power lines, and underground electrical conduit. Excavations did not impact infrastructure or utilities including towers, underground conduits, and water drain lines.

Per Edison's setback requirements, trees were planted at least 100' from tower footings.

As a security measure, vines were removed and vegetation was planted several feet from perimeter walls to preclude trespassers from accessing the substation facility.

The Edison monument sign and retainer walls were demolished and removed. The largest retainer wall at the base of the largest hill remained and was buried.

Water meters and water mains were salvaged, protected and used for the new landscape installation.

Existing primary drains (10), overflow drains (5) and tertiary drains (approximately 50) were protected in place for use with the new installation. Five primary drain lines were repaired.

All facilities within the public right-of-way, including city streets, pedestrian sidewalks, cross-walks, bus stops, light posts, water meters, curb out drain outlets, trees were protected from damage during construction.

Challenges

Many of the primary and overflow drains where damaged and not operating. These items were repaired at no additional cost to Edison.

The existing irrigation mainline was in poor condition and replaced with a new mainline.

Soils

Five thousand cubic yards of existing sandy loam was mined and reused onsite in bioswales, infiltration trenches and biodetention basins. Clay soils were excavated from biodetention and infiltration trenches and were used as base soils under mounds and bioswales.

Carbon Testing

Prior to site development the average carbon sequestration in the top 12” of soil was 1.19 pounds. See Appendix A: Soil Pre-Test for Carbon Content.

At the end of the two-year management and monitoring period, soil carbon sequestration had increased by 25% to 1.50 pounds. See Appendix B: Soil Post-Test for Carbon Content.

Soil Biology

Baseline data for measuring biological content in pre-existing site was taken by testing soil from a “base site” located near the project site along Taft Avenue, immediate east of the Costa Mesa Freeway (SR 55). See Soil Appendix C: Soil Base Test for Biological Content.

Soil was also tested on the project site, and at the end of the two-year management and monitoring period, site soil had 13 times more biological content than that of base soil. See Appendix D: Soil Site Test for Biological Content.

During the time of soil testing for carbon and biological content, sandy loam soils on the base site were 75% below field capacity[5] and sandy loam soils on the project site were 50% below field capacity, resulting in lower counts of active microbiology for both sites.

Challenges

There are two types of soil onsite: clay and sandy loam. In accordance with design objectives developed in the research phase of the project, sandy loam soils were mined and placed over mounds of mostly clay soils, placed in infiltration trenches and on top of bioswales. Clay was removed from infiltration trenches and placed adjacent the trenches to form the base of the bioswales. Biodetention basins were excavated and buried under sandy loam wherever feasible.

[5] Field capacity (θ_{fc}) refers to the water content remaining in soil two to three days after an irrigation or rain event, after natural drainage has decreased or ceased.

A bioswale planted with Juncus grass. To facilitate infiltration, sandy loam was placed atop clay soil mounds and bases.

However, these design objectives were not consistently implemented per plan. The more common practice was to combine sandy loam soils with clay soils, resulting in decreased irrigation efficiencies due to variable infiltration rates. These inefficiencies led to constant monitoring and adjustment of the controllers, often resulting in dry soils or excessively wet soils. This condition was more problematic in the summertime, when water needs increase. Dry soil, which leads to low levels of biological content and capacity for carbon sequestration, was a chronic condition throughout the two-year management and monitoring phase.

Low Impact Development

Based on the feasibility assessment for using Low Impact Design elements, the following measures were implemented:

- Sandy loam soil was used as rapid infiltration media.
- Storm water drainage slopes were reduced from average 2% to .5%, allowing more soil infiltration.
- A drainage system was developed to drain in the direction of the city streets. Both streets flow at approximately .5% to the main municipal drainage system near the intersection of N. Tustin Street and E. Taft Avenue.
- Several LID devices were developed to capture and mitigate up to 40,000 gallons of storm water onsite. Total capacity of the drainage system has not been determined.

The new drainage system is a redundant system, designed to ensure storm water does not pond for more than 72 hours (required Orange County Vector Control District) and is mitigated by vegetation before it flows into the municipal system. Because average rainfall during the two-year management and monitoring period was 44% lower than normal the system has not been adequately tested for efficacy.

Design Considerations

During a substantial rain event (.75" an hour) the top 12" of the site's sandy loam soils will absorb most of the precipitation. Sandy loam soils have approximately 15% field capacity and can hold 2" of water per 12" of soil. If the rain persists and the soils saturate beyond field capacity, storm water will drain over soil surfaces at a minimum of .5% into infiltration trenches, which measure 2' wide by 3' deep, and are filled with sandy loam.

The infiltration trenches were design to extend past the slower draining (.1" an hour) clay soil layer under the sandy loam, to the faster draining (.2" an hour) clay layer. Once the infiltration trenches fill to capacity, it surface drains through bioswales to 7 biodetention basins where it is ponds for infiltration. Once the biodetention basins have reached capacity, drainage flows via drain pipe to the main municipal system inlet near the intersection of North Tustin Street and East Taft Avenue. By the time drainage has entered the municipal drainage system it has been mitigated by site soils and vegetation.

Design Features

- 1,080 linear feet of 2'x3' deep infiltration, the surface grassed lined bioswale;
- 1,020 linear feet of 4'x12" deep rock channels that serve dual purpose of an aesthetic component and channel storm water to a biodetention basin behind the corner monumentation;
- 3,080 linear feet of grass lined bioswales;
- 7 biodetention basins, 5 having Chambermaxx® underground detention systems. Water detention capacity is approximately 40,000 gal;
- Four of the five overflow drains redirected into infiltration trenches and bioswales;
- Repaired four primary drains to the streets.

A bioswale and storm water detention basin (northerly view from North Tustin Avenue).

Challenge
Due to the lack of substantial rainfall over the two-year management and monitoring period, the system has not been tested to its full capacity. The site has been inspected during rain events and very little standing water was observed. One location off North Tustin Street had a facility overflow pipe draining into a bioswale that drained into the biodetention basin south of the bus stop.

Soil volume was underestimated. During construction, an increased soil volume of 10%, coupled with the difficulty of moving extra soil on a long, narrow site posed a challenge. The plan called for excavated clay soils to be buried under mined sandy loam. However, the amount of excavated soils created tight working conditions and less compliance with grading objectives, resulting in some areas not covered with sandy loam.

Irrigation

Average irrigation water use for the pre-existing landscape was 9 AFY. After construction the SmartScape site was managed and monitored by Coastkeeper for 24 months to achieve and verify project objectives. During that time, irrigation use averaged 4.62 AFY, a 48% reduction from the previous landscape. In the first year of the management period, water use for irrigation was 3.06 AF or a 66% reduction in annual irrigation water use. In the second year of the management period, water use for irrigation was 6.18 AF, representing only a 31% reduction. See Appendix E: Irrigation Water Use.

Average yearly rainfall for the site is 13". However, the first 12 months the site received only 7.28" of precipitation and the second 12 months, 7.25", averaging 44% below normal rainfall. The rain shortfall equals 1.37 AF. If irrigation water use calculations take into account rainfall shortages, average water use is reduced to 3.25 AF, or a 63.8% reduction compared to the pre-existing landscape. See Appendix F: Precipitation Data**.**

Challenges
The irrigation system did not work at its optimum efficiency. It took several months to establish scheduling, repair non-operating valves and heads, improve poor head coverage, develop irrigation as-built drawings, provide scheduling and zone charts, and revise several areas with low water pressure.

Parr Electrical Contractors, Edison's onsite leasing tenants, impact our project by tapping into the project irrigation system and took several thousand gallons of water over the course of several months until Edison made other arrangements for them. The volume of water use is unknown.

Late last year, starting in July and ending early September, a previous landscape maintenance company mistakenly took over the project, deactivated the weather base controllers several times, trimmed the trees, hand irrigated, adjusted heads and "maintained" the site. During that time irrigation use spiked, the amount of water wasted could not be determined.

Vegetation

Planting Design Objectives

The SmartScape project is designed to be sustainable for a life cycle of one hundred years. Hydrozones, or grouping of plants according to water needs, were developed to simulate native habitats and help achieve this objective. Hilltops with their loamy soil, for instance, simulate oak woodlands or coastal sage scrub habitats. The lowland bioswales and infiltration basins with their wet soil would simulate coastal grasslands. The biodetention basins with their seasonal wet soil simulate riparian wetlands.

A hydrozone within the SmartScape project features California native plants in the loamy hilltop (background) and grasses that thrive on wetter soil in the lowland and bioswale (foreground).

SmartScape was designed to be resilient, able to tolerate drought, flood, fire, urban impacts (compaction), plant pests and disease. Plants were chosen and placed to minimize plant loss and reduce the project's green waste. To lessen impact from pest and diseases the plant palette had no more that 30% of the species coming from one family, 20% from one genus and 10% from one species.

The SmartScape project is highly diverse with 25 shrub, succulent and grass species and 5 tree species. Overall, the site has 195 trees, 446 large shrubs, small trees, and 20,444 ground cover shrubs, succulents and grasses. In comparison, the previous landscape had 4 tree species and 1 grass species.

As previously discussed, the goal of conventional landscape maintenance is to preserve the aesthetic qualities of the landscape. In contrast, the SmartScape project is designed for longevity and functionality, and therefore, natural succession will be allowed and encouraged. Large shrubs such as lemonade berry and small trees like the toyon will be allowed to spread by seed. Grasses will be allowed to regenerate from seed and flowering plants will be allowed to go through full cycle of pollination, blooming and reseeding.

The vegetation is generally in good health and from the public-facing perspective the project appears orderly and aesthetically pleasing. However, the grasses were cut two months late this season and are struggling; a few dozen have died. The ground cover shrubs are thriving in most areas but along the ridges and south facing slopes off of North Tustin Street they are sparse and several have died.

Challenges
The vegetation on the hilltops and south facing slopes are the driest and has struggled. The irrigation requires frequent adjustments in these areas to ensure good spray coverage.

Pest Control

Rodents
The previous landscape had a rodent infestation. During construction most of the rodents migrated to the substation side (inside) of the wall through the tertiary drain pipes. At night they came back through the drain pipe to feed on newly planted vegetation. Of the 6,000 plants lost, approximately two-thirds can be attributed to rodent predation. Several months into the management and monitoring of the project, Edison retained a pest control service and currently the rodents are under control. Ongoing rodent control will be used as a best practice.

Weeds
The pre-existing landscape was largely planted with Kikuyu grass, a warm season grass that is partially dormant in the winter. Kikuyu grows aggressively, primarily in rhizomes, and thrives in the sandy loam soils. The management of the weed will require spot applications of glyphosphate herbicide.

Insects
There are no significant insect pest problems at this time.

Composting

A composting facility was designed as part of the project. The objective is to recycle nutrients onsite, which would eliminate the costs and carbon emissions in hauling away and dropping off green waste.

The preferred and most appropriate method for onsite composting specific to the project is hot composting. This method requires an equal mix of green (nitrogenous) waste and brown (carbonaceous) waste, aeration and water. In February the grasses are mowed down generating considerable brown waste; however, the other vegetation onsite is young and minimal green waste has been generated. As the vegetation matures, the landscape is more likely to have a greater balance in waste to facilitate more productive composting.

Landscape Management

Labor and Resources

The site is currently being managed by Harvest Landscape Enterprises (Harvest), who provides a crew of 5 to tend the site once a week for approximately 5 hours. The landscape management crew's regular activities include adjusting the irrigation, removing debris along the 2,700 feet edge of the project adjacent to the sidewalks, and eradicating Kikuyu grass and weeds.

Vegetation

The grasses were cut late in the season and for the most part are responding well. The grasses on North Tustin Street are having difficulty due primarily to irrigation coverage. Some of the grasses have died and should be replaced.

Soils

Unlike those of a conventional landscape, the soils of the SmartScape project are an ecosystem in itself and must be continually managed such that they in turn support healthy plant growth. Ideal is to maintain a 2" layer of compost on the ground to reduce soil compaction, erosion, increase soil moisture, modify soil temperature for healthy plant growth, provide nutrients to soil biology and generally keep an aesthetically pleasing landscape.

Storm water

During the 24 months of management and monitoring, precipitation was 44% below normal. There were two rain events where the site received more than ½" of rainfall. The site was inspected on those days and there was no storm water ponding or flows observed.

Challenges

Previous Landscape Management Specifications: An oversight led the landscape contractor for the pre-existing site to continue maintaining the new landscape. For a period of approximately 8 weeks, Harvest and another landscape contractor overlapped. Because both crews frequently visited the site within the same timeframe, the damage could not be quantified.

PAR Electrical Constructors: PAR, Edison's onsite lessee, negatively impacted the project by tapping into the landscape's irrigation line and driving over vegetation, which killed dozens of plants and damaged irrigation heads. In addition, the PAR site harbors most of the rodents that also damaged plants. Coastkeeper notified Edison of these issues and the problem was resolved within 5 months.

Debris: The debris onsite from pedestrians and the force of the traffic along Taft Avenue and Tustin Street was greater than anticipated. Transients who live onsite additionally contribute to the debris and present a fire hazard by cigarette smoking and using kerosene burners, which have both been found onsite. Ongoing management must include particular attention to debris removal.

Rodents: The rodent populations have decreased but may continue to pose a challenge to the project. The squirrels onsite are non-native vermin that have contributed to the loss of several thousand plants. The rabbits are native, but have not been destructive to the landscape.

Community Impact: Pedestrians and cyclists have broken irrigation heads, compacted soils, littered the bioswales, and killed vegetation. In addition, during the two-year management and monitoring period, there were two automobile accidents that also greatly impacted the project.

VII. Recommendations

Lessons Learned

Design-Build Execution
As previously discussed, the SmartScape project was developed using the design-build approach—a method in which design services, construction services, and in the case of this project, landscape management services are all delivered by a single project team. The team consisted of water quality experts, landscape architects, landscape contractors, and landscape management experts.

Central to design-build methodology is the practice that all members of a project team—regardless of function—be engaged and well versed in all aspects of planning, design development, implementation, management, and monitoring. This degree of engagement ensures that project scope, goals, objectives, and challenges can be collectively understood and thoroughly addressed.

Adaptive Project Management
Because SmartScape is a pilot project, goals and objectives should be addressed and continually revisited not only in the early phases of project planning, but throughout the construction, management, and monitoring phases as well. This approach to project management enables the team to experiment, innovate, and modify the work plan as necessary, while ultimately meeting goals and objectives.

Adaptive project management is additionally important to the SmartScape project because the landscape was designed to simulate natural habitats. Unlike conventional landscapes that are designed to maintain a static set of aesthetic or social qualities, SmartScape was designed to simulate natural habitats, which are constantly growing and changing. Thus, it is vital that landscape managers respond to inevitable flux and actual conditions, and adjust management objectives accordingly.

Landscape Construction
Landscape construction, particularly for a project of this scale and level of coordination, is a highly specialized skill. To minimize risk, challenges, and setbacks, it is critical that the project team enlist a landscape contractor who possesses relevant experience.

Recommendations

Ongoing Monitoring

Continue to monitor irrigation water use, fuel use, herbicide, insecticide, and fungicide use, fertilizer use, carbon emissions and management costs. Evaluate results to ensure the SmartScape project continues to operate as a productive system, providing ecological benefits and opportunities for long-term cost management.

