Appendix B: Sustainable Communities Strategy Documentation and Related Information

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Sustainable Communities Strategy Documentation and Related Information

This appendix includes additional documentation in support of the Sustainable Communities Strategy (SCS) pursuant to California Senate Bill 375 (Steinberg, 2008) (SB 375) and describes how the 2025 Regional Plan fulfills the requirements of the SCS as described in the senate bill, including:

- A link to the Technical Methodology to Estimate Greenhouse Gas (GHG) Emissions for the Regional Plan and SCS accepted by the California Air Resources Board (CARB)
- SB 375 GHG Targets set by CARB and Results of the GHG Emissions Reductions
- Resource areas and farmland in the region
- SB 375 Areas for Transit Priority Projects and California Senate Bill 743 (Steinberg, 2013) (SB 743) Transit Priority Areas

Technical Methodology to Estimate GHG Emissions

Pursuant to SB 375, CARB is required to review each metropolitan planning organization's (MPO's) proposed Technical Methodology for quantifying GHG emissions reductions from the SCS as well as the final quantification. SANDAG coordinated with CARB staff on review and edits to the Technical Methodology to Estimate GHG Emissions for the Regional Plan and SCS. SANDAG submitted a final **Technical Methodology** to CARB on January 28, 2025, which was accepted by CARB on February 7, 2025.

SB 375 GHG-Reduction Targets Set by CARB and Results of GHG Reductions

In 2010, CARB established the original SB 375 regional GHG-reduction targets for each MPO for years 2020 and 2035. For the San Diego region, the carbon dioxide (CO_2) reductions were set at 7% and 13% per capita for cars and light trucks from 2005, respectively. In 2018, CARB approved updated targets that reflect more aggressive per capita CO_2 reductions of 15% for 2020 and 19% for 2035 compared to 2005.

2020 GHG-Reduction Target

SANDAG has prepared an estimate for CO_2 reductions in 2020 using a fusion of existing data and estimated regional travel. Because there are no direct methods for measuring either vehicle miles traveled (VMT) or GHG emissions, SANDAG must deploy estimation techniques to determine whether the 2020 GHG-reduction target was met. In line with CARB SCS evaluation guidelines, SANDAG adjusted the regional VMT estimate for 2020 from the activity-based model (ABM) system based on observed freeway counts, speeds, and VMT estimates from the Caltrans Performance Measurement System (PeMS). SANDAG then used CARB's Emission Factors (EMFAC) model, EMFAC2014 to take the adjusted VMT data tables as input for CO_2 emissions modeling.

Based on this methodology, the San Diego region reduced per capita CO_2 emissions by 17.9% in 2020 compared to 2005 baseline, which exceeds the 2020 target set for SANDAG of 15% reduction. **Attachment B1: SB 375 2020 GHG Reduction Estimate** contains the methodology for calculating the estimate for CO_2 reductions in 2020.

PeMS measured data for 2020 was significantly impacted by COVID-19 due to intermittent stay-home orders; changes in employee work location and telework; tourism travel; package and food delivery; crossborder travel restrictions; declines in public transit ridership; and price of gasoline, among many other impacts.

2035 GHG-Reduction Target

Implementation of the SCS is estimated to result in a 19.32% CO_2 emissions reduction for cars and light-duty trucks by 2035 compared to 2005. The GHG reductions for the plan were calculated using EMFAC2014 and adjustment factors based on the methodology provided by CARB to account for differences in emissions rates between EMFAC2007 (used to set the targets in 2018) and EMFAC2014. Based on **CARB 2019 Final SCS Program and Evaluation Guidelines Report**, MPOs should use the same methodology and version of EMFAC as used in the second RTP/SCS for the third RTP/SCS. SANDAG used EMFAC2014 in the 2021 Regional Plan amendment (the third RTP/SCS) and the same version for the 2025 Regional Plan and its SCS (the fourth RTP/SCS) to standardize the results of the GHG reductions calculations.

Off-model calculators were used to calculate emissions reductions associated with strategies that are not accounted for in SANDAG travel demand modeling tools (see Table B.3). Table B.1 summarizes the CO_2 per capita reductions from on-model and off-model strategies after accounting for the EMFAC adjustment factor and induced demand adjustment. **Attachment B2: SB 375 GHG Adjustment Due to Induced Demand** contains the methodology for calculating the induced demand adjustment.

Table B.1: Summary of CO_2 Per Capita Reduction as Compared to 2005: On- and Off-Model Results and Adjustment (2035)

	2035
Per Capita Reduction (On-Model Results Only)	21.57%
Per Capita Reduction (Off-Model Results Only)	0.23%
CARB Adjustment Factor for EMFAC (2007-2014)	-1.7%
Induced Demand Adjustment	-0.775%
Per Capita Reductions	**19.32%**

Note: Values may not sum total indicated due to rounding.

2050 Greenhouse Gas-Reduction Target

While the state does not set a 2050 target for GHG emissions reduction, similar methods were used to estimate per capita CO_2 emissions reductions from cars and light-duty trucks as a percent reduction compared to 2005 levels. After 2035, SANDAG assumes that free floating carsharing programs may sunset due to the rise and popularity of on-demand ridehailing services. These assumptions result in lower “off-model” reductions in 2050. For 2050, on-model CO_2 reduction is 21.8% and off-model CO_2 reduction is 0.15%. After applying the CARB adjustment factor of 1.6% and an induced demand adjustment of 0.84%, estimated CO_2 reduction for 2050 is 19.51%.

2025 Regional Plan Strategy Quantification

The strategies in the Regional Plan, which contribute to GHG reductions toward the region’s target span a wide range of scenarios employing methods to influence the performance of the region’s transportation system. The elements of these strategies can be broken down into Transportation System Infrastructure and Operations, Demand Management, and Land Use. As described in Table B.2, some strategies included in the plan are a continuation or expansion of strategies from the 2021 Regional Plan, while some strategies are new for this plan. The quantification approach for each strategy is indicated in Table B.2. **Chapter 3: Implementation Actions** describe the commitments or key actions that implement the Regional Plan strategies.

The two main quantification approaches are the SANDAG regional travel demand model ABM3 and a set of off-model calculators developed to handle elements that cannot be treated by ABM3. **Appendix M: Travel Demand Modeling Tools** includes documentation of the travel demand model and off-model calculators. The selected approach for each strategy element is based first upon a determination of whether that element can be represented in the ABM3 travel demand model. This determination has been made based upon the ABM3 technical documentation, the ABM3 sensitivity analysis report, and the findings of the ABM3 technical advisory committee. As described in the **Technical Methodology** submitted to CARB, those elements that cannot be represented in ABM3 were then considered for off-model quantification based upon the expected impact of that element on the overall performance of the transportation system as well as an identification of a feasible off-model methodology and associated recommendations from CARB and prior off-model developments (at SANDAG and other MPOs).

Table B.2: Quantification Approach for the 2025 Regional Plan Strategies

Strategy	Inclusion in Prior SCS?	Quantification Approach
Transportation System Infrastructure and Operation		
Highway/Roadways Strategies • Managed Lanes • High-Occupancy Vehicle (HOV/High-Occupancy Toll [HOT] policies) • Regional Bike Network • Local complete streets improvements	Yes	ABM3
Transit Strategies: • Commuter Rail • Light Rail • Next Generation Rapid • Local Bus	Yes	ABM3
Flexible Fleet Strategies: • E-bikes • Microtransit/ Neighborhood Electric Vehicles (NEV) • Micromobility	Yes	ABM3
Technology Strategies: • Transportation technology • Smart Signals	Yes	ABM3
Demand Management		
Telework	Yes	ABM3
Vanpool	Yes, off-model in prior SCS.	Off-Model
Carshare	Yes, off-model in prior SCS.	Off-Model
Pricing strategies: • Transit Fare Subsidies • Priced managed lanes • Parking pricing • Ridehail fees	Yes	ABM3
Land Use		
SCS Land Use Pattern that considers: • Job–Housing Balance • Mixing of uses • Transit-Oriented Development • Local planning assumptions • Housing needs	Yes	ABM3

Off-Model Strategies

SANDAG has included two off-model strategies to estimate GHG emissions reductions from programs that cannot be applied in ABM3. For the Regional Plan, the off-model analysis includes vanpool and carshare. Strategies include programs facilitated and administered by SANDAG as well as services operated by third parties. Details on the methods and assumptions of the off-model calculators are included in Appendix M. Table B.3 summarizes the CO_2 reductions associated with each off-model strategy.

Table B.3: Summary of Off-Model Strategies: Percent Per Capita CO_2 Reduction as Compared to 2005

