



## WESTSIDE SUBWAY EXTENSION PROJECT

# Updated Direct Ridership Forecasting Report

September 8, 2011





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## 1.0 INTRODUCTION

### 1.1 Memorandum Purpose

The purpose of this report is to present daily ridership estimates (both boardings and alightings) using a Direct Ridership Forecasting (DRF) model for the following stations that are part of the Locally Preferred Alternative (LPA) for the Westside Subway Extension Project:

- Wilshire/La Brea
- Wilshire/Fairfax
- Wilshire/La Cienega
- Wilshire/Rodeo
- Century City
  - Constellation Option
  - Santa Monica Option
- Westwood/UCLA
  - On-Street Option
  - Off-Street Option
- Westwood/VA Hospital
  - North Option and South Option treated as one in this analysis due to the close proximity of station entrances

This report updates the direct ridership forecasting conducted for the *Smart Growth Evaluation Report* (Metro, August 2010) by using a more refined land use and demographic data set. However, a direct comparison between the two forecasts should not be made because the *Smart Growth Evaluation Report* used future year 2035 projections and this analysis focuses on using detailed existing (year 2010) land use and demographic data.

### 1.2 Direct Ridership Forecasting

Direct Ridership Forecasting models use multivariate regression based on empirical data to determine the station characteristics that influence rail transit patronage. They respond directly to factors such as parking, feeder bus levels, station-area households and employment, and the effects of transit oriented development. Rail ridership is traditionally forecast with region-wide travel demand models, which often represent transportation networks and land use at an aggregate scale. Such models are typically unresponsive to changes in station-level land use and transit service characteristics. DRF models are directly and quantitatively responsive to land use and transit service characteristics within the immediate vicinity and catchment area of transit stations.

The DRF model used for this study was based on the model<sup>1</sup> developed for the Bay Area Rapid Transit (BART) Demand Management Study. This model predicts changes in ridership at individual

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<sup>1</sup> The model development report is contained as Appendix B.

stations along the BART heavy rail system during the AM and PM peak hours and was based on empirical relationships found through statistical analysis of BART system ridership data and the 2008 BART Station Profile Study (BART 2008) for the BART system. To determine if the DRF model developed for the BART system was suitable for use on the Westside Subway Extension Project, the DRF model was compared to daily ridership data collected in 2008 along the existing Metro Heavy Rail Transit service in Los Angeles.

### 1.3 Model Input Variables

Data was developed for nearly 100 independent variables believed to be potentially predictive of station ridership. The station level data collected from the BART system was used to perform ordinary least squares (OLS) regression analysis to predict daily boardings. This analysis is based on empirical relationships found through statistical analysis of station ridership and local station characteristics. Multiple iterations of all collected data were tested in the regression model, but the variables that entered into the DRF model as significant were the following:

- Total population within a one-half mile walkshed
- Total employment within a one-half mile walkshed
- Retail employment within a one-half mile walkshed
- Non-retail employment within a one-half mile walkshed
- Neighborhood (on-street) parking spaces within a one-half mile walkshed
- Total vehicle parking spaces within a one-half mile walkshed
- University catchment population
- Total catchment population
- Total catchment non-retail employment
- Station bike parking spaces
- Pedestrian accessibility and design rating
- Number of trains arriving and departing in the AM and PM peak hours
- Number of supporting bus routes

### 1.4 Model Development Process

The objective of the BART DRF model development effort was to derive statistically valid models capable of predicting current station-specific ridership, both boardings and alightings, over nine time periods:

- AM Early
- AM Pre-Peak Shoulder
- AM Peak
- AM Post-Peak Shoulder



- Midday
- PM Pre-Peak Shoulder
- PM Peak
- PM Post-Peak Shoulder
- Evening

Boardings models were developed for each time period for four modes of access: Walk/Bike, Transit, Park, and Drop Off. These models were combined to develop the total boardings for each time period. Alightings models followed a similar process, but with only three modes of egress: Walk/Bike, Transit and Drive.

The mathematical form of each model is a linear regression formula. The variables included in each model, along with overall model performance indicators (R-squared) are presented in Table B-2 through Table B-5 of Appendix B. The R-squared indicator expresses how close the model comes to explaining all of the station-to-station variability in the dependent variable. For example, a perfect R-squared value of 1.0 model indicates the variation in PM ridership among all BART stations is fully described by the model's combination of independent variables (population, employment, etc.) with their respective coefficients and constant term.

## **1.5 Model Validation**

The purpose of the validation of the BART DRF model was to ensure the model was statistically valid and capable of predicting current daily ridership (boardings and alightings) for existing Metro HRT service in Los Angeles. The model was also validated to ensure the model was capable of responding to input changes, and therefore able to predict future transit ridership at the seven candidate stations.

Daily ridership data collected in 2008 for the following 13 stations along the Red/Purple Lines was provided by Metro for the DRF model validation.

1. Metro Red Line North Hollywood Station
2. Metro Red Line Universal City Station
3. Metro Red Line Hollywood/Highland Station
4. Metro Red Line Vermont/Sunset Station
5. Metro Red Line Vermont/Santa Monica Station
6. Metro Red Line Vermont/Beverly Station
7. Metro Red Line Hollywood/Western Station
8. Metro Red Line Hollywood/Vine Station
9. Metro Red/Purple Line Wilshire/Vermont Station
10. Metro Red/Purple Line Westlake/MacArthur Station
11. Metro Red/Purple Line 7th Street/Metro Center Station