Quantify Captured Storm Water

Quantify and monetize the site's functionality by monitoring and measuring storm water volumes in the bio-detention basins, infiltration trenches, and bioswales to demonstrate the cost benefits of water conservation.

SmartScape Storm Water Quality Enhancement System

Due to diminishing rainfall, the potential functionality of the landscape design may be underutilized. Conduct a two-part study to (1) determine the feasibility of capturing the entire 34-acre facility's storm water runoff and conveying it into the SmartScape system, and (2) capturing and treating North Tustin Street and East Taft Avenue's storm water runoff.

Apiculture

The practice of maintaining honey bee boxes onsite would provide the simultaneous benefits of (1) enhancing the ecosystem with increased pollination, (2) mitigating the debris and fire hazards introduced by transients, and (3) creating an additional security buffer between the substation facilities and the landscape. Bees could be provided by professional apiarists known as "guerilla beekeepers," who are in the practice of rescuing and relocating honeybee colonies free of charge in exchange for harvesting honey.

Carbon Emissions Study

Conduct a study to assess the feasibility of capturing and sequestering up to 20 pounds of carbon in the top two cubic feet of site soils (1,250 tons of carbon sequestration).

Education and Marketing

Implement educational outreach and marketing programs that illustrate the site's positive environmental and community impacts and demonstrate Edison's commitment to sustainability. Encourage local businesses, public agencies, homeowners' associations, and similar entities to adopt SmartScape techniques and Low Impact Development (LID) design features.

Replicate SmartScape

Conduct a cost benefit analysis to assess the feasibility and anticipated outcomes of implementing similar resource efficient landscapes. Replicate the design features and management techniques of the pilot project at substations, office complexes, and other Edison owned facilities.

VIII. Conclusion

The Villa Park Substation SmartScape Project, a collaboration between Southern California Edison and Orange County Coastkeeper, was developed as a model for resource efficient landscapes. The site's pre-existing landscape, consisting of turf grass and several dozen trees, was replaced by a sustainable landscape that was both ecologically functional and aesthetically pleasing. The project achieved the following goals:

1. To reduce resources by 50% by using advanced landscape technology.
2. To develop achievable objectives, metrics, and technologies that are replicable at other Edison facilities, businesses, and residential parcels.
3. To develop a sustainable landscape that is biologically diverse, resource efficient, and aesthetically pleasing for a lifecycle of 100 years.

Following construction, Coastkeeper engaged in a two-year program to manage the site using sustainable landscaping practices and techniques and monitor the ecological benefits afforded by the project's Low Impact Development (LID) design features. The following objectives were achieved:

- A 50% reduction in maintenance costs.
- A 48.6% reduction in irrigation water use.
- A 54% reduction in carbon emissions.
- Capture and mitigation of 100% of storm water onsite.
- A 25% increase in soil carbon sequestration.

During construction, management, and monitoring, the following secondary objectives were achieved:

- A 66% reduction in gasoline and diesel consumption by outdoor power equipment and hauling vehicles.
- An 87% reduction in the use of herbicides, pesticides, and fungicides.
- An 85% reduction in the use of fertilizers.
- A 200% increase in onsite avian life.
- An 800% increase in microorganisms present in soil.
- A 50% reduction in water and sewer costs.
- The development of an onsite composting facility with the potential of further reductions in gasoline consumption and management costs.

In summary, the pilot project was quantifiably successful, providing measurable positive impacts to Edison, the local environment, and the community. The Villa Park substation site now serves as an iconic model for resource efficient landscapes and a tangible demonstration of Edison's long-term and ongoing commitment to sustainability.

SPECIFICATIONS FOR LANDSCAPE MANAGEMENT, OPERATIONS, AND BEST PRACTICES FOR THE VILLA PARK SUBSTATION SMARTSCAPE PROJECT

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Southern California Edison
2244 Walnut Grove Ave.
Rosemead, California 91770

Site:
Southern California Edison Villa Park Substation
1934 E. Taft Avenue
Orange, CA 92865

Date: June 9, 2013

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Appendix A: Landscape Management Specifications and Best Practices (cont'd)

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Appendix A: Landscape Management Specifications and Best Practices (cont'd)

INTRODUCTION

The Villa Park Substation SmartScape Project: A Model of Sustainable Landscape Designed and Management is a joint project between Southern California Edison and Orange County Coastkeeper. The project converted a conventional 3 acre landscape into a resource efficient one that is designed to serve as a model for other SCE facilities, commercial and residential development.

The project features drought-tolerant plant design, cutting-edge technology and sustainable landscape management practices that reduce maintenance cost, conserve water, reduce carbon emissions, mitigate storm water runoff and increase soil carbon sequestration. A two-year monitoring study following the landscape installation evaluated and verified the outcomes of the project goals and objectives.

Project Goals

1. Use advanced technology and design to develop a resource efficient, suitable landscape reducing resources by 50%.

2. Develop a resource efficient landscape with achievable objectives, metrics and technologies that are replicable for other sites.

3. Develop a landscape that is diverse, resource efficient and aesthetically pleasing for the next 100 years.

Project Objectives

To reach project goals, primary objectives and best practices were established to reduce management and operational cost, enhance stormwater quality, reduce water use, reduce carbon emissions, and increase soil carbon sequestration. To ensure objectives were met, after construction the site was managed and monitored for two years. The results were published in a final report prepared by Orange County Coastkeeper for Southern California Edison. The following are the Primary Objectives and the results after two years of management:

- To reduce maintenance cost by 40%. Actual reduce in maintenance cost was 50%;
- To reduce irrigation by 50%. Actual reduction in irrigation was 48.6% (note: during both years of management rainfall was down by 44% from an annual average of 13");
- To reduce the landscape carbon footprint by 60%. Actual reduction in carbon emissions was 54%;
- To capture and mitigate 100% of onsite storm water drainage. Actual storm water captured and mitigation was 100% (note: rainfall was 44% below normal);
- To increase soil carbon sequestration by 300%. Actual increase in soil carbon sequestration was 25%.

Appendix A: Landscape Management Specifications and Best Practices (cont'd)

Management Objectives
Manage the landscape using Best Practices as defined in the scope of work. Best practices are methods, techniques and or processes that have consistently shown results superior to those achieved with other means, and that is used as a benchmark. In addition, a "best practice" can evolve to become better as improvements are discovered and the landscape matures and changes. Landscape management and operations shall adhere to Best Practices as defined in the scope of work in these specifications.

SPECIFICATIONS AND BEST PRACTICES

I. Storm Water Management
PART I GENERAL
1.01 Objectives: The demonstration projects are designed to harvest storm water for vegetation use, to reduce stormwater runoff, and improve water quality.

1.02 Benefits: Capturing stormwater in bioswales, bio-detention, and infiltration basins reduces pollutants entering municipal drainage system. It improves water quality, protects soils and vegetation, traps sediments, keeps nutrients on site for plant's metabolism, stores and recycles organic carbon.

1.03 As-built Landscape Plans (See Appendix I)

PART II BEST MANAGEMENT PRACTICES
2.01 Bioswales (April):

A. Remove debris and trash and dispose of in legal landfill

B. De-silting: In April, one month after grasses have been trimmed, de-silt the bioswale by removing the top ½" organic debris and sediment from the bottom of the swale and have the debris composted offsite in a legal composting facility. The area of organic debris removal should be 2' wide, centered on the bottom of the swale, and extending its length to the juncus plants in the biodetention basins. Replace the organic debris and sediment with 1" of composted greenwaste, Forest Floor 0-2", by Aquinaga Green Fert. Co. or equal.

2.02 Biodetention Basins (September)

A. Remove debris and trash and dispose of in legal landfill

B. Chambermax

1. Once a year in September, clean concrete inlets and drain pipes to underground Chambermax. Inspect the chambers and silt load using the observation ports. See Landscape Asbuilts Appendix I, page 2.2 Grading Plan, for details of Chambermax.

2. Desiltation: If silt builds up to 50% capacity of the Chambermax, have the silt removed by vacuum truck. Access to the chamber can be made through the observation ports.

Appendix A: Landscape Management Specifications and Best Practices (cont'd)

2.03 Drain Catch Basins (September)

A. Debris Removal: Remove debris, silt and trash and dispose of in legal landfill

B. Pipe outlets: Clean pipe outlets

2.04 Pop-up Drainage Emitters in Bioswales (September)

A. Debris Removal: Around the emitters remove debris, silt and trash and dispose of in legal landfill.

B. Lid: Lift lids to ensure they operate and clean opening

2.05 Drain Pipe Outlets Through Street Curb (September):

A. Debris Removal: Remove debris and trash and dispose of in legal landfill

B. Sweeping: Sweep up silt in gutter around outlet, 20' upstream and downstream from gutter and dispose silt in legal landfill.

II. Soil Management

PART I GENERAL

1.01 Objectives: Develop healthy soils to sustain vegetation. The soil food web is the community of organisms living all or part of their lives in the soil. It's composed of beneficial flora and fauna that form a beneficial symbiotic relationship with the vegetation. By feeding the soil the plants are feed.

1.02 Benefits: Utilizing and enhancing soil biology leads to healthy vegetation, a reduction in water use, cleans storm water, reduces use of pesticides, fertilizers, lower's carbon emissions, labor and inputs.

1.03 As-built Landscape Plans (See Appendix I)

PART II BEST PRACTICES

2.01 Soil Probing Analysis (monthly):

A. Soil Probing:

1. Using a steel soil probe, probe soils to 12" deep and manually test soils for water infiltration, soil compaction, soil type (clay, sand, silt) and moisture content.

2. Apply minimum one probe per 10,000 square feet of planting area

3. Vary the location of probing from month to month

B. Compacted Soils (as-needed basis):

1. Using the soil probe, the contractor shall identify compacted soil areas

2. Mitigate compacted soil areas by cultivating the top 4" of soil; apply 50 lbs or agricultural gypsum per 1,000 sf.; and cover with 2" deep composted greenwaste mulch, "Forest Floor" 0-2" by Aquinaga Green Fert. Co. or equal.

Appendix A: Landscape Management Specifications and Best Practices (cont'd)

2.02. Mulching (September): Mulch all bare planting areas with 2" deep composted greenwaste, "Forest Floor" 0-2" by Aquinaga Green Fert. Co., or equal.

2.03 Soil Biology Testing: In October, test soil for biological activity. Contact Earthfort, 635 SW Western Blvd, Corvallis, OR 97333, (541) 257-2612/info@earthfort.com, www.oregonfoodweb.com , for testing protocols and soil additives (Earthfort's Soil ProVide and ReVive) application rates.

2.04 Soil Biology Additives: In January of each year, the contractor shall apply Earthfort Soil ProVide and Soil ReVive products, at application rates per Earthfort's specifications.

III. Irrigation Management
PART I GENERAL
1.01 Objectives: Irrigate the landscape using the latest proven technology to maximize efficiency.

1.02 Benefits: Efficient use of irrigation results in lower cost of water, sewer fees, operational cost, leads to healthier vegetation, zero runoff, and reduce carbon emissions.

1.03 The Site:
A. The irrigation system: WeatherTrac Pro 2 Central Controllers. System manager must be certified by WeatherTrac.
B. Site Data:

- The site is approximately 2.88 acres
- Annual average rainfall is 13"
- Evapotranspiration Rate is 49.7"
- See page 4.3 of Irrigation As-builts Appendix I. Estimated Total Water Use (ETWU) is 5.62

C. Historical Record (2-years): If site receives average annual rainfall, an average of 4.5 acre feet (18") of irrigation is required.

1.04 As-built Landscape Plans (See Appendix I)

PART II BEST PRACTICES
2.01 Irrigation Scheduling:

A. Deep Roots: To encourage deep roots irrigate using multiple repeat cycles.

B. Soil Probing: Shall be used to determine soil moisture depth, overall moisture levels and the need to adjust irrigation schedules. See SOIL MANAGEMENT, 2.01 Soil Probing Analysis

C. Soil Moisture: Soils will be allowed to dry to a 50% moisture depletion level between irrigations in order to avoid root-rot and allow adequate air to be present in the soil.

Appendix A: Landscape Management Specifications and Best Practices (cont'd)

D. Irrigation Scheduling: Scheduling will be coordinate with all other management activities.

2.02 Soil probing (weekly): Using the results from soil probing, adjust irrigation station as per soils probe testing.

2.03 System Inspection (weekly): Contractor shall maintain all components of the irrigation system in proper working order, as per manufacturer's specifications, by inspecting the system, including the meter, backflow, controller box, quick couplers, and surface conditions near mains and lateral pipes (check for leaks). In more detail inspect the following:

A. Controllers:
1. Weather Base (monthly):
a. Review each station to ensure effective operations per schedule.
b. Utilize soil probing to determine soil moisture content adjust schedule accordingly.

B. Irrigation Valves (weekly):
1. Conventional Valves:
a. Check each valve for leaks, defective solenodes, and broken wires.

2. Drip Irrigation Valves:
a. Check each valve for leaks, defective selenodes, and broken wires. weekly
b. Clean out filter by removing filter body, exposing the screen and cleaning. (quarterly)
3. Repairs (as-needed): Identify leaking and or defective valves, report findings to owner with a cost to repair estimate.

C. Heads:
1. Distribution Uniformity: Activate each station and observe sprays. Adjust spray heads accordingly. (weekly)

2. Broken Spray Heads and Bubblers (as-needed): Repair and or replace broken heads with same make and model.

D. Drip System:
1. Drip lines and Emitters (weekly):
a. Activate system, inspect drain lines and emitters.
b. Locate breaks in pipe and repair.

2. Flushing:
a. Prior to adding new tubing flush system. (as-needed)
b. Flush the entire system (quarterly)

3. Flush and Air Valves: During flushing of system identify defective flush and air valves and replace.

E. Main and Lateral Irrigation Lines (weekly): Activate system and observe for broken mains and lateral lines. Report findings to owner and repair same day.

F. Backflow Device (annually): Shall be inspected annually by a certified backflow inspector. Repair defects and record inspection accordingly.

G. Irrigation System Pressure (monthly): Activate system and inspect pressure at the point of connection and at the last heads on the longest line.

2.04 Replacement Parts: All irrigation replacement parts shall be as original installation or approved equals.

2.05 Estimate for Repair: The Contractor shall list damage to irrigation system and provide Southern California Edison with a cost estimate of repair/replacement.

2.06 Irrigation Schedule (monthly): The contractor shall track and record the amount of water applied to various site hydrozones.

IV. Vegetation Management
PART I GENERAL
1.01 Objectives: To maximize performance and benefits, maintain vegetation in healthy condition.

1.02 Benefits: Healthy vegetation provides the following environmental services:
- It reduces overall site disturbance including soil compaction and erosion;
- Maintains ability of the site to manage stormwater flows and treat stormwater;
- Minimizes costs by reducing need for soil amendments and thus reducing inputs;
- Reduces long term management needs and cost;
- Improves biodiversity and animal habitat;
- Cleans air, water and conserves energy

1.03 Planting Plans (See Appendix I Landscape As-built Plans)

PART II STANDARDS
2.01 Pruning General: The intent of this style of pruning is to maintain the natural plant appearance. Shrubs are intended to fill planting spaces as much as possible.

