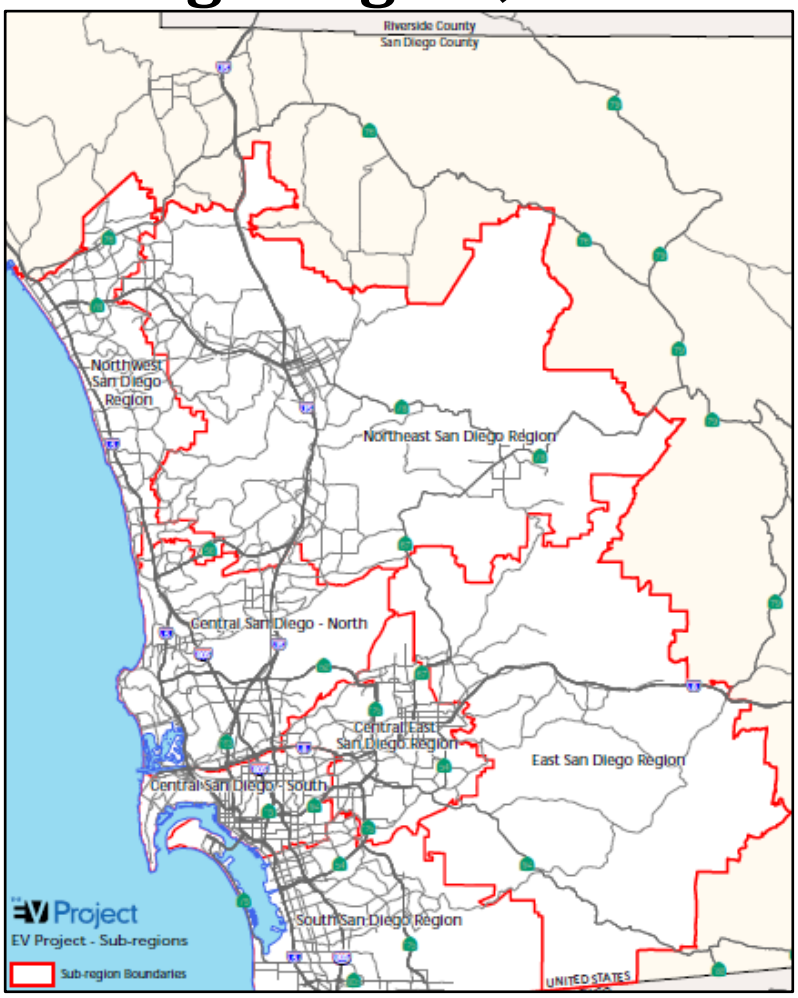
# EV Micro-Climate™ Plan
# for
# San Diego Region, California

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ecOtality™
NORTH AMERICA

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# Acronym List

| | |
|---|---|
| **BEV** | Battery Electric |
| **DC** | Direct Current |
| **DCFC** | Direct Current Fast Charger |
| **DOE** | Department of Energy |
| **EPRI** | Electric Power Research Institute |
| **ESAC** | EV Project Stakeholder Advisory Committee |
| **EV** | Electric Vehicle |
| **EREV** | Extended Range Electric Vehicle |
| **EVSE** | Electric Vehicle Supply Equipment |
| **GIS** | Geographic Information System |
| **GM** | General Motors |
| **HH** | House Hold |
| **MGRA** | Master Geographic Reference Area |
| **PEV** | Plug-in Electric Vehicle |
| **PHEV** | Plug-in Hybrid Electric Vehicle |
| **ROW** | Right-of-Way |
| **SANDAG** | San Diego Association of Governments |
| **SDG&E** | San Diego Gas and Electric |
| **SRO** | Single Room Occupancy |
| **U.S.** | United States |

## Preface

The development of a public charging infrastructure is critical to the success of electric vehicles (EVs). Public education is merging with EV introduction and public policy to create the enthusiastic framework for the long-held dream of electrified, private-use transportation.

ECOtality North America (ECONA), a subsidiary of ECOtality, has been involved in every North American EV initiative since 1989. ECONA developed the EV Micro-Climate™ as an integrated turn-key program to ensure an area is well equipped with the needed infrastructure to support the consumer adoption of electric transportation. Beginning with extensive feasibility and infrastructure planning studies, the program provides a blueprint to create a rich EV infrastructure.

The EV Micro-Climate process starts with the EV Infrastructure Deployment Guidelines to organize and drive the preparations for this infrastructure. With significant input from local stakeholders, this foundation paves the way for a long-range plan.

The Long-Range Plan examines the potential maturation of the EV market and EV infrastructure over the long term. While it is difficult to achieve consensus on long-term plans because of unknowns in the economy, transportation issues, technological advances, human behavior, and related costs, there is wide acceptance that EVs are in fact a growing force in automotive transportation, and EV penetration is fully expected to achieve a significant market share within the next 10 years. The Long-Range EV Infrastructure Plan for Greater San Diego provides a review of the current behavior of vehicle operators and industry projections of EV sales as a means of understanding the expected EV population in the Greater San Diego area by the year 2020.

The purpose of this document is to record the process used by the EV Project for distributing, locating, and selecting publicly available EVSE sites. The input to this document is the work of the Long-Range EV Infrastructure Plan for Greater San Diego. An important output of this document is a series of maps to identify geographic locations for the publicly available Level 2 EVSE and DC Fast Charge equipment. This output will be used to find specific EVSE hosts leading to EVSE installations. This document also serves as a deliverable as required by the U.S. Department of Energy (DOE) contract for the EV Project, and is a standard offering as part of ECOtality's Micro-Climate.

# 1 Introduction

## 1.1 Background

The term "PEV" is used to denote all grid-connected plug-in electric vehicles, including plug-in hybrid (PHEV) and battery electric vehicles (BEV). At the end of 2010, Nissan dealerships in the San Diego region began the sale of a BEV, the Nissan Leaf, and General Motors dealerships began the sale of an extended range electric vehicle (EREV), the Chevrolet Volt. The Leaf has a reported range of 100 miles on a single charge and the Volt has a battery only range of up to 40 miles on a single charge with its range then extended another 300 miles via an onboard gas generator. In 2011 ECONA will begin deploy charging infrastructure (EVSE) in six regions of the United States, including San Diego, as part of The EV Project.

The EV Project is the largest deployment of EVs and charge infrastructure in history. On August 5, 2009, ECONA a subsidiary of ECOtality, Inc. was awarded a $99.8 million grant from the DOE and matched with funds from ECONA and partners to embark on this Project. The Project officially was launched on October 1, 2009 and will last approximately 36 months. The EV Project was later expanded to a total of $230 million. ECONA is partnering with Nissan North America and General Motors to deploy up to 8,300 electric vehicles, the Nissan LEAF and Chevy Volt, and approximately 14,000 charging systems to support them in strategic markets in six states: Arizona, California, Oregon, Tennessee, Texas, and Washington. In California, ECONA also received $8 million grant from the California Energy Commission.

The EV Project will collect and analyze data to characterize vehicle use in diverse topographic and climatic conditions, evaluate the effectiveness of charge infrastructure, and conduct trials of various revenue systems for commercial and public charge infrastructure. The ultimate goal of The EV Project is to take lessons learned from the deployment of these first 8,300 EV's and the charging infrastructure supporting them, to enable the streamlined deployment of the next 5,000,000 EVs.

There is a general understanding that a strong regional (as well as interregional) effort will support a transition to alternative fuels. Public-private coordination and action will help communicate to the market (e.g., fuel producers and suppliers, vehicle manufacturers, potential customers, and others) that the San Diego region is committed to and seeks to attract investment in alternative fuel vehicle and infrastructure, like PEVs and EVSEs.

A local stakeholder group, EV Project Stakeholder Advisory Committee (ESAC), comprised of public and private entities in the San Diego region, has been guiding EV infrastructure planning efforts, with the intent to ensure that EV charging needs are identified and met with the unique characteristics of San Diego in clear focus. The precise role of the ESAC in the Micro-Climate

Planning process is described in detail later in this document. Participating ESAC organizations are listed below in Table 1.1.

**Table 1-1 ESAC Organization Composition**

| Organization |
|---|
| California Center for Sustainable Energy |
| City of Chula Vista |
| City of Escondido |
| City of La Mesa |
| City of Oceanside |
| City of Poway |
| City of San Diego |
| City of Santee |
| CleanTECH San Diego |
| County of San Diego |
| ECONA |
| Miramar College |
| Port of San Diego |
| Qualcomm |
| SANDAG (San Diego Association of Governments) |
| SDG&E (San Diego Gas & Electric) |
| SDSU (San Diego State University) |
| UC Davis ITS, PH&EV (University of California at Davis, Plug-in Hybrid & Electric Vehicle Center) |
| UCSD (University of California at San Diego) |

*ESAC Group facilitated by ECONA

## 1.2 Deployment Guidelines

EV Infrastructure Deployment Guidelines for the San Diego region set the foundation for both the Long-Range Plan and Micro-Climate Plan by covering key considerations and concepts. The Deployment Guidelines created a common planning framework by establishing the capabilities of the various types of PEVs entering and expected to enter the consumer market in the next several years. The Deployment Guidelines also established the basic capabilities of EVSEs, especially as they relate to the refueling and use of PEVs. The different categories of PEV charging (*e.g. residential, fleet, etc.*), including publicly available charging are defined in the

Deployment Guidelines, and the myriad of considerations to address when siting EVSE are discussed. Such considerations include signage, lighting, safety, point of sale options, maintenance, ownership, and disability requirements. Finally, the Deployment Guidelines provided a high level overview of codes and regulations and utility integration. Codes and regulation such as the National and California Electric Codes, nationally recognized testing laboratories' listings, and municipal codes are covered.

## 1.3 Long-Range Plan

Building on the foundation provided by the Deployment Guidelines, the *Long-Range EV Infrastructure Plan for Greater San Diego* examined three main areas affecting PEV charge infrastructure deployment: driver behavior, PEV and EVSE projections, and demographics and travel patterns. Both driver behavior and PEV / EVSE projections are examined at both national and San Diego region levels, while demographics and travel patterns are specifically focused in the San Diego region. Given the inextricable relationship of PEVs and EVSE, the Long-Range Plan includes discussion of possible necessary ratios of PEVs to EVSE to constitute a rich PEV charging network. The potential numbers of EVSE required for a rich charging network are then applied to existing and growth projected regional population, taking into account demographics, and with special attention to traffic patterns and employment centers throughout the region as important factors in locating EVSE. Driving behavior informs the specific types of locations or land uses that EVSE should be placed at in order to serve PEV drivers. The Long-Range Plan considers likely growth rates and locations (in population and traffic volumes) given a 10-year planning time horizon.

# 2 Two-Year Planning Horizon

This Micro-Climate Planning Document takes the first step in implementing the *Long-Range EV Infrastructure Plan for Greater San Diego* by determining the general locations for the initial EV charge infrastructure to be deployed within a two-year time horizon. By virtue of focusing on a two-year time horizon, some of the unknowns that are part of the work in the *Long-Range EV Infrastructure Plan for Greater San Diego* are made more specific and definable. This greater specificity creates a more actionable blueprint for EVSE installations in the San Diego region. The two factors given greatest specificity by a two-year planning horizon are EVs and EVSE projections.

## 2.1 Electric Vehicles

Automakers Nissan and General Motors (GM) had begun sales of their initial PEVs (the LEAF and Volt respectively) during 2010 with stated model year production runs of 25,000 LEAFs and 50,000 Volts. Both had also committed to the San Diego market as one of the first launch markets for consumer sales of the vehicles for 2011, with full U.S. sales beginning at the end of 2011 or beginning of 2012. While precise San Diego market projections for LEAF and Volt sales are not available, because of Nissan and GM's partnership in the EV Project minimum EV Project commitments of 1,000 LEAFs and possibly several hundred Volts for 2011 are reliably anticipated. Additionally, general indication from both Nissan and GM to the San Diego indicate a strong demand for the LEAF and Volt in the San Diego market possibly leading to a couple thousand LEAFs and couple thousand Volts in the San Diego region by the end of 2011, with more growth predicted for 2012.

In addition, to Nissan and GM automakers Mitsubishi, Ford, Toyota, Coda, and Think are targeting late 2011 or 2012 for launch of their own PEVs. Although no commitments have been made by the above automakers as to which U.S. markets they would start EV sales in, San Diego represents a likely market because of proactive electric utility and local government efforts to ready the region for electric vehicles, because of regional demographics supporting potential PEV ownership, and because of the rich public charging infrastructure to be put in place as part of the EV Project.

## 2.2 Electric Vehicle Supply Equipment

Just focusing on the resources of the EV Project, San Diego's publicly available charging infrastructure will be comprised of over 1,000 public charging stations by the end of 2011. This number of EV Project EVSE is highly likely to be augmented in 2011 and especially in 2012 by more EVSE because of the growing need for EVSE attributable to increased numbers of PEVs, as noted above, and because of strong regional support for PEVs as indicated by local government and utility policies and actions.

# 3 EV Micro-Climate Planning

## 3.1 Process Overview

### 3.1.1 Deployment Guidelines and Long-range Plan

As described previously both the *Electric Vehicle Charging Deployment Guidelines for Greater San Diego* and *Long-Range EV Infrastructure Plan for Greater San Diego* provide a significant foundation for and inputs into this Micro-Climate Plan. Without such work both the accuracy of this plan to address regional needs and the potential action ability of this plan would be compromised.

### 3.1.2 EV Project Stakeholder Advisory Committee (ESAC) Role

As with the *Electric Vehicle Charging Deployment Guidelines for Greater San Diego* and *Long-Range EV Infrastructure Plan for Greater San Diego,* the ESAC has a primary role in guiding the Micro-Climate planning process and influencing the results to reflect unique regional characteristics and needs. The steps the ESAC took in developing this Micro-Climate Plan are described below.

- Preparation – EV and EVSE Capabilities and PEV Charging Desires

Starting with the preparation of *Electric Vehicle Charging Deployment Guidelines for Greater San* Diego and *Long-Range EV Infrastructure Plan for Greater San Diego*, the ESAC member organizations have been immersed in PEV and EVSE technology capabilities and functioning. Through review of materials for and attendance and participation in 20 working group meetings of 1-2 hours and one half-day interactive workshop, they developed a strong working knowledge of PEV ranges, battery recharge times with various levels of EVSE charging, factors (such as temperature, terrain, driving behavior, etc.) that affect PEV performance, PEV consumer demographics, and electric utility rate structures.

For EV Micro-Climate planning, this knowledge was specifically augmented with review of recent literature on observed charging behavior and perceived charging needs of PEV drivers or intenders (Appendix A), along with basic Geographic Information Systems (GIS) analysis capabilities. This additional information readied the ESAC to review different data sets available for constructing an EVSE location model and setting reasonable values for the inputs to such location models.

- Strategic Goals of Micro-Climate Plan

An important first step in any planning effort is to set the goal or goals of that planning effort. In this situation, the ESAC considered multiple possible goals, but settled on two overarching goals to be achieved through the EV Micro-Climate planning process and implementation of the subsequent EV infrastructure deployment according to the EV

Micro-Climate. With a heavy reliance on the EV Project for a significant portion of the EV infrastructure development in 2011 and 2012, the ESAC settled on the following primary goal:

> *To enable study of infrastructure deployment and driver behavior, to learn lessons from this study and refine the EV infrastructure deployment methodology.*

Measures identified to achieve this goal include maximizing matching data through placement of EV Project EVSEs where it is likely EV Project study participants will use them. Only data from an EV Project participant's vehicle linked to an EV Project EVSE will be used. Data will not be used from all other connections to EV Project EVSE from non-EV Project participants or EV Project participant connections to a non-EV Project EVSE. EVSE placement at locations likely to be used by EV Project participants is the first measure necessary to build a robust data set, the second measure is maximizing the availability of those EVSEs to EV Project participants by selecting uses that will offer many opportunities (per day and per year) for EV charging. The third and final measure is the design and implementation of special projects or focus areas for EVSE placement that also ensure availability to EV Project participants.

A secondary goal the ESAC set for the Micro-Climate, given a 10-plus year life cycle for EVSE, is:

> *To place EV Project EVSEs in locations that will serve as the foundation of a rich charging network for all future PEV drivers, where this goal does not conflict with the primary strategic goal.*

Measures identified to meet this secondary goal include achieving consistency of EVSE placement with the recommendations of the *Long-Range EV Infrastructure Plan for Greater San Diego*, which includes an examination of demographics and travel patterns in the San Diego region.

- Data Suggestions and Provisioning

All ESAC member organizations were offered an opportunity to provide input on the data that would be used in the Micro-Climate Plan. The varied focus, both subject area and geographic, of the ESAC member organizations ensured consideration of a broad set of data, under such general categories as land use, transportation, market research, electric grid capacity, and driver behavior. ESAC organizations also provided access to data available within their organizations to facilitate the Micro-Climate planning process. Discussion of data ultimately used in the Micro-Climate modeling is described in detail later in this document.

- Modeling Guidance

Based on (constrained by) available data the ESAC reviewed, multiple models were provided for identifying the placement of EVSEs according to the stated strategic goals of the Micro-Climate process. This model review occurred over approximately one month, and for many ESAC organizations, involved review and input from multiple departments/units within the organization, leveraging their areas of expertise, such as transportation facility planning, electric distribution system planning, and land use planning, amongst others. Ultimately, the ESAC provided explicit direction on the design of the location modeling for Level 2 and direct current fast charger (DCFC) EVSE infrastructure deployment that is described in greater detail later in this document.

- Focus Group for Land Use Suitability

Also, ESAC member organizations and their representatives specifically provided explicit input on the value of certain factors (*e.g.* trip attraction, employment center, annual EVSE availability, etc.) in the EVSE land use suitability location modeling by serving as focus group members. As focus group members, ESAC members scored land uses and assigned values to certain factors anonymously. They then reviewed and discussed the scores and weights in a workshop setting arriving at general consensus on those scores and weights to use in the modeling.

- Community Viz Workshop

In addition to serving as an ESAC member organization, the San Diego Association of Governments (SANDAG) provided valuable modeling and GIS expertise to the Micro-Climate process. A very visible and instructive element of this expertise was the use of a Community Viz application that allowed the ESAC to interactively explore and fine tune land use suitability model parameters at a half-day workshop. This use of Community Viz at the half day workshop allowed for a more complete understanding of the modeling decisions the ESAC was considering and facilitated an expedient decision making process.

- Special Focus Areas

As part of achieving the primary goal of the Micro-Climate planning process and based on filling gaps identified in the EVSE location modeling ultimately designed, the ESAC outlined four special focus areas for EVSE placement: workplace charging, DCFC corridor planning, non-residential PEV home area charging, and (not as a part of the EV Project) Indian Gaming casino EV charging. These four special study areas required additional discussion and considerations to determining how to implement the first three as part of the EV Project, and why the fourth should be considered a priority as part of a rich EV infrastructure. All four special focus areas are discussed in detail later in this document.

## 3.2 Data for Micro-Climate Planning

All data used as part of the EV Micro-Climate planning effort and generally described below are retained by SANDAG to enable use by all SANDAG member agencies (all 18 municipalities and the County of San Diego) in the San Diego region. The only exception to this is the data used in Electric Utility Grid Capacity analysis, which is retained exclusively by San Diego Gas & Electric (SDG&E).

### 3.2.1 Distribution of Nissan Registrants

As a foundation for the design and deployment of a public EV charging network, it was determined critical to understand where PEV drivers, specifically those who could be EV Project participants, live and would regularly charge their PEVs in a residential setting. This need is based on the commonly held concept of the expected EV charging hierarchy as shown in the graphic below from Electric Power Research Institute. As an EV Project partner, Nissan was able to provide certain data on LEAF registrants. Status as a LEAF registrant requires fulfillment of the second main step in LEAF sales process, where potential LEAF purchasers place a refundable $99 deposit for the opportunity to order a LEAF. Data provided was limited to a count of LEAF registrants by zip code in the San Diego region (Figure 3-1) in order to facilitate the Micro-Climate process while providing required consumer privacy protection.