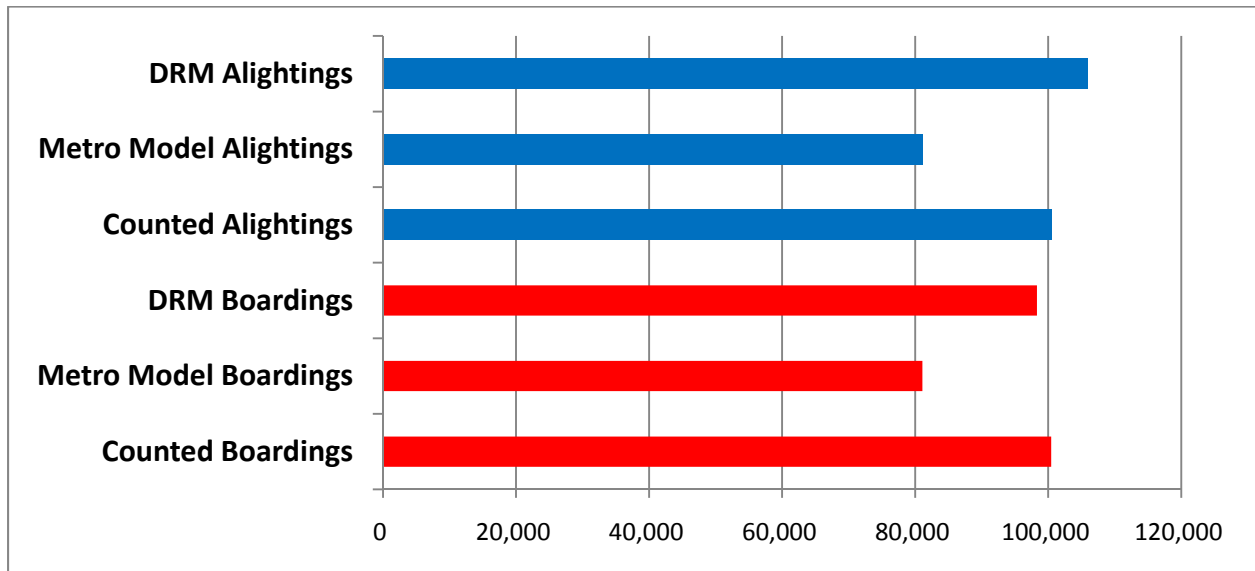
12. Metro Purple Line Wilshire/Western Station

13. Metro Purple Line Wilshire/Normandie Station

Station-related demographic, land use, and transit data within a ½-mile walking distance of each of the 13 stations were derived with TAZ data from the base year Metro Regional Travel Demand Model. The TAZ data was also used to develop station catchment population and employment data to account for kiss and ride patrons as well as patrons who may park nearby. Feeder transit, transit frequency, and other transit-related data were collected from Metro’s website.

The model validation results for daily boardings and alightings at all 13 stations are presented in Figure 1-1 along with the results from the Metro Regional Travel Demand Model for the same 13 stations.

**Figure 1-1. DRM Model Validation Results**



As shown in Figure 1-1, the DRF model under-predicts system-wide Metro Red/Purple Line daily boardings by approximately 2% and over-predicts daily alightings by approximately 5%, while the Metro Regional Travel Demand Model under-predicts both boardings and alightings by approximately 19%.

Based on the model validation results, it was determined that the DRF model was suitable for forecasting daily ridership (boardings and alightings) at each of the seven stations for the Metro Westside Subway Extension.





## 2.0 DATA SOURCES AND ANALYSIS METHODOLOGIES

Data for the 13 DRF model input variables (as identified in Section 1.3) were collected for each Westside Subway Extension Station. These variables were used to predict daily boardings at each station.

### 2.1 Walkshed Analysis

The Network Analyst tool in ArcGIS<sup>3</sup> was used to measure walking distance on the existing street network from the primary entrance for each station option. Consistent with the *Westside Subway Extension Draft Environmental Impact Statement/Draft Environmental Impact Report*, one-half mile walksheds from the primary station entrance have been evaluated.

### 2.2 Population Data

Population data were obtained from the 2000 United States Census at the Census Block level. Year 2010 Census Estimates at the Census Block Group level were used to derive growth factors that were then applied to the 2000 Census data to reflect 2010 population numbers contained within each walkshed. When Census Blocks were fully contained within a walkshed, the population from the Census Block was counted. If a Census Block was split by walksheds or only partially contained in one walkshed, the population was divided proportionately based on how much of the Census Block was located within one walkshed distance versus another. Open space and non-residential areas were taken into account when splitting Census Block populations.

### 2.3 Employment Data

Real estate data obtained from Grubb & Ellis, a respected commercial real estate service and investment company, were used to estimate the number of jobs within each walkshed. Grubb & Ellis maintains a detailed real estate database (*Grubb & Ellis/Costar*) of every leasable office and retail property in Los Angeles and lists the rentable building area (RBA) for each building contained in the data set. Because the database lists total RBA for each property, a vacancy factor of 10 percent has been assumed for all office and retail/food service space in this analysis to represent standard market conditions. While the vacancy rate for Century City office space is currently 13 percent (*Los Angeles Times*, 2011), a senior officer at Grubb & Ellis indicated that 10 percent represents a typical vacancy rate under standard market conditions. Therefore, 10 percent of the RBA within each walkshed has been assumed to be vacant.

To estimate the number of jobs provided at each property, square feet per employee standards have been applied to the RBA for each property. A per-room employee standard has been applied to the number of hotel rooms for each hotel contained within a walkshed. Table 2-1 details the standards applied to calculate the number of jobs at each property contained within the walksheds. Appendix A provides the detailed job calculations for each property, as well as the walkshed the property falls within.

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<sup>3</sup> ArcGIS is a Geographic information system (GIS) software used to analyze spatial relationships and spatial data.

**Table 2-1: Land Use per Employee Standards**

Land Use	Standard	Units
Office	350	square feet
Retail	600	square feet
Food Service	450	square feet
Hotel	2	rooms

Source: Fiscal Impact Analysis Model (FIAM) South Florida Regional Planning Council, 2011

### 2.3.1 Validating Employment Data Accuracy

As part of the *Century City Station Options Updated Jobs and Population Inventory Memorandum* (Metro, May 2011), two validation checks were performed for the Century City Station to validate the derived employment data:

1. Job estimates from this analysis were compared to U.S. Census 2009 employment estimates at a Census Block level. The same approach to split Census Block population data described above was applied to Census Block employment data to estimate walkshed employment. Based on these Census Block estimates, approximately 33,408 jobs are accessible within the one-half mile walkshed of the Constellation Option, suggesting that the analysis contained in this memorandum is comparatively accurate.
2. Through the Century City Chamber of Commerce, occupancy data and total RBA of most of the main office buildings in Century City were obtained from property managers. In total, these buildings averaged 387 square feet of RBA per occupant, which is close to the 350 square feet per occupant assumption used to calculate office jobs in the analysis using the Grubb & Ellis data above.

## 2.4 Parking

No LPA station will offer park-and-ride facilities, so this value was set to zero for each analyzed location.

## 2.5 University Population

The University of California, Los Angeles (UCLA), with a total enrollment of just under 40,000 (including undergraduates, graduate students, and interns/residents), is located within a one-half mile walk of the Westwood/UCLA Station (either the Off- or On-Street Option). Although the majority of the campus falls outside the one-half mile station walkshed, the penchant for students to walk farther than a typical pedestrian and presumed high frequency shuttle service between the station and campus suggests that the entire campus should be considered in the DRF model.