2.02 Pruning Standards:

A. Live Foliage Removal: Remove no more than 10%-20% of the live foliage at any one time.

B. ANSI Standards: Prune specific plants as per American Nation Standard ANSIA300 (Part I) – 2001 Pruning, for Tree Care Operations-Tree, Shrub, and Other Woody Plant, Maintenance – Standard Practices (Pruning)

2.03 Pruning Requirements for Specific Vegetation: (See Appendix IV.)

2.04 Pruning Equipment:

A. Hand Shears: A short –handled tool used to cut stems and branches. Use "Drop – Forged shears for branches one-quarter inch in diameter or smaller.

B. Loppers: A Long-handled tool used to cut larger branches (one-quarter – three-quarter inch dia.).

C. Hedging Shears: A long-bladed tool used to trim hedges. Electric or gas powered versions are acceptable

D. Pruning Saw: A curved-blade tool used to cut branches larger than three-quarters of an inch in diameter.

E. String Line Trimmer: An electric or gas-powered tool used to edge, or dead –head annuals, perennials and grasses.

F. Pole Pruner: Verify its use and safety precautions with Edison.

2.05 Pruning Definitions:

A. Dead-heading: The removal of spent or dead flowers or flower clusters. Used to create a longer season of bloom or to improve plant's appearance. Dead-heading is done before seeds have been produced. Dead head flowers only once allowing the second bloom to mature to seed.

B. Edging: The pruning back of plants along edges, paths, streets, and next to planter walls. To give the edge a natural appearance, do not cut all the branches back to the same point.

C. Thinning (light pruning): The process of removing entire stems and branches to give more light and room for remaining plant growth, or to accentuate the plant's growth habit.

D. Corrective Pruning: Corrective Pruning that takes care of the structural problems of larger shrubs and trees when it is first noted. Use corrective pruning to mitigate, included bark, crossing or rubbing structural branches, multiple leaders (codominance), watersprouts and suckers.

PART III BEST PRACTICES

3.01 Ground Cover and Shrubs:

A. Groundcover and Shrub Areas:

1. Shall be uniformly irrigated to ensure consistent growth and plant coverage.

2. Groundcover areas shall be kept free of weeds and grasses

3. Sparse groundcover areas will be checked for soil moisture levels, irrigation coverage, and soil compaction to help determine growth problem.

3.02 Grasses

1. Use string line trimmer to shear grasses in March

2. Remove trimmings and compost offsite.

3.03 Vines (as-needed):

1. Remove all vines on walls.

2. Keep all foliage 3' from face of surface of wall.

3. Keep all tree limbs 3' from face of wall extending vertically to 35' height.

3.04 Trees:

A. Tree Height and Management: Contractor shall manage all trees up to 14' in height using ANSI standards except for trees under power lines. Trees above this height tree and under power lines shall be management by qualified tree maintenance service.

B. Health Monitoring: Trees shall be inspected for structural integrity, broken branches, and general health condition.

C. Tree Stakes: All newly planted trees shall have their stakes removed after two years.

D. Deep Watering: Trees shall be deep watered to encourage deep roots and discourage surface root damages. Soil moisture shall be checked using a soil probe.

3.05 Vegetation List with Specific Action

A. Shrubs:

- *Salvia greggi* 'Furman's Red' (Firecracker Sage): In January-February prune dead wood and reduce foliage by 25% to promote new spring growth.

- *Archtostaphylos* species (Manzanita): Second year, pinched or lightly headed back in March or April (while new growth is still tender) to promote a dense growth habit. Do not prune manzanitas during cool, wet, winter months.

- *Aloe species*: Remove flowering stems two months after flowers have died.

- *Fremontodendron californicum* (California Flannel Bush): Second year, light prune, do not cut into old wood.

Appendix A: Landscape Management Specifications and Best Practices (cont'd)

- *Rhamnus californica* (California Coffeeberry): Second year, March - May lightly pinch or prune.
- *Eriogonum fasciculatum* (Buckwheat): Prune flowers six weeks after turning brown.
- *Salvia clevelandi* (Cleveland Sage): Lightly prune spent flower heads back to promote dense branching habits. Avoid cutting into older wood. Prune in late fall or early winter, before, or as the new growth begins to expand.
- *Juncus patens* (California grey rush): Use a coarse, heavy rake to groom the plants and remove dead leaves from other plants that collect in the rush's stems.
- *Agave* species: Remove flowering stems two months after they have died. The rosette that flowered dies, but produces offspring (pumps) that will continue the planting.
- *Yucca Flamentosa:* Remove flowering stems two months after they have died.

B. Grasses:

- *Muhlenbergia* 'Regal' : Shear the grass to 6"-8" clumps in March
- Muhlenbergia rigens: Shear the grass to 6"-8" clumps in March
- Pennisetum "Fairy Tails": Shear the grass to 6"-8" clumps in March
- Fescue Grass Mix (tower and service road): In September mow to 6" height.

C. Trees:

- *Cercis occidentalis* (Western Redbud): Maintain as multi-trunk tree, do not remove basal stems. To increase bird foraging do not prune flowers.
- *Heteromeles arbutifolia* (Toyon): Second year, thin vegetation in early winter. Remove no more than 10% of the foliage.
- *Prunus ilicifolia spp.ilicifolia Hollyleaf Cherry:* Do not prune
- *Lagerstroemia indica,* Crape Myrtle: Every year in October prune suckers from base of tree to promote multi-trunk character. Every three years in October, prune dead limbs (not to exceed 10% of total limbs) to maintain multi-trunk character.
- *Rhus lancea*, African Sumac: Once a year prune all suckers at the base. Every three years thin foliage (less than 10%) to maintain multi-trunk character.

V. Wildlife (Birds) Management

Appendix A: Landscape Management Specifications and Best Practices (cont'd)

PART I GENERAL

1.01 Objectives: Enhance bird life through plant and insect diversity, landscape (habitat) structure and low impact landscape management practices.

1.02 Benefits: Bird life is a primary indicator of a healthy environment.

PART II BEST PRACTICES

2.01 Plants:

A. Manage vegetation as per the work schedule and best practices found herein.

B. For plant replacement follow landscape improvement plans and specifications.

C. On perennial shrubs deadhead flowers only once, allowing the second bloom to mature to seed. Allow the deadheaded flowers to remain on the ground as mulch.

2.02 Insects: Insects shall be considered a food source for birds and mammals.

2.03 Birds:

A. Do not prune or shear vegetation with birds nest, wait until after nesting (April) and remove vegetation.

B. Power Equipment: During nesting season (February – April) keep the use of motorized equipment to a minimum.

VI. Pest Management

PART I GENERAL

1.01 Objectives: Utilize Integrated Pest Management in the landscape, it recognizes that landscape pests are organisms that interfere with the management regime of the landscape-plants and /or soils – and that the health of a landscape requires the use of proactive and reactive methods.

1.02 Benefits: Integrated Pest Management requires close observation of the vegetation and support systems (soils, drainage, irrigation, fertility, maintenance). Through close observations problems with vegetation is recognized early, pest identified, and remedial actions taken to reduce the impacts of the "pest".

1.03 As-built Landscape Plans (See Appendix I)

PART II BEST PRACTICES

2.01 Standards for Implementation of Integrated Pest Management

A. Intervention to control pests by use of chemicals or biological products is considered as a last resort. Consult with project Pest Control Advisor for proper low impact pest control.

B. Monitoring (weekly):

Appendix A: Landscape Management Specifications and Best Practices (cont'd)

1. Monitor the landscape continuously by inspecting the plants weekly, particularly through the main growing season of the different species. Observe the growing tips, tops and undersides of leaves, stems, trunks and base of the plants. Record the general condition of the garden.

2. Monitor whether natural enemies of the plant pest infesting the garden are present. If the natural enemies of the insect are present in sufficient numbers, no additional control methods may be necessary.

3. If a problem arises, find the source. Determine if the major problem is due to an imbalance or malfunction in the support systems, plant pest and or disease.

C. Best Method:

1. Consult with the project Pest Control Advisor to determine best method for mitigation. The method should do the least harm to the environment, garden, other plants, the natural pest predators, and the affected plants or plants. Prior to implementation, provide the Landscape Architect with the PCA's recommendation for his review and approval.

2. Evaluate whether the chosen method is working. Evaluate if each method is effective in controlling the targeted pest. Check for any short-or long -term harm to the environment, plants, natural plant pest enemies and or beneficial organisms. Report findings to project Landscape Architect.

2.02 Rodent Control: Southern California Edison has contracted with a pest control service to keep rodent populations and damage to a minimum. Complete eradication is not desirable; control of the population is the objective.

2.03 Weed Management (weekly):

A. Prevention:

1. Clean equipment before using on site.

B. Physical Control:

1. Remove by hand hoe, all weeds while they are still young and before they set seed or produce rhizomes or tubers.

2. Remove small patches before they get larges.

3. Remove entire weed, including the root.

4. Use dandelion fork or fishtail weeders to removed weeds with a thick taproot.

6. For areas 100 square feet and larger, mowing, shredding, string line trimmer is acceptable.

C. Cultural Control:
   1. Adjust irrigation to reduce weed growth.

   2. Cover bare soil areas with weed free 2" composted greenwaste mulch

D. Post Weed Removal (as-needed): Spread 3" deep high quality composted greenwaste. Keep mulch 6" from base of plant crowns.

E. Revegetation: If required, replant area with vegetation and cover newly planted areas with 2" deep composted greenwaste mulch, 0-2" Forest Floor (Aquinaga Green, Fert Co.) or equal.

F. Chemical Control:
   1. The Contractor shall consult with a Pest Control Advisor (PCA) who shall identify the pest species and the proper controls using the least impact chemical solution.

   2. The PCA shall specify, chemical controls and the Contractor shall provide a licensed qualified applicator to administer the chemicals applying per manufacturer's instructions.

G. Allowable Chemical Controls include the following:
   1. Natural Herbicides:
      a. Pre-emergence herbicides, corn gluten meal;
      b. Postemergent herbicides, herbicidal soaps;
      c. Postemergence herbicides, vinegar;

   2. Synthetic Herbicides
      a. Postemergence, Glyphosate

VII. Waste Management

PART I GENERAL

1.01 Objectives: Reduce green waste through best practices.

1.02 Benefits: Recycle nutrients on site.

1.03 As-built Landscape Plans (See Appendix I)

PART II BEST PRACTICES

2.01 Greenwaste (weekly): Utilize on-site composting area. See As-built Landscape Plans, Appendix I for location. Use hot composting and vermi-cultural methods that utilize only on-site green and brown vegetative waste. Use composted greenwaste in bare planting areas.

2.02 Trash and Debris (weekly):

Appendix A: Landscape Management Specifications and Best Practices (cont'd)

A. All planting areas are to be kept clean of trash and debris.

B. The sidewalk edge: Three feet from the edge of the sidewalk into planting areas shall be clean of trash and debris. Once a year this areas should receive 2" of composted green waste.

C. Trash Removal: All trash and debris shall be removed from site and disposed of in a legal landfill.

D. Driveways and Decomposed Granite: Clean driveway and decomposed granite surfaces Remove vegetative debris, trash, and litter from all surfaces.

E. Decomposed Granite Driveways:
A. Raking (monthly): Rake decomposed granite, filling in depressions and providing a smooth surface. Do not alter the surface drainage.

F. Debris (weekly): Remove weeds, vegetative debris, trash, and litter from all surfaces. Compost vegetation and dispose of trash and litter to legal landfill.

G. Masonry Walls (as-needed): Using a spray hose, spray water wash masonry walls.

H. Graffiti: Contact Edison's facility manager to make them aware the graffiti and the location.

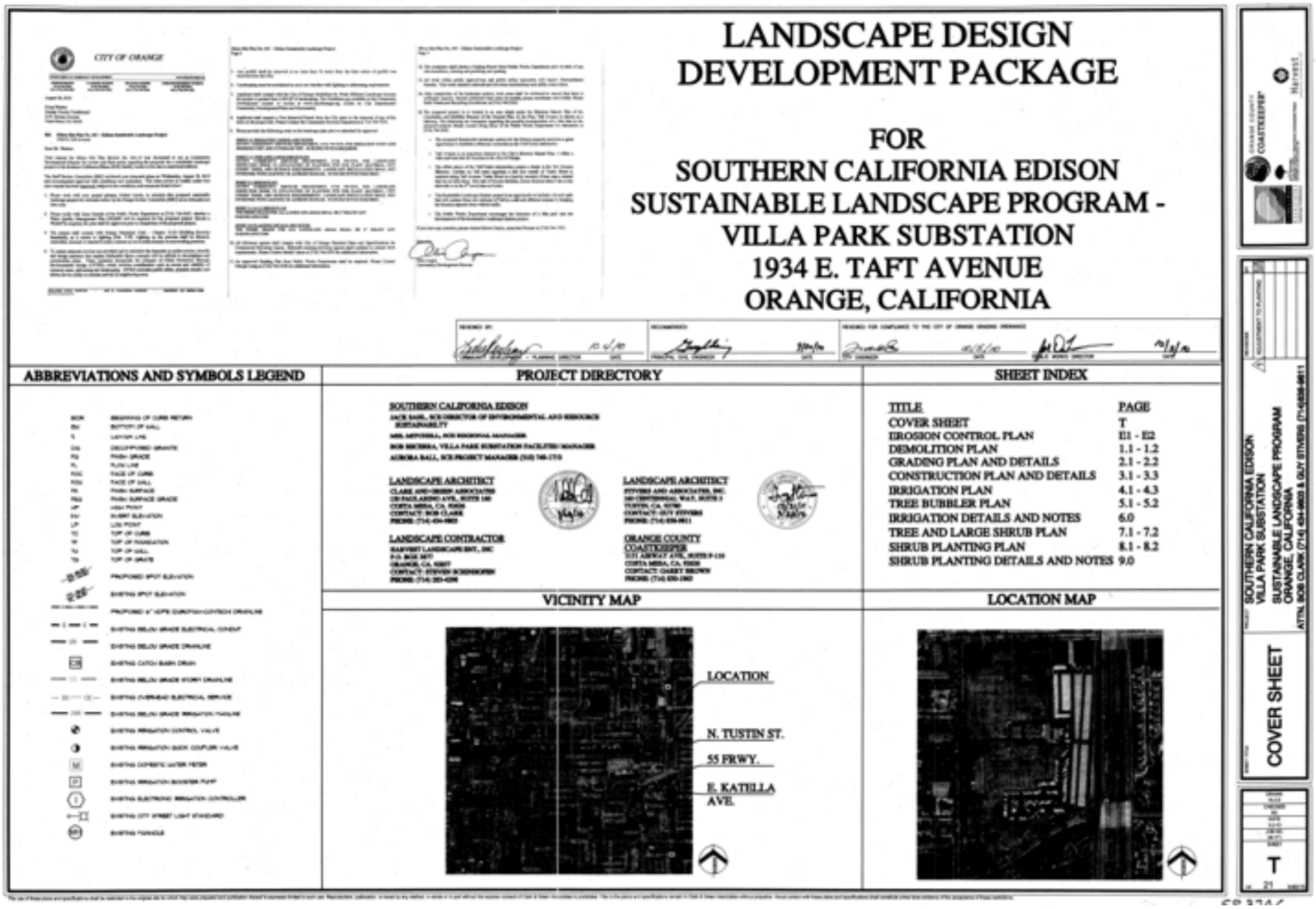
VIII. Emergencies

The Contractor shall provide emergency services. System and protocols to be determined.