Off-Model Strategy	2035
Vanpool	0.15%
Carshare	0.08%
Total	**0.23%**

Table B.4: Sustainable Communities Strategy Information

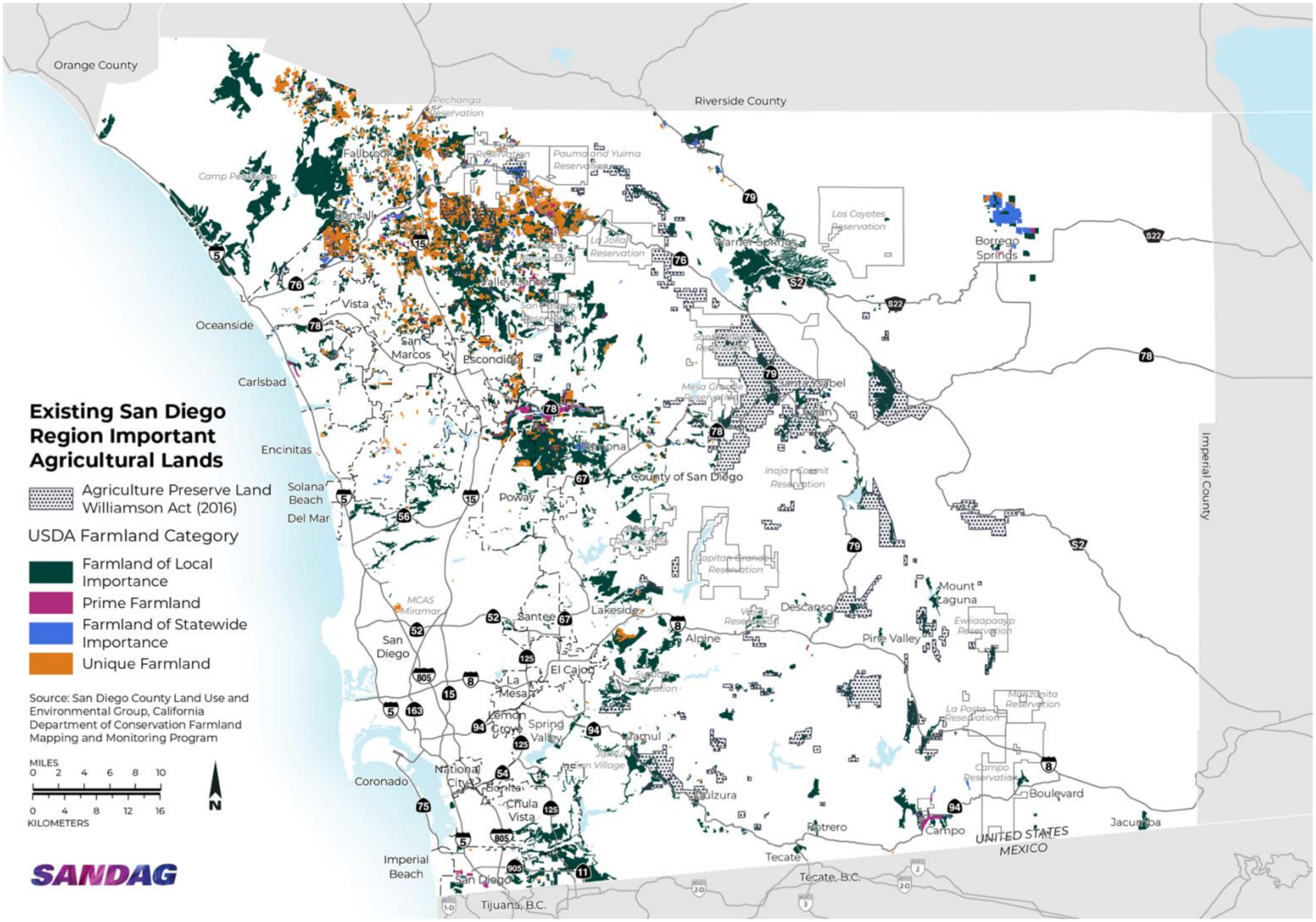
Requirement Category	Regulatory Text	Addressed
SCS Requirement	California Government Code (CGC) Section 65080(b)(2)(B) Each MPO shall prepare a sustainable communities strategy subject to the requirements of Part 450 of Title 23 of and Part 93 of Title 40 of the Code of Federal Regulations, including the requirement to utilize the most recent planning assumptions considering local general plans and other factors. The sustainable communities strategy shall:	The focus of Chapter 2 is the Sustainable Communities Strategy (SCS); however, components of the SCS are integrated throughout the Regional Plan chapters and appendices.
Land Use	CGC Section 65080(b)(2)(B)(i) Identify the general location of uses, residential densities, and building intensities within the region.	See Chapter 2 and Appendix F.
Housing Goals	CGC Section 65080(b)(2)(B)(vi) Consider the state housing goals specified in Sections 65580 and 65581.	See Chapter 2 and Appendix F.
Housing Goals	CGC Section 65080(b)(2)(B)(ii) Identify areas within the region sufficient to house all the population of the region, including all economic segments of the population, over the course of the planning period of the regional transportation plan taking into account net migration into the region, population growth, household formation and employment growth.	See Chapter 2 and Appendix F.
Housing Goals	CGC Section 65080(b)(2)(B)(iii) Identify areas within the region sufficient to house an eight-year projection of the regional housing need for the region pursuant to Section 65584.	See Chapter 2 and Appendix F.
Natural Resources	CGC Section 65080(b)(2)(B)(v) Gather and consider the best practically available scientific information regarding resource areas and farmland in the region as defined in subdivisions (a) and (b) of Section 65080.01.	See Appendix B and Appendix Q.
Transportation Network	CGC Section 65080(b)(2)(B)(iv) Identify a transportation network to service the transportation needs of the region.	See Chapter 2 and Appendix A.

Requirement Category	Regulatory Text	Addressed
Meeting GHG Reduction Targets	CGC Section 65080(b)(2)(B)(vii) Set forth a forecasted development pattern for the region, which, when integrated with the transportation network and other transportation measures and policies, will reduce the GHG emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the GHG emission reduction targets approved by the state board.	See Chapter 2, Appendix B, and Appendix F.
Meeting Federal Air Quality Requirements	CGC Section 65080(b)(2)(B)(viii) Allow the regional transportation plan to comply with Section 176 of the federal Clean Air Act (42 U.S.C. §7506).	See Appendix C.

Resource Areas and Farmland in the San Diego Region

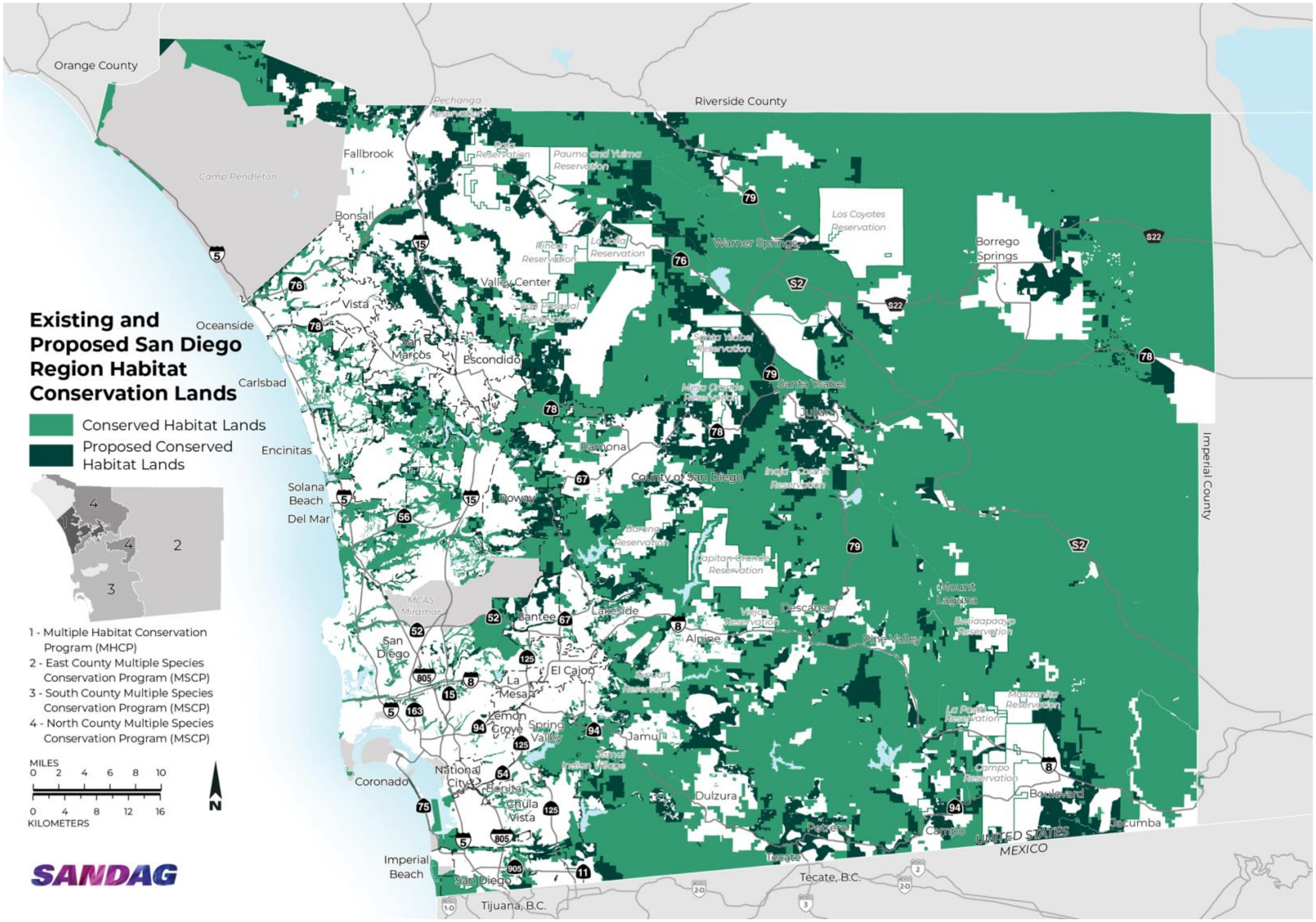
The following maps show San Diego's vast amounts of natural land and resources, which are valuable for conservation and recreation. Figures B.1 through B.4 show where vegetation, existing and proposed habitat conservation lands, wetlands, important agricultural lands, and other natural resources are located within the San Diego region. One of the strategies of the Regional Plan is to preserve natural resources and farmland to the extent feasible for current and future residents and visitors to the region.

Figure B.1: Existing San Diego Region Important Agriculture Lands



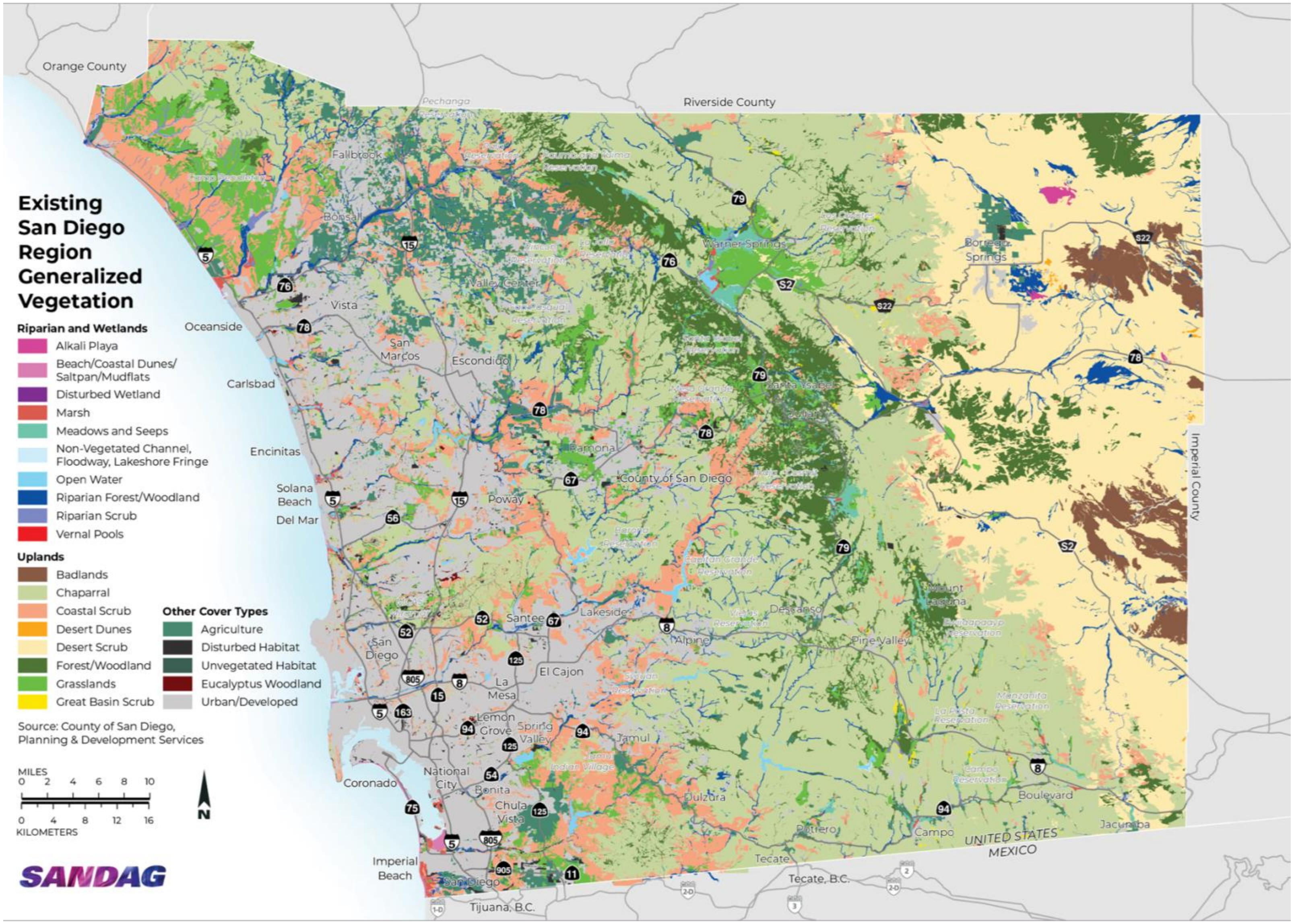
Source: San Diego County Land Use and Environmental Group, California Department of Conservation Farmland Mapping and Monitoring Program