More than 70 percent of students (28,820 undergraduates, graduate students, residents, and interns combined) commute from their off-campus residence to UCLA<sup>4</sup>. The current transit mode share among commuting students is 33.2 percent and a substantial increase is expected with a Westwood/UCLA subway stop. However, West Los Angeles, including the cities of Santa Monica and Culver City, has a high concentration of overall UCLA student commuters, and that area will not be served

<sup>4</sup> 2010 State of the Commute Report (UCLA Transportation, 2011)



by the subway. Instead of inputting the entire student population into the DRF model, it was conservatively estimated that only 25 percent of student commuters (about 7,000) are potential riders.

## **2.6 Catchment Population and Employment**

The catchment area refers simply to the most likely service areas for each station. These areas are developed based on the proximity to the station and the ease of access over different transportation modes. Each station catchment has a unique area and they do not overlap. Since many bus transit and drop-off access riders come from outside the one-half mile station area, catchment area population and employment data are often more descriptive than half-mile variables for feeder transit and auto drop-off models.

## **2.7 Bike Parking**

Bike parking inputs were obtained from the *Station Circulation Report*. The Metro Bicycle Program recommended bicycle parking supply per station were used in this analysis, ranging from 45 spaces at the Wilshire/Rodeo Station to 117 spaces at the Westwood/UCLA Station.

## **2.8 Pedestrian Accessibility and Design Rating**

The pedestrian accessibility and design rating relates directly to the connectivity and accessibility of the station, as well as its orientation (automobile or pedestrian). The measure combines three categories to form a score from 1 to 6. Each station scored a single point for being underground. All stations except for Westwood/VA Hospital scored a point for not being adjacent to a freeway. Stations also scored a point for each direction (out of four) that the station provides direct access to the surrounding neighborhood without having to travel at an angle more than 45 degrees in either direction or having to cross a freeway/expressway, a large parking lot, or an industrial area.

## **2.9 Subway Service Frequency**

The LPA is expected to operate seven days per week, 365 days per year, with hours of operation from 4:30 a.m. to 1:30 a.m. Peak-period headways of 4 minutes will be in effect during weekday non-holidays, from 6:00 a.m. to 9:00 a.m. and from 3:00 p.m. to 7:00 p.m. Off-peak headways of 10 minutes will be in effect during the remaining weekday hours of operation and on weekends. Service frequencies on other Metro Rail lines and bus routes in the corridor will be the same as for the No Build Alternative.

## **2.10 Supporting Bus Routes**

With the LPA, no major restructuring of bus routes is expected, and bus fleet requirements will not be modified in a major way. Thus, existing bus routes that serve the station areas were counted as supporting bus routes and input into the model. The number of buses serving each station area per hour was obtained from the *Feeder Service Operations Plan*. For the Century City Station options (Constellation and Santa Monica), Metro Rapid 704 was counted as feeder service even though the route does not stop adjacent to either of the station entrances. Similarly, Metro Local 4 was assumed as feeder service for the Constellation Option.

### 3.0 STATION AREA POPULATION AND EMPLOYMENT

Table 3-1 summarizes the population and jobs within one-quarter and one-half mile walksheds for each potential station area. Adjustments made for large institutions are as follows:

- Approximately 16 percent of Fox Studios is located within the one-half-mile walkshed of the Constellation Option. To provide a conservative estimate, only 16 percent of the 2,600 Fox Studios employees (no contractors) were included within the one-half-mile walkshed job totals included in Table 3-1.
- A total of 25,550 faculty and staff are employed at UCLA. However, West Los Angeles, including the cities of Santa Monica and Culver City, has a high concentration of UCLA faculty and staff that will not be served by the subway. For the DRF model jobs input, it was conservatively estimated that 25 percent (6,390) of faculty and staff commuters are potential riders.

Figure 3-1 through Figure 3-9 show each station or station option for two walkshed distances (one-quarter mile and one-half mile) and list the jobs and population within each walkshed.

**Table 3-1: Walkshed Population and Jobs**

Westside Subway Extension Station	Total Jobs 1/4 Mile	Total Jobs 1/2 Mile	Population 1/4 Mile	Population 1/2 Mile
Wilshire/La Brea	2,210	5,390	1,460	7,320
Wilshire/Fairfax	2,880	11,710	710	4,650
Wilshire/La Cienega	3,360	10,530	920	4,600
Wilshire/Rodeo	8,250	16,960	780	4,420
Century City (Santa Monica)	10,310	27,290	180	1,900
Century City (Constellation)	20,170	31,040	210	2,010
Westwood/UCLA*(Off Street)	10,360	19,870	1,260	7,170
Westwood/UCLA*(On Street)	10,310	19,980	1,280	7,470
Westwood/VA Hospital	3,500	7,600	0	470

*Source: Fehr & Peers, 2011; 2000 U.S. Census; 2010 U.S. Census Estimates; Grubb & Ellis/Costar, 2011; UCLA, 2011*

\*Total jobs one-half mile for Westwood/UCLA Station options include 25 percent of the UCLA faculty and staff total of 25,550