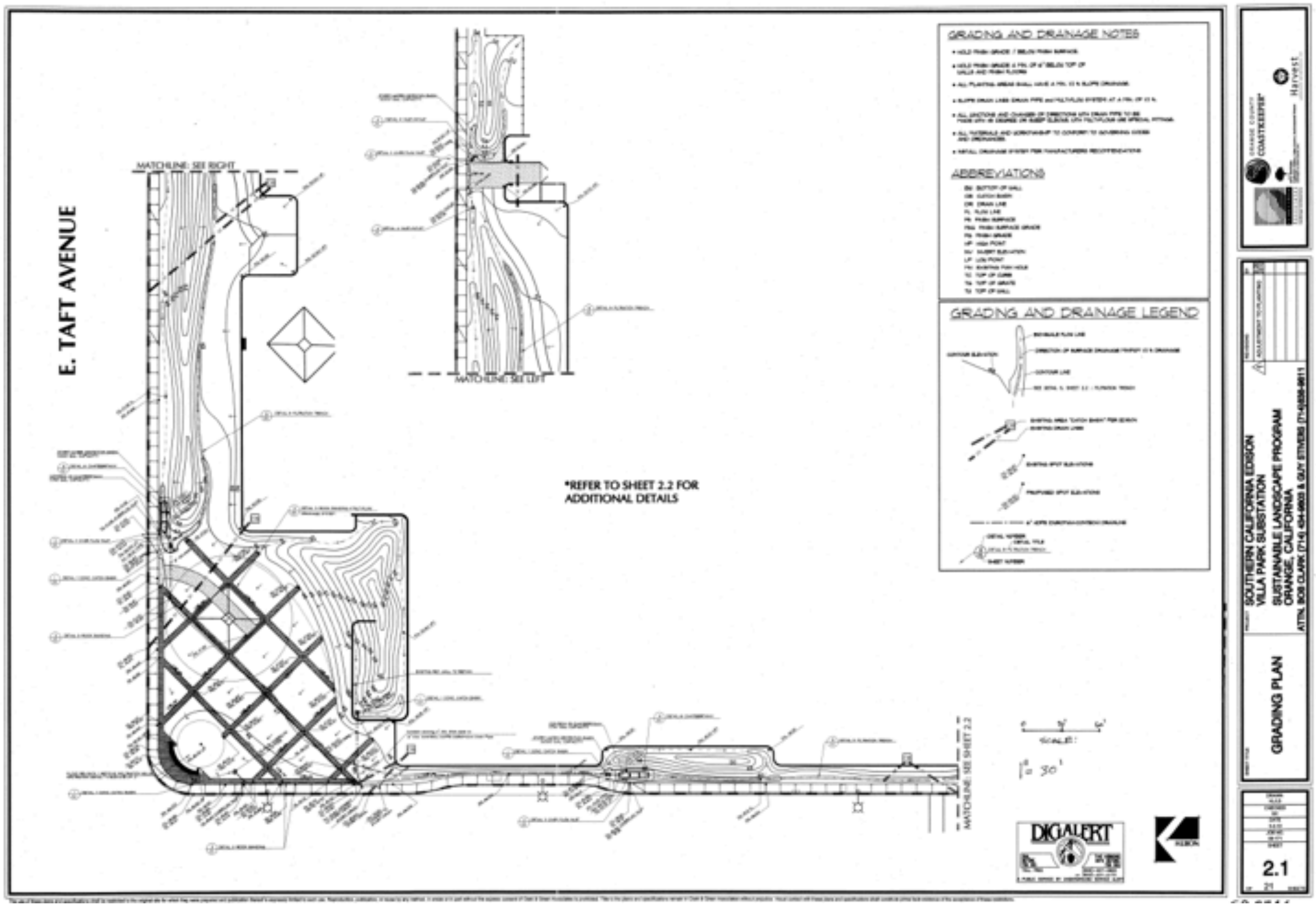
IX. Monitoring

To ensure project environmental, social and cost benefits continue into the future a comprehensive monitoring system should be established by a third party agency (to be determined).

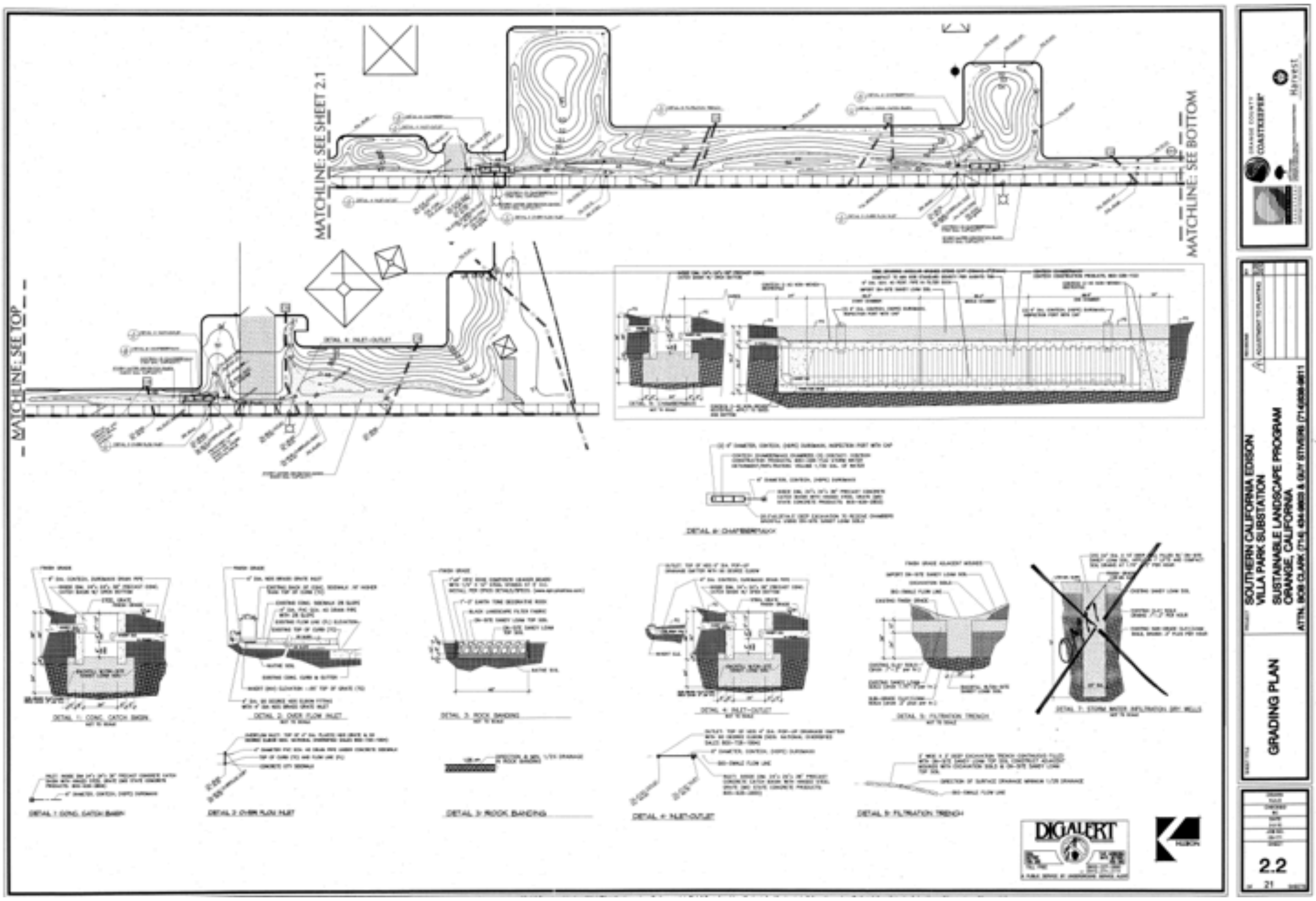
Appendix B: As-Built Drawings



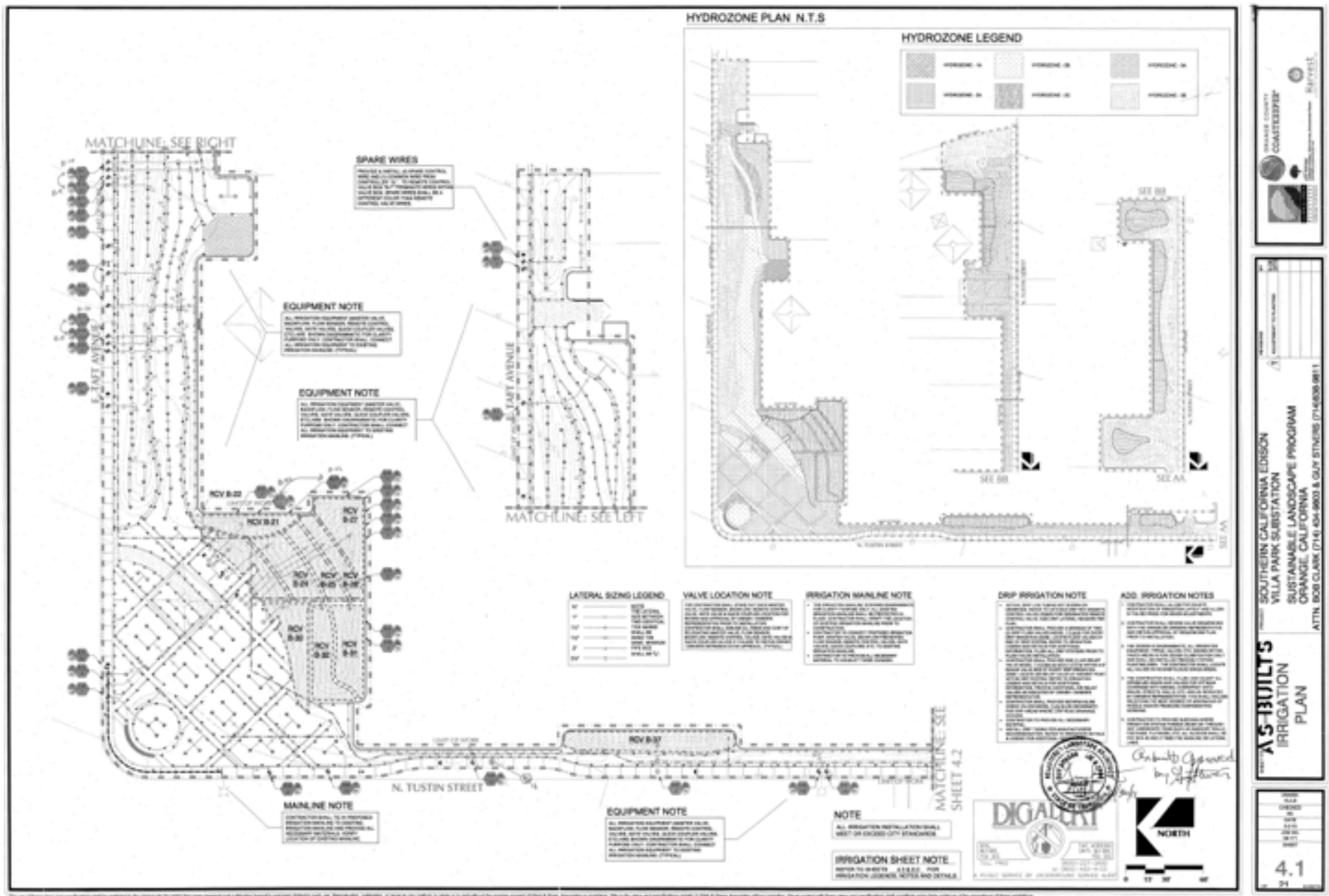
Appendix B: As-Built Drawings (cont'd)



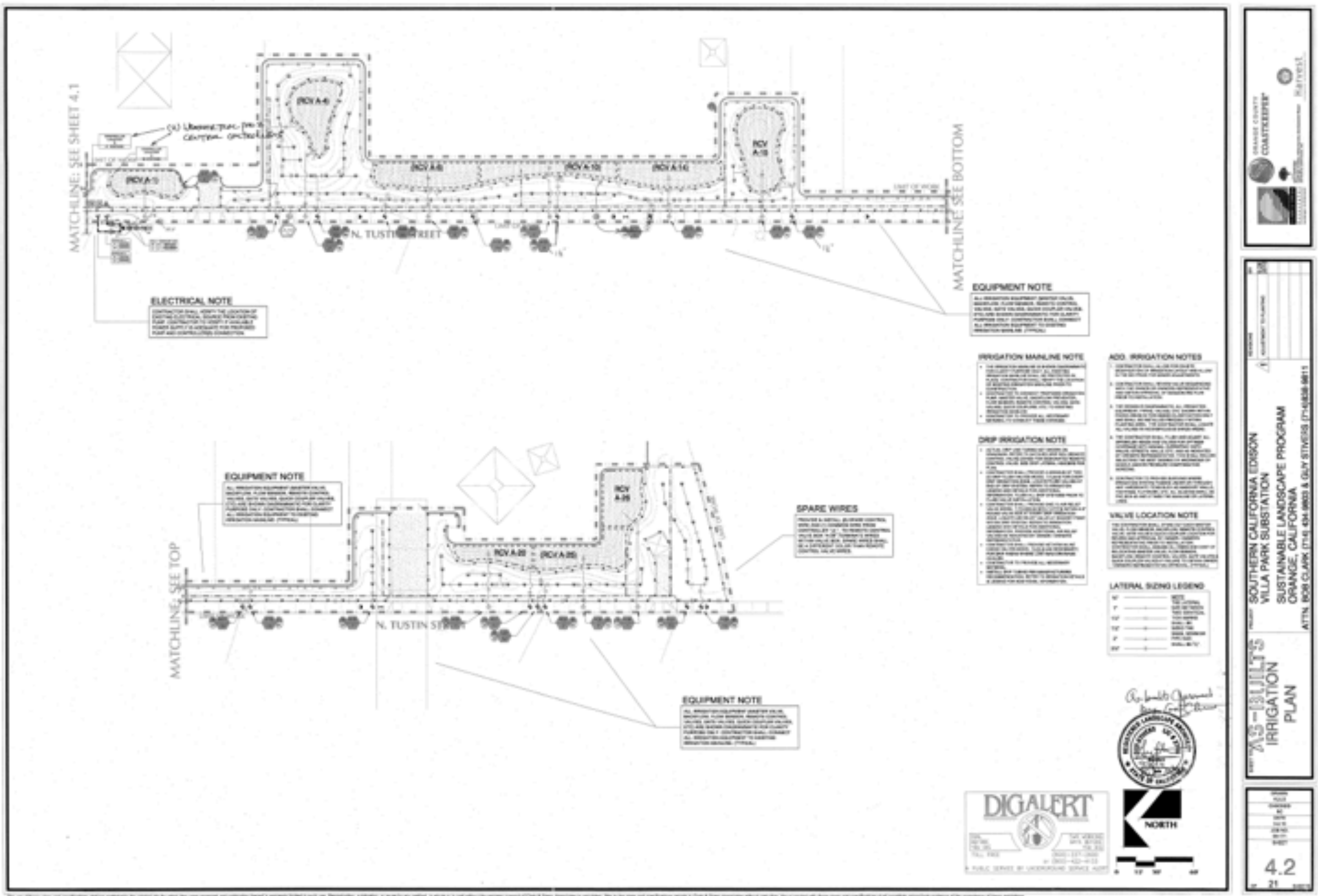
Appendix B: As-Built Drawings (cont'd)



