FINAL

BCAG 2024 RTP Travel Demand Model

BCAG V2.0 - Development Report

Prepared for

BCAG
BUTTE COUNTY ASSOCIATION OF GOVERNMENTS

September 2024

FEHR & PEERS

RS22-4241

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1 Introduction

This report presents the Travel Demand Forecasting (TDF) model built for the Butte County Association of Governments (BCAG) in preparation for the 2024 Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS) Update. This report describes the model development process, including the data sources used to develop key model inputs.

General Discussion of the TDF Model

This section summarizes the answers to commonly asked TDF model questions and how BCAG can use the model.

What is a TDF model?

A TDF model is a computer program that simulates traffic levels and travel patterns for a specific geographic area. The program consists of input files that summarize the area's land uses, roadway network, travel characteristics, and other key factors. Using this data, the model performs a series of calculations to determine the number of trips generated, the beginning and ending location of each trip, the mode of travel for each trip, and the route taken by the trip. The model's output includes projections of traffic volumes on major roads and important metrics such as vehicle miles of travel (VMT) needed for emissions forecasts and environmental impact analysis.

How is a TDF model useful?

The TDF model is a valuable tool for preparing long-range transportation planning studies, like the RTP. The TDF model can be used to estimate the average daily traffic volumes on the major area roads in response to planned population and employment growth, changes in transportation infrastructure, and policy assumptions; it also provides a consistent platform to analyze different land use and transportation scenarios.

How do we know if the TDF model is accurate?

To be deemed accurate for projecting traffic volumes in the future, a model must first be calibrated to a year in which actual land use data and traffic volumes are available and well-documented. A model is accurately validated when it replicates actual traffic counts on the major area roads within certain ranges of error established in the *2024 California Regional Transportation Plan Guidelines* (California Regional Transportation Plan Guidelines. (2024). Sacramento, CA: California Transportation Commission.) and it demonstrates stable responses to varying levels of inputs.

The BCAG model has been calibrated and validated to 2022 base year conditions using observed traffic counts, census data travel survey estimates, big data (StreetLight Data, Inc.), and land use data compiled by BCAG staff.

Is the BCAG TDF model consistent with standard practices?

The BCAG model is consistent in form and function with standard travel forecasting models used in transportation planning. The model includes a land-use based trip generation module, a gravity-based trip distribution model, a capacity-constrained equilibrium traffic assignment process, and a mode choice component that estimates transit, walk, and bike trips and generates auto trips for drive alone, shared ride with two people, and shared ride with three or more people. In addition to passenger travel, a separate truck trips model is included. The travel model uses Version 6.5 Citilabs Cube Voyager transportation planning software, which is consistent with many of the models used by local jurisdictions in California and throughout the nation.

How can the TDF model be used?

The TDF model can be used for many purposes related to the planning and design of Butte County's transportation system. The following is a partial listing of the potential uses of the model.

- To update the RTP/SCS
- To estimate VMT for emissions analysis and SB 743 compliant transportation impact studies
- To analyze land use and circulation elements of city or county general plans
- To conduct a regional transportation mitigation fee program
- To evaluate the traffic impacts of area-wide land use plan alternatives
- To evaluate the shift in traffic resulting from a roadway improvement
- To evaluate the traffic impacts of land development proposals
- To determine trip distribution patterns of land development proposals
- To support the preparation of project development reports for Caltrans

What are the TDF model limitations?

The BCAG TDF Model has been developed for regional planning purposes within a trip-based model framework. The model conforms to the recommendations outlined in the 2024 Regional Transportation Guidelines for Group B2 metropolitan planning organization (MPO) but does have limitations.

- The current structure has limited sensitivity to factors that may affect trip generation rates such as significant declines in economic activity. (e.g., COVID-19 effects). However, since the model has a land use occupancy component, economic cycles can be reflected in the assumed intensity of land uses within the model.
- Although the model network includes all local roadways, not all local roadways are assigned vehicle trips. Use of the model for local applications will require sub-area refinements and validation to ensure the model is appropriately sensitive to changes at this scale.
- A new mode choice component was added to the v1.0 BCAG model which was originally prepared for 2020 RTP/SCS. However, due to the lack of more recent mode choice survey data, the base year 2022 condition is still calibrated based on the 2010-2012 California Household Travel Survey, which might not fully align with the current post-pandemic conditions. Future

model updates would benefit from more current household travel surveys, on-board transit survey, and additional data sources such as Big Data.