Figure 3-1: Wilshire/La Brea Station Walkshed Population and Jobs

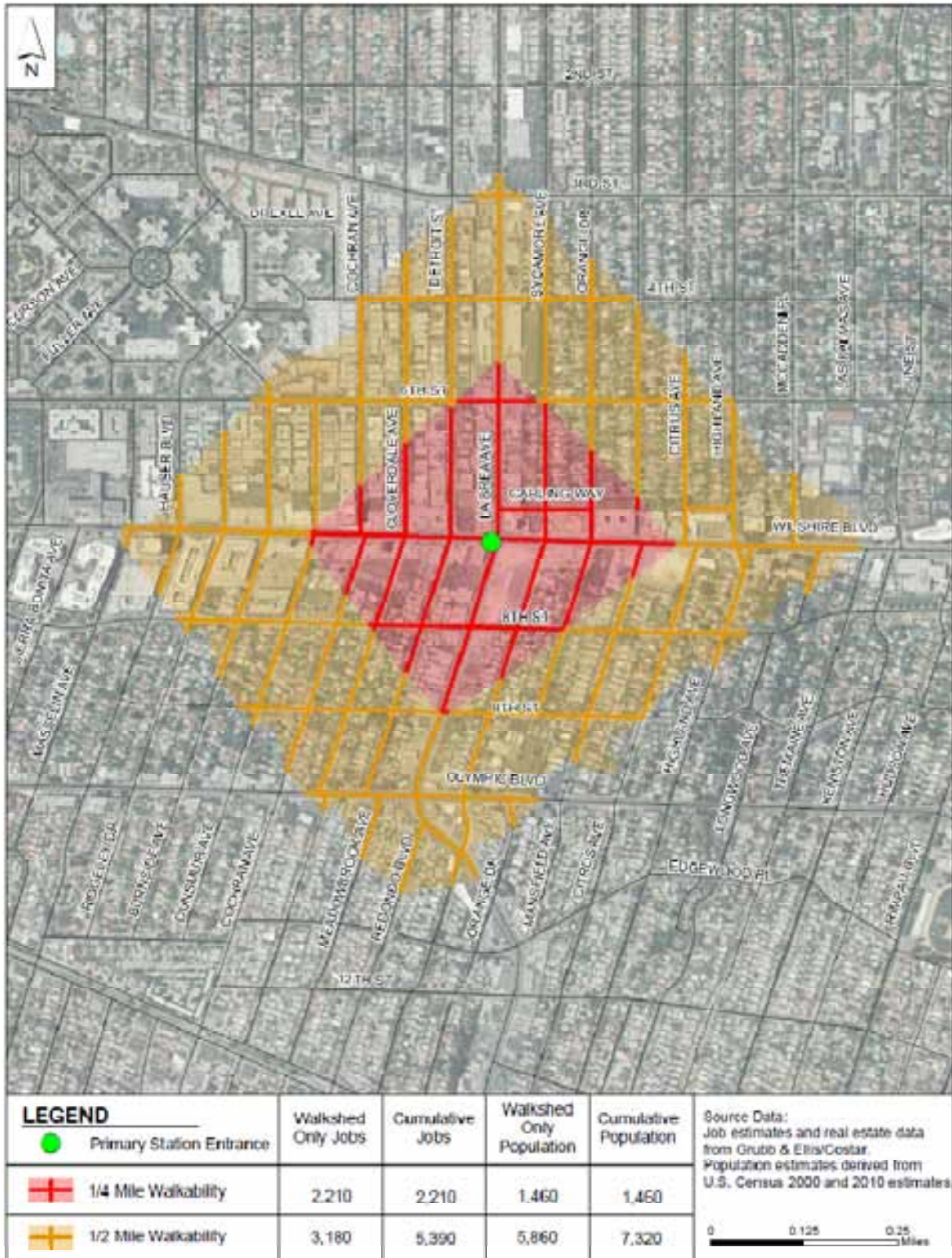
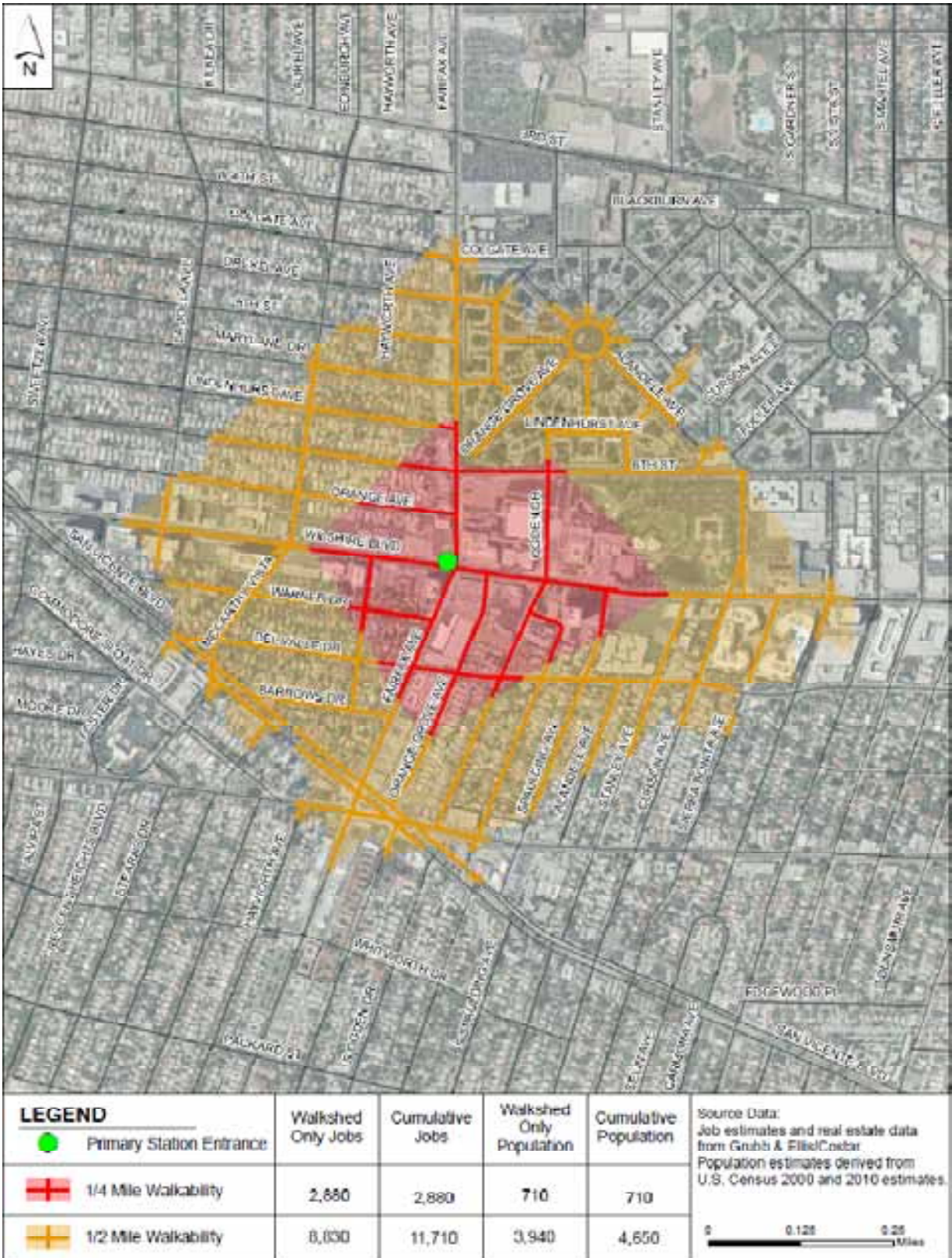




Figure 3-2: Wilshire/Fairfax Station Walkshed Population and Jobs



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Figure 3-3: Wilshire/La Cienega Station Walkshed Population and Jobs