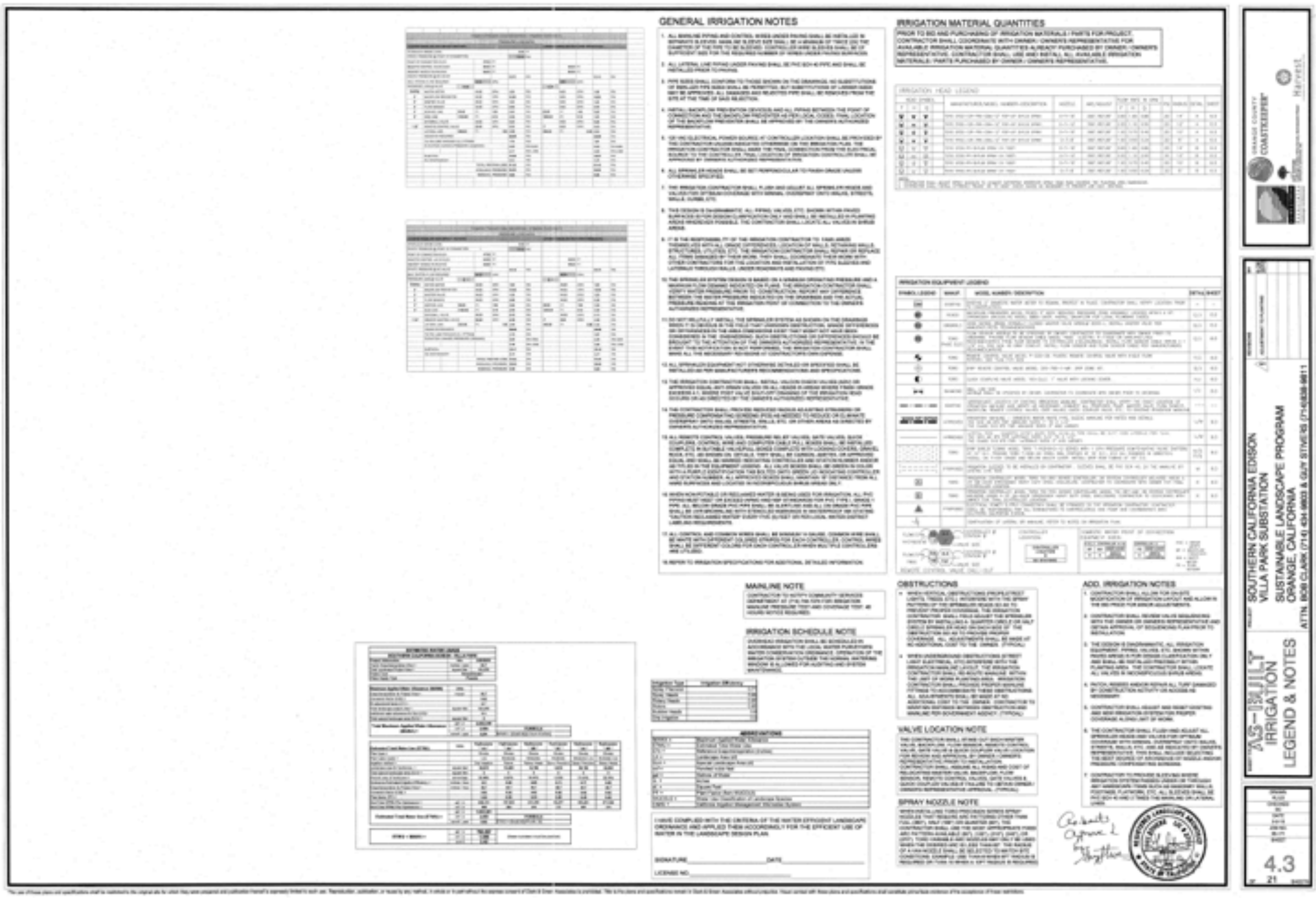
Appendix B: As-Built Drawings (cont'd)

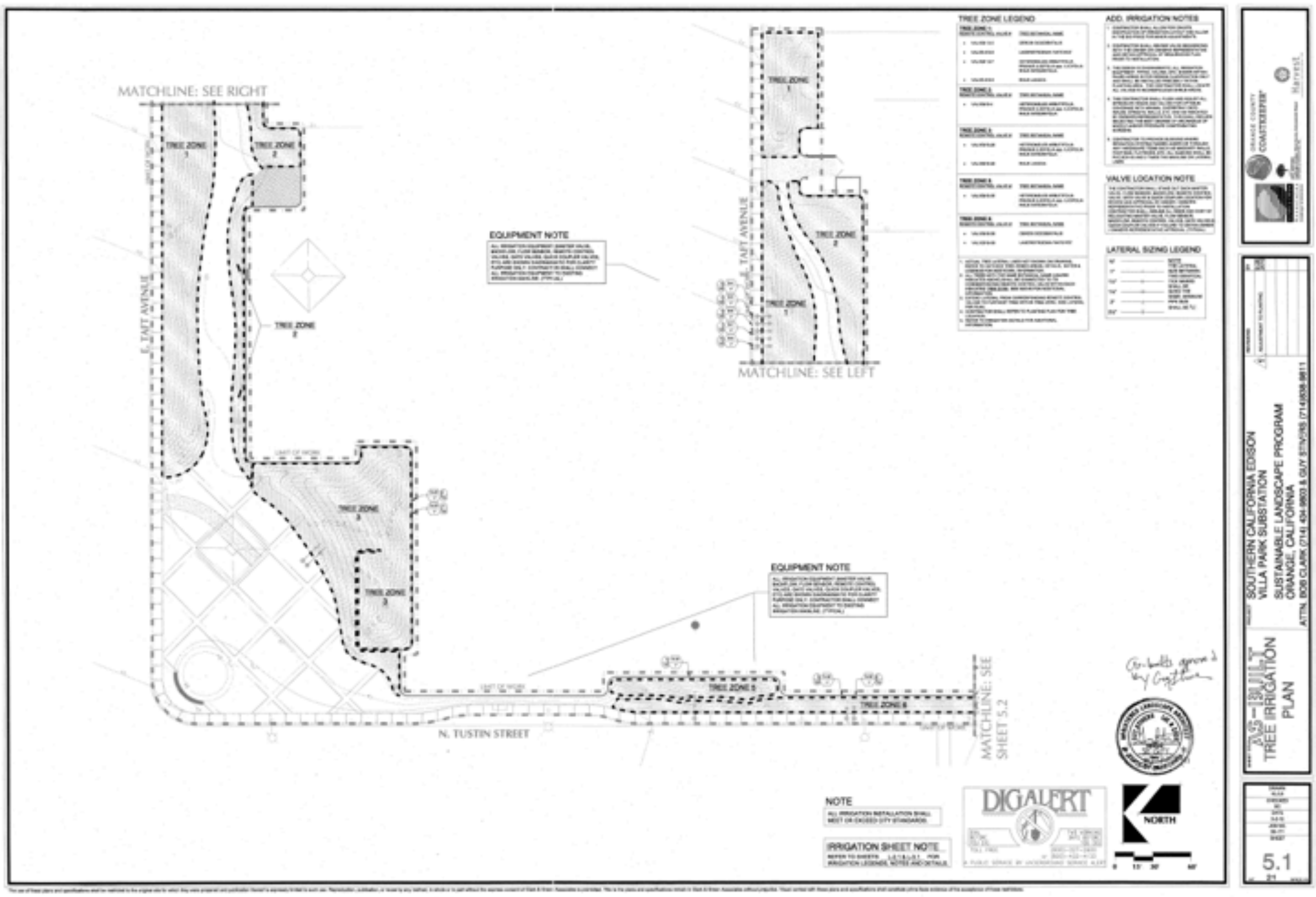


Appendix B: As-Built Drawings (cont'd)

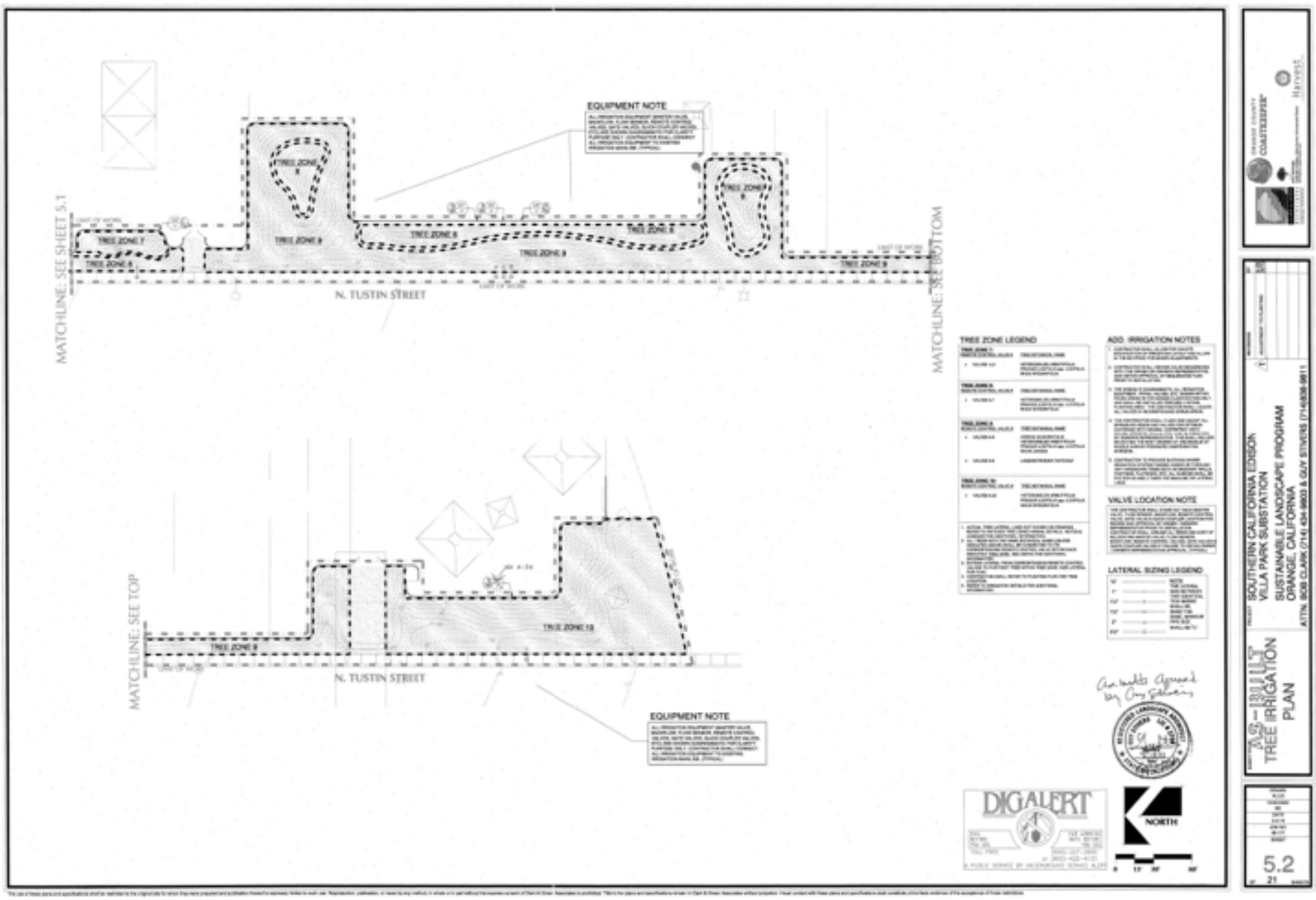


Appendix B: As-Built Drawings (cont’d)

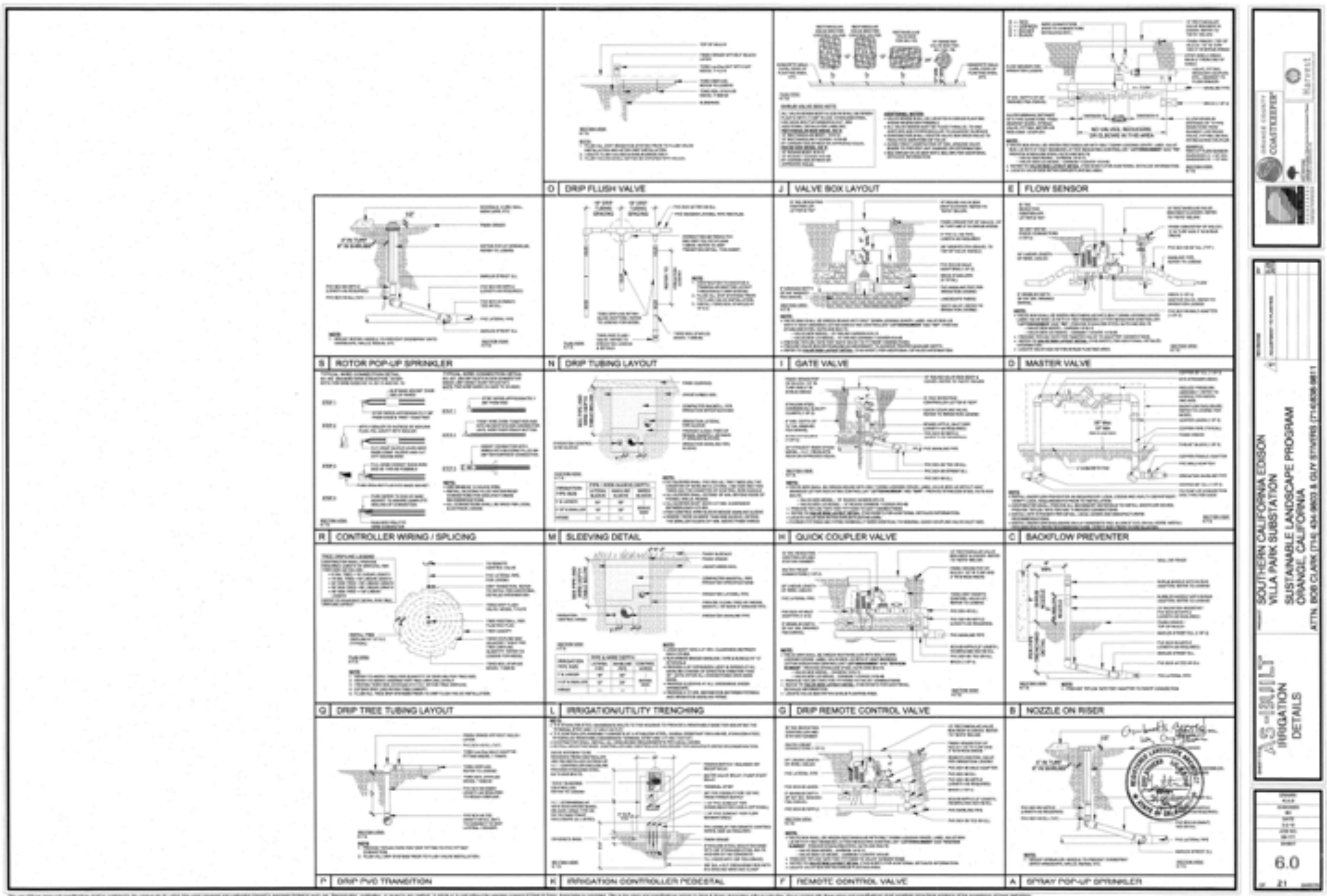



MATCHLINE: SEE RIGHT
TREE ZONE 1
TREE ZONE 2
E. TAFT AVENUE
TREE ZONE 2
EQUIPMENT NOTE
TAFT AVENUE
TREE ZONE 1
TREE ZONE 2
TREE ZONE 1
MATCHLINE: SEE LEFT
TREE ZONE LEGEND
ADD. IRRIGATION NOTES
VALVE LOCATION NOTE
LATERAL SIZING LEGEND
TREE ZONE 3
TREE ZONE 3
EQUIPMENT NOTE
TREE ZONE 5
TREE ZONE 5
N. TUSTIN STREET
MATCHLINE: SEE SHEET 5.2
NOTE
ALL IRRIGATION INSTALLATION SHALL MEET OR EXCEED CITY STANDARDS
IRRIGATION SHEET NOTE
DIGALERT
NORTH
SOUTHERN CALIFORNIA EDISON
VILLA PARK SUBSTATION
SUSTAINABLE LANDSCAPE PROGRAM
ORANGE, CALIFORNIA
AS-BUILT
TREE IRRIGATION
PLAN
5.1