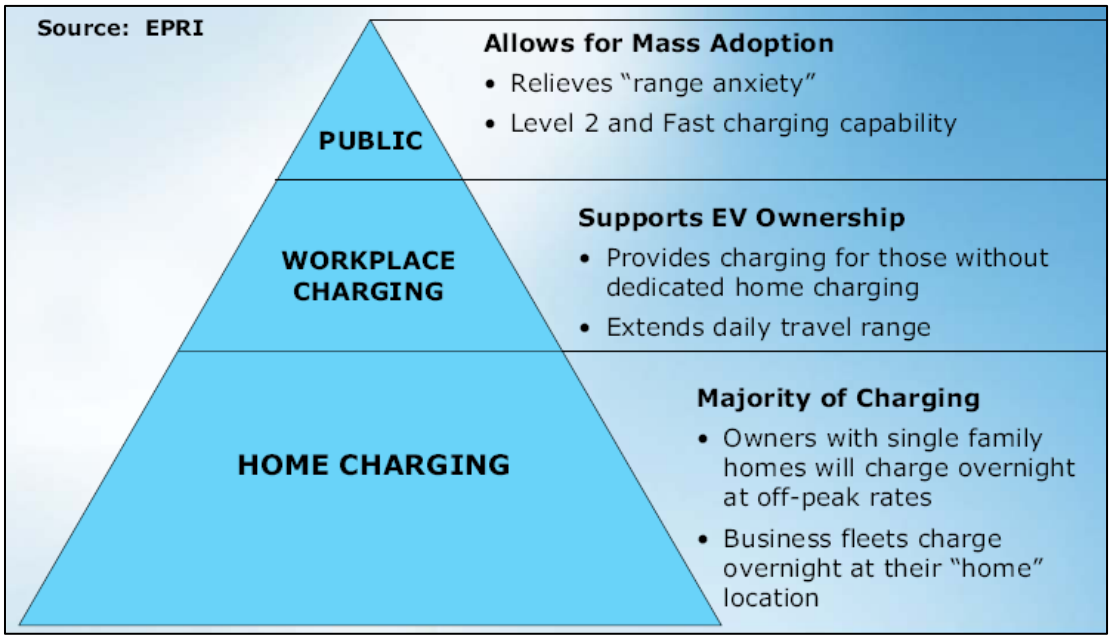



**Figure 3-1 EV Charging Hierarchy**

### 3.2.2 Electric Utility Grid Capacity

The two-year time horizon of the Micro-Climate, and the reliance in EV Project resources to deploy a significant portion of the public EV charge infrastructure in the San Diego region within 2011 necessitated a capacity constraints analysis of the local electric distribution system, as significant local distribution system upgrades were not anticipated as likely to occur within the same time horizon. The constraints analysis was to identify those areas with significant distribution infrastructure constraints limiting the placement of EVSE or completely restricting placement of EVSE.

SDG&E conducted a local distribution system constraints analysis in-house because of security limitations on sharing such system data. The conclusions of the constraints analysis relative to both Level 2 and DCFC EVSE placement, attributable to the EV Project, in non-residential districts (mainly commercial districts) was that, in general, there are no limitations based on the total number of EVSEs likely to be sited through the EV Project, and in the likely densities (densities are discussed in more detail later in this document). SDG&E noted that the placement of a DCFC does warrant more interactive process, requiring early utility notification prior to securing a host site for DCFC, to ensure that the findings of the constraints analysis are germane to the specific site selected

### 3.2.3 Master Geographic Reference Areas (MGRA)

The base unit of geography for the model was MGRA, a proprietary data unit designed and used by SANDAG. MGRAs are roughly the size of census blocks in urban and suburban areas, and census block groups in rural areas. MGRAs are designed to nest to larger standard geographies such as census tracts, zip codes, and municipal boundaries. They are delineated in a way to preserve the contiguity of trip producing and attracting land uses. A subset of MGRAs was selected for use in the model, based on the ZIP codes that were defined as the initial study areas for the EV project. Trip attractions and total employment have been tabulated by MGRA. Land use is also tabulated by category for each MGRA; it is possible for more than one land use in each MGRA.

### 3.2.4 Land Uses

Land use categories, 102 in total, were used as the potential targets for EVSE placement. The land use categories generally correspond to underlying municipal zoning designations and covered all possible uses in the region, such as airports, beach, park and ride lots, hotel, regional shopping centers, specialty retail, and many others (see complete list of land uses with descriptions in Appendix B). The land use category data is maintained by SANDAG, through periodic updating with local municipalities and the County of San Diego in the San Diego region.

### 3.2.5 Trip Attractors

Trip attraction refers to the destination point of a trip in the trip generation model. Each trip has two trip "ends" (i.e. a beginning point and a destination point) and the trip generation model calculates trip ends separately. One end is classified as a trip attraction (i.e. the destination, or end point of the trip). For example, the home end of home-based trips is defined as the production end and the work location is defined as the attraction end. Shopping centers, recreation facilities, and work locations are all trip "attractors" upon which the attraction weight is based for modeling purposes. This bifurcation of trip ends and subsequent focus on destinations allows for a quick initial screening out of all trip origination locations, and for the development of a trip attraction weight based on the volume of trips attracted.

### 3.2.6 Employment Centers

Employment center refers to the number of jobs in the zone that the land use is located in, and implies a nearby day-time population. Employment data was not disaggregated by job classification (*e.g.* service, retail, industrial, etc.), rather it reflects aggregated job counts. Employment centers were first defined on a binary scale as MGRAs with more than twice the employment density of the study area mean. Then, the remaining areas were standardized on the number of jobs in the area (Figure 3-2).

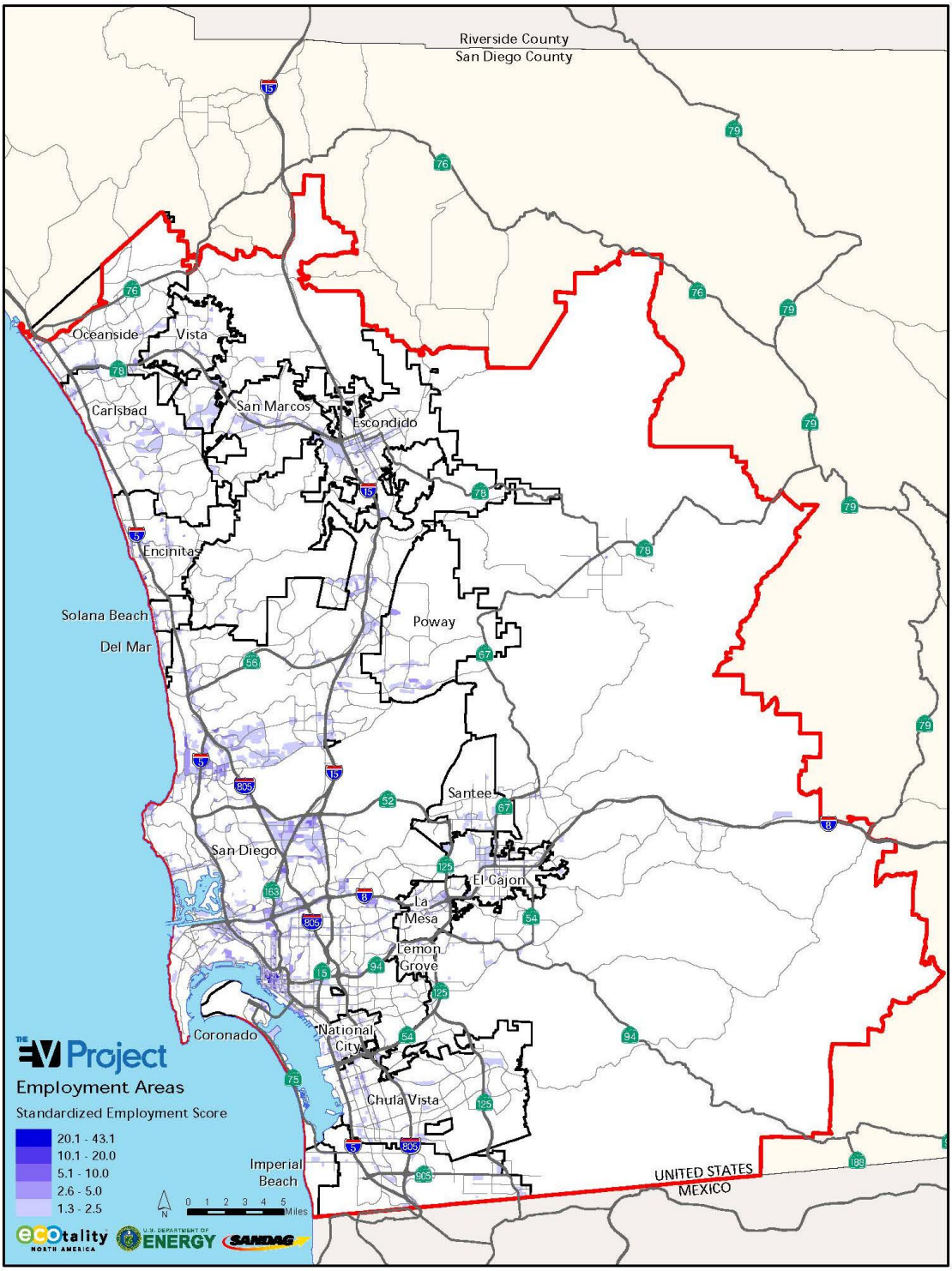



Figure 3-2 Employment Areas

### 3.2.7 Regional Attractors

Regional attractors refer to those areas or locations that have historically attracted trips from a broad area across the San Diego region. Specifically, regional attractors often attract trips from greater distances than other locations or areas. All regional attractors with qualifying land uses (those ranked highest in the land use suitability analysis described in detail later) were mapped (Figure 3-3).

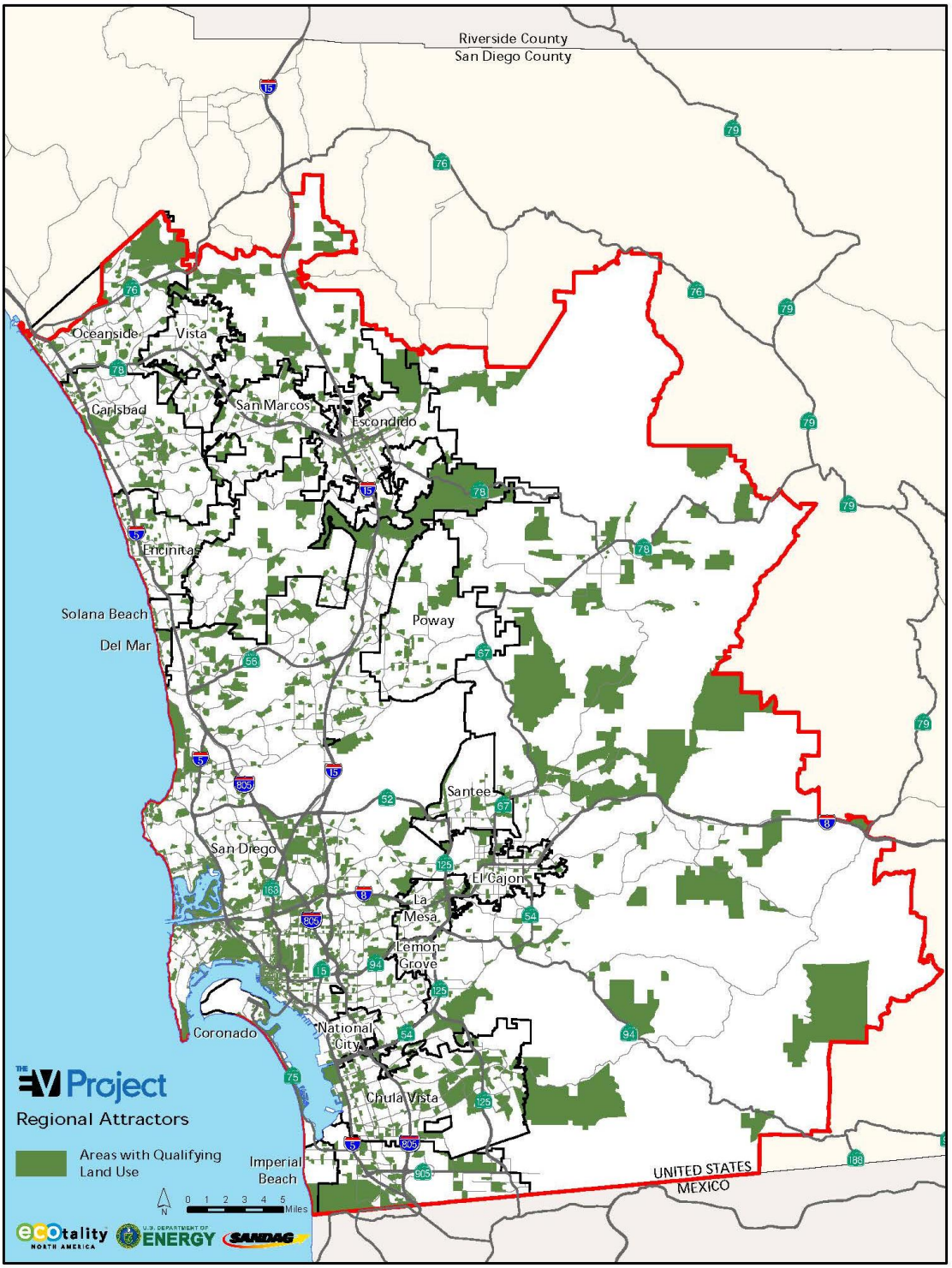



Figure 3-3 Regional Attractors

### 3.2.8 Smart Growth Areas

Smart growth areas refer to areas mapped by SANDAG, as part of the 2008 Smart Growth Concept Map update. The areas reflect existing, planned or potential locations for smart growth that can be characterized as typically more compact higher density areas that are typically walkable and near public transit. The areas were identified by SANDAG through extensive outreach with and input from the municipalities and communities where the areas are located.

These areas will see future development investment and remain or develop as vital areas within the many communities in the San Diego region, and for that reason are seen as important possible locations for public EV charging consistent with the secondary goal the ESAC set for the Micro-Climate.

## 3.3 Level 2 and DCFC EVSE Plans

The ESAC was given authority to construct the EVSE location model with the explicit requirement that the model implement the two previously stated strategic goals, and with an understanding of the available data for modeling purposes. Additionally, the ESAC was directed to consider that the results of any location selection model would be a map with ¼ mile diameter locations that have the greatest number of potential optimum EVSE sites within them. Optimum Level 2 EVSE locations were initially defined as those locations with:

- High number of users
  - Integrated into daily life
  - Available to many different users
- High frequency of vehicle turnover
  - Vehicle stay times of 45 minutes to approximately 3 hours
- Significant availability
  - Maximize the number of open days per week and per year
  - Maximize the number of open hours per day

Optimum DCFC locations were initially defined as those locations with:

- High number of users
  - Integrated into daily life
  - Available to many different users
- Very high frequency of vehicle turnover
  - Vehicle stay times of 5 minutes to 30 minutes
- Significant availability
  - Maximize number of open days per week and per year
  - Maximize number of open hours per day

### 3.3.1 Methods / Analysis

Two basic EVSE location models were presented to the ESAC to use as a reference / touchstone and/or to review and modify. The first model assigned values for placement of Level 2 or DCFC EVSE, based on the type of area the EVSE would be located in, such as a PEV home area, employment area or route to employment area, or finally a regional attraction. Appendix C provides more detail on this model (Level 2 EVSE Optimization (sample) model 1). The second model, which can be described as a Land Use Suitability Analysis model, was based primarily on rating each land use category's suitability for hosting Level 2 or DCFC EVSE. A land use's suitability for hosting EVSE was primarily based on the following factors:

- Daily hours of availability
- Average stay of 45 minutes to 3 hours for Level 2
- Average stay of 5 minutes to 30 minutes for DCFCs
- Availability for many users (takes account of any restrictions, such as employee only use, etc.)
- Availability throughout the year (taking account of seasonality)

Descriptions of both models and the three categories identified for model 1 above can be found in Appendix C.

The ESAC chose to consider using and modifying both sample models. The ESAC members, serving as a focus group, rated the different categories on a 1 to 5 (5 being highest) scale. Additionally, the group provided input on the value (a weight) of each land use suitability factor, including presence in an Employment Center and the MGRA's trip attraction number. Table 3-1, below, shows the final agreed upon weights for the land use suitability categories for Level 2 EVSE, and Table 3-2 shows the same for the DCFC EVSE.

**Table 3-1 ESAC Land Use Suitability Category Weights (Level 2)**

| | Daily Hours Availability | Average Stays 45m-3H | Available to Many Users | Availability Throughout Year | In an Employment Center | Trip Generation |
|---|---|---|---|---|---|---|
| **Weight** | **3.00** | **3.83** | **3.50** | **4.17** | **3.83** | **3.17** |

**Table 3-2 ESAC Land Use Suitability Category Weights (DCFC)**

| | Daily Hours Availability | Average Stays 45m-3H | Available to Many Users | Availability Throughout Year | In an Employment Center | Trip Generation |
|---|---|---|---|---|---|---|
| **Weight** | **4.17** | **3.67** | **3.83** | **4.33** | **2.17** | **3.67** |

The ESAC was also provided with summary information of the latest academic studies on PEV charging perceptions and behavior (Appendix A), to further inform their modeling choices.

Using the aforementioned data, and the scores and weights from the ESAC, SANDAG analysts prepared GIS layers showing which MGRAs scored well within each model. After an interactive preliminary review conducted in a half-day Community Viz workshop, and discussion of the limitations of available data (largely a lack of geographically precise PEV driver home locations) to effectively develop EVSE Optimization (sample) model 1, ESAC members made a decisions to proceed with the Land Use Suitability Analysis (sample model 2) for both Level 2 and DCFC EVSEs.

### 3.3.2 Decisions

The ESAC selected sample model 2 (Land Use Suitability Analysis), and further concluded that there should be some special focus areas taken into account to fine tune the implementation of the Micro-Climate both for Level 2 and DCFC EVSEs.

Under the Land Use Suitability Analysis model as designed, the mean scores for each MGRA were totaled; the ESAC specified weights were used as a multiplier. One of the assumptions we made going into the model was that land use scores would be totaled by MGRA on a presence/absence basis (*i.e.* two MGRAs would receive the same score for regional shopping centers even if one shopping center was twice the acreage). We decided on this approach to avoid skewing the results toward certain land uses based on size rather than stakeholder scores. MGRAs were designed to avoid splitting contiguous land uses, so we were confident that the presence/absence approach would not be affect by "sliver polygons" showing up in the land use table. Results of the scoring were summed for each suitability category by MGRA, rewarding MGRAs with multiple compatible land uses.

MGRA raw scores were normalized against the highest scoring MGRA, and then broken down into three main categories – highly probable, probable and average/below average. Highly probable MGRAs represented MGRAs well above the average score and probable MGRAs represented MGRAs above the average score. Only MGRAs in the top two categories were mapped as potentially optimal locations for EVSE.

### 3.3.3 Level 2 and DCFC EVSE Plan Maps

Given the large size of the San Diego region maps showing the results of the previously described modeling, were prepared both at the full region scale, and for seven sub-regions to allow for greater visual detail. Figure 3-4 shows the seven sub-regions.