Figure 3-4: Wilshire/Rodeo Station Walkshed Population and Jobs

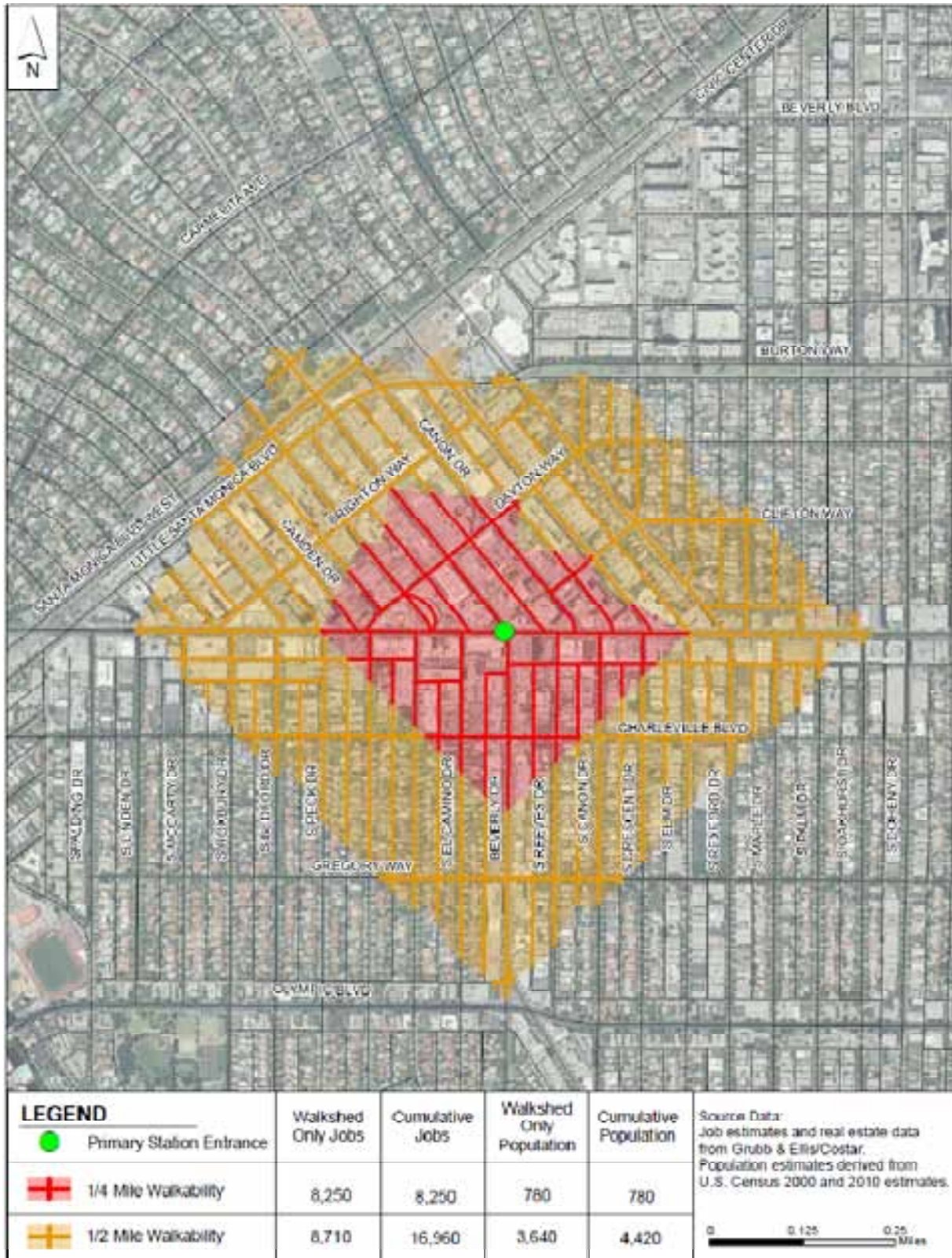






Figure 3-5: Century City Santa Monica Station Option Walkshed Population and Jobs