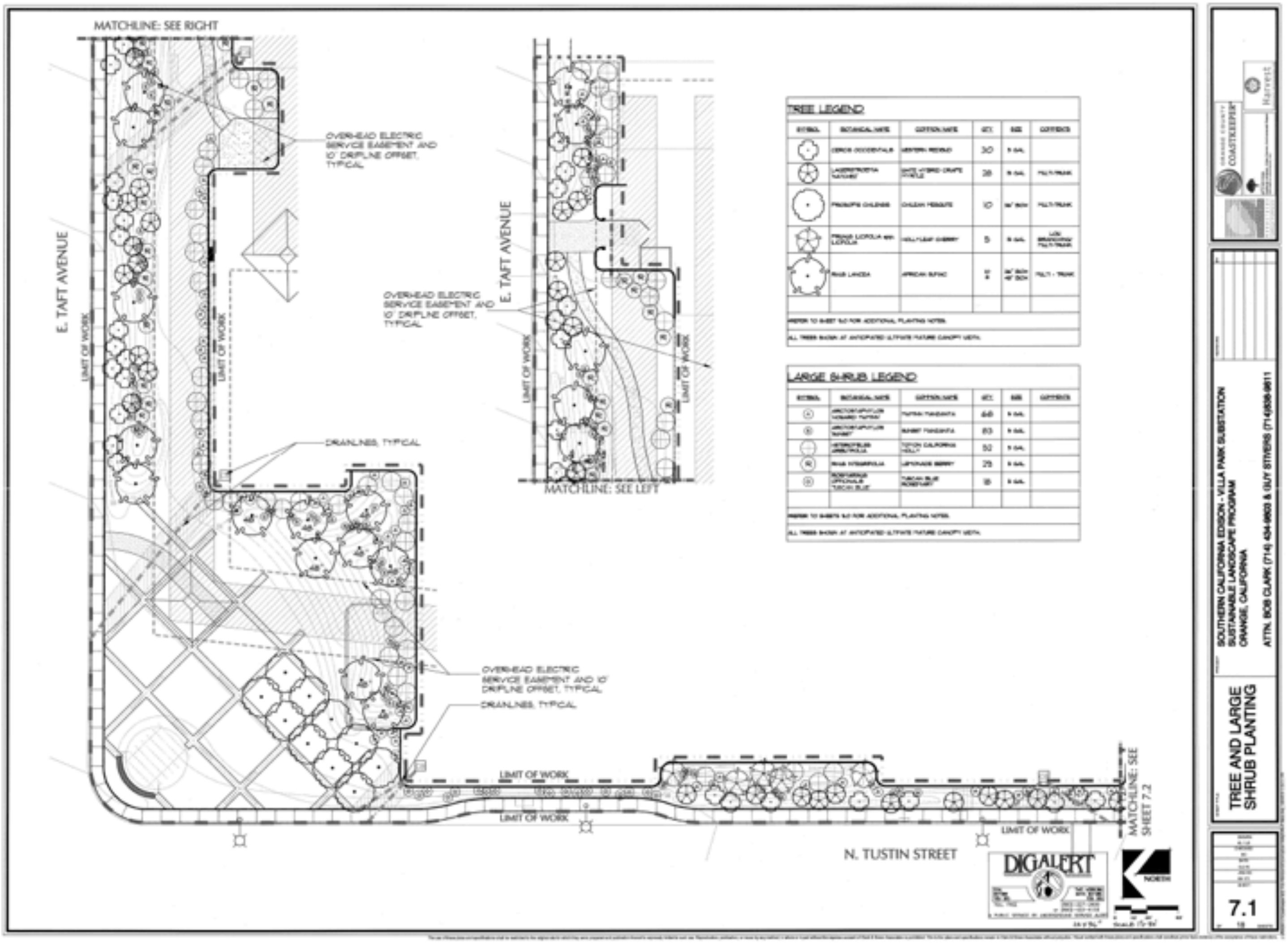
Appendix B: As-Built Drawings (cont'd)

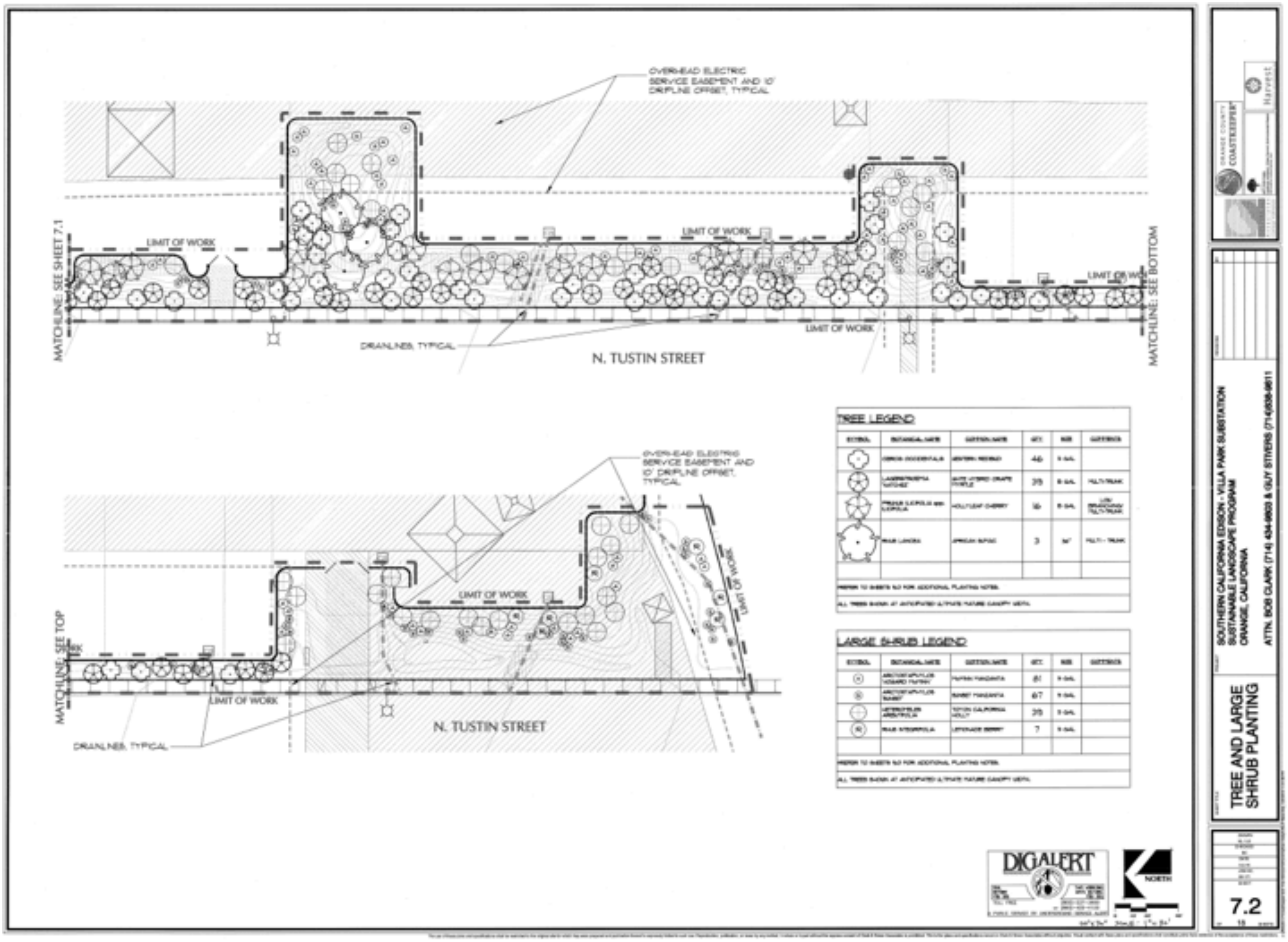


Appendix B: As-Built Drawings (cont'd)



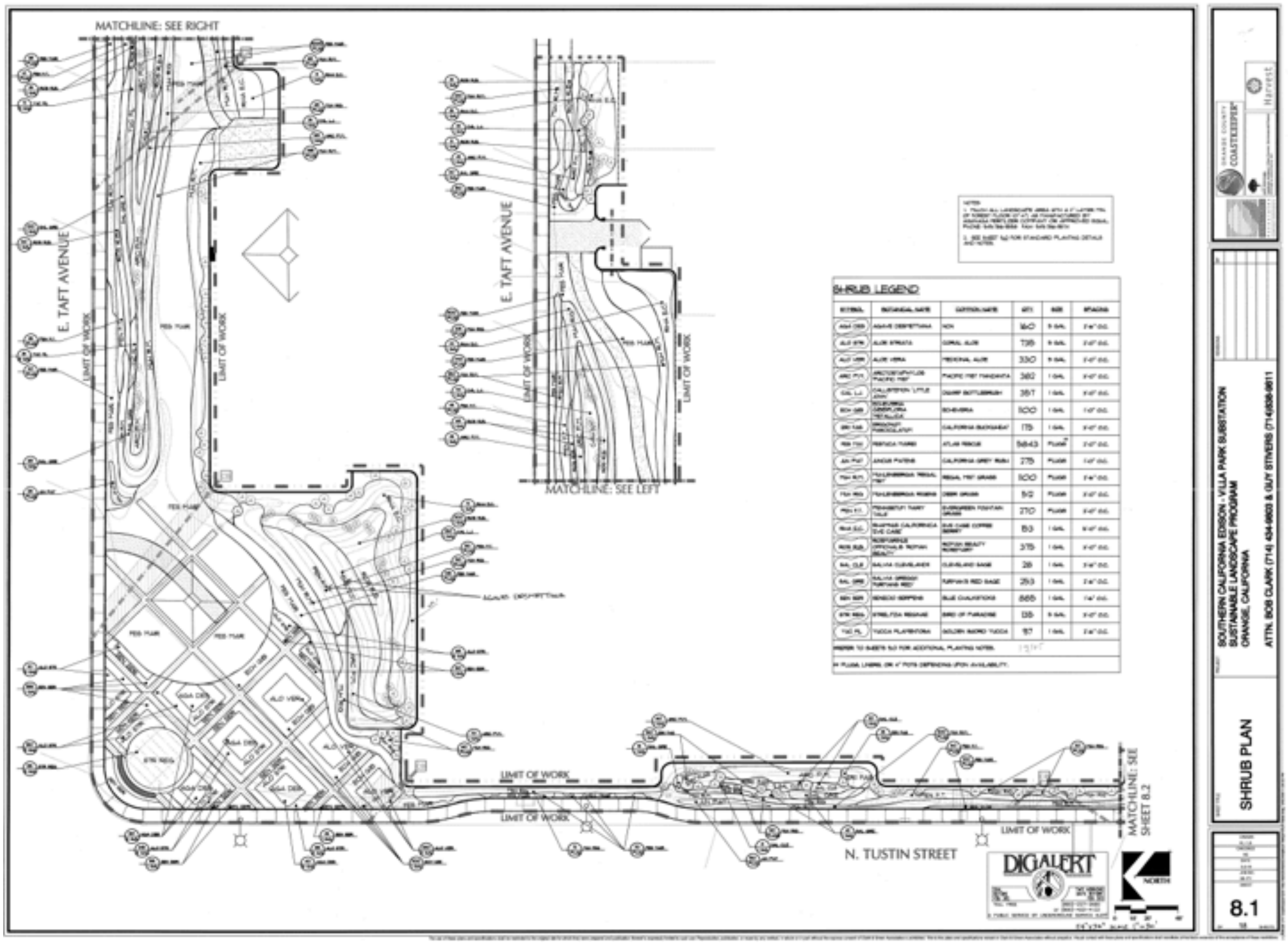
Appendix B: As-Built Drawings (cont'd)



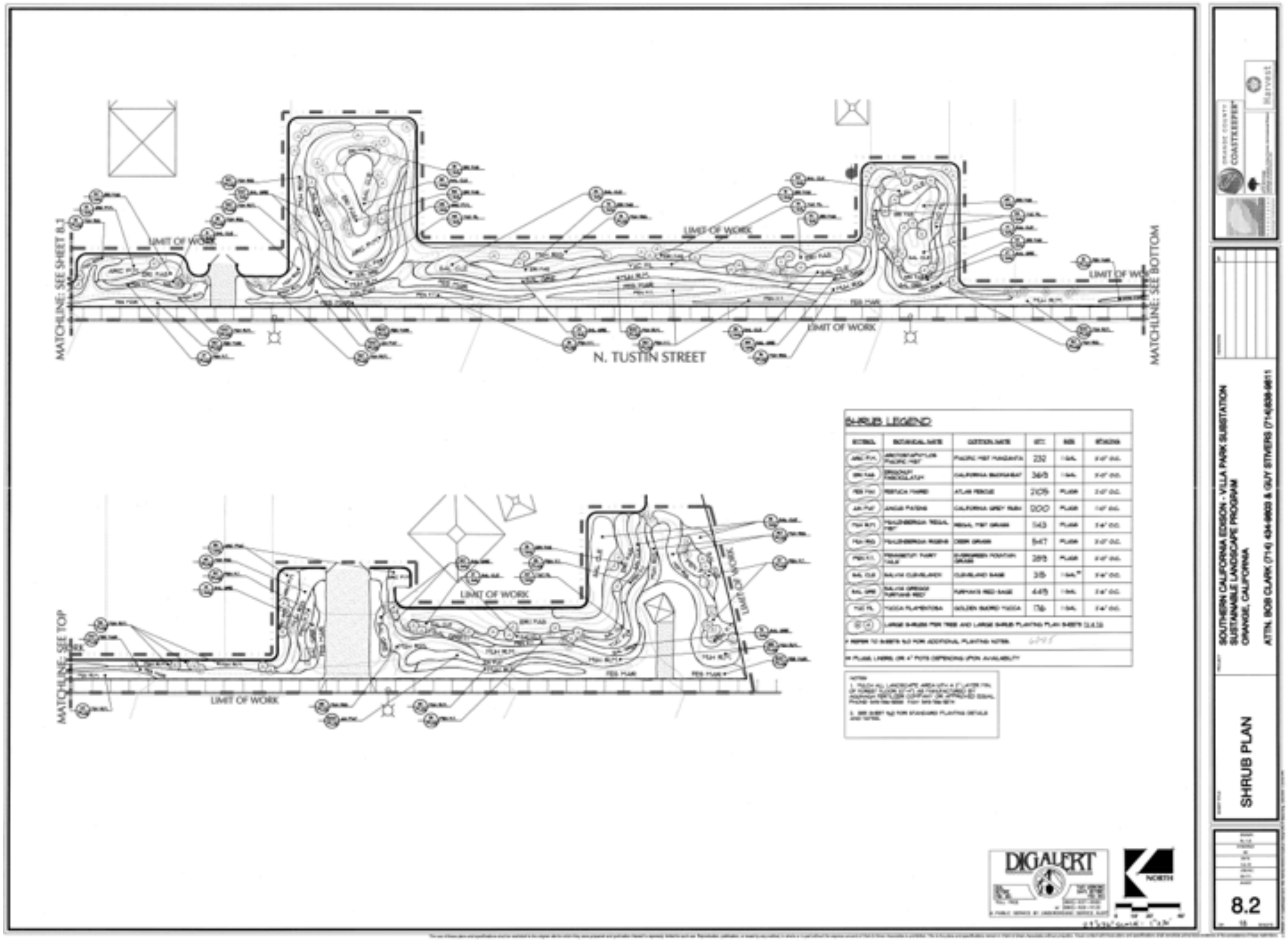


OVERHEAD ELECTRIC SERVICE EASEMENT AND 10' DRIPLINE OFFSET, TYPICAL
LIMIT OF WORK
MATCHLINE: SEE SHEET 7.1
MATCHLINE: SEE BOTTOM
DRAINLINES, TYPICAL
N. TUSTIN STREET
MATCHLINE: SEE TOP
TREE LEGEND
LARGE SHRUB LEGEND
DIGALERT
NORTH
SOUTHERN CALIFORNIA EDISON - VILLA PARK SUBSTATION
SUSTAINABLE LANDSCAPE PROGRAM
ORANGE, CALIFORNIA
TREE AND LARGE SHRUB PLANTING
7.2