Figure B 2: Existing and Proposed San Diego Region Habitat Conservation Lands



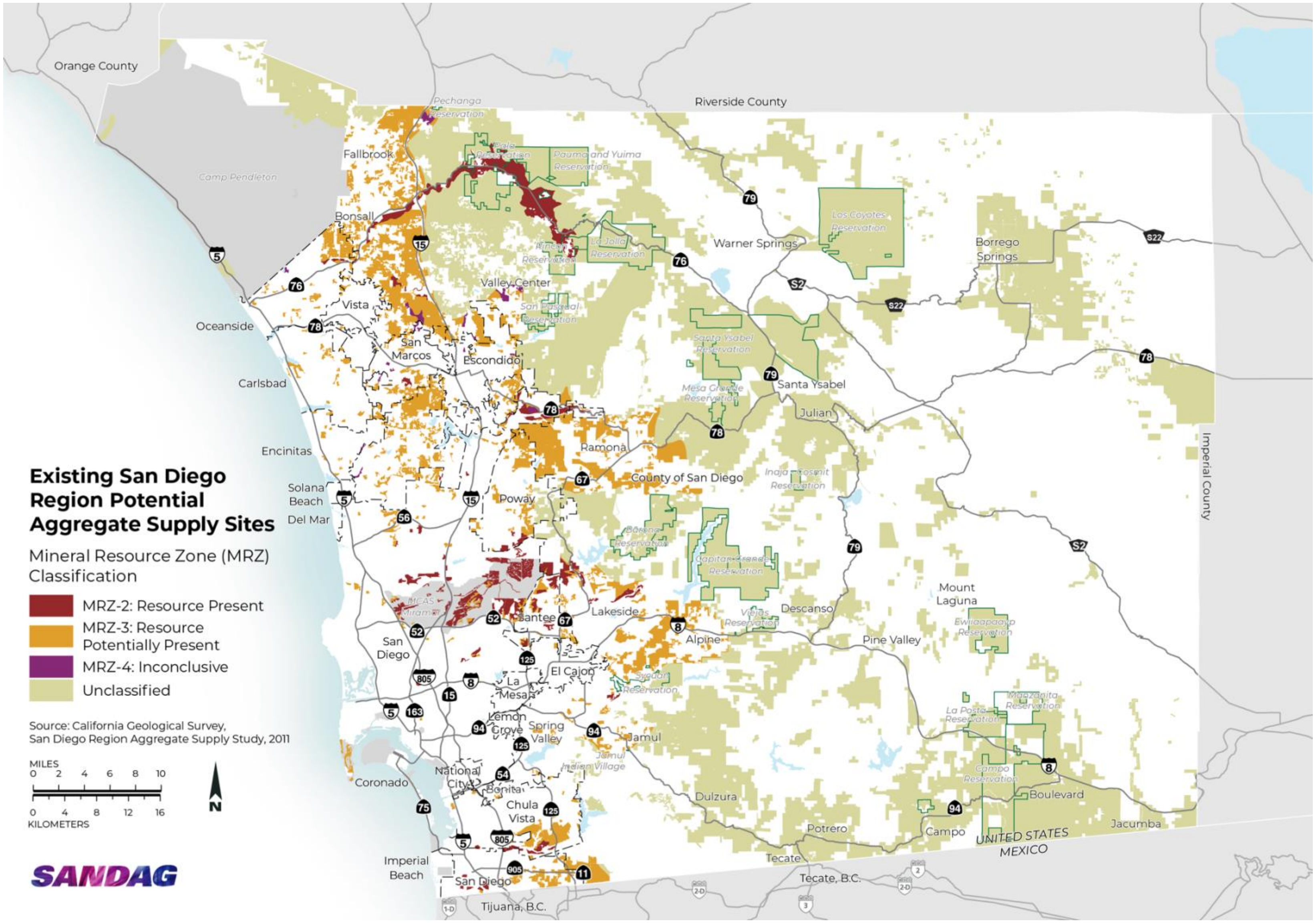
Source: SANDAG

Figure B.3: Existing San Diego Region Generalized Vegetation



Source: County of San Diego, Planning & Development Services

Figure B.4: Existing San Diego Region Potential Aggregate Supply Sites



Source: California Geological Survey, San Diego Region Aggregate Supply Study, 2011

Transit Priority Projects Under SB 375

SB 375 provides a streamlined environmental review for Transit Priority Projects[1] that, among other things, are located within a half mile of a "major transit stop," defined in Public Resources Code Section 21064.3[2], or "high-quality transit corridor," defined as a corridor with fixed-route bus service with service intervals no longer than 15 minutes during peak commute hours. Assembly Bill 2553 amended the headway threshold for major transit stops from 15 minutes to 20 minutes, effective January 1, 2025. Figure B.5 and B.6 depict potential areas for Transit Priority Projects based on the 2035 and 2050 transit system.

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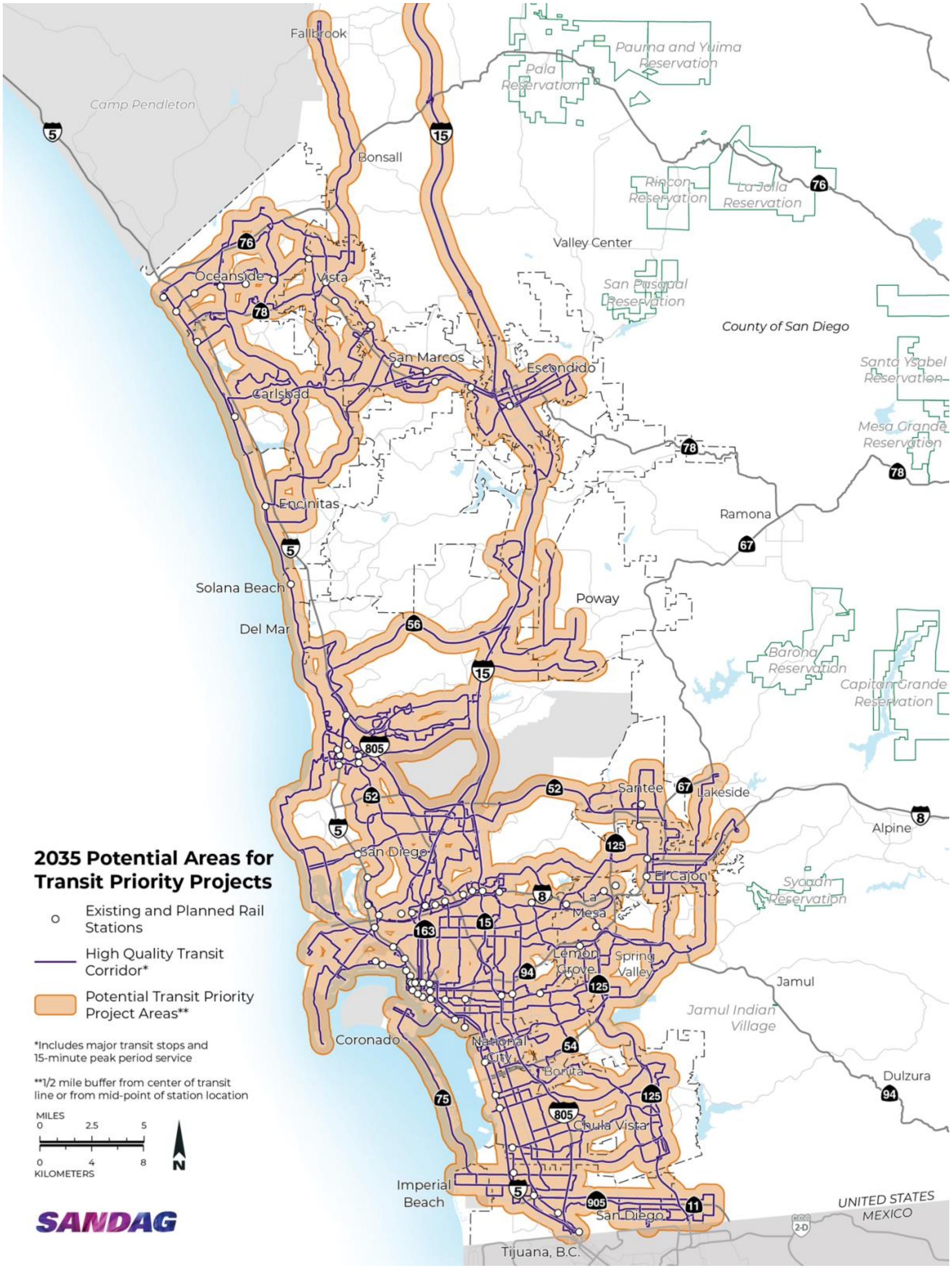
[1] "Transit Priority Project" is defined in Public Resources Code Section 21155.1. 3

[2] "Major transit stop" means a site containing any of the following:

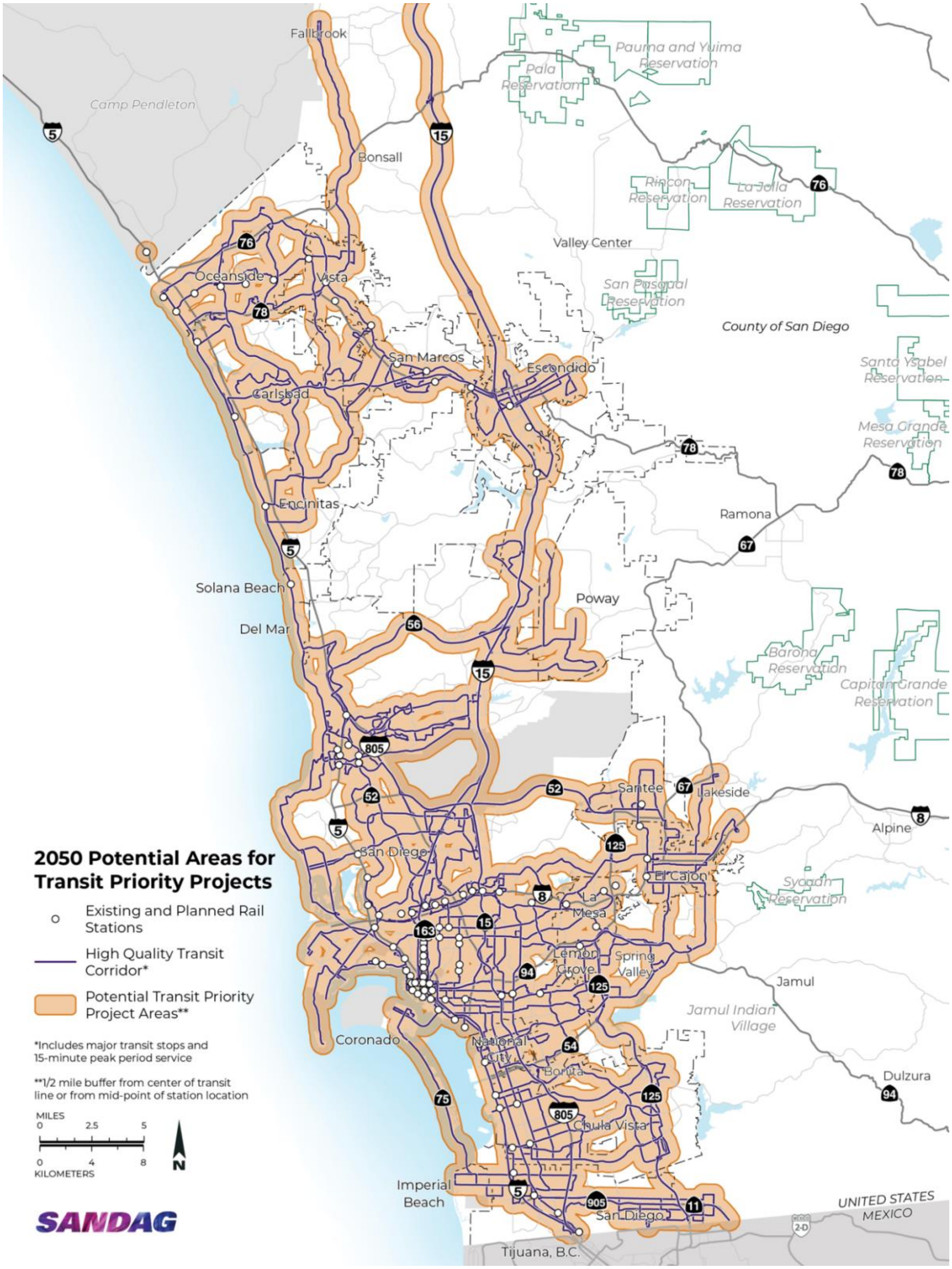
a. An existing rail or Bus Rapid Transit station.
b. A ferry terminal served by either a bus or rail transit service.
c. The intersection of two or more major bus routes with a frequency of service interval of 20 minutes or less during the morning and afternoon peak commute periods.

Figure B.5: 2035 Potential Areas for Transit Priority Projects



Source: SANDAG

Figure B.6: 2050 Potential Areas for Transit Priority Project



Source: SANDAG

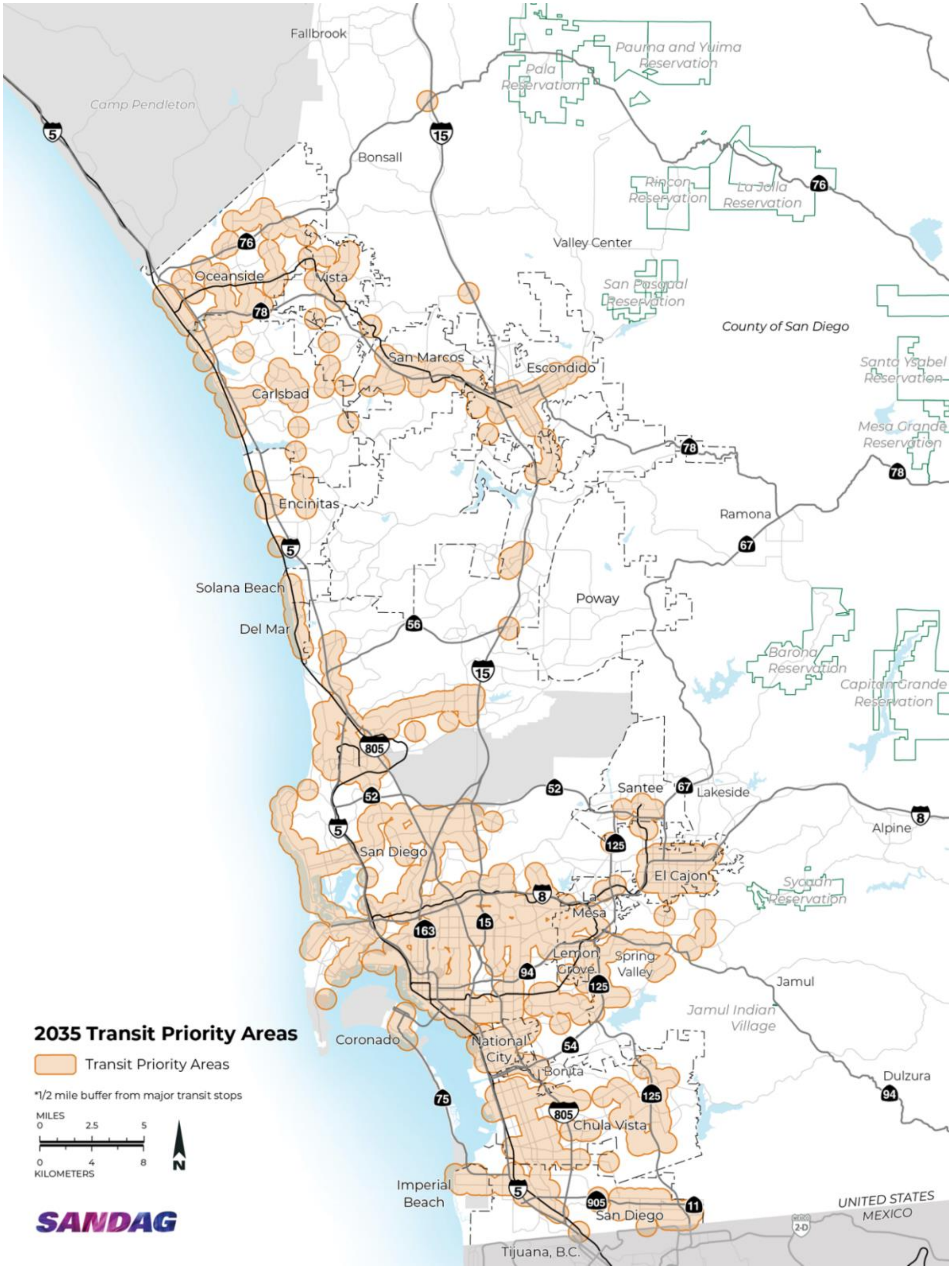
Transit Priority Areas Under SB 743

SB 743 provides for streamlined environmental review for projects within Transit Priority Areas, which is an area within a half mile of a “major transit stop,” defined in Public Resources Code 21064.3[3]. Figure B.7 and B.8 depict Transit Priority Areas as defined by SB 743 based on the 2035 and 2050 transit system, respectively. Assembly Bill 2553 amended the headway threshold for major transit stops from 15 minutes to 20 minutes, effective January 1, 2025.

[3] “Major transit stop” means a site containing any of the following:

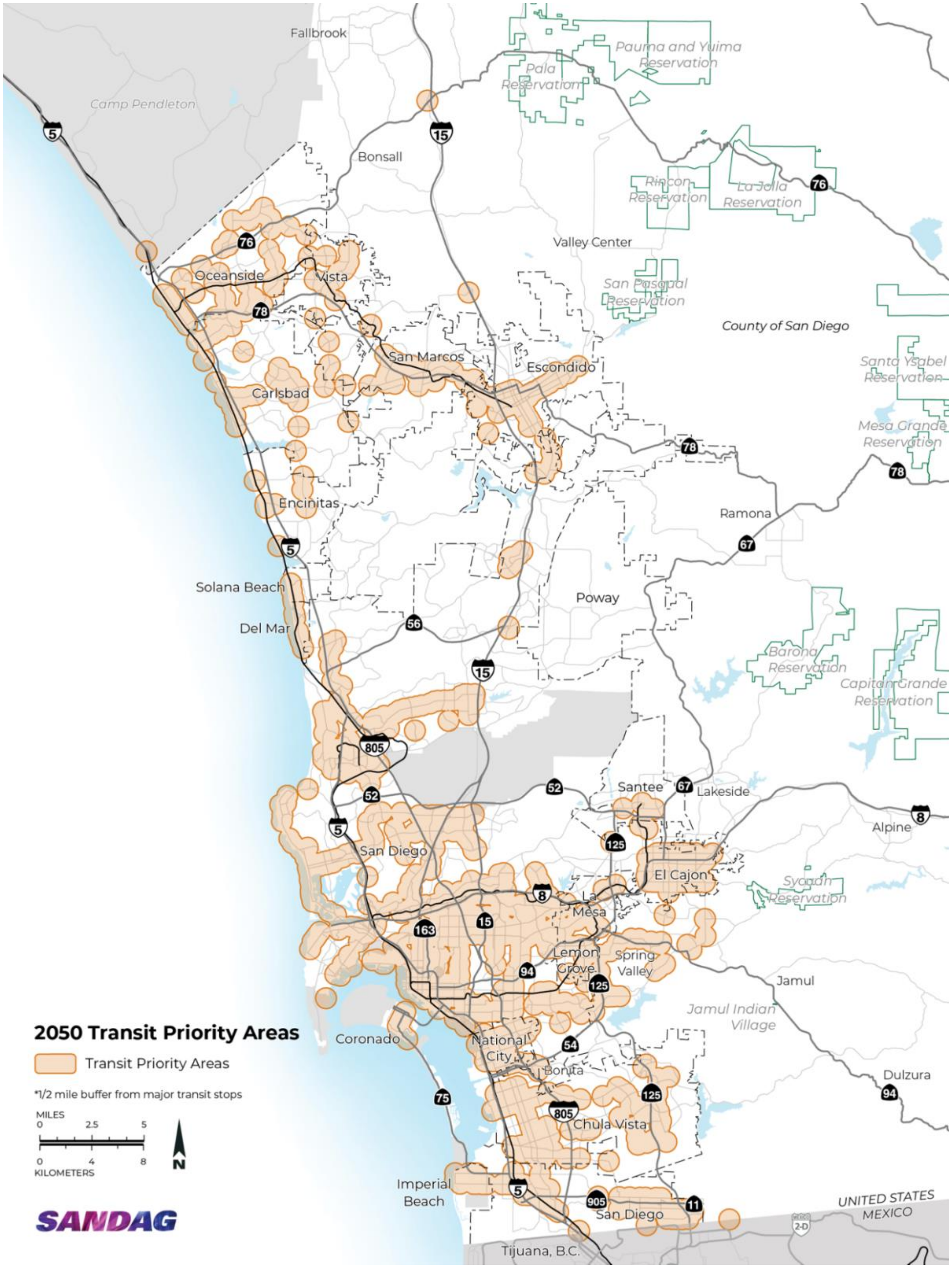
a. An existing rail or Bus Rapid Transit station.
b. A ferry terminal served by either a bus or rail transit service.
c. The intersection of two or more major bus routes with a frequency of service interval of 20 minutes or less during the morning and afternoon peak commute periods.