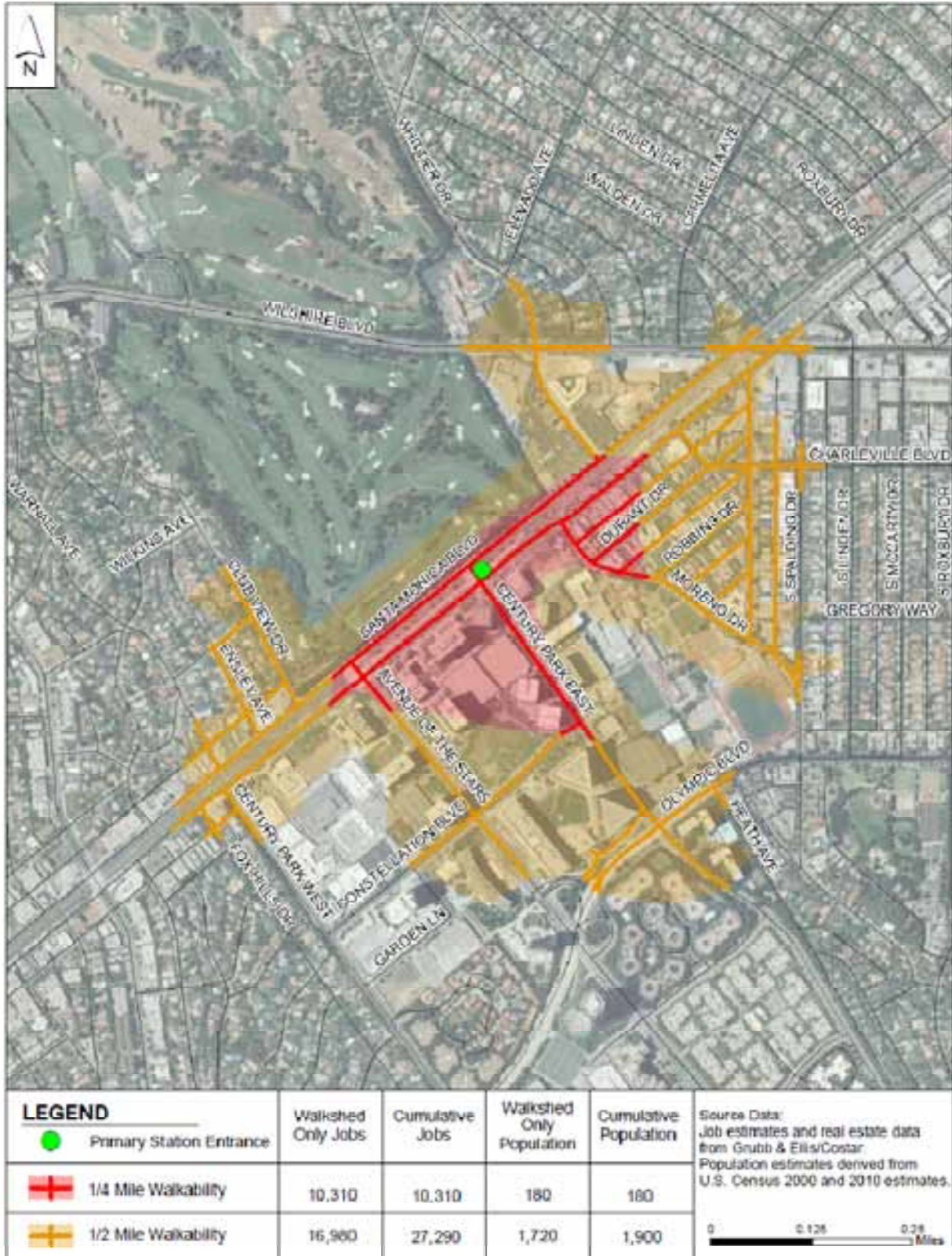
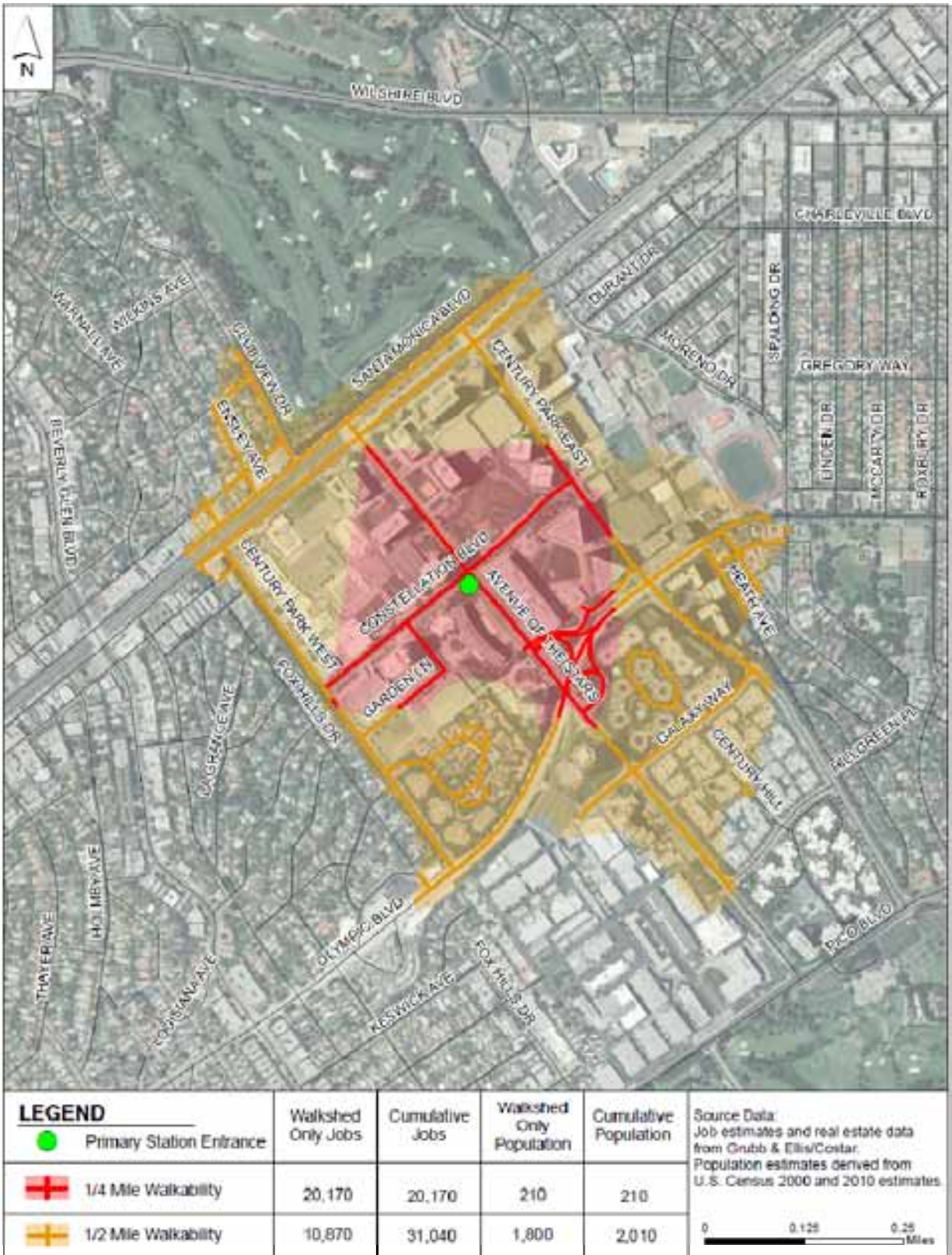




Figure 3-6: Century City Constellation Station Option Walkshed Population and Jobs



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Figure 3-7: Westwood/UCLA Off-Street Station Option Walkshed Population and Jobs