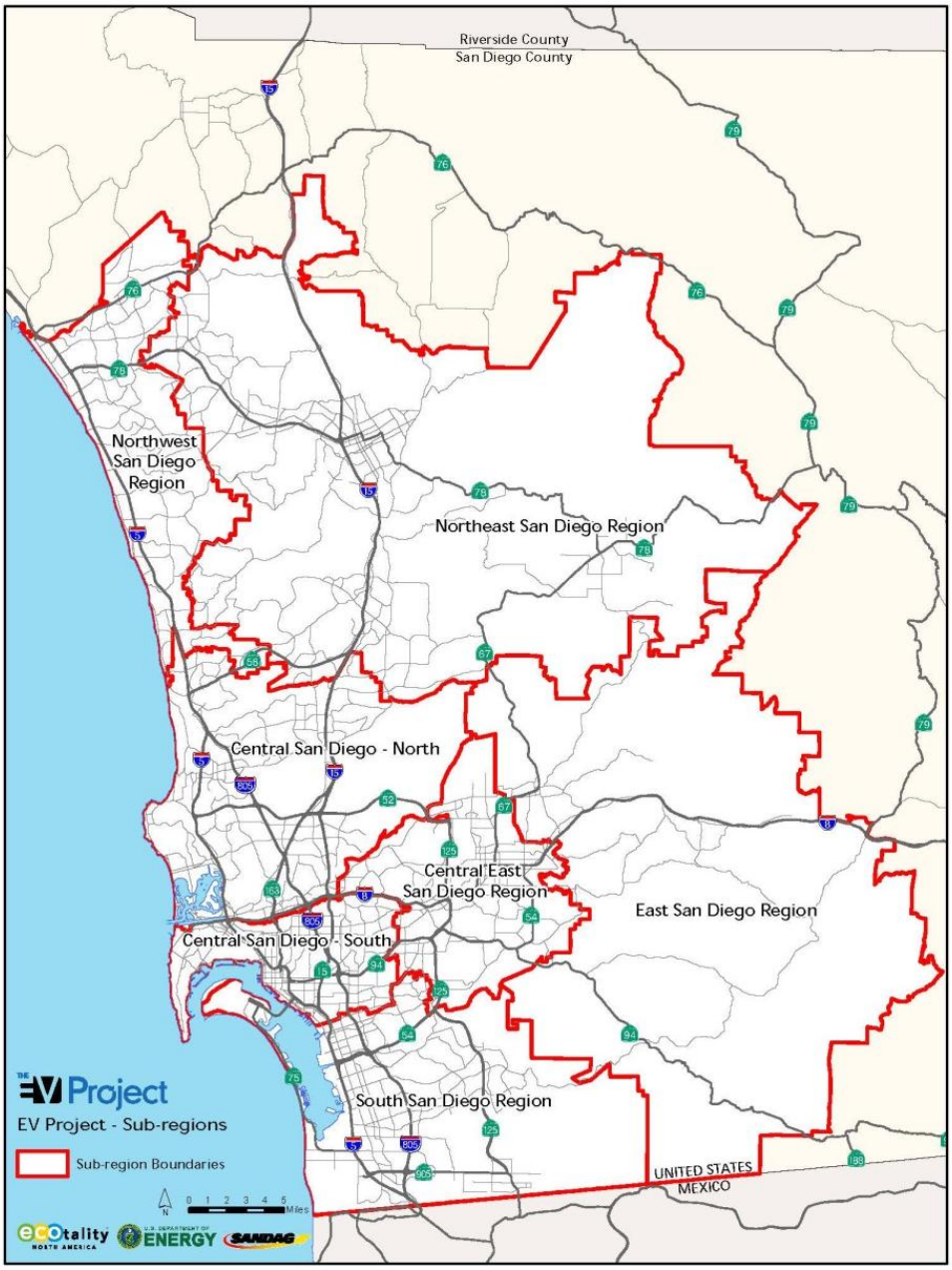



Figure 3-4 EV Project Sub-Regions

Potential locations for Level 2 EVSE based on the modeling are shown at the full region scale below in Figure 3-5. Figure 3-6 shows the potentially optimal locations for DCFCs.

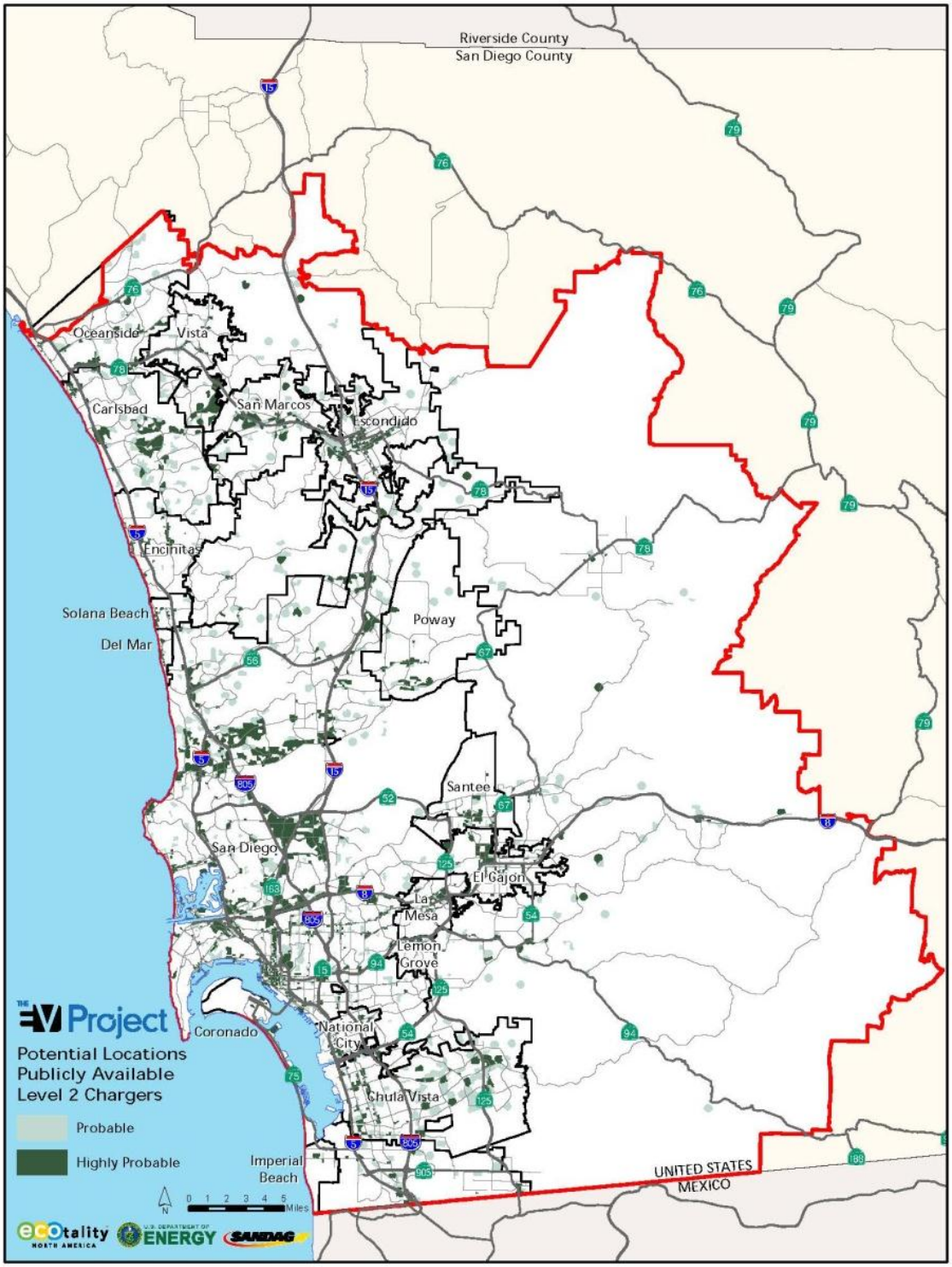



Figure 3-5 Potential Locations AC Level 2

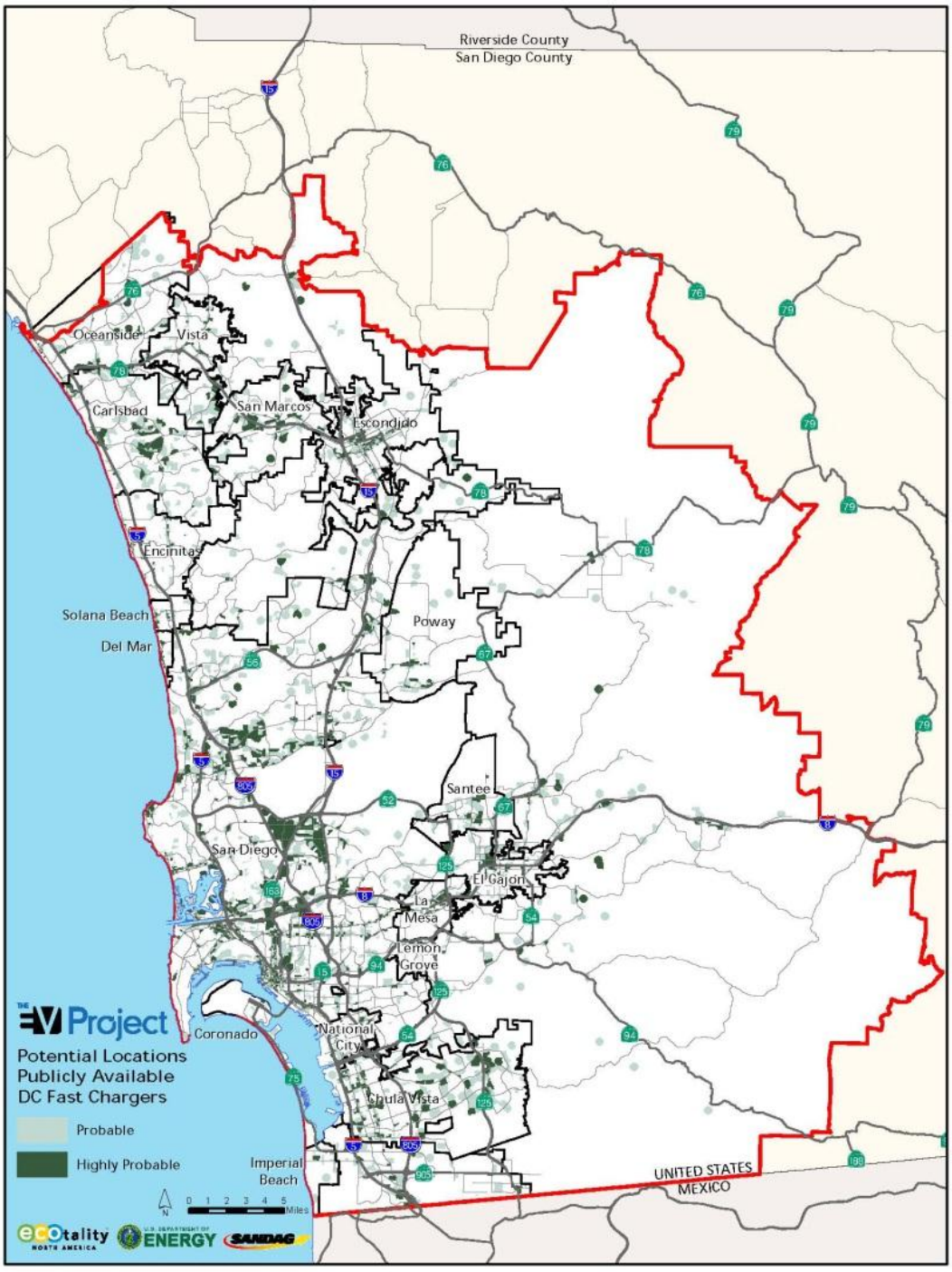



Figure 3-6 Potential Locations DCFCs

The same locations shown in Figure 3-5 and Figure 3-6 are also shown in Figure 3-7and Figure 3-8, below, which shows their overlap with existing and planned smart growth opportunity areas.

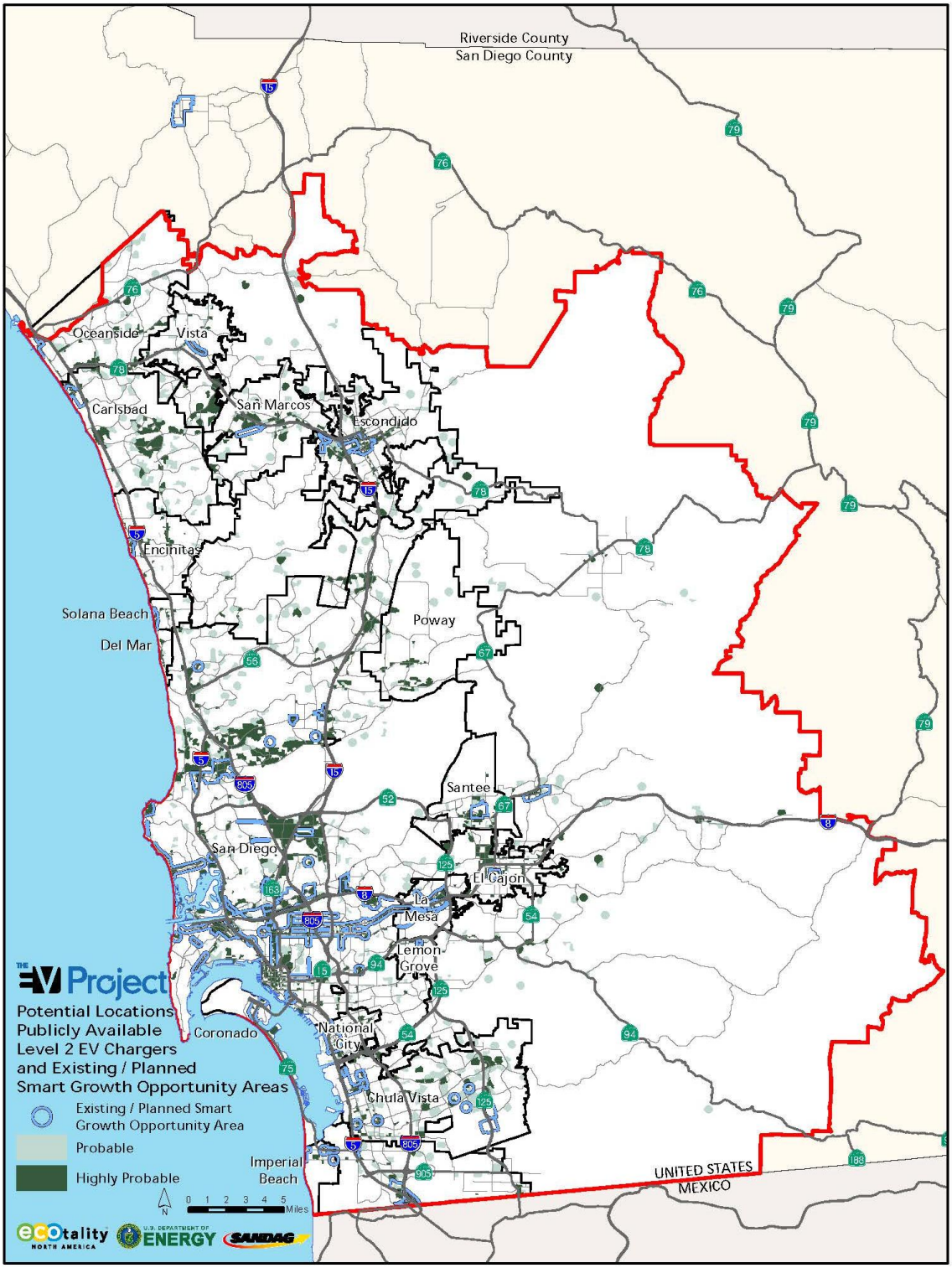



Figure 3-7 Potential Locations AC Level 2

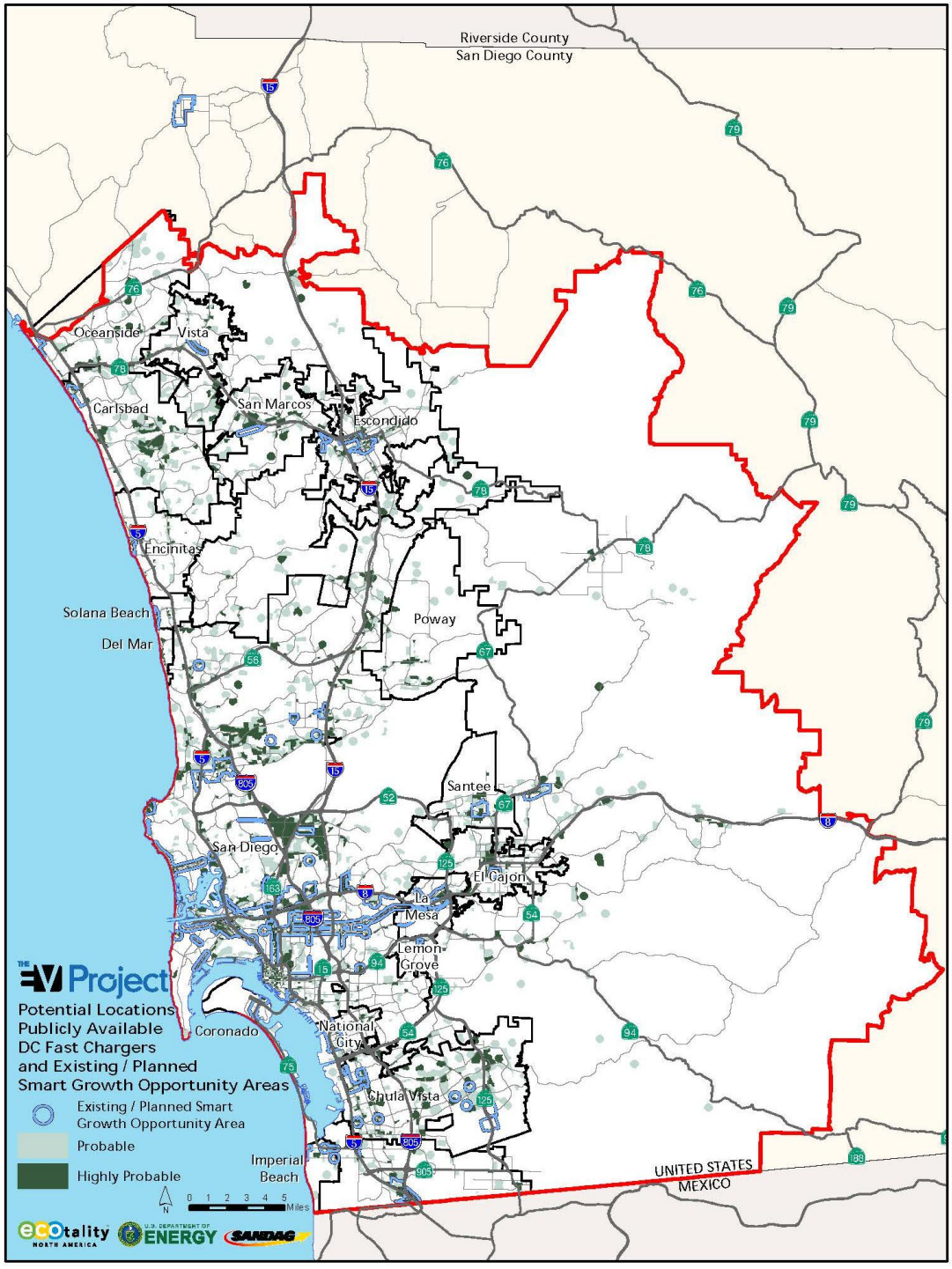



Figure 3-8 Potential Locations DCFCs

Screening the locations shown on Figure 3-5 for qualification as a regional attractor yielded the results shown on Figure 3-9.