Figure B.7: 2035 Transit Priority Areas



Source: SANDAG

Figure B.8: 2050 Transit Priority Areas



Source: SANDAG

Attachments

- Attachment B1 – SB 375 2020 GHG Reduction Estimate
- Attachment B2 – SB 375 GHG Adjustment Due to Induced Demand

Attachment B1:
SB 375 2020 GHG Reduction Estimate

SB 375 2020 GHG Reduction Estimate

Executive Summary

A central component of the 2025 Regional Plan and its Sustainable Communities Strategy (SCS) is measuring the plan's performance under California Senate Bill 375 (Steinberg, 2008) (SB 375). SB 375 seeks to reduce per capita passenger and light truck GHG emissions when compared to a 2005 baseline. The two compliance years that must be evaluated under SB 375 are 2020 and 2035. For these two years, the California Air Resources Board (CARB) established regional per capita GHG reduction targets for SANDAG from the 2005 base year. The 2020 target is defined as a 15% per capita GHG reduction from 2005 levels.

Reporting SB 375 performance for the year 2020 requires the incorporation of observed data, which became a challenging endeavor due to the COVID-19 pandemic. For 2020 analysis in the 2025 Regional Plan, SANDAG will continue to use an application of the SANDAG Series 14 SCS land use pattern and activity-based model version (ABM2+) from 2021. The SANDAG Series 15 SCS land use pattern and post-pandemic version of ABM (ABM3) have a base year of 2022. Due to the nature of the pandemic during 2020, there is no reasonable or prudent way to estimate demographic, economic, and transportation input data for use in ABM3. The 2020 analysis will continue to use the adjustments made using pre-pandemic data and modeling tools.

Series 14 and ABM2+ had a base year of 2016 and treated 2020 as a normal, non-COVID year. Performance results directly from ABM are referred to as "unadjusted." This resulted in VMT being overestimated and required modification of existing research tools and methods to provide an adjusted SB 375 VMT and GHG reduction estimate for 2020.

The process includes adjustments focused on three main components: adjusting freeway VMT, adjusting freeway speed distribution, and omitting off-model calculators. The adjustments to freeway VMT and speed, based on observed Caltrans data, were employed to create a new input file for CARB's Emissions Factors (EMFAC) software. EMFAC2014 is used for SB 375 emissions estimation.

After the adjustment of freeway VMT and freeway speeds for 2020, the 2020 per capita GHG reduction is 18% compared to 2005. The 18% per capita GHG reduction represents a conservative estimate that was limited only to empirically measured changes related to transportation behavior during 2020. While the actual reduction could be greater than 18%, there was insufficient telemetry to accurately quantify additional adjustments.

Introduction

SANDAG's SCS land use pattern and transportation model have been used to evaluate SB 375 performance for the previous three SCS submittals. An ABM can evaluate the performance of many projects, policies, and programs that lead to reductions in per capita VMT. These on-model elements include increased transit service, changes to land use policy, parking policy, freeway Managed Lanes, active transportation infrastructure, teleworking, and some technology-based asset management that increases roadway reliability. In addition to the existing regional modeling tools, "off-model" evaluation of GHG reduction programs and policies are used in SB 375 performance analysis. Off-model adjustments are used because not all programs and policies to reduce SB 375 category VMT can be precisely measured in the SANDAG ABM. The combination of on- and off-model evaluations is used to develop the SB 375 per capita GHG reduction estimate.

Because 2020 is now a historic year and transportation behavior was heavily influenced by the COVID-19 pandemic, the standard approach of using the land use pattern, ABM, and off-model calculators was insufficient to accurately estimate 2020 passenger vehicle VMT for evaluation of the 2020 SB 375 per capita GHG reduction target. All components of an unadjusted 2020 SB 375 performance evaluation were inventoried and examined. For each component, a determination was made to assign one of three courses of action: keep component as-is, modify the component, or omit the component.

Once the inventory and determinations were complete, components which required modification went through a two-step process of adjusting based on empirical data, then finding a solution on how those adjustments would be reflected in a new EMFAC input file. Each adjustment was tested individually in EMFAC to ensure that the quantitative results of the test accurately reflected the expected qualitative outcome. After EMFAC testing was complete, the EMFAC input file was run in EMFAC version 2014. The EMFAC results, along with other standard adjustments unrelated to COVID-19, were then combined to produce a 2020 SB 375 per capita GHG reduction value.

2020 SB 375 GHG Reduction Estimation Components

SANDAG Activity-Based Model

ABM2+ provides a systematic analytical platform very similar to ABM3 and is intensively data-driven so that different alternatives and inputs can be evaluated in an iterative and controlled environment. For SB 375 evaluation, the two primary outputs are VMT and vehicle speed bins (defined as the percentage of vehicles that fall within speeds in 5 mph increments, from 5 mph to 70 mph). Other outputs from ABM2+ are used as inputs to off-model calculators. The VMT and speed bin output from the year 2020 were used to create a custom EMFAC2014 input file. EMFAC2014 is then run in a special SB 375 mode where only VMT and speed bins from light-duty autos are evaluated. Another aspect of EMFAC in SB 375 mode is that a great majority of future fleet vehicle technology is not part of the analysis. This is done for the purposes of minimizing exogenous variables that may interfere with measuring per capita GHG reduction relative to 2005. Because of this, it is important to note that gross GHG output levels from EMFAC2014 output in SB 375 mode are not reflective of all vehicle classes and vehicle technologies. EMFAC2014 SB 375 outputs are only used to evaluate compliance with the regional targets.

Many projects, programs, and policies that seek to reduce light-duty VMT under SB 375 are incorporated into ABM2+. Projects could be new or enhanced transit service, new or enhanced transit Park & Ride locations, addition of dynamically managed lanes on the region's freeway network, additional or enhanced bicycle facilities, and arterial road diets. Programs which can be modeled in ABM2+ include telework and transportation demand management. Policy inputs to ABM2+ can include transit fares, parking cost, parking locations, congestion pricing, transportation network company (TNC) fees, and land use patterns.

These components are applied consistent with the Regional Plan assumptions for each year of analysis, and their cumulative effects related to SB 375 are reflected in the VMT and speed output once an ABM2+ model run for a given year is complete.

External Regional Travel

The external travel models predict characteristics of all vehicle trips and selected transit trips crossing the San Diego County border. This includes both trips that travel through the region without stopping and trips that are destined for locations within the region. Trips that travel through the region without stopping, along with any associated VMT, are not required in SB 375 evaluation. The external-to-external VMT is excluded in the analysis.

Off-Model Calculators

The GHG reduction benefits from the programs evaluates off-model are excluded from this analysis.

EMFAC Software Version Adjustment

SANDAG used EMFAC2007 to quantify GHG emissions reductions from its first SCS. For the 2025 Regional Plan and SCS, SANDAG is using EMFAC2014 as stipulated by CARB. Using a different EMFAC model version influences estimates and evaluation of SB 375 metrics. CARB staff has developed this methodology to allow SANDAG to adjust the calculation of percent reduction in per capita CO_2 emissions used to meet the established targets when using EMFAC2014 for their third and fourth Regional Transportation Plan (RTP)/SCS. This method will neutralize the changes in fleet average emission rates between the version used for the first RTP/SCS and the version used for the second RTP/SCS. The methodology adjusts for the small benefit or disbenefits resulting from the use of a different version of EMFAC by accounting for changes in emission rates and applies an adjustment when quantifying the percent reduction in per capita CO_2 emissions EMFAC2014.

Component Selection for 2020 Adjustment

The 2020 SB 375 GHG analysis adjustment examined two factors. First, whether each component was materially affected by travel changes associated with COVID-19 and, second, whether enough empirical data existed to quantify those travel changes when compared to a non-COVID state of the component. While there may be anecdotal or broad metrics to the changes to travel that occurred due to COVID-19, only robust data should be considered to properly adjust a specific model output component. If this data were unavailable, the component would be either omitted or unchanged from the analysis. Table B1.1 shows an itemized list of components that are considered for 2020 adjustment and how those components compare to an unadjusted analysis.