- Model parameters relying on household travel survey data are based on a small sample size. The current household travel survey data is from 2010-2012 California Household Travel Survey which might be outdated especially with the travel behavior changes associated with post pandemic conditions. Additional big data (StreetLight Data, Inc.) is used to calibrate the model parameters to better reflect the base year 2022 condition. However, future model updates would benefit from a larger sample of households in Butte County and a more recent household travel survey.
- The trip-based model structure does not allow for complete estimates of forecasts of vehicle trips (VT) or vehicle miles traveled (VMT) generated by residential households or individual persons. Vehicle trips are assigned at the TAZ level and any connection to individual land uses that originally generated the trips are lost. VT and VMT can be expressed as ratios such as VMT per capita or VMT per household. But these ratios are based only on dividing total VMT by the number of people or households in the model area. It does not indicate the level of VT or VMT being generated.
- New technologies in the automotive market, such as autonomous vehicles (AV), are not currently included in the BCAG model. As AV penetration occurs and their operation on local roadways becomes more common, general travel behavior is expected to change. However, there is currently insufficient evidence or data to accurately assess the impact of AVs on trip generation and mode split, so AV technology is not incorporated in the current version of the BCAG model. As more data and studies on AVs become available, future updates to the model should consider including AVs in the model structure.

What updates were made to this version of the model?

When preparing 2020 RTP/SCS, major updates and changes were done for the BCAG model, including the change of platform from TransCAD to Cube, major improvements in trip generation process, and additional features including travel cost function, mode choice model and other updates. For 2024 RTP/SCS, the model base year was updated from 2018 to 2022. Additional significant refinements or changes include upgrading the model run structure from Cube Catalog to Cube Voyager. Besides this change, other updates include model input updates, model re-calibration with big data, and feature improvements. All the updates and changes are summarized below.

- *Platform update:* BCAG v1.0 runs on Cube version 6.4.3 with GIS features. The updated BCAG v2.0 runs with the latest Cube version 6.5 Voyager, with no additional requirements of GIS features.
- *Model Run Set-up:* BCAG v1.0 was established in Cube platform with Cube Catalog. In this version, the script is upgraded to a master script and run with Cube Voyager. All the post-processing analysis are saved as separate scripts that can be run for model output summaries.
- *Recalibration:* Trip generation and trip distribution based on StreetLight data and traffic counts that account for travel behavior changes from pre-pandemic to 2022 conditions.
- *Land Use Inputs:* Updated base year 2018 data to represent new base year 2022.

- *New Trip Generation Land Use:* A new land use category is added to the model to account for CSU Chico on-campus student housing.
- *Traffic Analysis Zone (TAZ) split:* Model TAZs are refined for the known future projects, such as Barber Yard in City of Chico, and Tuscan Ridge in Butte County. Additional boundary adjustments and TAZ split are done for CSU Chico, and nearby zones.
- *Transportation Projects:* The transportation project list was updated to reflect the currently planned and programed projects. The model network input is updated from geodatabase network to Cube .net format master network, with details about the project year, number of lanes, posted speed, and facility type to accommodate for the future year model development.
- *Traffic Assignment Parameter*: The capacity adjustment link attribute is updated to correctly represent the capacity for auxiliary lanes. Additional changes are made to the capacity lookup table to better assign the traffic into the model network based on the capacity calculated using facility type, speed, and number of lanes.
- *Updated Traffic Counts:* 2022 traffic counts were collected to calibrate and validate the existing 2022 conditions, which considers the post COVID-19 and post-Camp Fire effects on traffic conditions. Additional Caltrans annual traffic counts and big data are used to cross-verify the collected traffic counts including at gateways.

The updates to the model reflect an existing 2022 condition, with changes that help to streamline model run procedure and ease the model use for project application.

What future updates would benefit the model for regional scenario planning?

- Refine economic factors at a more specific geography and forecast cross-classified socioeconomics for each scenario for both residential and non-residential land use types.
- Evaluate shifts in future assumptions such as autonomous vehicles, demographics, fuel price, and land use development patterns.
- Update the truck trip model to reflect the changes in local delivery and larger economic trends associated with internet shopping.
- Although the model passes reasonableness checks, and static and dynamic validation, it is recommended that the model be validated in the study area before it used for local-scale projects. This is especially important in the near-term during the recovery of Paradise, since land use development and travel patterns may change significantly in a shorter amount of time than occurred pre-Camp Fire.

Study Area

The model area for the BCAG TDF Model encompasses Butte County, which includes the cities of Chico, Paradise, Oroville, Biggs, and Gridley. **Figure 1** shows the BCAG TDF model area. To represent travel into and out of Butte County, the model also includes 20 "external gateways" at major roads that cross the county line.