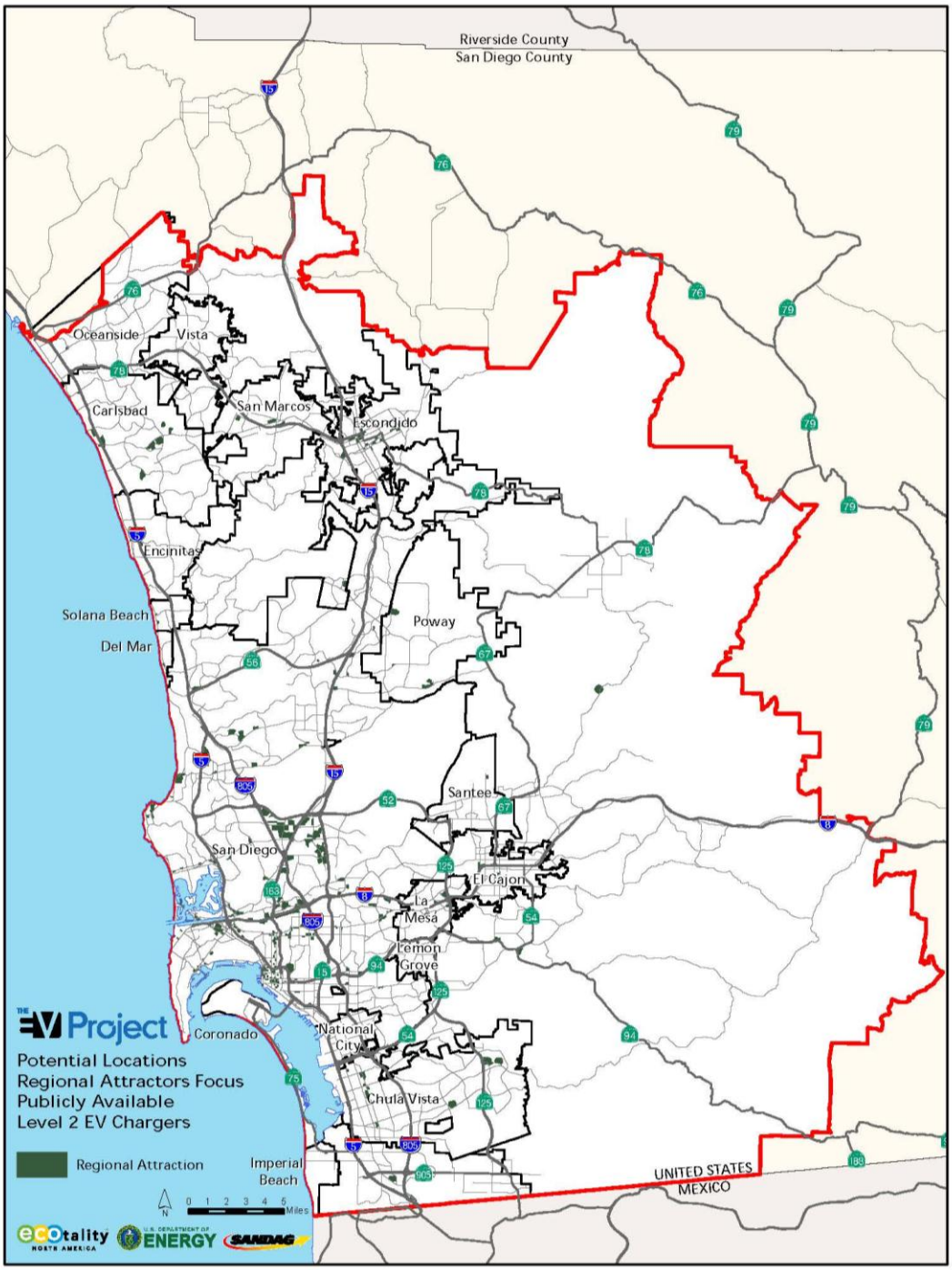



Figure 3-9 Potential Locations Regional Attractor Focus

Finally, screening the locations shown on Figure 3-5 for qualification in a top scoring employment area yielded the results shown on Figure 3-10.

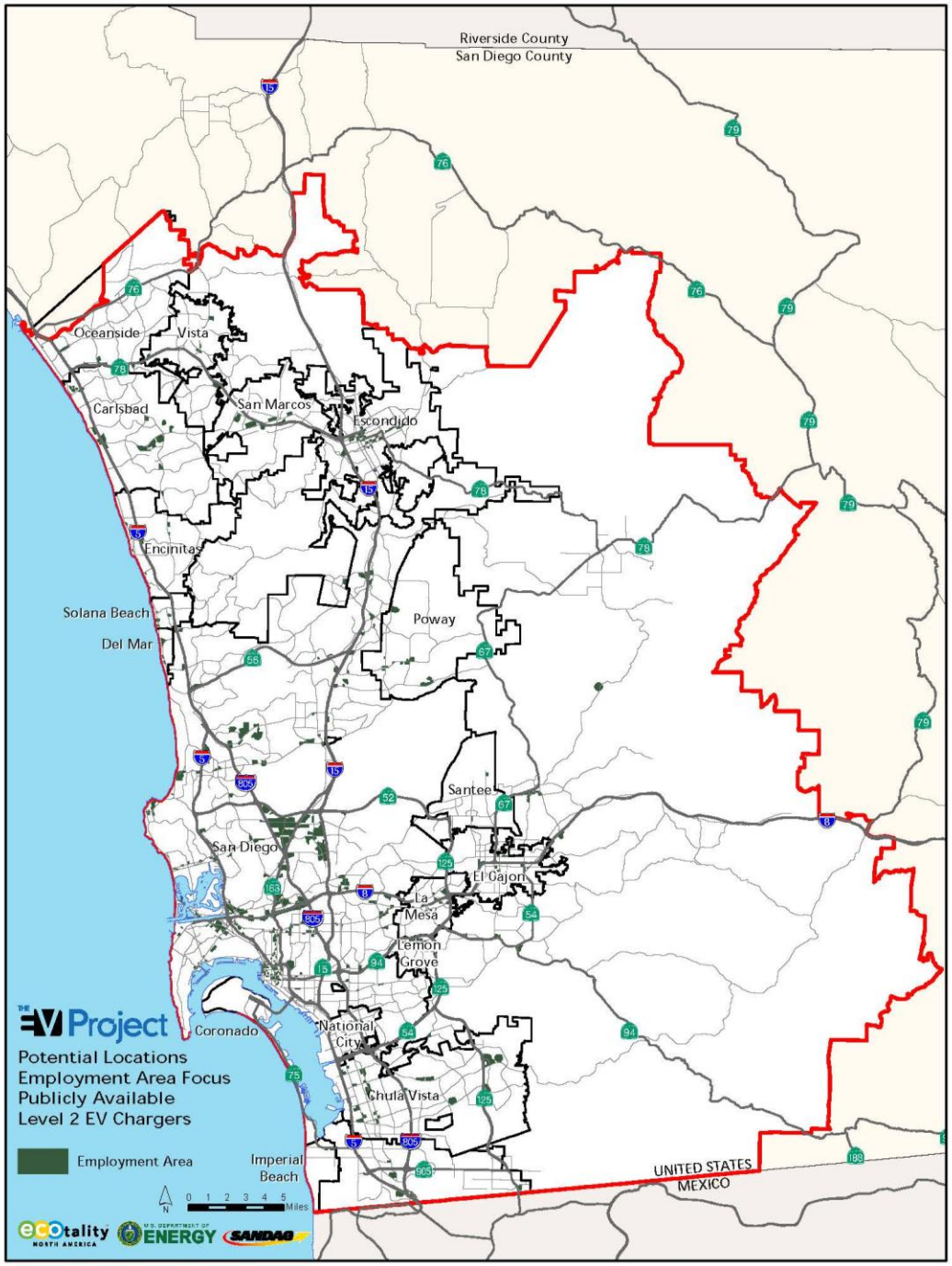



Figure 3-10 Potential Locations Employment Focus

Figure 3-11 through Figure 3-24 depict the potentially optimal areas for Level 2 and DCFCs, respectively, in each of the sub-regions. Each map includes aerial imagery to offer more

information on the development context of that area. These maps are based off the MGRAs shown in Figure 3-5 and Figure 3-6.