Table B1.1: SB 375 Component Comparison

Component	2020 Unadjusted Analysis	2020 Adjusted Analysis
Standard Freeway VMT	✓	
Freeway VMT Adjustment		✓
Standard Arterial VMT	✓	✓
External-to-External VMT	✓	✓
Vanpool	✓	
Carshare	✓	
EMFAC Version Adjustment	✓	✓

Vehicle Miles Traveled Adjustments

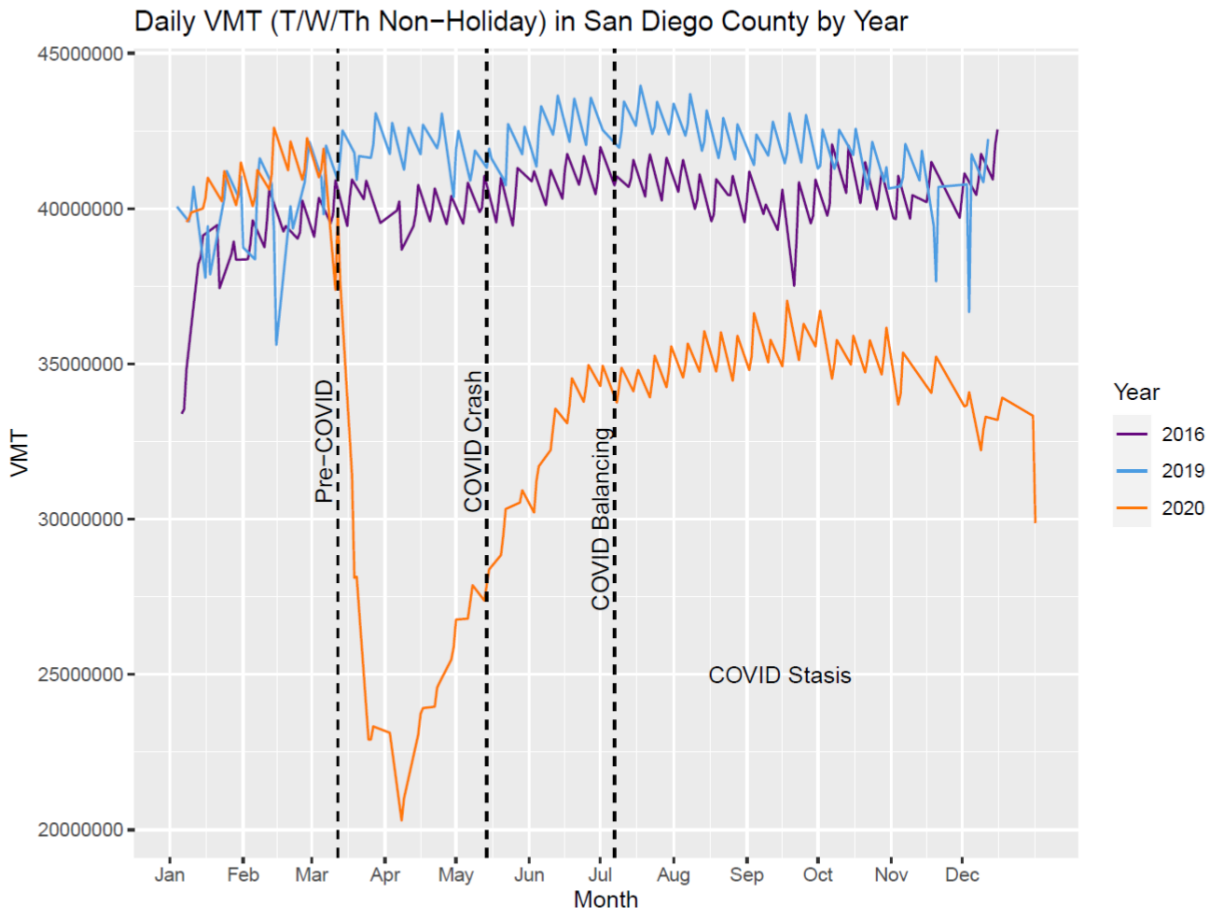
This approach relies on Caltrans Performance Measurement System (PeMS) 2020 freeway VMT data for non-holiday Tuesdays, Wednesdays, and Thursdays to estimate a weighted reduction to pre-COVID 2020 freeway VMT based on post-COVID VMT data. This reduction as a percentage was then applied to ABM2+ VMT results only for freeway facility types. An initial analysis of PeMS freeway data was conducted for three years: 2016, 2019, and 2020. 2016 was selected to compare to the calibrated base year of ABM2+. 2019 was evaluated to compare annual trends in 2019 to pre-COVID trends of 2020. Figure B1.1 shows how the freeway VMT data for 2020 varied substantially. Based on a visual inspection of the data, 2020 was grouped into four periods defined by the changes to freeway VMT in San Diego County. The four periods of pre-COVID, COVID crash, COVID balancing, and COVID stasis were statistically evaluated for structural breaks in the VMT data to determine the exact dates of each period.

While the PeMS VMT data was a reliable resource, there were some limitations. Hardware reliability and changes to commercial travel are two of those limitations. PeMS reports detector health for the equipment that measures freeway travel. For 2020, the average fidelity reported by PeMS for Tuesday through Thursday was 82%. This figure does not assert that VMT was underestimated by 18% on average, rather those missing samples were interpolated to produce an estimated VMT that is reflective on an entire day of travel. All days that had an observed fidelity of less than 70% were investigated to ensure that no outliers existed in the overall dataset. For commercial travel, there was clear anecdotal evidence that deliveries increased because of COVID-19. PeMS does not classify VMT by vehicle type. It is possible that commercial and goods movement VMT increased in 2020 while light-duty auto travel decreased. Since there is no method to disaggregate light-duty VMT from PeMS data, the conservative approach would be to use the total VMT data to adjust light-duty VMT trends.

Arterial VMT was not able to be adjusted at the time due to lack of empirical data and uncertainty over how increased goods movement and commercial travel interacted with the arterial network in 2020. The variety and amount of arterial facilities differ from freeways enough to not reliably ascribe freeway VMT trends to the arterial network. There was a high likelihood that arterial VMT did decrease due to COVID-19, but not enough reliable data existed to reasonably quantify the reduction. This specific analysis does not adjust arterial VMT, even though sufficient evidence now exists that arterial VMT did decrease.

Post pandemic analysis of empirical data indicated that arterial VMT did decrease in a meaningful manner. The Caltrans Highway Performance Measurement System (HPMS) reports VMT data by county and general facility type for each calendar year. An analysis of 2019 and 2020 HPMS data for San Diego County indicated an approximately 25% reduction in non-freeway VMT between 2019 and 2020. Another data source, the Texas A&M Transportation Institute's Urban Mobility Scorecard (UMS), has historically partnered with a commercial data provider, INRIX, to provide travel data for major metro areas across the nation. For the San Diego metro area, the UMS indicated an approximately 21% reduction in arterial VMT between 2019 and 2020.

Figure B1.1: Caltrans Freeway Performance Measurement System Daily VMTs in San Diego County by Year



Source: Performance Measurement System (PeMS), Caltrans

Determining the date ranges for Figure B1.1 was not an arbitrary task. The *strucchange* package in the R programming language was used to mathematically identify the location of multiple breakpoints within the 2020 VMT data. These breakpoints served as the end points for each period of 2020 (pre-COVID, COVID crash, COVID balancing, and COVID stasis). Visually, it was clear that there were three noticeable changes in the time series (i.e., the date partitions that divided each of the four periods) but identifying exactly when those changes occurred could be subject to debate. The *strucchange* package endogenously determines the dates in which these changes occurred. Table B1.2 shows the exact date ranges of each 2020 period along with other time frame units that were considered for analysis. A more detailed description of the structural break analysis can be found in the Additional Background section of this Attachment.

Table B1.2: 2020 Weekday (Tuesday–Wednesday–Thursday, Non-Holiday) Freeway VMT Groupings by Date Range

2020 Dates	Description	Average Freeway VMT
January 1–December 31	Calendar Year	34,003,689
January 1–March 31	Q1	38,055,361
April 1–June 30	Q2	28,687,235
July 1–September 30	Q3	35,171,993
October 1–December 31	Q4	34,322,311
January 1–March 12	Pre-COVID	40,609,642
January 1–March 12	Pre-COVID (median)	40,772,942
March 17–December 31	Post-COVID	32,306,747
March 17–December 31	Post-COVID (median)	34,114,325
March 17–May 14	COVID crash	25,374,455
May 19–July 7	COVID balancing	32,462,977
May 19–July 7	COVID balancing (median)	33,001,344
July 8–December 31	COVID stasis	34,818,292
January 1–March 12 and July 8-December 31	Pre-COVID and COVID stasis	36,561,925

The two time periods considered for analysis of the 2020 freeway VMT adjustment were the pre-COVID and post-COVID median VMT values. Table B1.3 shows that when comparing these two time periods, a 16.33% decline in overall weekday freeway VMT occurred due to COVID-19.

Table B1.3: Preferred VMT Grouping for 2020 Adjustment

Period Group in 2020	Average Weekday Freeway VMT (Median)	Name of the Period Group
Pre-COVID VMT (median)	40,772,942	“Normal 2020”
Post-COVID VMT (median)	34,114,325	“Adjusted 2020”

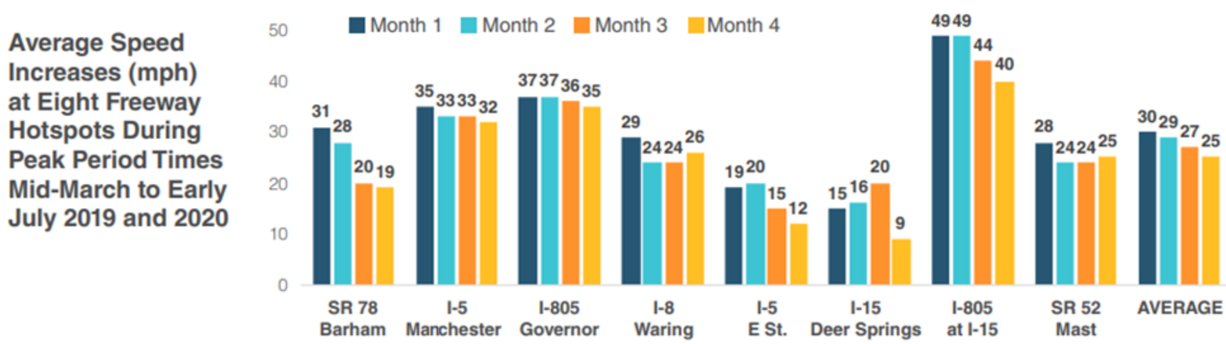
External-to-External VMT Adjustment

The unadjusted SB 375 ABM2+ analysis calculated that 1.0% of light-duty VMT in 2020 should be removed due to that VMT being associated with travel that never stopped inside of San Diego County. While this figure most likely changed during the COVID period in 2020, there was insufficient data to support modifying the analysis from the original value. The most reasonable and prudent course was to leave this 1.0% value unchanged in the adjusted analysis.