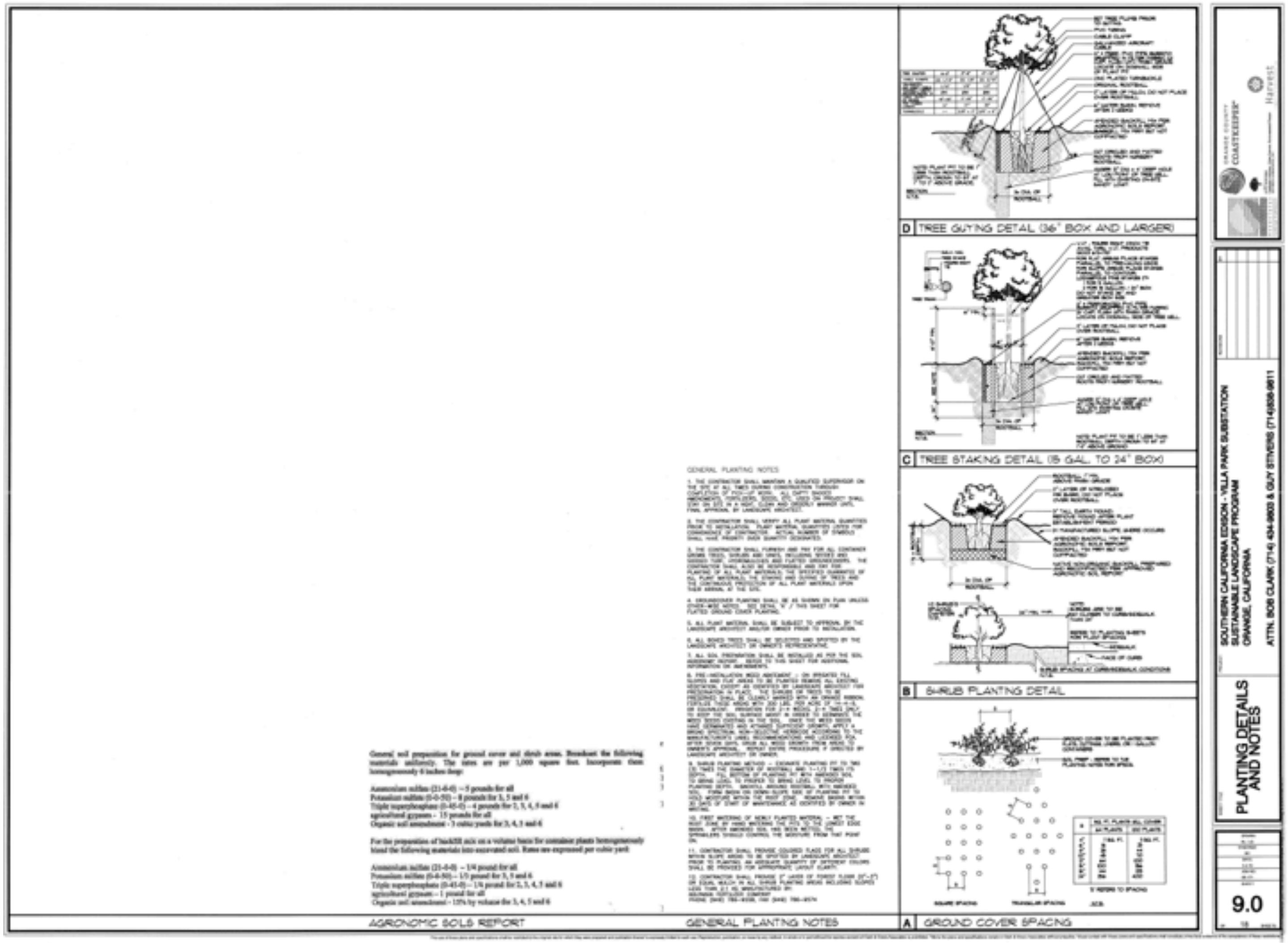
Appendix B: As-Built Drawings (cont'd)



Appendix B: As-Built Drawings (cont'd)



Appendix B: As-Built Drawings (cont'd)



Apppendix C: Soil Pre-Test for Carbon Content

WALLACE LABORATORIES, LLC

365 Coral Circle
El Segundo, CA 90245
phone (310) 615-0116 fax (310) 640-6863

September 26, 2009

Stivers & Associates
160 Centennial Way, Suite 3
Tustin, CA 92780

RE: SMARTSCAPE

Dear Guy,

sample ID	09-268-02	09-268-03	09-268-04	09-268-05	09-268-06	09-268-07	09-268-08		
description	#1	#2	#3	#4	#5	#6	#7	average	target
pH	7.13	7.35	7.60	7.69	7.75	7.96	7.92	7.63	6.5-7.9
salinity	0.97	0.76	1.60	1.55	0.72	0.62	2.35	1.22	0.5-3
chloride	10	28	243	178	39	24	227	107	<150
nitrate	4	2	5	5	2	1	5	4	20-30
nitrogen	0.186%	0.138%	0.040%	0.073%	0.019%	0.040%	0.145%	0.092%	
organic carbon	2.047%	1.860%	0.653%	1.112%	0.373%	0.809%	2.288%	1.306%	
C:N	11.0	13.4	16.2	15.2	19.5	20.3	15.8	15.9	
organic matter	4.09%	3.72%	1.31%	2.22%	0.75%	1.62%	4.58%	2.61%	3% - 5%
pounds organic carbon 1 foot deep per acre	81,892	74,414	26,130	44,460	14,930	32,353	91,517	52,242	1.20 lbs per ft
phosphorus	19.6	10.5	1.9	3.9	5.7	9.1	23.5	10.6	8-20
potassium	275	174	48	112	55	50	143	122	60-180
iron	35.19	40.58	12.59	43.76	27.57	55.67	16.99	33.19	4-15
manganese	12.17	3.77	1.75	3.26	1.88	2.01	23.32	6.88	0.6-3
zinc	14.78	11.54	3.49	8.45	2.07	4.86	51.68	13.84	1-3
copper	5.84	5.33	1.55	3.41	2.58	2.67	15.66	5.29	0.2-3
boron	0.15	0.12	0.12	0.13	0.07	0.07	0.47	0.16	0.2-0.5
magnesium	195	193	119	124	136	99	144	144	25-100
sodium	135	89	94	97	56	42	188	100	<200
sulfur	35	20	38	55	13	13	193	52	25-100
texture	gravelly sandy loam	loamy sand	sandy loam	sandy loam	gravelly sandy loam	gravelly loamy sand	sandy loam		
lime	no	no	no	no	no	no	no	no	
sand	53.6%	63.9%	78.9%	73.7%	73.7%	76.7%	65.8%	69.5%	
silt	28.3%	21.5%	16.4%	19.7%	17.3%	16.9%	21.4%	20.2%	
clay	18.1%	14.7%	4.7%	6.6%	9.0%	6.4%	12.8%	10.3%	
gravel	27.3%	16.8%	9.5%	19.8%	22.0%	24.9%	18.7%	19.9%	

Appendix D: Soil Post-Test for Carbon Content

WALLACE LABS 365 Coral Circle El Segundo, CA 90245 (310) 615-0116	SOILS REPORT	Print Date May 15, 2013	Receive Date 5/14/13
	Location	SC Edison Villa Park Substation	
	Requester	Guy Stivers	

Sample ID Number	13-135-17	13-135-18
Sample Description	12"	20"
Total nitrogen, dry weight basis	0.089%	0.051%
Total carbon, dry weight basis	1.500%	0.433%
carbon:nitrogen ratio	16.8	8.4
organic matter based on carbon	3.00%	0.87%
moisture content of soil	9.1%	6.0%

Analytical data determined on soil fraction passing a 2 mm sieve.

organic carbon per cubic foot for soil weighting 100 pounds per cubic foot	1.50	0.43

Appendix E: Soil Base Test for Biological Content

Biological Analysis
Soil

earthfort

Report prepared for:
Stivers & Assoc
Guy Stivers
160 Centennial Way #3
Tustin, CA 92780 USA
(714) 838-0727
guystivers@att.net

Report Sent: 5/23/2013
Sample#: 01-116249 | Submission:01-023033
Unique ID: Base
Plant: Not Indicated
Invoice Number: 9883
Sample Received: 5/13/2013

For interpretation of this report please contact:
Earthfort Labs
info@earthfort.com
(541) 257-2612

Consulting fees may apply

Organism Biomass Data		Dry Weight	Active Bacteria (µg/g)	Total Bacteria (µg/g)	Active Fungi (µg/g)	Total Fungi (µg/g)	Hyphal Diameter (µm)
Results		**0.960**	4.09	307	0.94	65.5	2.75
Comments		Above Range	Below range	In range	Below range	Below range	
Expected Range	Low	0.45	75	300	75	300	
	High	0.85	150	600	150	600	

		Protozoa (Numbers/g)			Total	Mycorrhizal Colonization (%)	
		Flagellates	Amoebae	Ciliates	Nematodes #/g	ENDO	ECTO
Results		**479**	**2888**	0	Not Ordered	Not Ordered	Not Ordered
Comments		Low	Low	Good			
Expected Range	Low	10000	10000	0	10	10%	10%
	High	100000	100000	200	20	50%	50%

Organism Biomass Ratios		Total Fungi to Tot.Bacteria	Active to Total Fungi	Active to Total Bacteria	Active Fungi to Act.Bacteria	Nitrogen Cycling Potential (lbs/ac)
Results		**0.21**	**0.01**	**0.01**	**0.23**	50-75
Comments		Low	Low	Low	Low	
Expected Range	Low	1	0.25	0.25	1	
	High	2	0.95	0.95	2	

Nematode detail (# per gram or # per mL)
Classified by type and identified to genus.
(If section is blank, no nematodes identified.)

635 SW Western Blvd Corvallis, OR 97333 USA
(541) 257-2612 | info@earthfort.com
www.oregonfoodweb.com

01-116249: Page 1 of 2

Appendix E: Soil Base Test for Biological Content (cont'd)

Stivers & Assoc Guy Stivers 160 Centennial Way #3 Tustin, CA 92780 USA (714) 838-0727 guystivers@att.net	Report Sent: 5/23/2013 Sample#: 01-116249 | Submission:01-023033 Unique ID: Base Plant: Not Indicated Invoice Number: 9883 Sample Received: 5/13/2013	For interpretation of this report please contact: Earthfort Labs info@earthfort.com (541) 257-2612 ***Consulting fees may apply***

Dry Weight:	Add organic matter to build soil structure, increase water holding capacity.
Active Bacteria:	Bacterial activity low, foods may be required.
Total Bacteria:	Good bacterial biomass.
Active Fungi:	Fungal activity low, foods may be required.
Total Fungi:	Low fungal biomass, foods and biology may be required.
Hyphal Diameter:	Good balance of fungi.
Protozoa:	Lacking species diversity.
Total Nematodes:	
Mycorrhizal Col.:	
TF/TB:	Too bacterial for imany plants
AF/TF:	Low fungal activity, foods may be required.
AB/TB:	Low bacterial activity, foods may be required.
AF/AB:	Bacterial dominated, becoming more bacterial.

Interpretation Comments:

Actinobacteria Biomass = 0 ug/g
Fair fungal diversity, hyphal diameter: 1.5 to 3um

Appendix F: Soil Site Test for Biological Content

Biological Analysis
Soil

Report prepared for:
Stivers & Assoc
Guy Stivers
160 Centennial Way #3
Tustin, CA 92780 USA
(714) 838-0727
guystivers@att.net

Report Sent: 5/23/2013
Sample#: 01-116250 | Submission:01-023033
Unique ID: Site
Plant: Not Indicated
Invoice Number: 9883
Sample Received: 5/13/2013

For interpretation of this report please contact:
Earthfort Labs
info@earthfort.com
(541) 257-2612

Consulting fees may apply

Organism Biomass Data		Dry Weight	Active Bacteria (µg/g)	Total Bacteria (µg/g)	Active Fungi (µg/g)	Total Fungi (µg/g)	Hyphal Diameter (µm)
Results		**0.920**	22.3	700	10.5	278	2.85
Comments		Above Range	Below range	Above range	Below range	Below range	
Expected Range	Low	0.45	75	300	75	300	
	High	0.85	150	600	150	600	

		Protozoa (Numbers/g)			Total	Mycorrhizal Colonization (%)	
		Flagellates	Amoebae	Ciliates	Nematodes #/g	ENDO	ECTO
Results		**4634**	38804	307	Not Ordered	Not Ordered	Not Ordered
Comments		Low	Good	High			
Expected Range	Low	10000	10000	0	10	10%	10%
	High	100000	100000	200	20	50%	50%

Organism Biomass Ratios		Total Fungi to Tot.Bacteria	Active to Total Fungi	Active to Total Bacteria	Active Fungi to Act.Bacteria	Nitrogen Cycling Potential (lbs/ac)
Results		**0.40**	**0.04**	**0.03**	**0.47**	100-150
Comments		Low	Low	Low	Low	
Expected Range	Low	1	0.25	0.25	1	
	High	2	0.95	0.95	2	

Nematode detail (# per gram or # per mL)
Classified by type and identified to genus.
(If section is blank, no nematodes identified.)