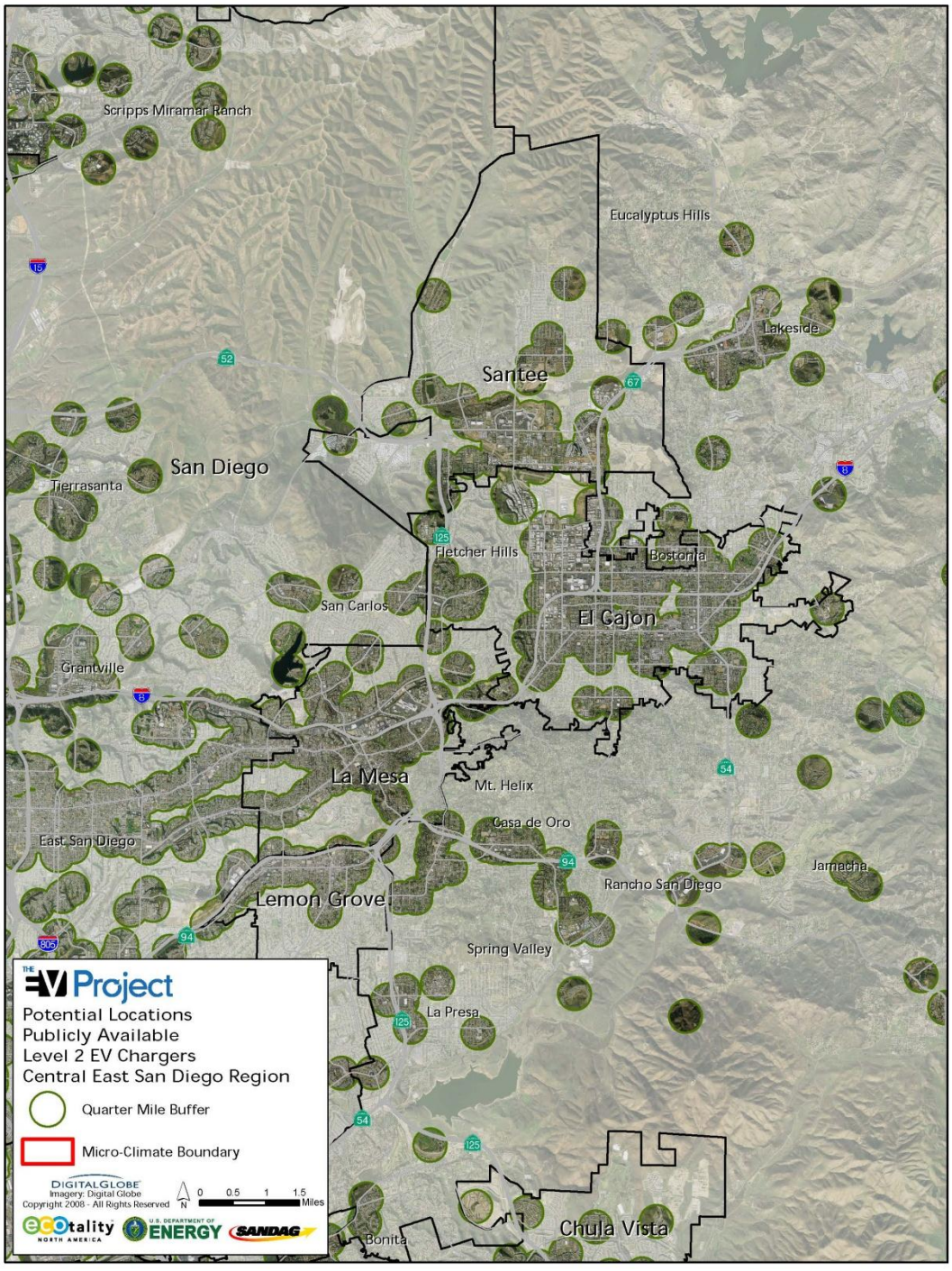



Figure 3-11 Aerial Imagery Level 2 EV Chargers – Central East San Diego Region

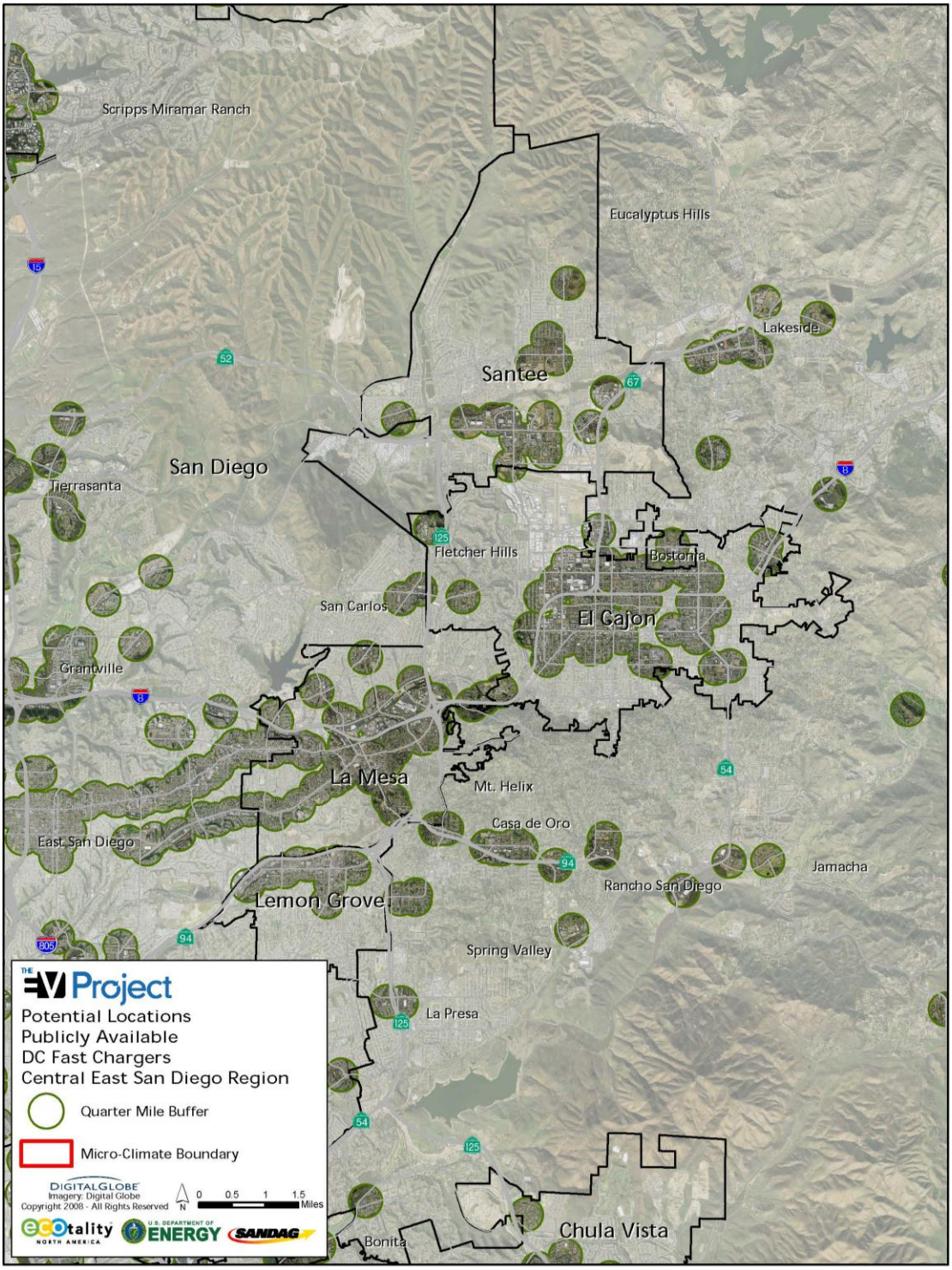



Figure 3-12 Aerial Imagery DCFCs Central East San Diego Region

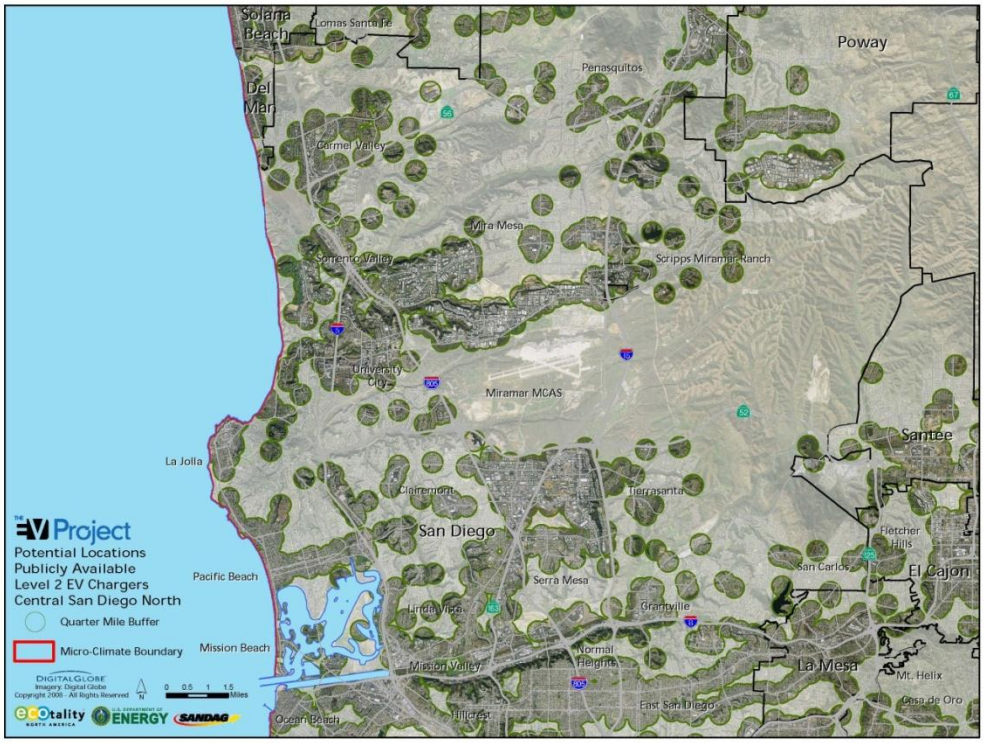



Figure 3-13 Aerial Imagery Level 2 EV Chargers Central San Diego North

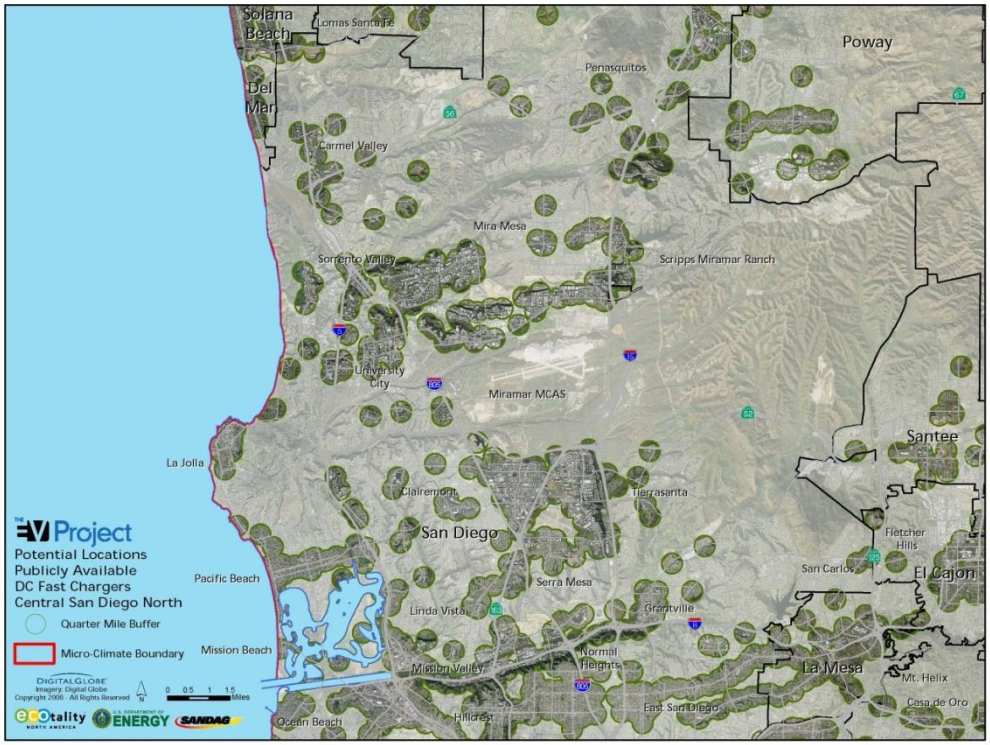



Figure 3-14 Aerial Imagery DCFCs Central San Diego North

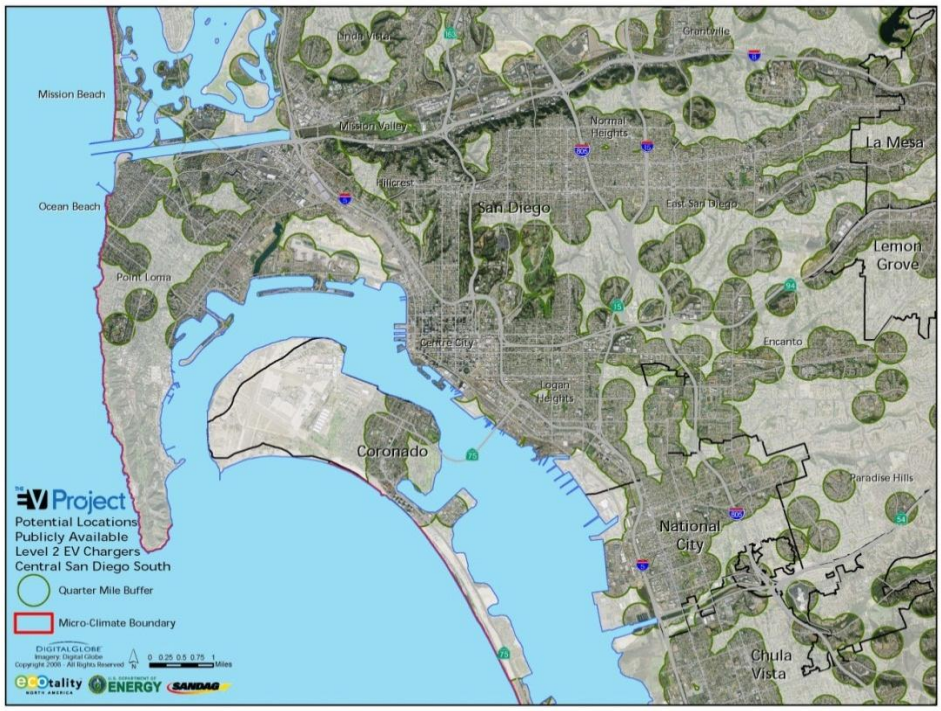



Figure 3-15 Aerial Imagery Level 2 EV Chargers Central San Diego South

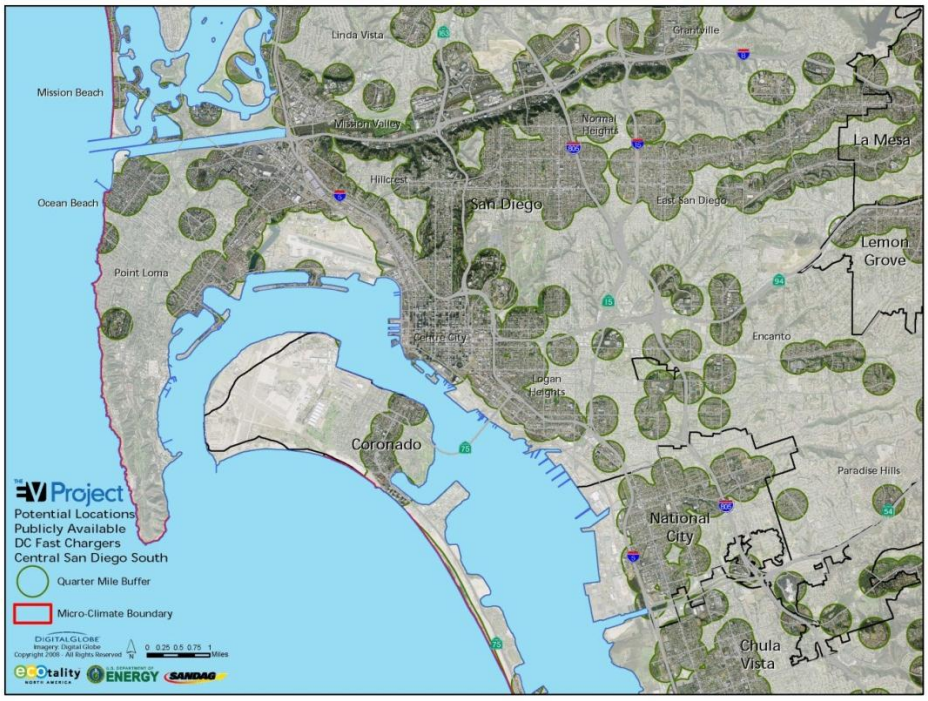



Figure 3-16 Aerial Imagery DCFCs Central San Diego South

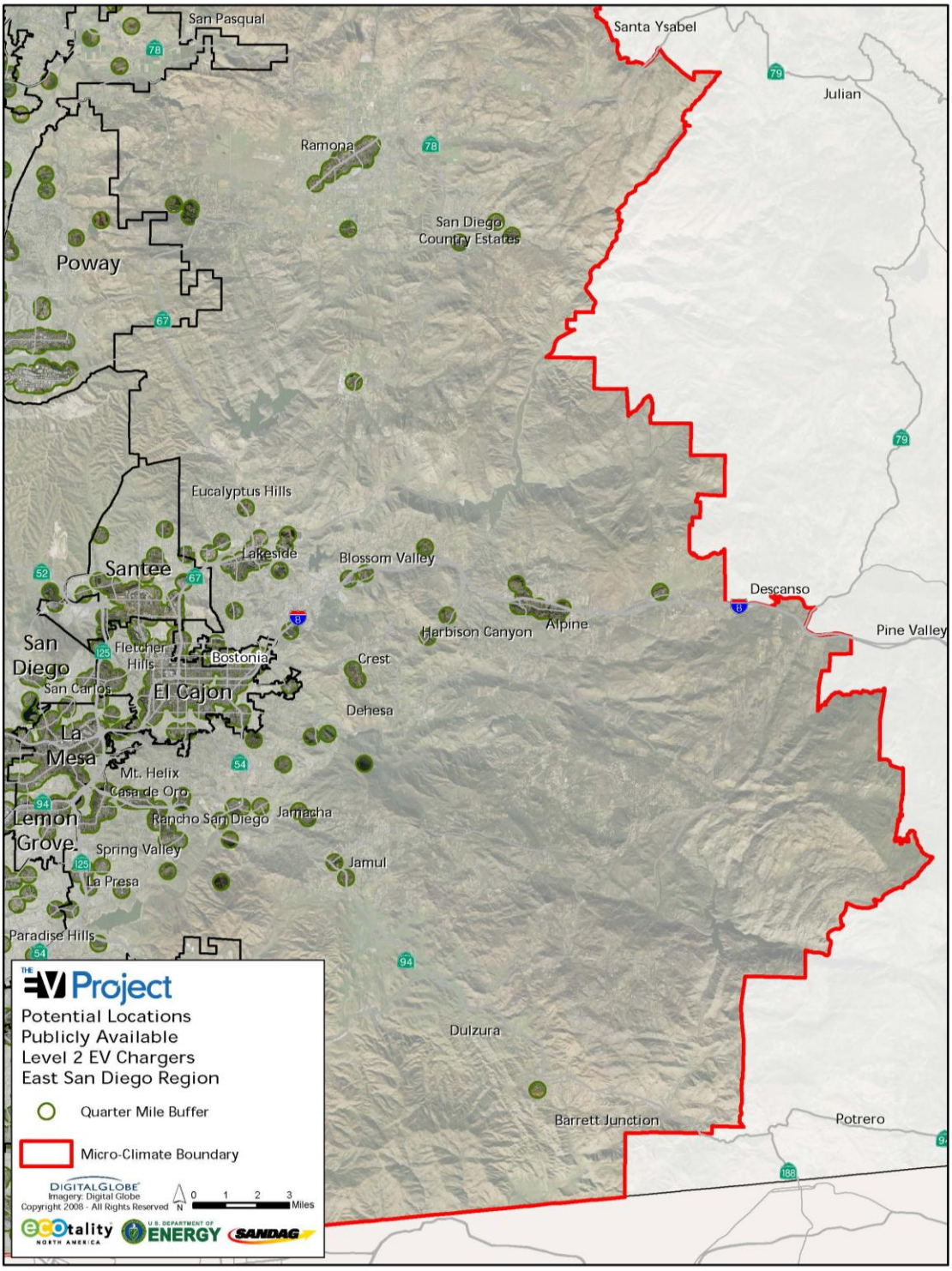



Figure 3-17 Aerial Imagery Level 2 EV Chargers East San Diego Region

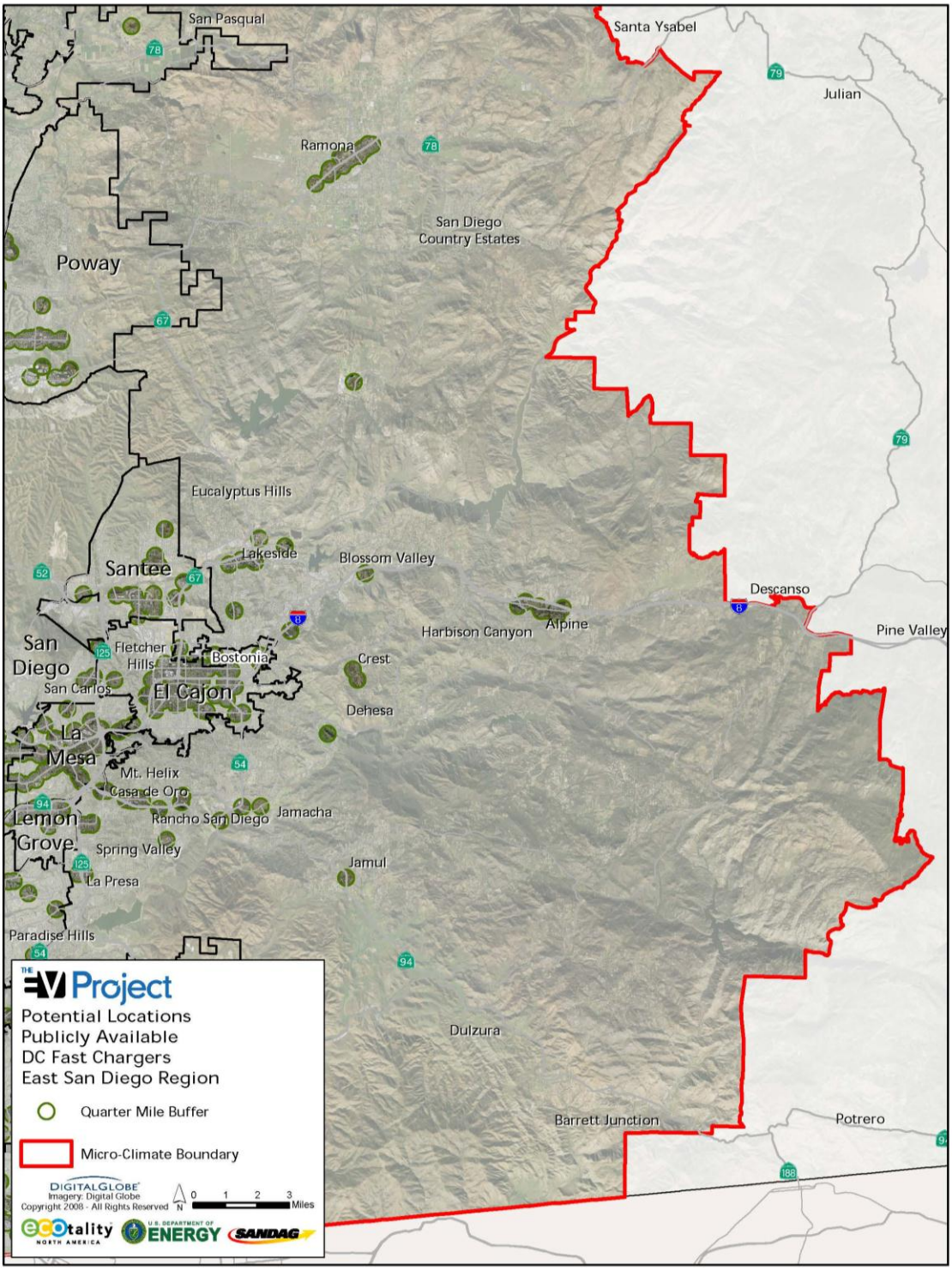



Figure 3-18 Aerial Imagery DCFCs East San Diego Region

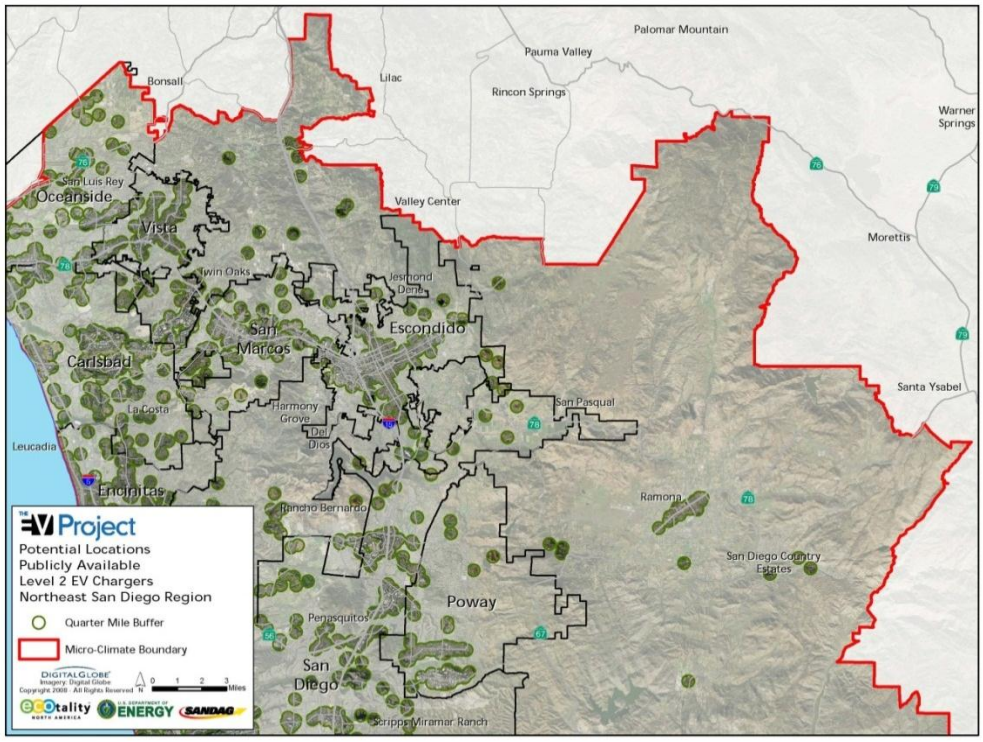



Figure 3-19 Aerial Imagery Level 2 EV Chargers Northeast San Diego Region

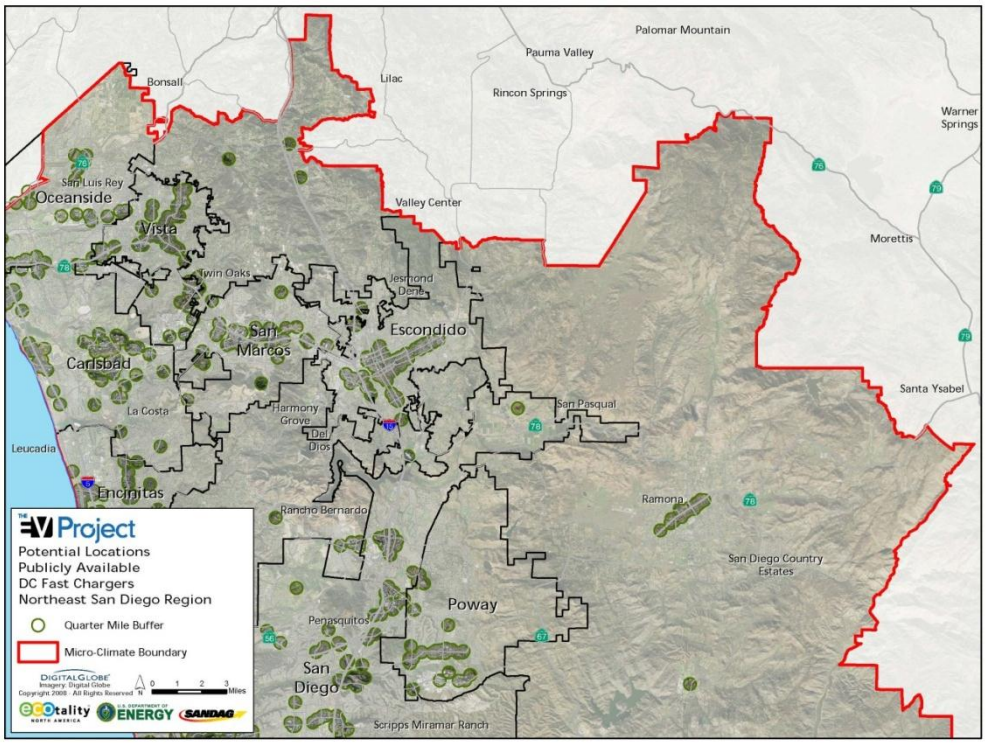



Figure 3-20 Aerial Imagery DCFCs Northeast San Diego Region

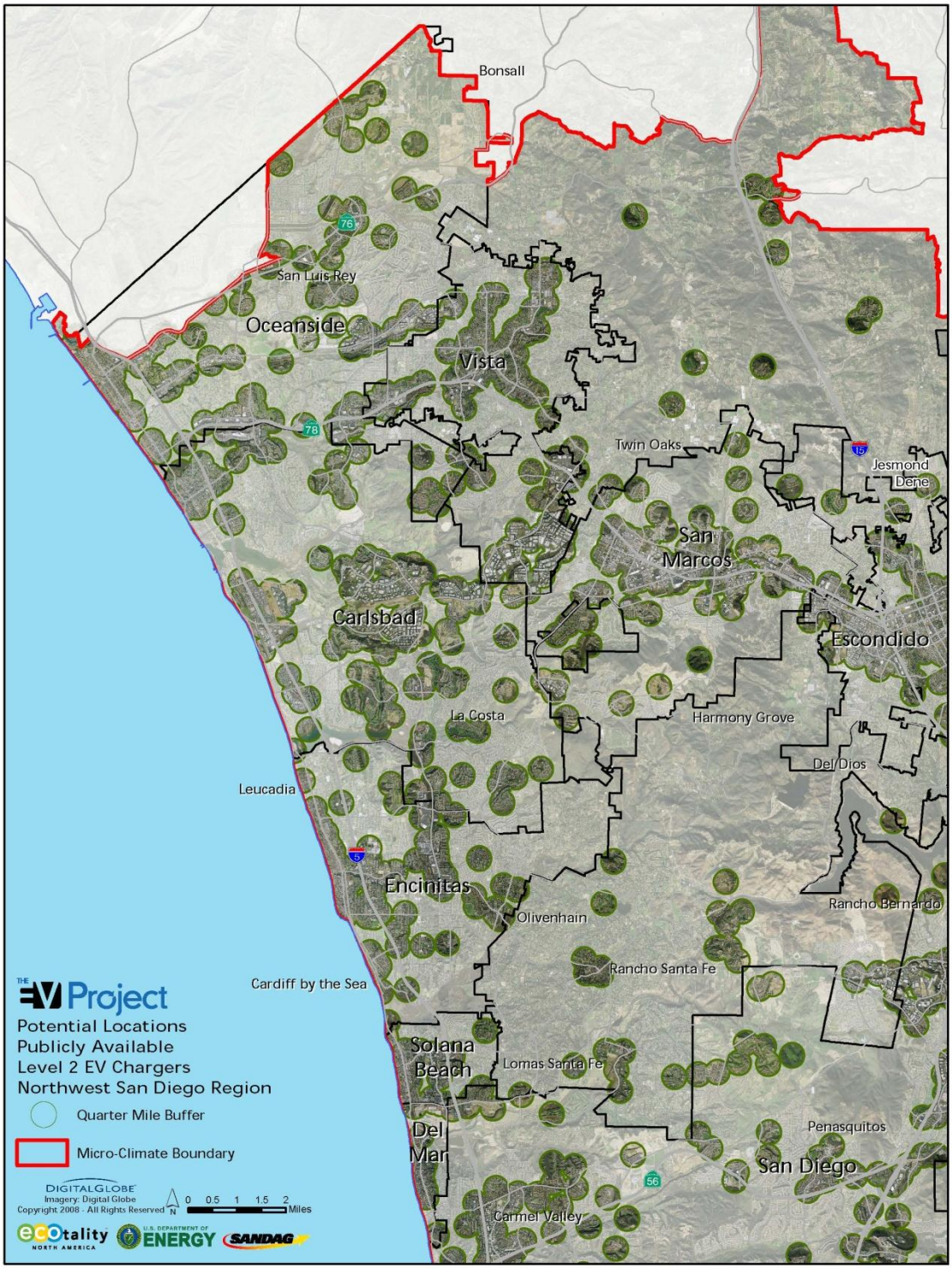



Figure 3-21 Aerial Imagery Level 2 EV Chargers Northwest San Diego Region

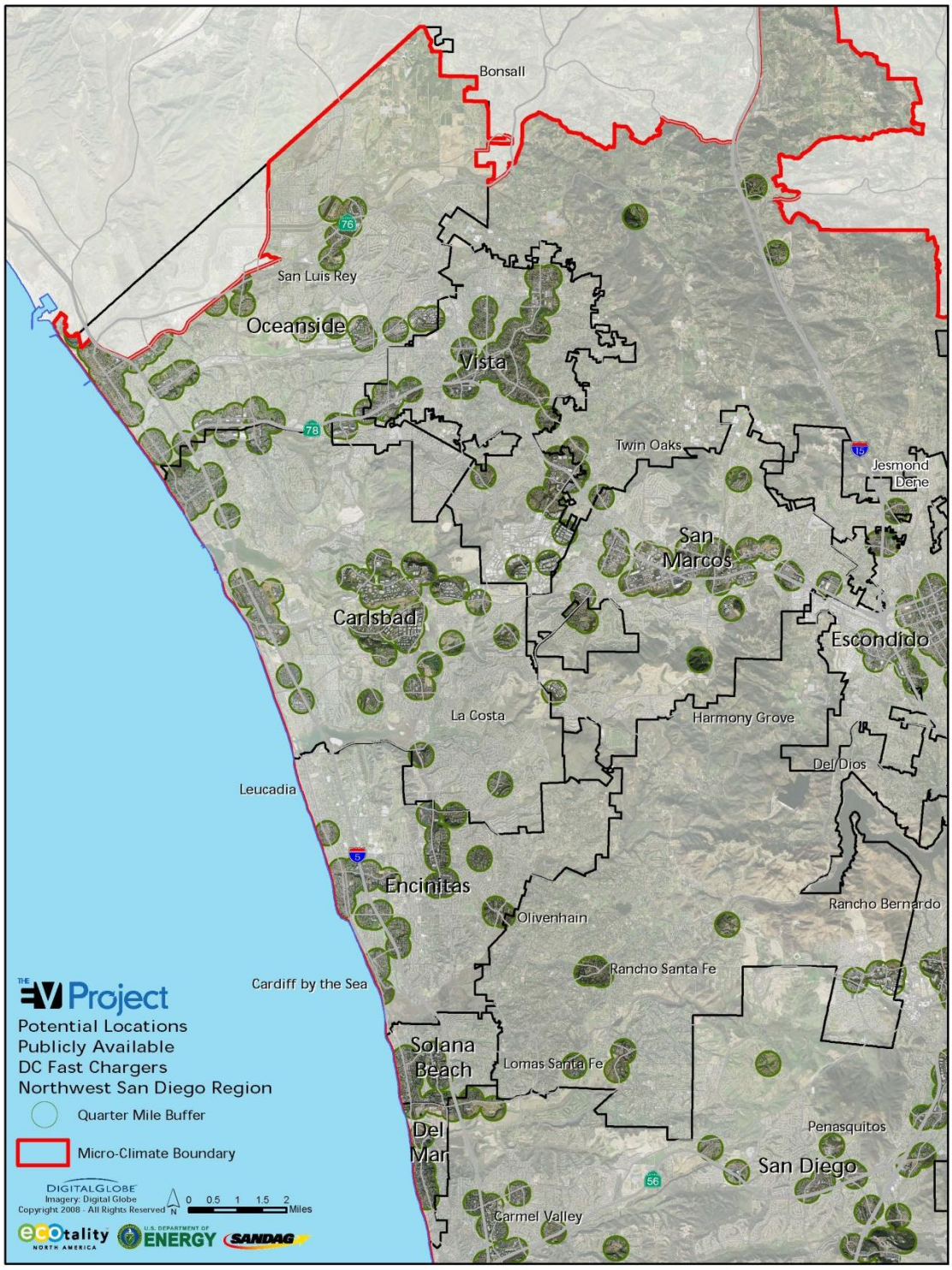



Figure 3-22 Aerial Imagery DCFCs Northwest San Diego Region

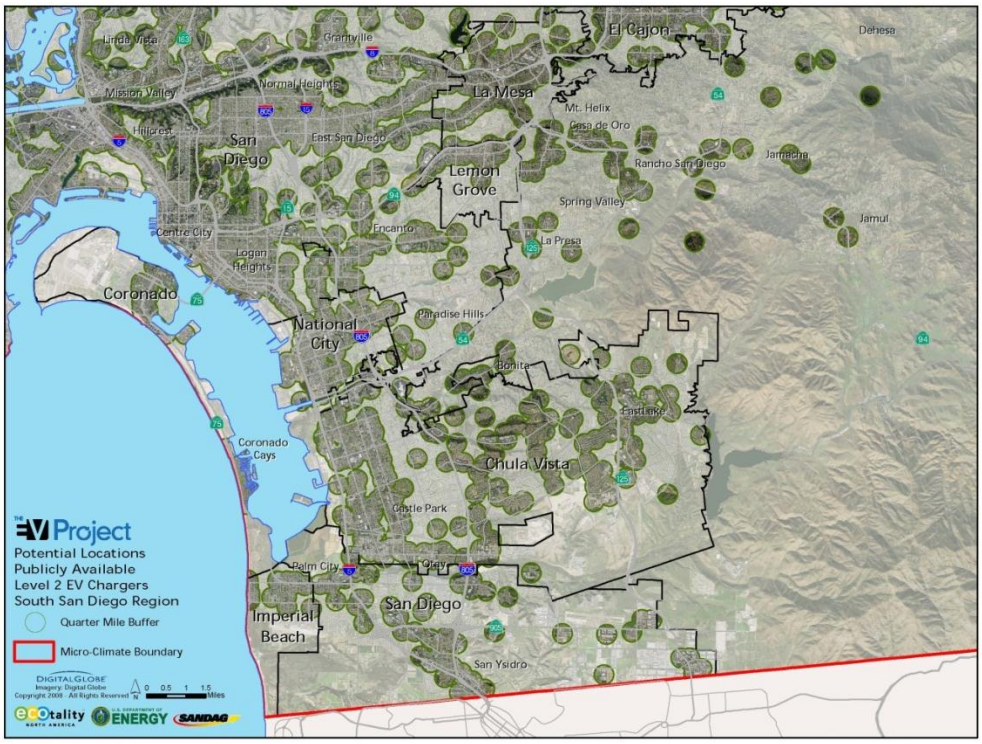



Figure 3-23 Aerial Imagery Level 2 EV Chargers South San Diego Region

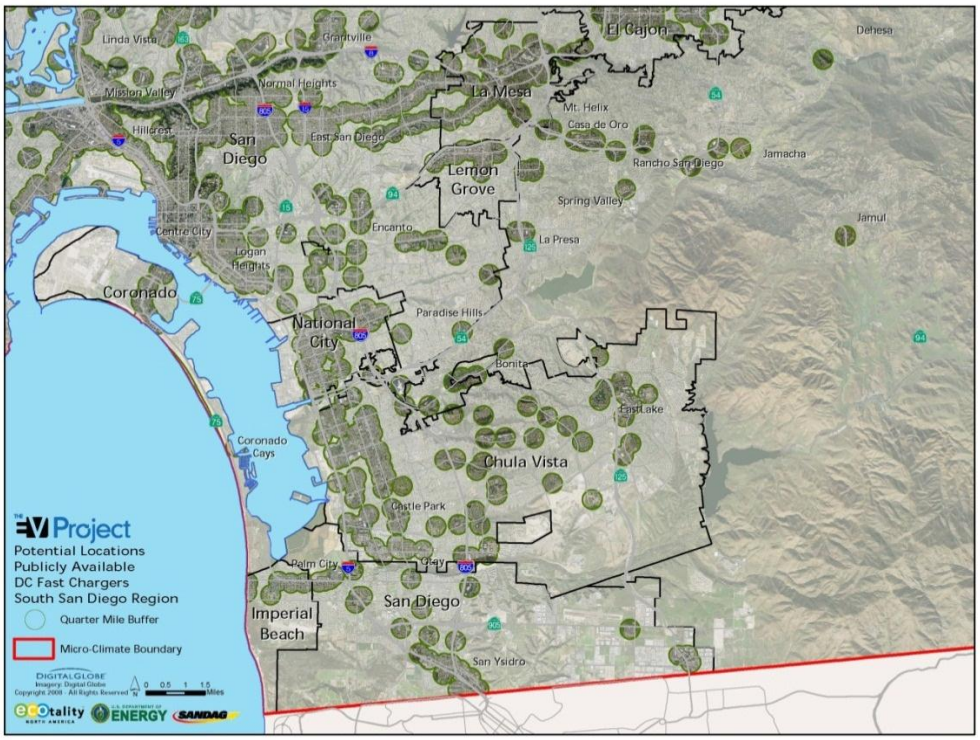



Figure 3-24 Aerial Imagery DCFCs South San Diego Region

## 3.4 EVSE Density Maps

EVSE density mapping for the potentially optimal locations for both Level 2 and DCFC EVSEs were combined. Additionally, no specific number of EVSEs was recommended in the potentially optimal areas mapped, rather each area received a standardized score relative to all the other locations. In this way the density mapping can serve to guide EVSE placement beyond that of the EV Project.

### 3.4.1 Methods

Ideal EVSE densities within top scoring MGRAs were created based on the standardized trip attractor number of each MGRA.

### 3.4.2 Density Maps

Figure 3-17 shows the standardized EVSE density scores throughout the San Diego region. An examination of the density map reveals a high degree of correlation with major employment area and regional attractor areas because of their high levels of trip attraction.

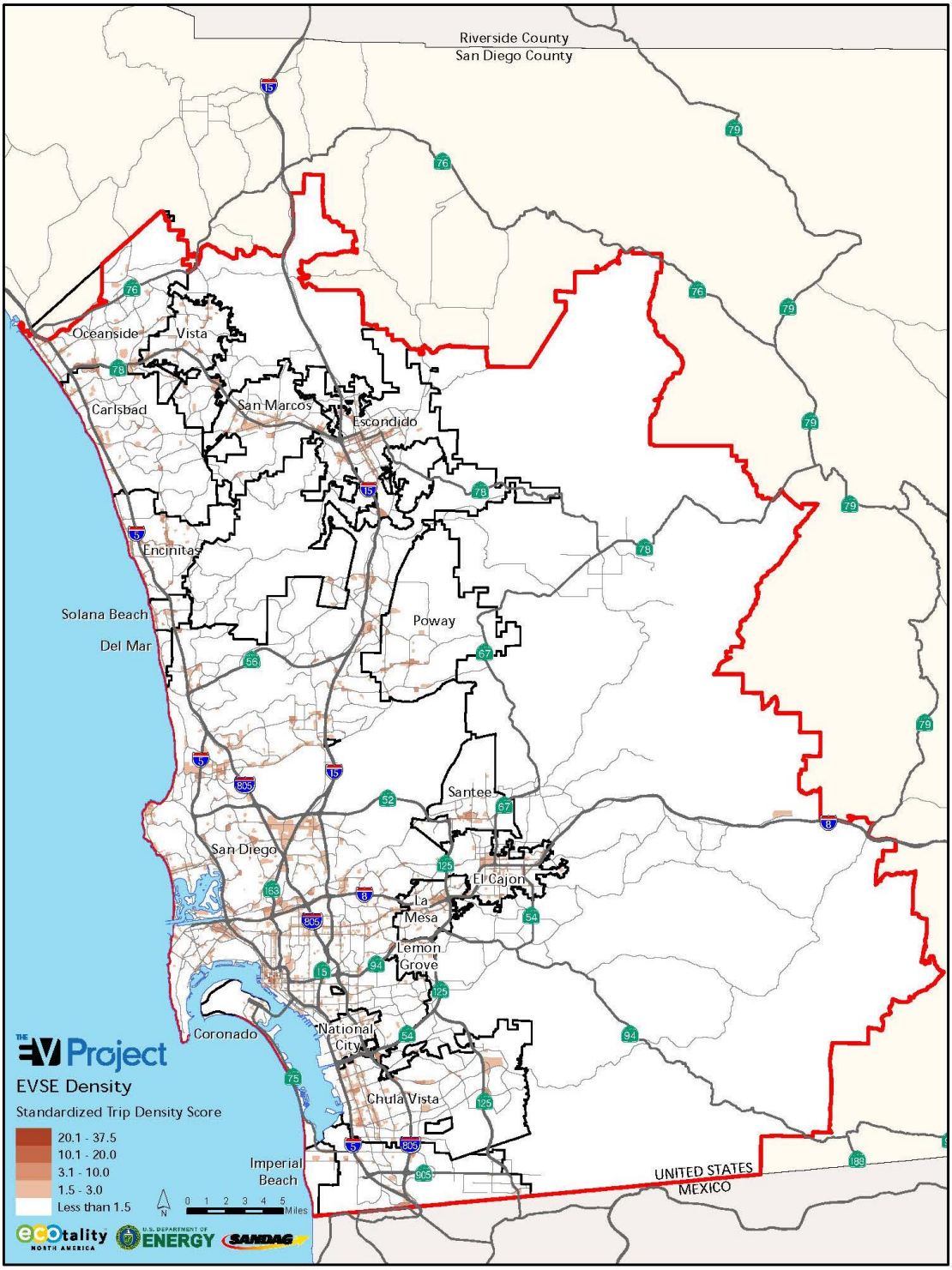



Figure 3-25 EVSE Density Scores

## 3.5 Special Focus Areas

In order to better meet the two stated strategic goals of this Micro-Climate planning effort, the ESAC provided further guidance to inform the implementation of EV charging infrastructure deployment according to the mapped potentially optimal locations previously shown. The four special focus areas below are to be employed to the degree practicable in selecting specific EVSE host sites.

Special focus area 1 – workplace charging – was an agreed necessity (and exception from the rest of the Micro-Climate planning for publicly available EVSE) because of the consensus in extent research indicating PEV drivers strong preference for workplace charging. Implementing a small subset of workplace charging EVSE installations will allow for more complete study under the EV Project.

### 3.5.1 Workplace Charging

#### *a. Description*

Placement of Level 2 EVSE at multiple places of employment places in San Diego region. EVSE at the places of employment would be less than 1:1 (EVSE to EV Project Participants at the place of employment).

#### *b. Rationale*

As identified in the literature on PEV charging preferences workplace charging is identified as second to home charging for the most preferred location to charge a PEV.