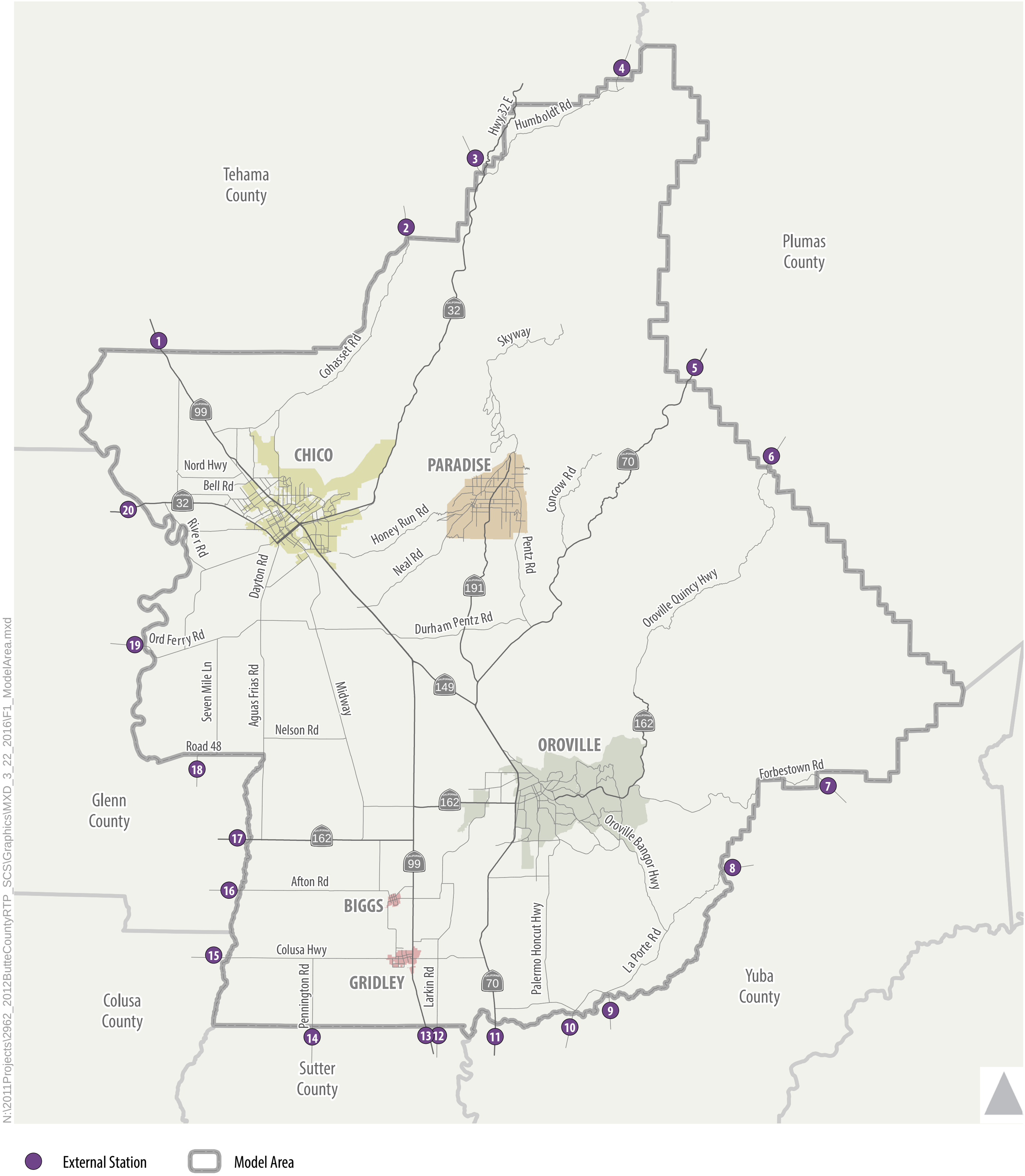


Figure 1

Model Area

2 Model Input Data

This section describes the data collection, review processes, and refinement for developing the model input data of the model.

Data Collection

A data collection effort was undertaken at the outset of the model development process. Data sources included the land use, roadway network, and traffic count database from BCAG, Caltrans Traffic Data Branch for highway counts, and CSU Chico for Geographic Information Systems (GIS) data. Additional data sources are listed below.

- 2021-2022 Census Bureau data
- Department of Finance (DOF) housing estimates
- California Statewide Household Travel Survey (CHTS), 2012
- Employment Development Department (EDD) employment estimates
- Longitudinal Employer-Household Dynamics (LEHD) data
- StreetLight Origin-Destination Mobile Device/Connected Vehicle Data (Big Data), 2019, 2022
- California Statewide Travel Demand Forecasting Model
- Bike and pedestrian facilities
- Transit routes, stops, and schedules
- Traffic counts
- Transit ridership

Traffic Analysis Zone System

TAZs represent geographic areas containing land uses that produce or attract trip ends. Travel demand models use TAZs to connect land uses to the roadway network. The TAZ boundaries for the BCAG model were developed from the Butte County parcel layer and closely nest within city boundaries in Butte County.