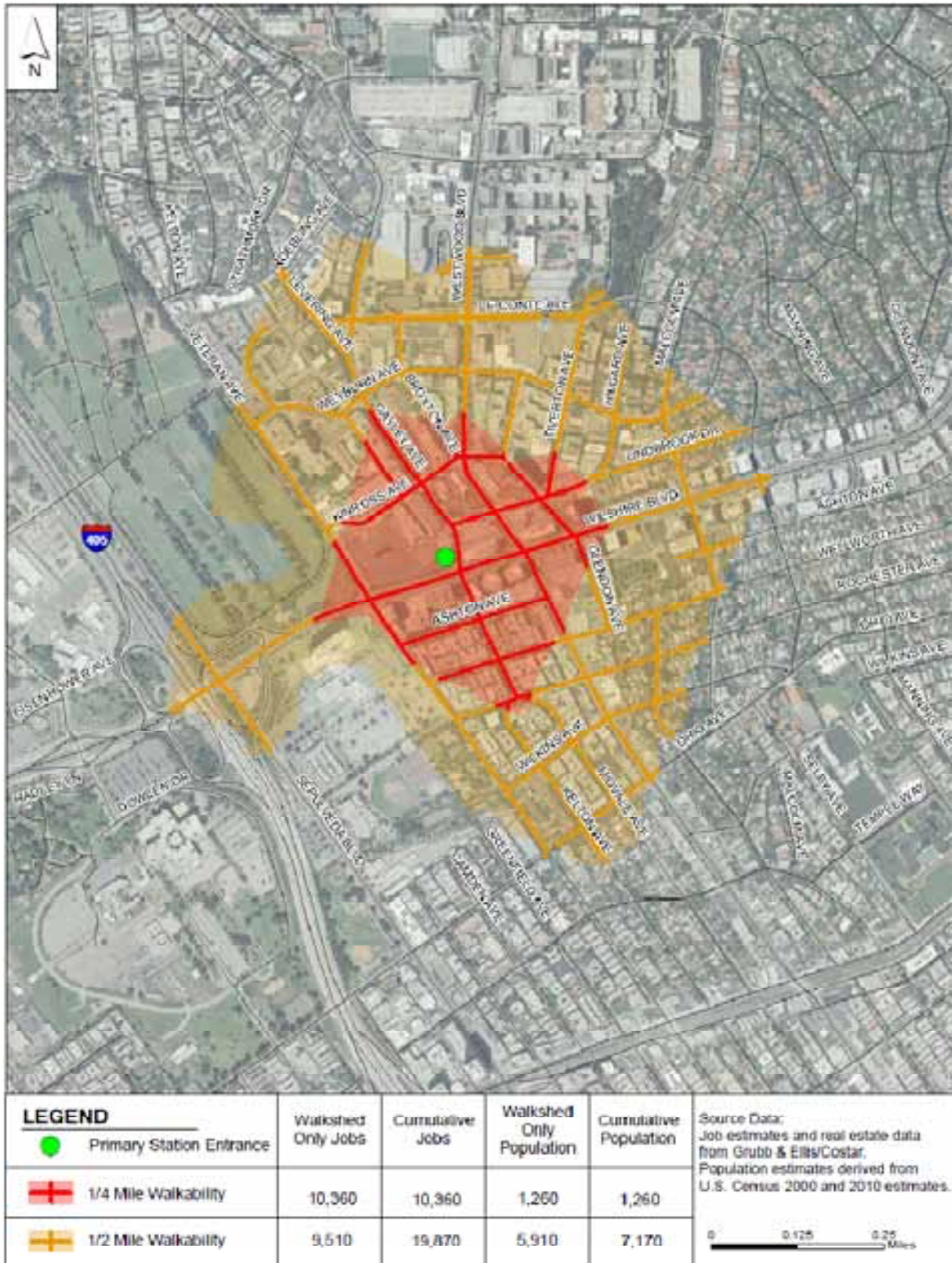




Figure 3-8: Westwood/UCLA On-Street Station Option Walkshed Population and Jobs

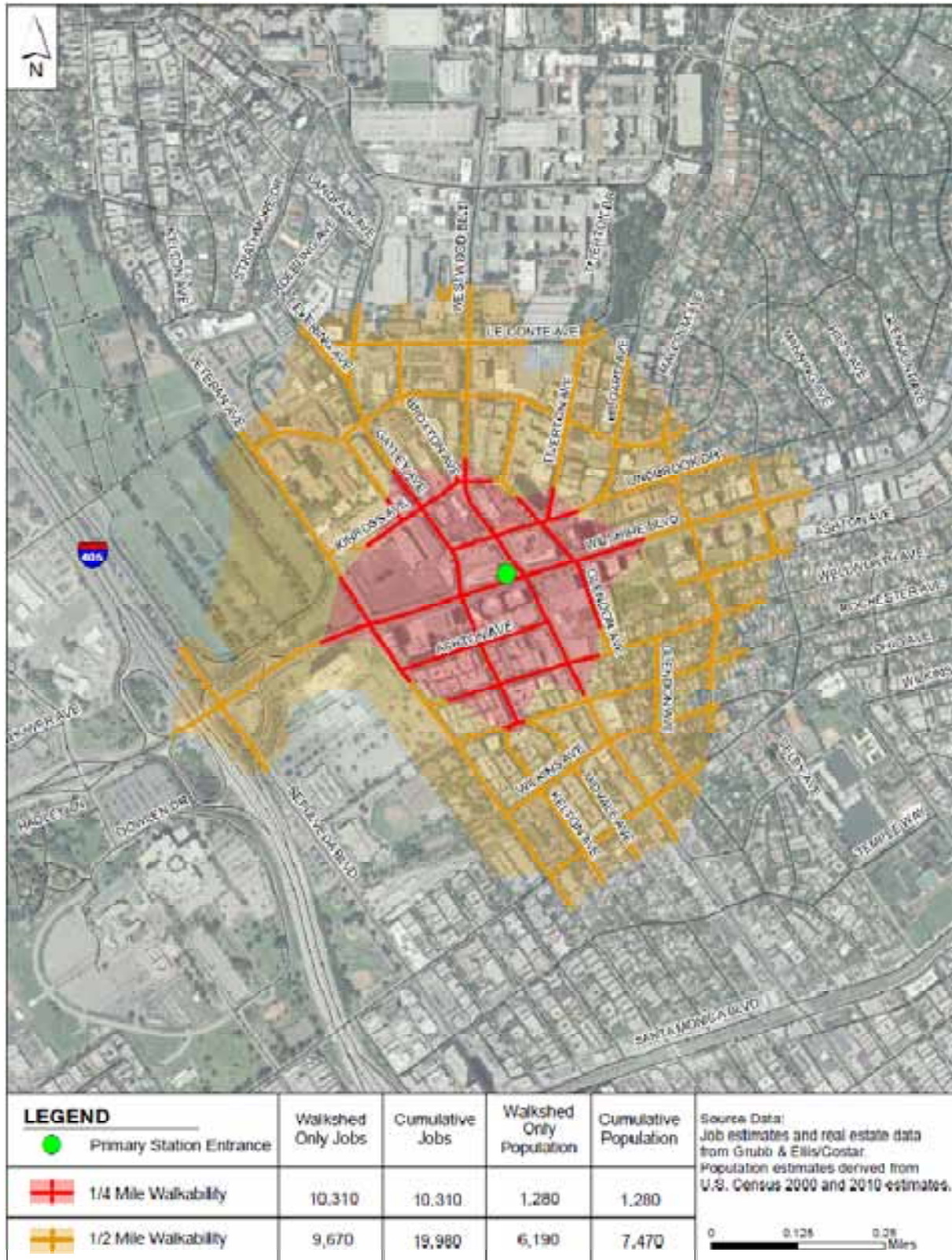
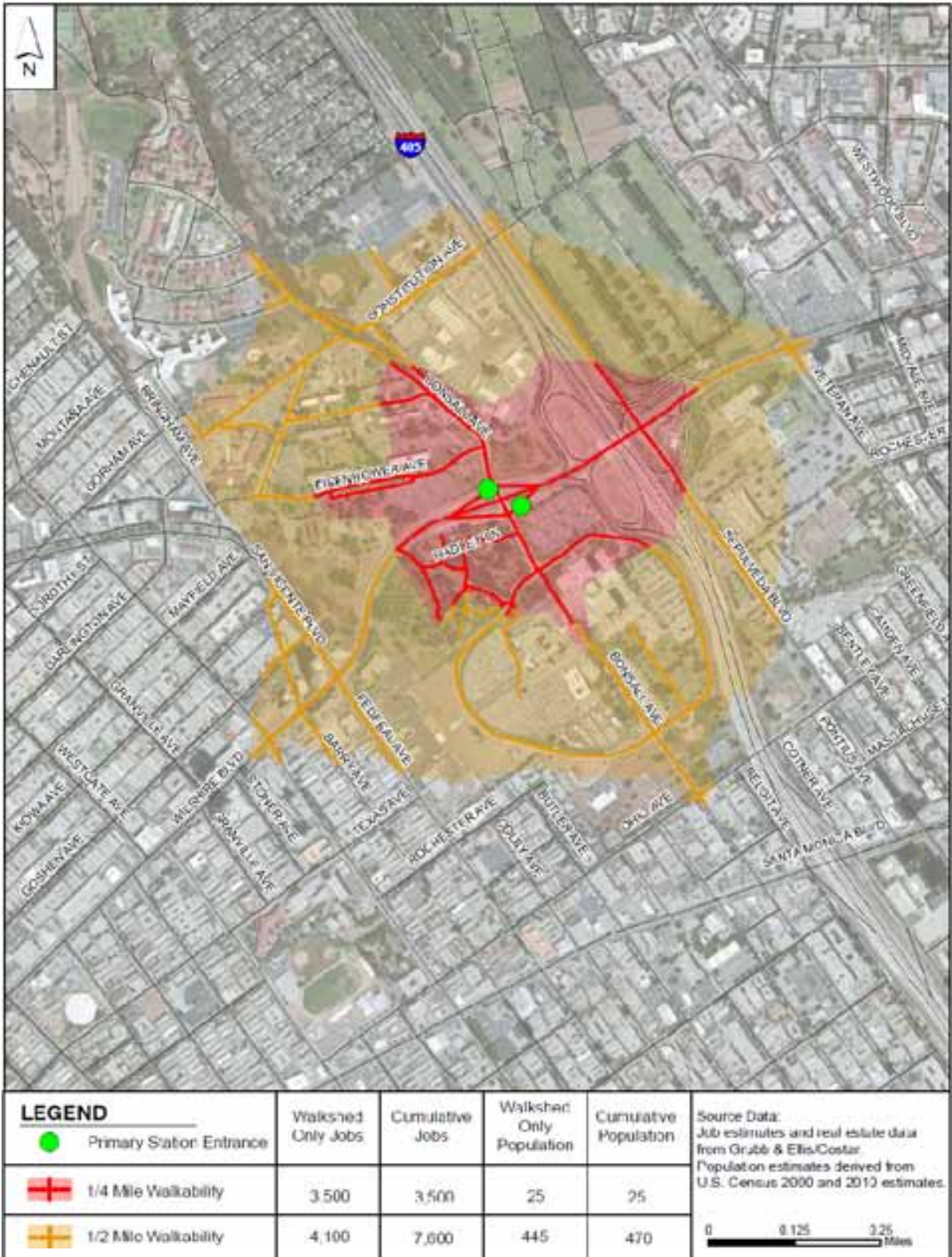