#### *c. Specifications*

With workplace charging there is a need to address the non-public nature of the parking facilities.

i. For large employers with multiple employees with PEV's (especially EV Project participants) consider fewer work place EVSE than EV Project participants at place of employment.
ii. Consider workplaces where parking is not reserved for employees, but is also available in open pool format to visitors/customers/public.
iii. Give consideration to workplaces in optimal Level 2 EVSE ¼ mile locations.
iv. Give consideration to workplaces that have demonstrated availability of parking facilities after work hours (before / after shifts and non-work days).
v. Consider park-and-ride lots as surrogate sites for workplace charging

Special focus area 2 – DCFC Transportation Corridors – recognizes the value of DC Fast charging to extend trips.

### 3.5.2 DCFC Transportation Corridors

#### *a. Description*

DCFCs located throughout the San Diego region along all major transportation corridors will be the backbone of the public charging infrastructure. The transportation corridor DCFCs will greatly facilitate effective travel within the San Diego region, and by placement at the periphery and beyond the periphery of the San Diego EV Project boundary will allow for travel outside of the San Diego region to other locations, such as Los Angeles. Given the relative proximity of Phoenix, AZ and its inclusion in the EV Project options for connecting San Diego to Phoenix via a DCFC link should be examined as well.

#### *b. Rationale*

Fast charge times of the DCFCs make them particularly well suited to travel between regions, or for trip extension purposes. Additionally, the fast charge times mean that the potential number of PEVs to be charged daily will be much greater than that for Level 2 EVSE. To realize this potential, DCFCs should be placed in locations that maximize the potential of EV drivers to access them, and transportation corridors offer this potential in carrying high volumes of vehicles throughout the day.

#### *c. Specifications*

As DCFCs will not be located directly on transportation corridors, but adjacent to them on access roads the conditions of the interchange connections, distance from transportation corridor and other factors should be documented and taken into account.

i. Major transportation corridors are defined as freeways and highways.
   1. Interstate Freeways 5, 8, 15 and 805
   2. State Highways 52, 54, 56, 67, 78, 125, 163, 905

ii. Approximately half of the transportation corridor DCFCs should be located at very high volume (*i.e.* clover leaf) designed interchanges, with the remaining half located at slightly lower volume designed (*e.g.* direct left/right turn movements from transportation corridor ramps) interchanges.

iii. Optimal DCFC sites should take into account characteristics of the host site use that match the typical charge times of 5 minutes to 25 minutes for the study vehicle. For example, gasoline filling stations without a convenience market or other on-site uses do not offer a complimentary (by time) service, as compared with a coffee shop, convenience store or other such business.

iv. DCFC spacing throughout the region should take into account the potential travel distance that can be added (up to approximately 80 miles in 30 minutes).

v. DCFC spacing through the region should include DCFC locations on transportation corridors at the periphery of the San Diego EV Project boundary. Additionally, DCFCs should be deployed between 30 and 50 miles

beyond the San Diego EV Project boundary along the same transportation corridors.