The TAZ boundaries from the previous model were maintained for this update, except for a few locations where TAZs were further split or boundaries modified to include additional details:

- Chico Barber Yard
- Tuscan Ridge (between Chico and Paradise near Skyway)
- CSU Chico Student Housing and adjacent CSU campus and residential areas
- Chico High School and adjacent residential areas

The TAZ identification numbering system, organized by plan area, is maintained with this update, as presented in **Table 1**. TAZ maps showing the zone boundary and zone number are shown in **Appendix A**.

Table 1: TAZ ID by Plan Area

Plan Area	Zone ID Range
Model Gateways	1-20 (21-99 Blank)
Biggs	100-122 (123-199 Blank)
Chico	200-532 (533-599 Blank)
Gridley	600-636 (637-699 Blank)
Oroville	700-816 (817-899 Blank)
Oroville – County	900-924 (925-999 Blank)
Paradise	1000-1117 (1118-1199 Blank)
Magalia	1200-1217 (1218-1299 Blank)
Unincorporated Butte County	1300-1559 (1560-1999 Blank)

Notes: Zone IDs that do not currently exist but are available for use in more detailed project analyses are noted in parentheses.
Source: Fehr & Peers, 2024.

The BCAG model TAZ system includes 929 zones in the model area covering Butte County, and 20 model gateways where major roadways provide access into the model area. The model gateways represent all major routes by which traffic can enter, exit, or pass through the model area. As noted in Table 1, there are blank zone IDs reserved for each plan area available for use in more detailed project analyses.

Gateways Data

The gateways dataset represents travel beyond the model boundary and contains the initial number of productions and attractions associated with the gateway locations by trip purpose. The home-based work productions and attractions are broken down by income category. **Table 2** below contains the location of all the gateways in the model.

Table 2: BCAG Model Gateway Location

Gateway TAZ	Location
1	Hwy 99 -north of Butter County Line
2	Cohasset Rd - north of Musty Buck Rd
3	Hwy 32 - north of Humboldt Rd
4	Humboldt Rd - north of Jonesville Rd
5	Hwy 70 - north of Butte County Line
6	Oroville Quincy Hwy - north of Haskins Valley Rd

Table 2: BCAG Model Gateway Location

Gateway TAZ	Location
7	Forbestown Rd - east of Reservoir Rd
8	La Porte Rd - northeast of Robinson Mill Rd
9	Loma Rica Rd - south of La Porte Rd
10	La Porte Rd - south of Butte County Line
11	Hwy 70 - south of Butte County Line
12	Larkin Rd - south of Butte County Line
13	Hwy 99 - south of Butte County Line
14	Pennington Rd - south of Rutherford Rd
15	Colusa Hwy - west of Cherokke Canal Rd
16	Afton Rd - west of Aguas Frias Rd
17	Hwy 162 - west of Butte County Line
18	Road Z - south of Road 48
19	Ord Ferry Rd - west of Hugh Baber Ln
20	Hwy 32 - west of Butte County Line

Source: Fehr & Peers, 2024.

Land Use Data

Land use data is one of the primary inputs to the BCAG model and this data is instrumental in estimating trip generation. The model's primary source of land use data is BCAG's residential, school, and commercial parcel and footprint datasets (maintained in a GIS format). Each database provides information on the existing level of development within the county and is aggregated to the model's TAZs. These databases are maintained by BCAG staff in association with CSU Chico. The land use data in the model is divided into several residential and non-residential categories. The BCAG model has 18 land use categories, which is consistent with the previous model except for the new land use type "CSU_HHSTU" representing the number of on campus student housing units. This new land use type is added to the model to better estimate travel activities near CSU Chico. Model land use categories and the detail description are described in **Table 3**.

Table 3: Model Land Use Categories

Land Use Type	Model Land Use ID	Units
Single Family Residential	SF_DU	Dwelling Units
Multi-Family Residential	MF_DU	Dwelling Units
Mobile Home Residential	MH_DU	Dwelling Units
Office	OFF_KSF	Thousand Square Feet
Medical Office	MED_KSF	Thousand Square Feet
Hospital	HOSP_KSF	Thousand Square Feet
Industrial	IND_KSF	Thousand Square Feet
Public/Quasi-Public	PQP_KSF	Thousand Square Feet
Park	PARK_AC	Acres
Neighborhood-Serving Retail	RET_KSF	Thousand Square Feet
Region-Serving Retail	RRET_KSF	Thousand Square Feet
Hotels	HOTEL_RMS	Rooms
K-12 School	K12_STU	Students
University	UNIV_STU	Students
Community College	CC_STU	Students
Casino	CASINO_SLT	Slots
On Campus Student Housing	CSU_HHSTU	Dwelling Units

Note: CSU_HHSTU is estimated based on the number of students that live in on-campus housing. It is assumed as 2 persons per dwelling unit.
Source: Fehr & Peers, 2024.