Figure 3-9: Westwood/VA Hospital North/South Station Options Walkshed Jobs and Population



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## 4.0 DAILY RIDERSHIP PROJECTIONS

Using the refined data set, the daily ridership projected with the DRF model (including both boardings and alightings) at the seven station locations is shown in Table 4-1.

**Table 4-1: Direct Ridership Model Boarding and Alighting Projections**

<b>Westside Subway Extension Station</b>	<b>Boardings</b>	<b>Alightings</b>	<b>Boardings+Alightings</b>
Wilshire/La Brea	5,030	5,360	10,390
Wilshire/Fairfax	5,630	5,890	11,520
Wilshire/La Cienega	5,520	5,760	11,280
Wilshire/Rodeo	9,240	9,460	18,700
Century City (Santa Monica)	10,300	10,460	20,760
Century City (Constellation)	11,230	11,390	22,620
Westwood/UCLA (Off-Street)	12,060	12,270	24,330
Westwood/UCLA (On-Street)	12,210	12,430	24,640
Westwood/VA Hospital	4,440	4,490	8,930

Source: Fehr & Peers

These ridership projections are based on existing conditions, including land use. Future changes in land use, which would result in population and employment increases or decreases, would affect future ridership projections.



## **5.0 SUMMARY**

Based on existing land use, demographics, and other input variables, the DRF model can project ridership (boardings plus alightings) at the LPA stations. The following summarizes the most important observations about the LPA stations resulting from the DRF modeling process.

### **5.1 Wilshire/La Brea, Wilshire/Fairfax, and Wilshire/La Cienega Stations**

These stations are projected to generate comparable ridership (10,390 to 11,520 daily boardings and alightings) due to similar demographics (jobs, population, and other characteristics, such as number of supporting bus routes, station design rating, etc.).

### **5.2 Wilshire/Rodeo Station**

The Wilshire/Rodeo Station is projected by the DRF model to be a high ridership station (18,700 boardings and alightings). This is due in part to significant employment opportunities, including the highest concentration of retail among the LPA stations, within a one-half mile walk of the station entrance.

### **5.3 Century City Station (Santa Monica and Constellation Options)**

The Constellation Option is projected to generate ridership (boardings and alightings) that is 9 percent higher than the Santa Monica Option. The primary reason why ridership is projected to be similar between the two station options (less than a 10 percent difference) is due to the DRF model being developed, calibrated, and validated to population and employment at a one-half mile walking distance. At a one-quarter mile walking distance, almost twice as many jobs (20,170 compared to 10,310) are accessible from the Constellation Option as are from the Santa Monica Option.

### **5.4 Westwood/UCLA Station**

The DRF model predicts the highest ridership for this station among all the LPA stations. The locations of the two station options are not far enough apart to result in meaningful differences in ridership predictions. This station location is unique in that it will provide access to housing, retail, offices, a major university, and a hospital.

### **5.5 Westwood/VA Hospital Station**

Of all the LPA stations, the DRF model predicts the lowest ridership for the Westwood/VA Station. There is very little residential or commercial land use within a one-half mile walk of the station that will generate ridership, which are the independent variables in the regression model that influence ridership the most. In this instance, the DRF model may not be sensitive enough to the feeder bus connection to West Los Angeles and Santa Monica that ridership at this station will be highly dependent upon.

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