Speed Adjustments

Not all travel changes associated with COVID-19 reduced GHG. As freeway VMT was being reduced due to stay at home health orders, those who still chose to make auto trips experienced substantially higher travel speeds on the region's freeways as seen in Figure B1.2. According to standard EMFAC output, high speeds typically result in more CO_2 per mile being emitted from light-duty auto classes. Since the increase in travel speed is a reflection of the near total elimination of severe congestion on the freeway network, it was decided to adjust speed bins in the EMFAC input file by "shifting" VMT from the congested speeds of 35 mph, 40 mph, and 45 mph to the non-congested speeds 55 mph, 60 mph, and 65 mph, respectively. It is important to note that in the speed adjustment step, VMT is conserved but GHG slightly increases.

Figure B1.2: Average Speed Increases (Miles Per Hour) During Peak Periods



Source: Performance Measurement System (PeMS), Caltrans

EMFAC Version Adjustment

The EMFAC version adjustment applies only to the differences between versions of software and was agnostic toward the differences between pre- and post-COVID. The EMFAC version adjustment for 2020 provided by CARB represents an additional 1.8% of per capita GHG in the analysis.

Omitted Components

The adjusted analysis for 2020 does not consider any GHG reductions from reduced arterial VMT, vanpools, and carsharing. Arterial VMT was not reduced or adjusted down even though enough evidence now exists that does show a similar reduction in VMT which was observed on freeways. Arterial VMT remains unadjusted from a regular, non-COVID, 2020 ABM2+ model run. Vanpool, and carshare GHG reductions were removed altogether because of COVID health and safety restrictions, a substantial increase in telework, and removal of congestion on the freeway network. Had these factors been considered for inclusion, they would have all resulted in a greater GHG reduction for 2020.

EMFAC Input Modification and Testing

Data for freeway VMT and freeway travel speeds was sufficient to use for 2020 adjustment. In order to accurately reflect this, methods had to be created that would take the empirical trends seen for VMT and speed, then apply them to standard 2020 ABM2+ output. These steps were necessary to modify EMFAC2014 input that would reflect the COVID adjustments, but still allow EMFAC2014 to run normally in SB 375 mode.

Freeway VMT adjustment was performed by taking a standard, non-COVID, ABM2+ model run for 2020, and classifying total VMT assigned to the transportation network as either freeway or non-freeway (arterial). This is a necessary step so that the 16.33% reduction cited in Table B1.3 will be applied to modeled freeway VMT but also allow for the calculation of total VMT reduction. EMFAC2014 does not accept VMT input by facility type, only by vehicle class. The overall VMT percentage reduction is needed so it will only be applied to the VMT from the four relevant SB 375 vehicle classes: Light-Duty Auto (LDA), Light-Duty Truck 1 (LDT1), Light-Duty Truck 2 (LDT2), and Medium-Duty Vehicle (MDV). Table B1.4 shows that the overall VMT reduction is 9.12%. That percentage is then applied to the SB 375 vehicle classifications and their associated fuel types in Table B1.5.

Table B1.4: Application of Caltrans Performance Measurement System Freeway Vehicle Miles Traveled Reduction Factor to ABM2+ VMT

Roadway Type	ABM2+ VMT	Adjusted VMT
Freeway	46,872,476	39,217,746
Arterial	37,100,269	37,100,269
Total	83,972,745	76,318,015
SB 375 VMT percent reduction	-	9.12%

Table B1.5: EMFAC2014 SB 375 Vehicle Category VMT Adjustments

Calendar Year	Vehicle Classification	Unadjusted VMT	Adjusted VMT
2020	LDA – Diesel	559,255	508,275
2020	LDA – Gas	49,742,424	45,208,038
2020	LDT1 – Diesel	3,760	3,417
2020	LDT1 – Gas	3,665,383	3,331,257
2020	LDT2 – Diesel	30,582	27,794
2020	LDT2 – Gas	15,739,987	14,305,172
2020	MDV – Diesel	174,880	158,939
2020	MDV – Gas	9,298,065	8,450,749

Freeway speed adjustments from ABM2+ output assumed that all modeled freeway VMT at a volume to capacity ratio of greater than 0.85 would have occurred at uncongested speeds. Table B1.6 shows the amount of VMT to be shifted for both the a.m. and p.m. peak periods from slower speed bins to faster speed bins.

Table B1.6: Calculation of Congested VMT Speed Adjustment Using ABM2+ VMT

Period	Total VMT All Roadways	Congested VMT Freeway Only	Volume to Capacity Ratio Threshold	Congested VMT Speed Adjustment Percentage
a.m.	17,142,006	3,005,695	0.85	17.53%
p.m.	20,631,071	1,545,288	0.85	7.49%

Speed bins are specified in EMFAC for all vehicle types by one-hour increments of time and 5 mile per hour increments of speed. The AM and PM adjustments from ABM2+ freeway data were applied to calculate new speed bin fractions where more VMT is assigned to faster speeds at the expense of slower speeds. Table B1.7 shows unadjusted and adjusted speed fractions. It is worth reminding that the speed adjustment step does not add or remove VMT from the analysis. It is exclusively shifted from slower to faster speeds.

Table B1.7: EMFAC2014 Speed Adjustments

Unadjusted Speed Fractions

Time of Day	Hour of Day	35 mph	40 mph	45 mph	55 mph	60 mph	65 mph
a.m. peak	6	0.043	0.035	0.041	0.041	0.064	0.406
a.m. peak	7	0.090	0.089	0.104	0.091	0.104	0.119
a.m. peak	8	0.090	0.089	0.104	0.091	0.104	0.119
p.m. peak	16	0.064	0.053	0.062	0.042	0.112	0.251
p.m. peak	17	0.075	0.079	0.101	0.101	0.105	0.130
p.m. peak	18	0.075	0.079	0.101	0.101	0.105	0.130

Adjusted Speed Fractions

Time of Day	Hour of Day	35 mph	40 mph	45 mph	55 mph	60 mph	65 mph
a.m. peak	6	0.035	0.029	0.033	0.048	0.070	0.413
a.m. peak	7	0.075	0.074	0.085	0.107	0.120	0.138
a.m. peak	8	0.075	0.074	0.085	0.107	0.120	0.138
p.m. peak	16	0.060	0.049	0.057	0.047	0.116	0.256
p.m. peak	17	0.070	0.073	0.093	0.107	0.111	0.137
p.m. peak	18	0.070	0.073	0.093	0.107	0.111	0.137

After the VMT and speed input modifications were tabulated, testing occurred of each component before both the VMT reduction and speed increase would be applied in the same input file. The testing process consisted of modifying an EMFAC2014 input file for 2020 with only one component for each test. Qualitative expectations would be that when compared to unadjusted, non-COVID, EMFAC output, the VMT only test would reduce SB 375 CO_2 substantially while the speed only test would slightly increase CO_2. The results of the tests were as expected, which gave confidence in an EMFAC analysis which placed both components in the same input file. The test and EMFAC results can be seen in Table B1.8.

Table B1.8: Summary of EMFAC2014 Component Tests and Final Preferred Adjustments

Scenario	VMT State	Speed State	SB 375 VMT	SB 375 CO_2 (tons)	CO_2 Difference From Unadjusted
2020 Unadjusted	Non-COVID	Non-COVID	79,214,338	39,275	—
2020 VMT Component	COVID	Non-COVID	71,993,371	35,695	↓ 3,580
2020 Speed Component	Non-COVID	COVID	79,214,338	39,300	↑ 25
2020 VMT and Speed Adjusted	COVID	COVID	71,993,371	35,718	↓ 3,557

Results

The adjustments resulted in a SB 375 per capita reduction over 2005 levels of 17.9%, which meets the CARB established target for the San Diego region of 15%. The results are shown in Table B1.9.

Table B1.9: SB 375 Analysis Comparison

Metric Description	2020 Unadjusted	2020 Adjusted
2020 SB 375 Per Capita Reduction Target	15%	15%
Total SB 375 GHG Per Capita Reduction	10.2%	17.9%
SB 375 VMT	79,214,338	71,993,371
External-to-External VMT Adjustment	-1.1%	-1.1%
SB 375 Emission/Person (lbs)	23.0	20.9
2005 Baseline Emission/Person (lbs)	26.0	26.0
Per Capita Reduction Before EMFAC Version Adjustment	12.0%	19.7%
EMFAC Version Adjustment % Per Capita	-1.8%	-1.8%

Additional Background

Structural Breaks Analysis

Recall that 2020 was partitioned into four different periods: pre-COVID, COVID crash, COVID balancing, and COVID stasis. Determining the date ranges for these periods of 2020 was not an arbitrary task. The *strucchange* package in the R programming language[4] was used to algorithimically identify the location of multiple breakpoints within the 2020 VMT data.[5] These breakpoints served as the end points for each period of 2020. Visually, it was clear that there were three noticeable changes in the time series (i.e., the date partitions that divided each of the four periods). 2020 VMT for non-holiday Tuesdays, Wednesdays, and Thursdays started off around the same levels as previous years, but crashed during the onset of the Coronavirus pandemic in the United States. After the initial crash, VMT levels steadily increased before stabilizing and leveling off the rest of the year (albeit still below pre-COVID levels). Identifying exactly when those changes occurred could be subject to debate. The "breakpoints" function within the *strucchange* package endogenously and objectively determines the dates in which these changes occurred.

[4] Achim Zeileis, Friedrich Leisch, Kurt Hornik, and Christian Kleiber, "'strucchange': An R Package for Testing for Structural Change in Linear Regression Models," *Journal of Statistical Software* 7, no. 2 (January 10, 2002): 1–38, jstatsoft.org/v07/i02.