Socio-Economic Data

The Socio-economic Data (SED) represents the number of households by housing type (single family, multi-family, mobile home, university student housing), number of residents, and household income level (low, medium, and high) for each TAZ. Additionally, the SED file contains the total square footage for the retail, regional retail, industrial, office, medical, hospital, and public/quasi-public land uses in addition to the number of hotel rooms, university students, community college students, K-12 students, park acreage, and the number of slot machines at the casinos.

Additional SED information includes household proportion by household type, size and income level. These SED proportion was updated in the 2020 RTP/SCS when BCAG model v1.0 was developed using U.S Census Bureau 2018 American Community Survey (ACS) 1-year Estimates for household inputs. When developing 2022 base year SED inputs, these values are preserved as the previous estimates with minor cleanups to calibrate to 2022 condition. These detail inputs are useful for project level analysis to better understand the change in trip generation by different land use combinations. This feature can also be used to evaluate different SCS strategies. The following section described the development of household information in the SED dataset for BCAG model v1.0 which are still valid for BCAG model v2.0.

The household information in the SED dataset was created by applying the household type proportions information from the U.S. Census Bureau. (U.S. Census Bureau (2018). American Community Survey 1-year Estimates. Retrieved from https://www.census.gov/data/developers/data-sets/acs-1year.html.) and applying them to the number of dwelling units in the land use datasets provided by BCAG. Through the application of these proportions the SED data contains the number of single family and multi-family dwelling units arranged by number of residents and household income category. The household income categories include:

1. Low: less than $35,000 a year
2. Medium: between $35,000 and $75,000 a year
3. High: greater than $75,000 a year

Additionally, the proportion of high, medium, and low-income jobs were calculated for each of the employment related land uses (retail, office, medical, etc.) for each TAZ. This input is currently not used in the model, but the details are retained in case future analysis is needed to further evaluate changes in travel behavior across different income groups for jobs. If employment attraction rate is available for each income group, those can be added into the model and the model would be able to estimate the trips based on employment by different income groups.

The U.S. Census Bureau Longitudinal Employer-Household Dynamics Quarterly Workforce Indicators (QWI)[1] dataset for 2018 was used to divide the employment land uses into the high, medium, and low-income categories. The average annual income was calculated for each North American Industry Classification System (NAICS) sector in Butte County using the QWI dataset. Each of the NAICS sectors were classified into a high (>$75,000), medium ($35,000 to $75,000), or low (<$35,000) category based on the estimated annual income. The NAICS sectors were then associated with one of the non-residential land use categories. **Table 4** below contains the relationship of NAICS sectors to the model land use with the corresponding income category. This relationship is currently preserved for both the 2022 base year and all forecast scenarios.

Table 4: Land Use Type by NAICS Sectors and Income Category

Land Use	Income Category	NAICS Sectors
Retail & Regional Retail	All Income Categories	44-45 Retail Trade, 72 Accommodation and Food Services
	Low (<$35,00)	44-45 Retail Trade, 72 Accommodation and Food Services

[1] U.S. Census Bureau. Longitudinal Employer-Household Dynamics, Quarterly Workforce Indicators (QWI). 2018. https://lehd.ces.census.gov/data/#qwi

[2] U.S. Census Bureau. Longitudinal Employer-Household Dynamics. LEHD Origin-Destination Employment Statistics (LODES). 2018. https://lehd.ces.census.gov/data/#qwi

Table 4: Land Use Type by NAICS Sectors and Income Category

Land Use	Income Category	NAICS Sectors
	Medium ($35,000 to $75,000)	-
	High (>$75,000)	-
Industrial	All Income Categories	21 Mining, 22 Utilities, 31-33 Manufacturing, 48-49 Transportation and Warehousing
	Low (<$35,00)	-
	Medium ($35,000 to $75,000)	21 Mining, 31-33 Manufacturing, 48-49 Transportation and Warehousing
	High (>$75,000)	22 Utilities
Office	All Income Categories	42 Wholesale Trade, 51 Information, 52 Finance and Insurance, 53 Real Estate Rental and Leasing, 54 Professional Scientific, and Technical Services, 55 Management of Companies and Enterprises, 56 Administrate and Support and Waste Management and Remediation Services, 71 Arts, Entertainment, and Recreation, 81 Other Services (except Public Administration)
	Low (<$35,00)	53 Real Estate Rental and Leasing, 56 Administrate and Support and Waste Management and Remediation Services, 71 Arts, Entertainment, and Recreation, 81 Other Services (except Public Administration)
	Medium ($35,000 to $75,000)	42 Wholesale Trade, 51 Information, 52 Finance and Insurance, 54 Professional Scientific, and Technical Services, 55 Management of Companies and Enterprises
	High (>$75,000)	-
Medical & Hospital	All Income Categories	62 Heath Care and Social Assistance
	Low (<$35,00)	-
	Medium ($35,000 to $75,000)	62 Heath Care and Social Assistance
	High (>$75,000)	-
Public/Quasi-Public	All Income Categories	22 Utilities, 61 Educational Services, 92 Public Administration
	Low (<$35,00)	-
	Medium ($35,000 to $75,000)	61 Educational Services, 92 Public Administration
	High (>$75,000)	22 Utilities