ESAC members generally agreed that there is likely less of a need for publicly available EV charging within close proximity to PEV drivers' homes, given the ability to home charge PEVs. The ESAC typically expects lower utilization levels of publicly available EVSE at true neighborhood level uses (*e.g.* a neighborhood shopping center, a small pocket park, etc.), and land use scores for such uses (used in the Land Use Suitability Analysis model) reflect this. However, they also recognize that as a seminal study into PEV driver charging behavior there should be some limited focus on neighborhood level uses to provide adequate data for analysis and conclusions.

### 3.5.3 PEV Home Areas

#### *a. Description*

PEV home areas are the zip codes and immediately adjacent areas to those zip codes (or MGRAs) where EV Project participants are likely to be located (based on Nissan registrant data). Level 2 EVSEs would be placed at local type land uses on main travel roads.

#### *b. Rationale*

Placing Level 2 EVSE at optimal land uses within and in close proximity to PEV home areas puts the EVSE at locations that PEV drivers have significant access to for local needs (*e.g.* grocery shopping, home goods/services, entertainment, etc.) on a regular basis (*i.e.* non-work hours, including weekends/days off).

#### *c. Specifications*

Various conditions of the PEV home area should be taken into account in selecting PEV home areas for this special study.

i. Several PEV home areas throughout the San Diego region shall be selected in order to reasonably ensure a sample size of 100 EV Project participants.
ii. Consider PEV home areas not located within major employment and destination areas, such as downtown San Diego, as PEVs in major employment and destination areas will already have Level 2 EVSE because of other optimal location factors.
iii. Level 2 EVSE locations should be at optimal sites that are considered primarily local attractors (*e.g.* grocery stores, bookstores, restaurants, home repair/goods stores, etc.).
iv. EVSE should be placed at a sufficient number of the local businesses in the select PEV home area to offer ample opportunity for use.

In order to achieve the secondary goal of developing the foundation of a robust EV charging network in the San Diego region, the ESAC noted the need to deploy EVSE to Indian Gaming Casinos throughout the region—though recognized that any such efforts must fall entirely outside of the resources of the EV Project.

### 3.5.4 Indian Gaming Casinos (Non-EV Project supported)

#### *a. Description*

Place Level 2 EVSE at Indian casinos, which in general attract significant numbers of vehicle trips.

#### *b. Rationale*

Indian casinos are regional destinations that, along with other supporting services on-site such as shopping and accommodations are significant traffic generators in the San Diego region.

#### *c. Specifications*

i. Consider locating Level 2 EVSE at all San Diego area Indian Casinos regardless of distance from transportation corridors and or PEV home areas.
ii. EVSE numbers to be based on trip attractor score.

# Appendix A – PEV Consumer Charging Preferences

PEV Consumer Charging Preferences and Behavior Literature Review:

Literature review was limited to academic or stringently reviewed professional articles that focused specifically on EV charging preferences (and behaviors) of PEV drivers. Most of the charging data that has been gathered and reported in the articles is consumer reported and tends to be highly aggregated. Only one study/article that by Electric Power Research Institute (EPRI) and Southern California Edison (2010) thoroughly reviewed extent research and identified gaps in the research. Those gaps identified include perceptions of public charging and a willingness to pay for public charging, along with the desirability for fast charging. The EPRI/Southern California Edison study is also the only study to provide fairly detailed demographic/psychographic characteristics of PEV intenders (those likely to purchase PEVs). Below is an outline summary of the seven articles reviewed and determined to be of significant focus on this topic.

- EPRI and Southern California Edison, 2010
  - Research methods
    - Survey of hybrid and non-hybrid owners to determine preferences of PEV charging
  - Half expect full charge 4 to 8 hours, so leads to strong at-home charging preference
  - Workplace charging identified as next most preferred
    - Statistically significant difference between non-hybrid owner and hybrid owners i.e. 49% vs. 61% (non-hybrid owner vs. hybrid owner)
  - Gas stations third most preferred
    - Statistically significant difference non-hybrid to hybrid owners, i.e. 24% vs. 15% (non-hybrid owner vs. hybrid owner)
  - Shopping center/malls fourth preference
    - 21% vs 19% (no statistical difference)
  - Preferences with 1% to 4%
    - Colleges/universities, coffee shops, government offices/buildings, train stations
  - Non-Hybrid owners
    - Few chose only public charging locations for their top two preferred
    - 20% (both) say they would use a public charging station at shopping or gas station if there are no price differences (differences from each other only or differences from home too?)
    - Charging stations most likely to use
      - Retail store = 23% & 20%
      - Gas station = 19% & 13% statistically significant difference

        - Charging station with free WIFI = 13% & 18% statistically significant difference
        - Club store = 12% & 16%
        - City owned 11% & 12%
        - Electric utility = 6% both
        - Gov't owned = 5% & 3%
        - Coffee shop = 5% & 6%
        - University = 4% & 3%
    - Demographics
        - House Hold (HH) income for intenders = 44% less than $50k, 32% $50-100k, 24% $100+k
        - 46% male; 54% female
        - Age: 18-29 = 29%; 30-39 = 29%; 40-49 = 21% and 50+ = 21%
        - 61% own home
        - Miles driven average – weekday = 43.5; weekend = 38
    - preferred cost hybrid owners would pay to charge their car:
        - 75% consumers willing to pay <$1/gal
        - 50% consumers willing to pay $1 per gallon of gas equivalent (e.g. gallon gas is 25 miles in most people's minds then willing to pay $1/public charge for 25 miles
        - ~30% willing to pay $1.50/gal equiv. and ~25-30% $2/gal gas equiv.
    - As the interest in purchasing a PHEV increases so does the willingness to pay for fast charge (and the amount to pay goes up)

- Axsen and Kurani, 2008
    - Research methods
        - 3 part online survey
            - Knowledge levels, driving diary and design games
    - Recharging – home is most frequent location of charge opportunity (time at that location and availability of an outlet)
        - Even on weekend home dominates, but more want to charge (29%) during the afternoon around 2pm
    - In design game fast recharging had lower appeal than other attributes like higher fuel economy

- Vyas and Santini, 2008
    - Pre-peak recharging at work is possible because of early arrival and long dwell times

- Kurani, Turrentine and Wright, 1997
  - Methods – mail survey and purchase intention games
    - 454 person survey, suburban CA new car buying households
      - Multi-car households
  - Most chosen away from home recharging locations
    - Work, shopping malls, recreation locations
  - Most who chose to buy EV, would pay for fast charge option (authors believe would be little used)
    - For those who paid for fast charge preferred locations
      - Fewer identified where they want it relative to what they identified for normal charging
      - Sites identified for fast charging visited less often than those for normal charging
      - Sites identified with longer distance travel were identified for fast charging (e.g. vacation destinations and along the highway)
    - From design intent game (51 HH)
      - 1 EV in multi-car HH, slow charging 100 mile range, 3 charge scenarios (slow, normal, fast)
        - Majority of charging would occur at home even if public available
        - Significant amounts daytime charging with just slow charging
          - But increased with normal charging
        - Home charging is key
        - Work is most popular away from home with normal charging
        - Fast charging along highways and at gas stations
          - Authors not sure there is a need for this

- Turrentine, Lee-Gosslin, Kurani and Sperling, 1992
  - Method – Purchase Intention Range Estimation Games
    - Los Angeles residents 236
  - Found adaptability that most willing to avoid excessive discharging of the battery

- Kurani, Turrentine, and Sperling, 1994
  - Method – Purchase Intention Range Estimation Games
    - 3 suburban counties of California, all with multi-car HH
  - Inescapable finding that multicar households easily adapt to driving range limits on one vehicle

- Kurani, Heffner and Turrentine, 2008
  - Method: 23 interviews with drivers of converted PHEV
  - Without deterrents / encouragement people will charge anytime
  - With unconstrained capability to charge, will charge in an unconstrained manner
  - Constraints may be viewed as bad thing on the surface, but could be parlayed into guidelines maximizing benefits

# Appendix B - Land Use Definitions

**1000 SPACED RURAL RESIDENTIAL –** Single family homes located in rural areas with lot sizes greater than one acre. Rural residential estates may have small orchards, fields or small storage buildings associated with the residential dwelling unit.

**1100 SINGLE FAMILY RESIDENTIAL**

1110 SINGLE FAMILY DETACHED – Single family **detached housing units**, on lots smaller than one acre. Newer developments may include clubhouses, recreation areas, pools, tennis, etc. located within and associated with the residential development, if a separate parcel/lot designation does not exist.

1120 SINGLE FAMILY MULTIPLE-UNITS – Includes single family **attached housing units**, duplexes, townhouses, and lower density condominium developments (in general, less than or equal to12 units per acre). Single family attached units are structures with one or more walls extending from ground to roof separating adjoining structures.

1190 SINGLE FAMILY RESIDENTIAL WITHOUT UNITS – Small parcels of land associated with larger residential parcels. Includes but not limited to strips of land adjacent to developed land, car ports, sloped land, or odd-shaped parcels. May include land where a building straddles parcels and only one parcel has dwelling units.

**1200 MULTI-FAMILY RESIDENTIAL –** Apartments and higher density condominium developments (in general, more than 12 units per acre). Newer developments may include clubhouses, recreation areas, pools, tennis, etc. located within and associated with the residential development, if a separate parcel/lot designation does not exist.

1280 SINGLE ROOM OCCUPANCY UNITS (SROs) – For Rent SROs provide small, fully furnished rooms with utilities included, and rent on daily weekly and monthly terms.

1290 MULTI-FAMILY RESIDENTIAL WITHOUT UNITS – Small parcels of land associated with larger residential parcels. Includes but not limited to strips of land adjacent to developed land, car ports, sloped land, or odd-shaped parcels. May include land where a building straddles parcels and only one parcel has dwelling units.

**1300 MOBILE HOME PARK –** Includes mobile home parks with 10 or more spaces that are primarily for residential use. (RV parks are included within the commercial recreation category).

**1400 GROUP QUARTERS**

1401 JAIL/PRISON/BORDER PATROL HOLDING STATION

1402 DORMITORY

1403 MILITARY BARRACKS

1404 MONASTERY

1409 OTHER GROUP QUARTERS FACILITY– Convalescent or retirement homes not associated with or within a health care facility, rooming houses, half-way houses, California Conservation Corps, Honor Camps and other correctional facilities.

**1500 HOTEL/MOTEL/RESORT**

1501 HOTEL/MOTEL (LOW-RISE) – Hotels, motels, and other transient accommodations with three or less floors. Commonly found along freeways and prime commercial areas.

1502 HOTEL/MOTEL (HIGH-RISE) – Hotels and motels that have four or more floors. Primarily found in downtown areas and near tourist attractions.

1503 RESORT – Resorts with hotel accommodations that usually contain recreation areas. Examples of resorts would be La Costa Health Spa, Lawrence Welk and the Olympic Resort in Carlsbad near the airport.

**2000 HEAVY INDUSTRY**

2001 HEAVY INDUSTRY – Shipbuilding, airframe, and aircraft manufacturing. Usually located close to transportation facilities and commercial areas. Parcels are typically large, 20-50 acres.

**2100 LIGHT INDUSTRY**

2101 INDUSTRIAL PARK – Office/industrial uses clustered into a center. The primary uses are industrial but may include high percentages of other uses in service or retail activities.

2103 LIGHT INDUSTRY-GENERAL – All other industrial uses and manufacturing not included in the categories above. These are not located inside of parks, but are usually along major streets or clustered in certain areas. Includes manufacturing uses, such as lumber, furniture, paper, rubber, stone, clay, and glass; as well as light industrial uses as auto repair services and recycling centers. Mixed commercial and office uses (if not

large enough to be identified separately) are also included. General industrial areas are comprised of 75 percent or more of industrial uses (manufacturing, warehousing, and wholesale trade).

2104 WAREHOUSING – Usually large buildings located near freeways, industrial or strip commercial areas.

2105 PUBLIC STORAGE – Public self-storage buildings are typically long, rectangular and closely spaced. Also includes RV storage areas.

**2200 EXTRACTIVE INDUSTRY**

2201 EXTRACTIVE INDUSTRY – Mining, sand and gravel extraction, salt evaporation.

**2300 JUNKYARDS/DUMPS/LANDFILLS**

2301 JUNKYARD/DUMP/LANDFILL – The landscape should show visible signs of the activity. Also include auto wrecking/dismantling and recycling centers.

**4100 AIRPORTS**

4101 COMMERCIAL AIRPORT – Lindbergh Field only.

4102 MILITARY AIRPORT – Airports owned and operated by the military. Found on Military bases.

4103 GENERAL AVIATION AIRPORT – All general aviation airports.

4104 AIRSTRIP

**4110 OTHER TRANSPORTATION**

4111 RAIL STATION/TRANSIT CENTER/SEAPORT – Major transit centers (e.g. Oceanside Transit Center, El Cajon Transit Center), rail stations (e.g. Santa Fe Depot, Solana Beach Station), Coaster stations (Oceanside, Carlsbad Village, Carlsbad Poinsettia, Encinitas, Solana Beach, Sorrento Valley, Old Town, San Diego), major trolley stations, and seaport terminals (Port of San Diego). Parking areas associated with these uses are included. Transit centers within shopping centers are included within the shopping center category.

4112 FREEWAY – Divided roadways with four or more lanes, restricted access, grade separations, and rights of way greater than 200 ft. wide. Includes all right of way and interchange areas, but not frontage roads.

4113 COMMUNICATIONS AND UTILITIES – TV and radio broadcasting stations, relay towers, electrical power generating plants, water and sewage treatment facilities, and large public water supply storage tanks.

4114 PARKING LOT-SURFACE – All surface parking lots not associated with another land use.

4115 PARKING LOT-STRUCTURE – All large parking structures not associated with another land use.

4116 PARK AND RIDE LOT – Stand-alone parking areas that are not associated with any land use. These are usually located near freeways.

4117 RAILROAD RIGHT-OF-WAY (ROW) – All railroad ROWs.

4118 SURFACE STREET RIGHT-OF-WAY – All street ROWs.

4119 OTHER TRANSPORTATION – Maintenance yards and their associated activities, transit yards and walking bridges.

4120 MARINE TERMINAL – National City and 10th Street (Centre City) marine terminals.

**5000 COMMERCIAL**

5001 WHOLESALE TRADE – Usually located near transportation facilities. Structures are usually large and cover the majority of the parcel. Examples are clothing and supply. Also includes swap meet areas.

5002 REGIONAL SHOPPING CENTER – Contain one to five major department stores, and usually have more than 50 tenants. Typically are larger than 40 acres in size.

5003 COMMUNITY SHOPPING CENTER – Smaller in size than the regional shopping centers. Contain a junior department store or variety store (i.e. a Target Center with other commercial stores) as a major tenant and have 15 to 50 other tenants. Smaller in size, 8 to 20 acres. May also have a variety store (i.e. Target, Home Depot or Price/Costco) by itself.

5004 NEIGHBORHOOD SHOPPING CENTER – Usually less than 10 acres in size with on-site parking. Includes supermarket and drug store centers not identified as community commercial. May include office uses that are not large enough to code separately. Neighborhood centers with over 100,000 sq. ft. are inventoried by the Chamber of Commerce, and The Union Tribune (Copley) also collects data on neighborhood centers.

5005 SPECIALTY COMMERCIAL – Tourist or specialty commercial shopping areas such as Seaport Village, Marina Village, Ferry Landing at Coronado, Bazaar del Mundo, Flower Hill, Glasshouse Square, The Lumberyard, Park Plaza at the Village, Promenade, Belmont Park, Del Mar Plaza.

5006 AUTOMOBILE DEALERSHIP – Includes National City Mile of Cars and Carlsbad's Car Country, among others.

5007 ARTERIAL COMMERCIAL – Includes commercial activities found along major streets (not in planned centers), with limited on-site parking. May include mixed office uses that are not large enough to be identified as a separate area. Also may include mixed residential uses, i.e. residential on top of commercial or residential units adjacent to commercial establishments.

5008 SERVICE STATION – Includes gasoline service stations and associated convenience store on stand-alone parcels where it is the primary use.

5009 OTHER RETAIL TRADE AND STRIP COMMERCIAL – Other retail land uses not classified above.

**6000 OFFICE**

6001 OFFICE (HIGH-RISE) – High rise buildings with **more than four stories** containing banking, offices for business and professional services (finance, insurance, real estate), some retail activities and restaurants.

6002 OFFICE (LOW-RISE) – Low rise buildings with **less than five stories** containing banking, offices for business and professional services (finance, insurance, real estate), some retail activities and restaurants.

6003 GOVERNMENT OFFICE/CIVIC CENTER – Large government office buildings or centers (outside of military reservations) and civic centers, or city halls of local governments. Also includes the Chamber of Commerce buildings and DMV Offices.

**6100 PUBLIC SERVICES**

6101 CEMETERY

6102 RELIGIOUS FACILITY

6103 LIBRARY

6104 POST OFFICE

6105 FIRE/POLICE/RANGER STATION

6108 MISSION

6109 OTHER PUBLIC SERVICES – Cultural facilities, museums, art galleries, social service agencies, humane societies, historic sites and observatories.

**6500 HOSPITALS**

6501 UCSD/VA HOSPITAL/BALBOA NAVAL HOSPITAL

6502 HOSPITAL-GENERAL – Hospitals not included above.

6509 OTHER HEALTH CARE – Medical centers and buildings or offices, health care services and other health care facilities. Smaller medical offices and facilities may be included within office, strip commercial or other surrounding uses.

**6700 MILITARY USE**

6701 MILITARY USE – Defense installations; operational facilities; maintenance facilities (non-weapons); research & development; supply & storage (non-weapons); community support facilities and any other military use that does not fall in other categories.

6702 MILITARY TRAINING – Academic, operational and combat training facilities; training ranges; and special purpose training ranges.

6703 WEAPONS FACILITY – Weapons assembly, maintenance and storage facilities.

**6800 SCHOOLS**

6801 SDSU/CSU SAN MARCOS/UCSD

6802 OTHER UNIVERSITY OR COLLEGE

6803 JUNIOR COLLEGE – Includes trade or vocational schools.

6804 SENIOR HIGH SCHOOL

6805 JUNIOR HIGH SCHOOL OR MIDDLE SCHOOL

6806 ELEMENTARY SCHOOL

6807 SCHOOL DISTRICT OFFICE

6809 OTHER SCHOOL – Includes adult schools, non-residential day care and nursery schools.

**7200 COMMERCIAL RECREATION**

7201 TOURIST ATTRACTION – Sea World, Zoo, and Wild Animal Park, Legoland.

7202 STADIUM/ARENA – Sports Arena, San Diego Stadium, and Petco Park.

7203 RACETRACK – Del Mar, San Luis Rey Downs.

7204 GOLF COURSE – Public and private golf courses.

7205 GOLF COURSE CLUBHOUSE – Clubhouses, swimming and tennis facilities and parking lots associated with the golf course.

7206 CONVENTION CENTER – Centre City, Embarcadero.

7207 MARINA – Includes marinas such as Oceanside Harbor, Quivira Basin, Shelter Island, Harbor Island, Embarcadero and Chula Vista marina.

7208 OLYMPIC TRAINING CENTER – Olympic Training Center in Chula Vista.

7209 CASINO – Gambling establishments, typically located on Indian Reservations.

7210 OTHER RECREATION-HIGH – High intensity uses primarily in urban areas. Drive-in theaters, fitness clubs, boys/girls clubs, YMCA's, swim clubs, and stand-alone movie theaters. Also includes tennis clubs without golf, rodeo grounds and senior recreation centers.