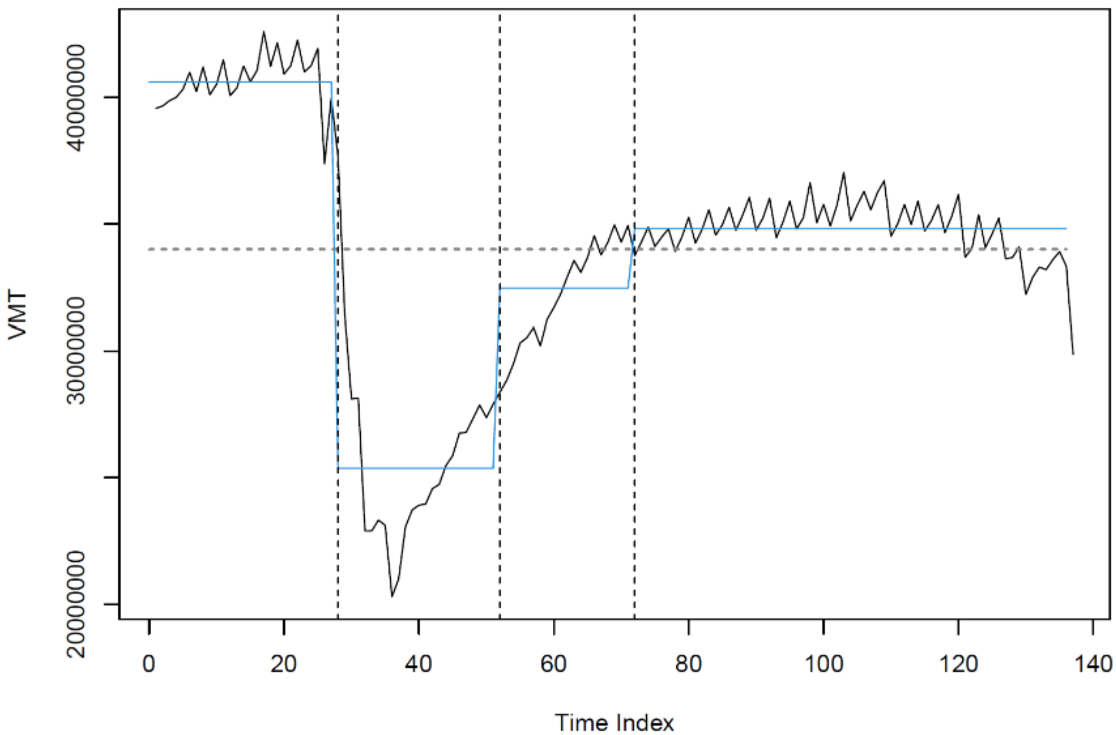
[5] Achim Zeileis, Christian Kleiber, Walter Krämer, and Kurt Hornik, "Testing and Dating of Structural Changes in Practice," *Computational Statistics & Data Analysis* 44, no. 1–2 (October 28, 2003): 109–123.

Given the initial assumption of three partitions, the *strucchange* package looks at all possible partition locations to minimize the sum of squared residuals in each partition and across all partitions. Formally, obtaining these dates to find the breakpoints are to find the set of breakpoints $d_1,\ldots,d_m$ that minimize the objective function below:[6]

$(d_{1,\ldots,}d_m) = \text{argmin} RSS(i_1,\ldots,i_m)$

RSS denotes the sum of squared residuals and $i_1,\ldots,i_m$ represents the number of partitions. Informally, we can think of the minimized sum of squared residuals as the line in each partition that minimizes the sum of the squared distances between each observation and the line itself.

Figure B1.3: 2020 VMT (Tuesday–Wednesday–Thursday Non-Holiday) in San Diego County with Breakpoints



Source: Performance Measurement System (PeMS), Caltrans

In Figure B1.3, it is evident that the three partitions (dotted vertical lines) and the line of best fit that minimizes the sum of squared residuals in each partition (the blue lines). The gray horizontal dotted line is the line of best fit without the partitions. The dates for which the breakpoints occurred were then extracted from the time index by matching the index to the date in the dataset. This time-series analysis was necessary because not only did it give a more accurate picture of what occurred in different points in 2020, but it also mathematically identified when these points occurred.

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[6] See page 112 of Achim Zeileis, Christian Kleiber, Walter Krämer, and Kurt Hornik, "Testing and Dating of Structural Changes in Practice," *Computational Statistics & Data Analysis* 44, no. 1–2 (October 28, 2003): 109–123 for more formal details.

Analysis Worksheet

Table B1.10: ABM2+ 2020 SB375 VMT and GHG Summary

Metric Description	2020 Unadjusted	2020 Adjusted	Remarks
AOC ($2010)	0.193	0.193	
Database Scenario ID	463	463	
Population	3,383,955	3,383,955	
SB 375 VMT	79,214,338	71,993,371	9.12% VMT Adjustment
SB 375 VMT / Person	23.4	21.3	
External to External VMT*	832,937	756,973	9.12% VMT Adjustment
External to External VMT Reduction	1.1%	1.1%	
SB 375 Emissions (tons)	39,275	35,718	
SB 375 GHG Emissions without E-E VMT (tons)	38,862	35,342	Adjusted CO_2 based on VMT& Speed adjustments
SB 375 Emissions / Person (lbs)	22.97	20.89	
Per Capita Reduction for 2005	11.7%	19.7%	
Off-Model Calculators VMT Reduction			
Vanpool	269,805	-	Removed from Analysis
Carshare	21,764	-	Removed from Analysis
Total VMT reduction	291,569	-	
SB 375 VMT / Person Reduction	0.09	-	
Off-Model Calculators: Daily Total GHG Reduction (tons)			
Vanpool	129.2	0.0	
Carshare	10.4	0.0	
SB 375 Off-Model Emissions Total Reduction (tons)	139.6	0.0	
SB 375 Off-Model Emissions Reduction/ Person (lbs)	0.08	-	
Off-Model GHG Reduction per capita	0.32%	0.00%	
Per Capita Reduction for 2005 with Off-Model Calc	12.0%	19.7%	
ARB Adjustment for EMFAC 2007 - 2014	-1.8%	-1.8%	
Final Per Capita Reduction for 2005	**10.2%**	**17.9%**	Adjusted Per Capita Reduction
Targets	**15%**	**15%**	

Attachment B2: SB 375 GHG Adjustment Due to Induced Demand

SB 375 GHG Adjustment Due to Induced Demand

This adjustment to the quantification of carbon dioxide (CO_2) emissions for the SANDAG Sustainable Communities Strategy (SCS) accounts for additional auto travel due to new roadway capacity that may not be fully accounted for in the Third Generation of SANDAG's Activity-Based Model (ABM3) output. Induced demand occurs when changes in travel demand are a direct or indirect result of new infrastructure investment.

A vast majority of additional lane mileage[7] in the SANDAG SCS comes from an expansion of the region's Managed Lane system. Existing infrastructure is maximized by repurposing shoulders or existing travel lanes to create Managed Lanes where shoulders, high-occupancy vehicle (HOV) travel lanes, or general purpose (GP) travel lanes exist today. Highway projects are limited to the existing footprint. Any exception will be thoroughly analyzed from an environmental and equity perspective. The new lane miles include four different categories of projects:

1. Projects completed since 2022, such as I-5 North Coast Corridor Managed Lanes from Manchester to SR 78
2. Other projects programmed in the Regional Transportation Improvement Program (RTIP) and under construction such as completion of SR 11 as a tolled facility connecting to the planned Otay Mesa East Port of Entry and SR 56 HOV lanes from I-5 to Carmel Valley Road
3. Projects programmed in the RTIP and slated for implementation such as the SR 52 Operational Improvements (truck climbing lane from Mast Boulevard to Santo Road and auxiliary lane from I-15 to Santo Road) and the SR 94/SR 125 Interchange and Arterial Operational Improvements
4. Projects planned in the 2025 Regional Plan for future implementation such as SR 78 Managed Lanes, SR 56 Managed Lanes, and closing gaps on I-805 and I-15

In the context of a regional plan, it is necessary to adequately account for both short- and long-term induced demand effects due to any added capacity to the roadway system. SANDAG ABM3 explicitly captures all the short-term induced travel behaviors through simulating changes in time of day, route assignment, frequency, mode, and location choice in response to the improved accessibility brought about by a roadway widening in a congested corridor. Long-term induced travel effects include potential household relocation to outer suburbs due to increased access provided by new or expanded roadways and potential land use development in areas with higher-than-average VMT without policy intervention. Currently, the SANDAG SCS land use pattern and the ABM3 modeling system account for long-term induced demand through iterative feedback loops. Base year (2022) skims from ABM3 were input into the land use model for producing forecasts for 2029. Then, the 2029 scenario was set up in ABM3 (using 2029 land use model outputs) and the resulting skims were input into the land use model to produce forecasts for years 2035 and beyond.

[7] Lane miles are used to measure the total length and lane count of a road. Lane miles are calculated by multiplying the centerline mileage of a road by the number of lanes it has. For example, a 2.5-mile segment of a 4-lane facility represents 10-lane miles.

A VMT based off-model adjustment was used to quantify the estimated unaccounted-for induced demand. The methodology for this adjustment borrowed elements from the existing induced demand calculator developed by the National Center for Sustainable Transportation (NCST) in conjunction with UC Davis. To calculate the VMT adjustment, the methodology follows the generally accepted principle that the magnitude of the increase of VMT due to induced demand results from a given increase in GP lane miles. Depending on GP facility classification, the elasticities for this increase are 1.0 or 0.75. The NCST calculator uses an elasticity of 1.0 for capacity expansions on interstate highways, and an elasticity of 0.75 for capacity expansions on class 2 or 3 facilities. Several corridor level tests were conducted in ABM3 to estimate its sensitivity to capacity changes by facility type. The average VMT elasticities resulting from these runs were 0.38 and 0.26 for class 1 and class 2 facilities respectively. Similarly, auxiliary lane capacity change tests were conducted in ABM3 which resulted in an elasticity of 0.13.

Table B2.1 shows inventory of all lane miles added in the plan by facility type: GP, Auxiliary, HOT, and toll. GP lanes are open to all vehicular traffic at all times of day. Auxiliary lanes are sometimes constructed between on- and off-ramps to allow vehicles more time and space to enter or exit the GP lanes. HOT lanes are used in the 2025 Regional Plan as lanes that are free to HOV 3+ users. Single-occupancy vehicles and HOV 2 users must pay a per-mile toll to use the Managed Lanes, and heavy-duty trucks are prohibited. A tollway is open to all vehicular traffic on the condition that all vehicles pay a toll.

The elasticities not accounted in ABM3 are used in conjunction with the inventory of lane miles added to calculate the VMT adjustments in both 2035 and 2050. The additional VMT is then converted to per capita GHG emission for SB 375 purposes. The results of the adjustment are an additional 712,116 daily SB 375 VMT from 2022 to 2035, a 1% per capita VMT increase, and a corresponding 1% per capita CO_2 increase. These differences decrease the calculation of the SB 375 per capita 2035 reduction by +0.78%, relative to 2005. When applied to the 2050 forecast year, the estimation methodology results in an additional 766,360 daily SB 375 VMT from 2022 to 2050, a 1.1% per capita VMT increase, and a corresponding 1.1% per capita CO_2 increase. These differences decrease the calculation of the SB 375 per capita 2050 reduction, by +0.84%, relative to 2005.

Table B2.1: Inventory of Added Lane Miles, 2022–2035 and 2036–2050, by Facility Class and Type

Federal Functional Class	Facility Type	2022-2035 Added Lane Miles	2036-2050 Added Lane Miles
Class 1	General Purpose	0	0
Class 1	Auxiliary	19	4
Class 1	Managed	69.6	0
Class 2	General Purpose	10.8	0.7
Class 2	Auxiliary	17.6	6.9
Class 2	Managed	49.3	16.3
Class 2	Toll	1.86	0
Class 2	Toll to General Purpose Conversion	48	0

Notes: Federal Functional Class 1 = Interstates; Federal Functional Class 2 = Other Freeways and Expressways