Source: Fehr & Peers, 2024.

The total number of employees by NAICS sector was calculated for each TAZ using the Workplace Area Summary datasets from the U.S. Census Bureau's Longitudinal Employer-Household Dynamics Origin-

Destination Employment Statistics (LODES)[2] dataset. The proportion of employees in each NAICS sector was calculated for each Census Tract, and these values were allocated to the TAZs using a spatial join in ArcGIS. The TAZs were assigned the NAICS sector proportions based on which Tract their centroid fell within.

The employment totals were then used to estimate the proportion of employees in each NAICS sector. The NAICS sector proportions were then assigned to the TAZs using a spatial join in ArcGIS. TAZs were assigned the proportion values based on which Tract their centroid fell within. The sector proportions were then summarized to each land use and income category using the crosswalk detailed in Table 4. The same percentages file is currently preserved in all scenarios and can be changed for individual scenarios as appropriate. Due to the lack of trip generation rate data for different employment income groups, this function is preserved in the model but is not currently used. However, if employment attraction rates by employment income groups becomes available, this function can be activated in the future.

[2] U.S. Census Bureau. Longitudinal Employer-Household Dynamics. LEHD Origin-Destination Employment Statistics (LODES). 2018. https://lehd.ces.census.gov/data/#qwi

Roadway and Bicycle Network

The model network combines the roadway and bicycle networks into one master network file. The master network is inclusive of all roadway and bicycle network links that existed in 2022 plus those planned to be added through 2045. As described in the model update section, the model network input is updated from the geodatabase network to Cube .net format master network, with details about number of lanes, posted speed, and facility type for different scenarios. This update eliminates the potential issue in model run set up due to the compatibility issue of Cube and ArcGIS versions. The updated master network is also easier to edit and understand. Development of the master network included appropriately sorting and merging all the GIS data collected for the roadway and bicycle networks, reviewing current and historical aerial maps, and refining the network for implementation into the model structure. The model master network still maintains a high level of detail of the roadway and bicycle facilities. Compared to geodatabase format network, Cube .net format network loses the true shape of each facility from the GIS centerline files. However, that level of detail has not influenced the model's output estimates and forecasts.

The roadway and bicycle facilities included within the master network also focuses on the most used facility types. The master network facility classifications included in the model, consistent with the Butte County RTP/SCS, are described below.

Freeways

Freeways are high-capacity facilities that primarily serve longer distance travel. Access is limited to interchanges typically spaced at least one mile apart. State Route (SR) 70 and SR 99 are the major freeways in Butte County. Portions of SR 149 that connect SR 70 and SR 99 are also designed to meet freeway standards.

High Occupancy Vehicle Lanes

High Occupancy Vehicle (HOV) lanes are dedicated facilities on freeways with access restricted to single occupant vehicles (i.e., vehicles with only the driver, no passengers). These facilities can be restricted by time of day. Currently, no HOV lanes exist within Butte County; this facility type is included in the available options for possible future projects and modeling.

Expressways

Expressways are high-capacity facilities that primarily serve intermediate distance travel between intercity destinations. Access is limited, but not to the extent of freeways, and travel lanes may or may not be divided. Portions of SR 70, SR 99, SR 149, and Skyway are classified as expressways in Butte County.

Arterials

Roadway segments classified as Arterials are major roads that provide connections within cities, between cities and neighboring areas, and through the cities (cut-through traffic) of Butte County. Arterials in Butte County typically have one or two lanes in each direction, with travel speeds of 30-40 miles per hour (mph).

Examples of these arterials are East Avenue in Chico, Clark Road in Paradise, and Olive Highway in Oroville.

Collectors

Collectors (Major and Minor) are facilities that connect local streets to the arterial system and may also provide direct access to local land uses. Collectors generally provide two travel lanes and typically have a posted speed limit of 25 mph or greater. Examples of these collectors are Ceres Avenue in Chico, Nunneley Road in Paradise, and Myers Street in Oroville.