7211 OTHER RECREATION-LOW – Campgrounds and other low intensity recreation. Includes public and private primitive and developed camping areas for tents and RVs. Also includes camps and retreat centers owned or used by religious organizations, scouting, or YMCA. Other low intensity uses such as rifle ranges are included.

**7600 PARKS**

7601 PARK-ACTIVE – Recreation areas and centers containing one or more of the following activities: tennis or basketball courts, baseball diamonds, soccer fields, or swings. Examples are Robb Field, Morley Field, Diamond Street Recreation Center, Presidio Park. Smaller neighborhood parks with a high level of use are also included as active parks.

7603 OPEN SPACE PARK OR PRESERVE – Wildlife and nature preserves, lands set aside for open space, and parks with limited development and access. Examples are Torrey Pines State Reserve, Penasquitos Canyon Reserve, San Elijo Ecological Preserve, Nature Conservancy properties.

7604 BEACH-ACTIVE – Accessible sandy areas along the coast or major water bodies (San Diego and Mission Bay) allowing swimming, picnicking, and other beach related recreational activities. Usually has parking associated with it.

7605 BEACH-PASSIVE – Other sandy areas along the coastline with limited parking and access (beaches along cliffs, or near preserves).

7606 LANDSCAPE OPEN SPACE – Actively landscaped areas within residential neighborhoods such as greenbelt areas, hillsides with planted vegetation (trees/shrubs), among others.

7607 RESIDENTIAL RECREATION – Active neighborhood parks that are for the use of residents only such as fenced in areas that may contain pools, tennis & basketball courts, barbecues & a community meeting room.

7609 UNDEVELOPABLE NATURAL AREA **(Planned land-use only)** – Undevelopable natural areas that are not part of an established open space park or preserve. Examples are Cleveland National Forest and open space easements around developments.

**8000 AGRICULTURE**

8001 ORCHARD OR VINEYARD

8002 INTENSIVE AGRICULTURE – Nurseries, greenhouses, flower fields, dairies, livestock, poultry, equine ranches, row crops and grains.

8003 FIELD CROPS – Pasture, fallow.

**9100 VACANT AND UNDEVELOPED LAND * (Historical and Existing only)**

9101 VACANT

**9200 WATER**

9201 BAY OR LAGOON

9202 INLAND WATER – Lakes, reservoirs and large ponds.

**9300 INDIAN RESERVATION * (Planned land-use only)**

**9400 PUBLIC/SEMI-PUBLIC * (Planned land-use only)**

**9500 UNDER CONSTRUCTION * (Historical and Existing only)**

9501 RESIDENTIAL UNDER CONSTRUCTION – Usually located near existing residential developments.

9502 COMMERCIAL UNDER CONSTRUCTION – Usually located near existing commercial or residential areas.

9503 INDUSTRIAL UNDER CONSTRUCTION – Usually located near existing industrial or commercial developments.

9504 OFFICE UNDER CONSTRUCTION – Usually located near existing industrial or commercial developments.

9505 SCHOOL UNDER CONSTRUCTION

9506 -ROAD UNDER CONSTRUCTION

9507 - FREEWAY UNDER CONSTRUCTION

**9600 SPECIFIC PLAN AREA * (Planned land-use only)**

**9700 MIXED USE * (Planned land-use only)**

* The same 4-digit land-use coding system is used for historical, existing and planned land-use. Codes that are used only for historical/existing or planned are indicated.

# Appendix C - Location Selection Models

The ultimate goal of any location selection model is to end up with ¼ mile diameter locations that have the greatest number of potential optimum EVSE sites within them. Optimum EVSE locations are defined as:

Level 2 EVSE commercial and public -

- High number of users
  - Integrated into daily life
  - Available to many different users
- High frequency of vehicle turnover
  - Vehicle stay times of 45 minutes to approximately 3 hours
- Significant availability
  - Maximize the number of open days per week and per year
  - Maximize the number of open hours per day

DCFC –

- High number of users
  - Integrated into daily life
  - Available to many different users
- Very high frequency of vehicle turnover
  - Vehicle stay times of 5 minutes to 30 minutes
- Significant availability
  - Maximize number of open days per week and per year
  - Maximize number of open hours per day

***Level 2 EVSE Location optimization (sample) model 1:***

Three categories of sites based on typical weekly / weekend schedules and associated driver behavior. (Note: A site may qualify and score within more than just one category.)

1. Around homes with PEVs. This category is intended to capture work-week morning and evening activities along with non-work week activities routinely performed within close proximity to home (*e.g.* grocery shopping, recreation, dining out, entertainment, shopping, school, medical, etc.).
2. Between homes with PEVs and major employment locations and along routes to/from major employment locations. This category is intended to capture work-week activities performed in-route to/from places of employment, and activities performed around places of employment (*e.g.* dining out, shopping, entertainment, school, medical, education, etc.).

3. Regional attractions. This category is intended to capture work-week and non-work week (*i.e.* special occasion) activities at sites that can attract drivers from all over the region (*e.g.* shopping, recreation, entertainment, education, health care, etc.).

The importance of land uses, distances from home or work, and other characteristics will likely vary under each of the three categories described briefly above. This model hypothesizes and attempts to capture the differences in characteristics for each category.

A particular site is scored on a weighted sum of its score within each of the three categories.

Qualifying and scoring within each category is described below.

Category 1: Around homes with PEVs

For sites to qualify as potential locations for EVSE land use would need to fall within one of the specified land uses. If a site is on the qualifying land use list for category 1 the site gains points if it is located within PEV home area zip code and for each PEV home area zip code within 4 miles. For this category, sites receive a greater weight (multiplier) for the PEV home area zip code they are located in. PEV home area zip codes are standardized scores based on probable density of PEVs in the zip code. Each PEV home area zip code score is multiplied by weight (1 if within and .5 if within 4 miles of) of the site's location relative to that PEV home area zip code. The sum of scores for a site from location within and proximity to PEV home area zip codes is multiplied by a standardized average daily traffic count for the road that the use is located on.

Category 2: Between PEV home and work, around work and along route.

For sites to qualify as potential locations for EVSE land use would need to fall within one of the specified land uses. A site on the qualifying land use list for category 2 will gain points if it is located within an employment area, within 3 miles of an employment area, and along a major transportation corridor connecting PEV home area zip codes to employment areas (*i.e.* within a ¼ mile of a freeway or prime arterial connecting an employment area to a PEV home area). Weights (multipliers) for site scoring are below:

| Site Location | Weight |
|---|---|
| Within employment area | 1 |
| Within 3 miles of employment area | 0.4 |
| Along route employment area to PEV home | 0.6 |

Employment areas are standardized scores of density of jobs / employment area. An employment area score is multiplied by the weight of a site's location relative to that employment area. The sum of scores for a site from location within and proximity to

employment areas and along major transportation corridors from employment areas is multiplied by a standardized average daily traffic count for the road that the use is located on.

Category 3: Regional attractions

For sites to qualify as potential locations for EVSE land use would need to fall within one of the specified land uses. A site on the qualifying land use list for category 3 will gain points based on its distance from PEV home area zip codes. Weights (multipliers) for site scoring are below:

| Site Location | Weight |
|---|---|
| 40 - 50 miles from PEV home area | 1 |
| 30-39 miles from PEV home area | 0.75 |
| 20-29 miles from PEV home area | 0.5 |
| <19 miles from PEV home area | 0.25 |

PEV home area zip codes are standardized scores based on probable density of PEVs in the zip code. The PEV home area score is multiplied by the distance weight. The average score for the site in each distance category is then calculated. The sum of average scores for a site based on distance from PEV home areas is multiplied by a standardized average daily traffic count for the road the use is located on. For uses with more than one main entry point the sum of standardized average daily traffic counts shall be the multiplier.

A site's score from each category is then multiplied by the category weight, as shown in the table below, and then summed for the grand total site score.

| Category Weights | Weight |
|---|---|
| Category 1 | 0.6 |
| Category 2 | 0.7 |
| Category 3 | 0.5 |

Category weights were assigned based on possible need for public charging and on potential hours a week a PEV driver might have for frequenting the land uses within each category. Need for public charging is primarily attributed to distance from home (where a PEV could leave with maximum range available). The potential hours a week a PEV driver might have for frequenting land uses within any given category are largely a factor of work and non-work periods. Assumptions are:

- Category 1
  - Activities occur within close proximity to home
  - 5-day work week hours before and after work of approximately 5 hours a day

    - 2-day non-work week hours of approximately 16 hours a day
- Category 2
    - Activities occur between home and work, and around work
    - 5-day work week with approximately 4 hours before, during break and after work for activities
- Category 3
    - Activities have higher probability of occurring at greater distances from home than for category 1
    - 2-day non-work week hours of approximately 16 hours a day, plus holidays and vacation days
    - Activities are more special occasions that would occur less frequently throughout the year than for categories 1 and 2

After sites in the San Diego region are scored a density map of optimum sites can be created, and ¼ mile diameter location boundaries (approximately 400 – 500 locations) can be created around the highest densities of optimum sites.

Ideal EVSE densities within the ¼ mile locations created can then be determined based on the sum of standardized average daily trips on the roads (excludes freeways within the locations) within each ¼ mile diameter location.

***Level 2 EVSE and / or DC Fast Charge Location optimization (sample) model 2:***

Sites scores are determined by multiplying a site's land use score by a standardized average daily traffic score for the road that serves the site. If the site is within a major activity center or employment area the major activity center / standardized employment area score is added to the average daily traffic score before being multiplied by the land use score.

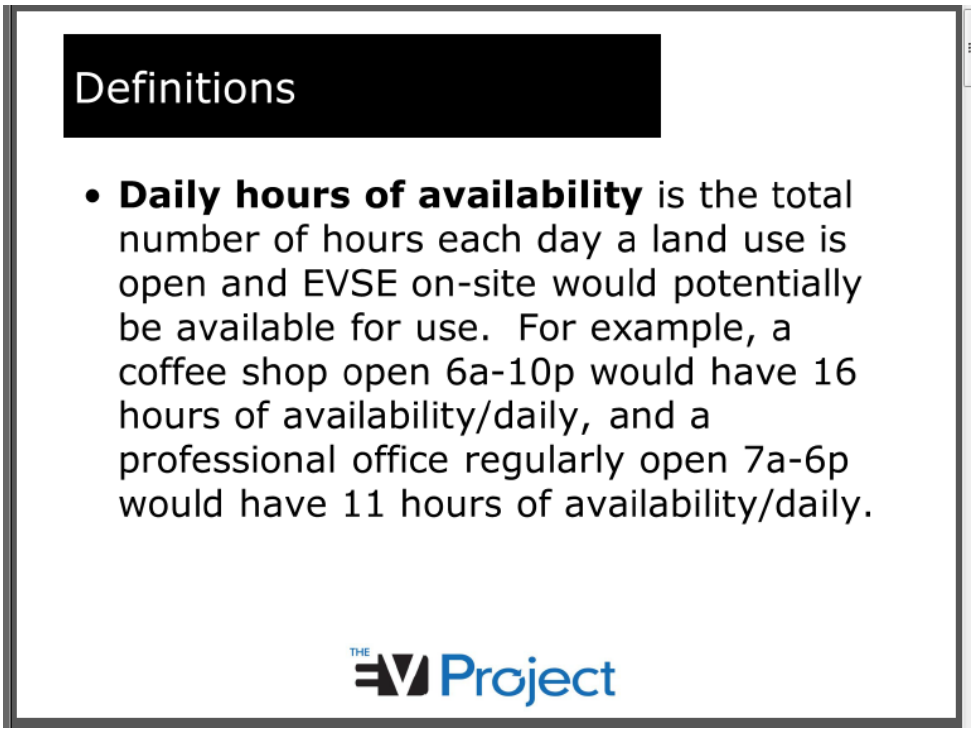
All land use scores are a composite of multiple factors. The following land use factors make up the composite land use score:

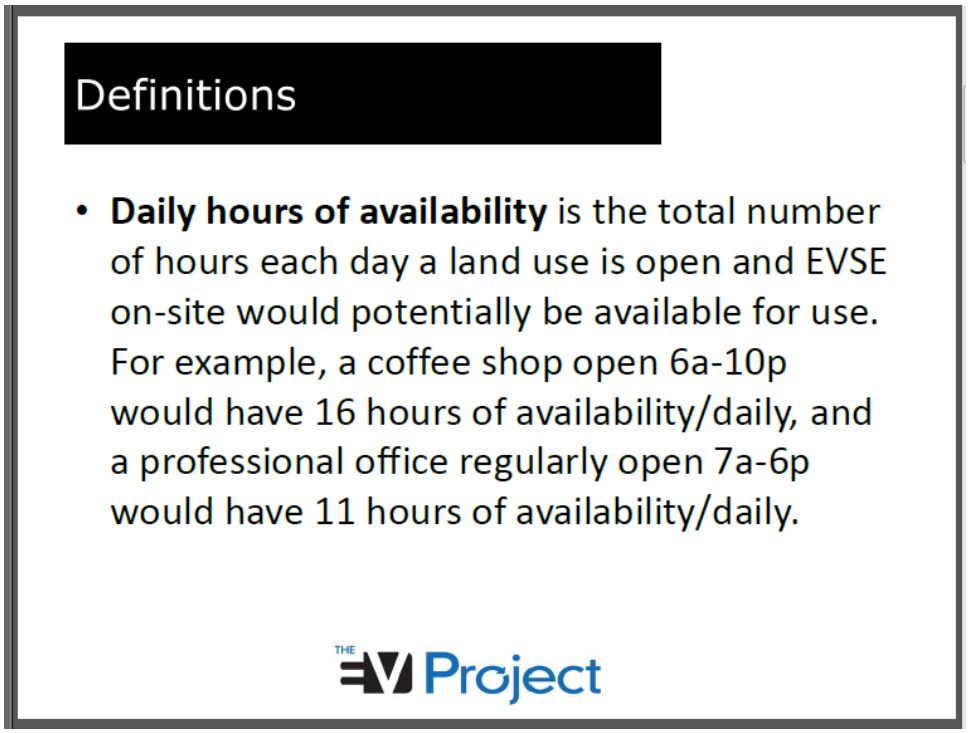
- Daily hours of availability
- Average stay of 45 minutes to 3 hours (for DC Fast charge the stay is 5 minutes to 30 minutes)
- Availability to many users (takes account of any restrictions, such as employee only use, etc.)
- Availability throughout the year (taking account of seasonality)

After sites in the San Diego region are scored a density map of optimum sites can be created, and ¼ mile diameter location boundaries (approximately 400 – 500 locations) can be created around the highest densities of optimum sites.

Ideal EVSE densities within the ¼ mile locations created can then be determined based on the sum of standardized average daily trips on the roads (excludes freeways within the locations) within each ¼ mile diameter location.

## Appendix D - ESAC Location Selection Handouts



## Definitions

- **Average stay** refers to the typical amount of time a patron, customer or visitor might stay at a land use, during non-night hours (10p – 6a). For example, a customer may stay at a gasoline filling station convenience store 5-10 minutes, or at a movie theater for 2-3 hours. Stay times of 45 minutes – 3 hours are suitable for DC Fast Chargers.

THE EV Project

## Definitions

- **Availability to many users** refers to a land use's openness to the general public to visit the use. A public beach is an example of a very available land use, while an airstrip for privately owned planes is an example of an unavailable use.

THE EV Project

## Definitions

- **Availability throughout the year** refers to the number of days a year that a land use is open to the public. As an example, a professional office closed on weekends might be available approximately 250 days/year, while a theme park might be available 365 days a year.

## Definitions

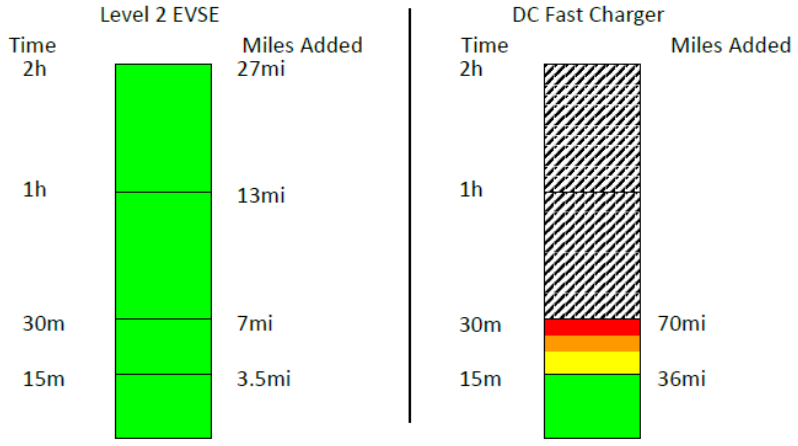
- **Employment center** refers to the number of jobs in the zone that the land use is located in, and implies a nearby day-time population.

## Nissan Leaf

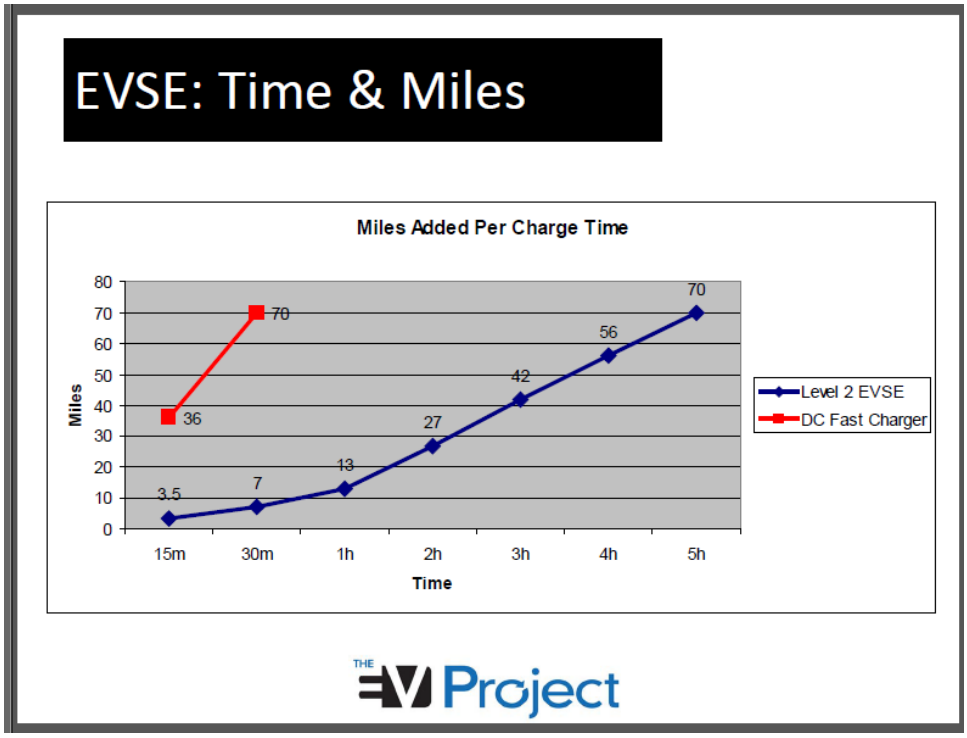
- Nissan Leaf
  - 100 mile maximum range
  - 24 kWh battery
  - Approximately 4.2 miles/kWh
  - 3.3 kW charger (Level 2)
  - Seats 5 people


THE EV Project

## EVSE: Time & Miles




THE EV Project


EVSE: Time & Miles
Miles Added Per Charge Time
Miles
80
70
60
50
40
30
20
10
0
15m
30m
1h
2h
3h
4h
5h
Time
3.5
7
13
27
42
56
70
36
70
Level 2 EVSE
DC Fast Charger
THE EV Project