635 SW Western Blvd Corvallis, OR 97333 USA
(541) 257-2612 | info@earthfort.com
www.oregonfoodweb.com

01-116250: Page 1 of 2

Stivers & Assoc
Guy Stivers
160 Centennial Way #3
Tustin, CA 92780 USA
(714) 838-0727
guystivers@att.net

Report Sent: 5/23/2013
Sample#: 01-116250 | Submission:01-023033
Unique ID: Site
Plant: Not Indicated
Invoice Number: 9883
Sample Received: 5/13/2013

For interpretation of this report please contact:
Earthfort Labs
info@earthfort.com
(541) 257-2612

Consulting fees may apply

Dry Weight:	Add organic matter to build soil structure, increase water holding capacity.
Active Bacteria:	Bacterial activity low, foods may be required.
Total Bacteria:	Excellent bacterial biomass.
Active Fungi:	Fungal activity low, foods may be required.
Total Fungi:	Low fungal biomass, foods and biology may be required.
Hyphal Diameter:	Good balance of fungi.
Protozoa:	Lacking species diversity.
Total Nematodes:	
Mycorrhizal Col.:	
TF/TB:	Too bacterial for some plants
AF/TF:	Low fungal activity, foods may be required.
AB/TB:	Low bacterial activity, foods may be required.
AF/AB:	Bacterial dominated, becoming more bacterial.

Interpretation Comments:

Actinobacteria Biomass = 0 ug/g
Fairly good fungal diversity, hyphal diameter: 1.5 to 5um

635 SW Western Blvd Corvallis, OR 97333 USA
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www.oregonfoodweb.com

01-116250: Page 2 of 2

Appendix G: Irrigation Water Use

SmartScape Irrigation Water Use
Villa Park Substation Water Meter Readings, 2011-2013

Year 1 of Management and Monitoring Period

Date of Reading	Interval	Meter Reading[1]	Water Use in Acre-feet
05/17/2011	N/A	73,729.6 cu ft	1.69 AF
09/11/2011	4 months	74,425.2 cu ft	1.60 AF
10/15/2011	30 days	74,557.2 cu ft	0.30 AF
11/15/2011	30 days	74,621.2 cu ft	0.15 AF
12/14/2011	29 days	74,673.6 cu ft	0.12 AF
01/15/2012	32 days	74,704.8 cu ft	0.07 AF
02/17/2012	33 days	74,757.5 cu ft	0.12 AF
03/20/2012	33 days	74,961.3 cu ft	0.47 AF
04/14/2012	28 days	75,009.8 cu ft	0.11 AF
05/17/2012	33 days	75,062.2 cu ft	0.12 AF

Year 2 of Management and Monitoring Period

Date of Reading	Interval	Meter Reading	Water Use in Acre-feet
06/25/2012	39 days	75,374.4 cu ft	0.71 AF
07/25/2012	30 days	76,033.4 cu ft	1.51 AF
08/15/2012	21 days	76,293.2 cu ft	0.60 AF
09/15/2012	30 days	76,607.3 cu ft	0.72 AF
10/19/2012	34 days	76,965.1 cu ft	0.82 AF
02/15/2013	120 days	77,235.9 cu ft	0.62 AF
05/10/2013	90 days	77,754.9 cu ft	1.19 AF

Summary

The previous landscape used approximately 9 AFY. Over the two-year period, average irrigation water use was 4.62 AFY, a 48.6% reduction.

During the first year of management and monitoring, between May 17, 2011 and May 17, 2012, water meter readings showed that 3.06 AF was used for irrigation. During the second year of management and monitoring, June 25, 2012 through May 10, 2013, irrigation water use for the project was 6.17 AF.

[1] Water meters measure cubic feet of water used. One cubic foot of water equals 7.48 gallons. For the purposes of monitoring the project's irrigation water use, cubic feet were converted to gallons, and gallons to acre-feet.

Appendix H: Precipitation Data

Monthly Precipitation Data for Station No.121[1], 2011-2013

Year	Month	Rainfall in Inches
2011	Apr	0.03
2011	May	0.52
2011	Jun	0.00
2011	Jul	0.00
2011	Aug	0.01
2011	Sep	0.06
2011	Oct	0.91
2011	Nov	1.36
2011	Dec	0.58
2012	Jan	1.43
2012	Feb	0.66
2012	Mar	1.72
2012	Apr	1.54
2012	May	0.00
2012	Jun	0.00
2012	Jul	0.18
2012	Aug	0.00
2012	Sep	0.00
2012	Oct	0.35
2012	Nov	0.63
2012	Dec	2.59
2013	Jan	1.19
2013	Feb	0.36
2013	Mar	0.41
2013	Apr	0.05

[1] Data retrieved from the OC Watersheds division of Orange County Public Works.

Appendix I: Avian Habitat Report

SmartScape Design Provides Improved Avian Habitat

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June 2012

INTRODUCTION

Conventional landscaping primarily consists of monoculture non-native grasses as cover, and large trees and /or shrubs as focus, or highlight plants. While these classic, simplistic landscapes are aesthetically pleasing, they provide little vegetation variation and complexity to attract and support native wildlife, primarily birds (Roth, R., 1976). Not only do these standard landscapes lack the variability to offer adequate year-round resources for birds, such as food and shelter, they are extremely high maintenance in regards to irrigation, electricity and labor needs (Stivers & Associates, 2010). Many plants in conventional landscapes are ornamental plants not native to the area, and so an artificial environment must be created in order for the plants to get the type of soil nutrients and water they need to thrive. This creates a demand for irrigation and fertilizers, and consequently, a demand for associated labor and electricity. Financial costs increase, as well as detrimental effects on the natural environment. Native vegetation is suppressed by these forced landscapes, leaving the resident wildlife denied of its natural ecosystem (Hostetler, M.E., and Main, M.B., 2010).

In an effort to design a more natural landscape and decrease the water, electricity and costs associated with conventional landscapes, SmartScape was created by Orange County Coastkeeper and Southern California Edison (SCE) to develop SCE's Villa Park (VP) Substation in the City of Orange. SmartScape will also serve as a model for a sustainable landscape that can be utilized to retrofit both residential and business areas. By planting native Southern Californian and other Mediterranean vegetation that is already naturally drought-resistant, irrigation needs are lessened dramatically. It is also hoped that by increasing the native vegetation, more avian species will return to utilize the area for resources (Burghardt, K.T., Tallamy, D.W., and Shriver, G.W., 2009). This native vegetation is a diverse mix of evergreen and flowering trees, shrubs, succulents and grasses, offering birds a wide range of textures and vertical variation for shelter and nesting opportunities. Additionally, varied food resources are provided, such as nectar, seeds, and the insects that will be attracted.

The objectives of this paper are to (1) compare a base site with the SmartScape site for avian species diversity and abundance: (2) and to identify opportunities for avian habitat improvement for SmartScape.

BACKGROUND

Villa Park Substation

Originally designed as a conventional landscape in 1973, this approximately three-acre area on the corner of Taft Avenue and Tustin Street surrounding SCE's VP substation was planted with 272 trees and large areas of non-native kikuyu grass. By the time this area was surveyed prior to the SmartScape restoration, only 65 trees remained, all in decline, either dead or dying from disease or structural defects.

In 2010, the SmartScape design was implemented and finally unveiled to the public. The dying trees and turf grass had been removed, and the "California-friendly" vegetation planted. On-site composting and vermiculture will provide rich, naturally enhanced soils. Systems of bio-swales, detention basins, and percolation trenches are in place to enhance irrigation and help eliminate dry weather runoff. The project was completed in April of 2011 and is now on a two-year management and monitoring program.

METHODOLOGY

Base Site Description

A quarter of a mile east of the SmartScape landscape site on Taft Avenue is an SCE easement, which will serve as a comparison site. Since this area is an unimproved site, it represents what the SmartScape area looked like before the restoration.

Methods

Both sites were observed several times during the spring of 2012. With the use of binoculars, detailed observations were taken on avian species sighted, how many, and what (if any) resources at the site were being utilized. Each site was also described by its existing vegetation and location.

OBSERVATIONS AND RESULTS

BASE SITE

Vegetation and Site Description

The Base Site, while usually requiring irrigation to keep the grass green, appears to have gone fallow. The turf grass covering the easement is dried out and largely dead. The area is completely flat and there are no other plants growing on the main portion of the site. The southern border of the site connects to a residential development. The western and eastern borders are fenced off from concrete areas. The northern border, which runs along Taft Avenue, is a sidewalk, lined with planted ornamental trees, shrubs, and grasses. *Photinia* and Indian Hawthorne bushes are both non-native, popular ornamentals originating from Asia. They are widely cultivated and grown for their showy flowers. Along with Crape Myrtles trees, originating from China, these are the dominant tall plant forms along the northern border. *Gazania* is the primary ground cover plant, native to South Africa.

The northern side of Taft Avenue is a residential neighborhood. Traffic on Taft Avenue is light and relatively quiet due to it being more residential, less busy than on Tustin Street.

Avian Life

A pair of Mourning Doves was observed foraging on the western portion of the easement, on the pavement. An individual Anna's Hummingbird was observed perched and singing on the Crape Myrtle trees, as well as on the power lines above the trees, several separate times. A Red-tailed Hawk was observed perched for several minutes on the top of the tower on the eastern end of the easement. Several House Finches were observed foraging in the shrubs along the sidewalk and flying over the area. Many Tree Swallows were observed flying over the main area of the easement above the fallow grass. It appeared that the swallows were feeding on insects in the grass. There were no other bird species observed using this site for resources.

SMARTSCAPE SITE

Vegetation and Site Description

The SmartScape site, located on the corner of Tustin Street and Taft Avenue, is visually much more heterogeneous plant-wise, than the Base Site. Instead of a monoculture turf grass for cover, there is a variety of native grasses, such as *Muhlenbergia rigens*, or deer grass, and wild ryes, rushes and sedges. These grasses were planted as cover and also in the drainage areas to help slow and filter excess rainwater. Many native, drought-resistant evergreen shrubs such as toyon (*Heteromeles arbutifolia*) and lemonade berry (*Rhus integrifolia*), as well as the Mediterranean rosemary (*Rosmarinus officinalis*), serve as mid and foreground plants. Lemonade berry (*Rhus integrifolia*), California buckwheat (*Erigonum fasciculatum*), Manzanita (*Arctostaphylos* species) and coffee berry (*Rhamnus californica*) are other native shrubs. Native trees have also been planted including Western Redbud (*Cercis occidentalis*) and Hollyleaf Cherry (*Prunus ilicifolia spp. ilicifolia*). "California-friendly" accent plants have also been added to bring focus to southern California's distinctive vegetation and diversity. These include succulents like aloe and agave, and colorful, flowering plants like bird-of-paradise.

Both Tustin Street and Taft Avenue that surround this location on the west and north borders are busy with regular auto and pedestrian traffic, busier and noisier than the base site. The neighborhood is primarily businesses.

Avian Life

An individual Red-tailed Hawk was observed perched on a tower within the substation for several minutes. Several Bushtits were observed feeding on the purple sage (*Salvia*), which offers seeds and nectar through its flowers. A Black Phoebe was observed for several minutes feeding on the insects attracted to the purple sage in the same area. An Anna's Hummingbird was observed foraging around the site often, visiting the red flowers of the dwarf bottlebrush (*Callistemon citrinus*) for nectar. Common Ravens were observed regularly in and around the substation and towers, a popular visitor to urban and rural areas for scavenging. Lesser Goldfinches were observed several times along Taft Avenue and Tustin Street, perched on the power lines and singing. A pair of Mourning Doves was observed for several minutes within the substation, resting together on the constructs. House Finches and House Sparrows were also observed many times foraging in the site. Tree Swallows were also observed flying over the site, foraging on the insects attracted to the plants.

Species	**Base Site**	**SmartScape Site**
Mourning Dove	X	X
Anna's Hummingbird	X	X
Red-tailed Hawk	X	X
House Finch	X	X
Tree Swallow	X	X
Bushtit		X
Black Phoebe		X
Common Raven		X
Lesser Goldfinch		X
House Sparrow		X
TOTAL (*n*)	**5**	**10**

DISCUSSION

While all of the ornamental, non-native plants in the Base Site easement are relatively drought-tolerant (excluding the turf grass cover), thus may requiring less irrigation, none are native to California. In a study by Burghardt, Tallamy, and Shriver (2009), landscape properties that were planted entirely with native plants supported higher avian diversity, abundance, and species richness, as well as supporting more caterpillars and caterpillar species, as opposed to traditional landscaped properties with non-native groundcover and shrubs. This study suggests that native landscaping can help to offset biodiversity losses in urban settings, in addition to saving water and electricity (Stivers & Associates, 2010).

Avian diversity and species richness was greater at the SmartScape Villa Park substation than the Base Site. Both sites had five species in common, suggesting that those species are common visitors to the greater area, probably year-round residents, and visit both sites regularly since they are in close proximity. The additional five species that were observed in the VP substation were largely observed utilizing the resources provided from the SmartScape retrofit, like the purple sage, for example. Indirect benefits, such as the native flowering plants attracting insects, will then attract flycatchers like the native Black Phoebe.

RECOMMENDATIONS FOR SMARTSCAPE LANDSCAPING

Trees not only complete the canopy and increase aesthetic value, they provide an important shelter resource for birds to use for nesting, roosting and protection. Trees also intercept more rain water and can increase the amount of available moisture for plants and wildlife to utilize, in addition to slowing down surface runoff. Over time, the native trees and shrubs planted at the Villa Park substation will grow larger, but will not create a great enough canopy to interfere with the overhead power lines or impede the integrity of the security walls. Therefore, more native trees and shrubs that can grow densely and to a safe maximum height for the area are recommended for additional planting, either at the Villa Park substation or at future SmartScape sites. This will increase the safe spaces available to attract native bird populations.

Although noise levels were not studied on this project, noise from traffic, businesses, and pedestrians was observed to be consistently greater at the VP Site compared to the Base Site. Increased noise in avian habitat can mask alarm calls to other birds, predatory sounds, and mating calls and songs. Many recent studies have shown that urban noise has a negative effect on avian life (Slabbekoorn, H. and Ripmeester, E. A. P., 2008; Fernández-Juricic, E., Poston, R., De Collibus, K., Morgan, T., Bastain, B., Martin, C., Jones, K., and Treminio, R., 2005). In the study by Fernandez-Juricis, et. al, 2005, native male House Finch songs were found to be different in many different parks based on different factors including habitat structure and ambient noise. One result was that male House Finches decreased the number of notes in their songs as ambient noise increased. This could be detrimental for successful breeding since females prefer males with long songs (Nolan and Hill, 2004). In order to attract and support successful native avian populations, an attempt to decrease the noise created by urbanization needs to be addressed in future projects. Planting larger, denser vegetation when possible will help, but further research into other possibilities is necessary.

SUMMARY

SmartScape's native landscaping design is well on its way to success in many ways. It already is incredibly beneficial to the environment by reducing storm water runoff and preventing excess pollution. Traditional fertilizers and chemicals are not used, since vegetation is native and already suited to and comfortable in the climate. Also, composting and vermiculture on site creates rich, nutritious soils and reduces waste.

SmartScape is still, if not a more, beautiful design than conventional landscape, since it implements complex and colorful native plants. It is clear from this study that even in the early stages of this SmartScape retrofit, it is already attracting greater avian diversity. As the plants and trees develop over the years and become more established, more resources for birds will be available and will hopefully be able to sustain diverse and abundant avian populations.

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