Local Streets

Local Streets primarily feed collector roads and generally provide two travel lanes with a posted speed limit of 25-30 mph. The model network focuses on freeways, arterials, and collectors but does include most of the local streets represented in the Butte County GIS centerline file to provide access from traffic analysis zones to the larger network. If a project application needs to assess local roadway performance, the model has been designed such that detail can be added to improve its sensitivity related to these facilities. These types of changes would typically be performed as part of a specific project application.

Transit Only Facilities

Transit Only facilities represent any lanes or dedicated travel-ways for transit use, restricted to all other vehicles. Currently no transit only facilities exist within Butte County; this facility type is included in the available options for possible future projects and modeling.

Bicycle Only Facilities

Bicycle Only facilities represent Class I multi-use off-street paths, or paved trails separated from roadways. These facilities restrict vehicle access and allow for shared use by cyclists and pedestrians. Class II bike lanes or Class III bike routes are represented along a roadway and identified separately based on the bicycle facility type attribute. The existing facilities were coded into the transportation network and coded with the appropriate functional type to prohibit use by other modes in both the accessibility calculation and in traffic assignment.

Pedestrian Facilities

Pedestrian facilities, such as sidewalks or multi-use paths, are not separately identified in this model. Access for pedestrians is assumed on all roadways and bicycle facilities, except for along freeways and expressways.

Table 5 shows each of the roadway and bicycle network facility types, along with the initial roadway speeds and capacities used for each roadway classification in the model.

Table 5: Model Roadway Facility Types

Facility Type ID	Facility Classification	Speed Range (MPH)	Lane Capacity Range (vphl)[1]
1	Freeway	55-65	1,750 – 2,000
2	Ramp: Freeway-to-Freeway	55-65	1,800
3	Ramp: Slip	20-45	1,500
4	Ramp: Loop	20-45	1,250
5	HOV	55-65	1,300 – 1,800
6	Expressway	35-55	800 – 1,100
7	Arterial	30-40	750 – 900
8	Collector	25-45	700 – 800
9	Local	25-30	600 – 700
10	Transit Only	25-55	NA
11	Bike Only	-	NA
100	Centroid Connector[2]	25	NA

1. vphl – vehicles per hour, per lane. These capacities are used for trip assignment purposes and do not reflect traffic operational throughput during peak hours, which is often lower especially if congestion occurs.
2. Centroid connectors are abstract representations of the starting and ending point of each trip, and therefore should have no capacity constraints

Source: Fehr & Peers, 2024.

The roadway and bicycle master network database include the network link attributes identified in **Table 6.** These attributes were checked using maps, aerial photographs, and other data provided by BCAG. In addition, the vehicle count data for the 309 roadway segments where traffic counts were collected in 2022/2023 are included at the relevant links for model validation.

Table 6: Master Network Link Variables

Attribute	Description	Example
A	A node	43
B	B node	11791
NAME	Roadway Name	SR 99
DISTANCE	Link distance in miles	3.56
DIST_ADJ	Link distance adjustment (e.g., at Model Gateways)	5
TERRAIN	Terrain (1=Flat, 2=Rolling, 3=Mountain)	1
PLAN_AREA	Planning area where link is located	Chico
DIR	Overall direction under all years (Two-Way = 0, One-Way=1). If any year is two-way, then this attribute is set to two-way.	0
USE	Indicate if the link is used in the model run	1
JURISDICTION	Political jurisdiction where link is located	Oroville
LANES_YEAR	Number of directional through vehicle travel lanes under specific year	1
SPEED_YEAR	Vehicle free-flow speed in miles-per hour under specific year	50
FACTYP_YEAR	Facility types under specific year. See Facility Types tab for codes	11
CAPADJ_YEAR	Vehicle lane capacity adjustment for Auxiliary Lane under specific year (factor for vehicle lane capacity adjustment: null, 0= no adjustment, 0.9 = adding 90% capacity)	0
TOLL_YEAR	Code used for cost for vehicles on toll facilities under specific year (i.e., VMT tax)	0
AREATYP_YEAR	Land use development affecting roadway capacity: Rural-1, Suburban-2, Urban-3, CBD-4	1
CNTID	Count ID	23
CNT_YR	Count Year	2017
DAY_CNT_TOT	Daily Count Two-Way Total	3,724
AM1_CNT_TOT	AM Peak Hour Count Two-Way Total	331
PM1_CNT_TOT	PM Peak Hour Count Two-Way Total	399

Source: Fehr & Peers, 2024.

In addition, the master network is also represented by nodes at the end of each roadway/bicycle link. The node attributes for the master network are presented in **Table 7**.

Table 7: Master Network Node Variables

Attribute	Description	Example
N	Node number	43
X	Y-coordinate of node in NAD_1983_StatePlane_California_II_FIPS_0402_Feet	6664944.483
Y	X-coordinate of node in NAD_1983_StatePlane_California_II_FIPS_0402_Feet	2248124.439

Source: Fehr & Peers, 2024.

Transit System

Rather than coding detailed transit routes, stops, and access, the transit system is represented by zones that have access and the frequency (in the form of headway) for adjacent transit routes. The TAZ dataset contains information on the peak and off-peak frequency of transit service for each TAZ. The frequency of transit service was determined for each of the TAZs using a GIS layer representing the bus stop locations throughout Butte County and 2022 B-Line schedules. TAZs that occurred within a quarter mile of a bus stop location were considered to be served by that bus stop. The frequency of peak and off-peak transit service was determined for each bus stop, and this information was assigned to TAZs that were within a quarter mile of the stop. If a TAZ was served by more than one bus stop, then the values from the bus stops with the most frequent service were assigned to the TAZ.

The 2022 transit frequency values were updated for future scenarios based on information provided by BCAG. Additionally, in the future scenarios, six micro-transit service areas are established in the City of Chico, the City of Oroville, and the Town of Paradise. A 15-minute headway was assumed for transit routes serving these micro-transit service areas. TAZ that either intersect with or fall within these six micro-transit service areas were identified and assigned the 15-minute headway. If a TAZ was served by stops on both fixed transit routes and within the micro-transit service areas, the most frequent service value was assigned to the TAZ.

As with most regional models, the transit system only includes routes and stops within Butte County. The primary reason is the sensitivity to transit of stop location relative to land uses outside of the travel model not being available or being too costly to obtain and model. Other common reasons for not including transit outside of the model region are the inability to accurately include number of stops, travel time, or transfers beyond the model boundary and the relatively low number of riders for a high level of effort.

Roadway Vehicle Counts

BCAG provided count data of vehicle traffic volumes on 309 roadway segments throughout the model area. Vehicle counts were conducted over a three-day period mid-week (Tuesday through Thursday) in Year 2022 and 2023. The data also includes breakdown by travel speed and number of heavy vehicles. The roadway vehicle count data was used for validation of the base year model.

Transit Routes and Ridership

BCAG provided transit stop, route, and ridership information for B-Line Transit, the local and regional transit service provider in the base year 2022. BCAG also provided the list of future transit projects as identified in the 2024 RTP and previous 2020 RTP.

2012 California Household Travel Survey (CHTS)

The California Household Travel Survey (CHTS) was conducted in 2012 and 2013 in 58 counties.[3] The CHTS is a combination of travel diary and GPS data, which allowed for under-reported information such as walking trips, non-home-based trips, and stops along a long trip. The CHTS is publicly available on nrel.gov at a granular level.

2012 CHTS data was previously summarized and used to validate base year 2018 of the BCAG Model v1.0 for 2020 RTP/SCS. As mentioned in the model limitation section, no additional CHTS data has been published since 2012/2013. The same CHTS data is used when calibrating and validating the updated base year 2022 for 2024 RTP/SCS.

Preparation and Cleaning of CHTS Data

The publicly available version of the 2012 CHTS required a substantial amount of preparation, including re-weighting, before it was suitable for model development. Fehr & Peers has done extensive data preparation, including statewide and county weights, to create tailored summaries. Examples are residential VMT, trip length, and mode share summaries. These can be found in **Appendix B.**

Identification of Trip Purposes

The 2012 CHTS data does not describe trip purposes directly; instead, it contains a "place" file whose attributes include a listing of up to three activities the respondent participated in at that place. A small list of place purposes was distilled from this activity information: HOME, WORK, COLLEGE, K12, SHOP, or OTHER. In this project, we summarize total person trips starting and ending within Butte County for all trip purposes.

Estimation of Survey Weights

Surveys capture the characteristics of an entire population by randomly sampling a small proportion of the population. Often, a perfectly random sample is hard to achieve — some groups are difficult to survey and are under-represented, other groups are over-represented. To balance this bias, estimated sample weights "reshape" the sample. Fehr & Peers estimated household sample weights for the CHTS to balance the survey sample to match county-level percentages for several variables as reported in the 2012 ACS 5-year estimates (U.S. Census Bureau (2018). American Community Survey 5-year Estimates. Retrieved from https://www.census.gov/data/developers/data-sets/acs-5year.html.). Listed below are variables used as controls for the re-weighting.

- Household size (one to seven or more).
- Household income (nine income categories).
- Number of workers per household (zero to three or more).

[3] https://dot.ca.gov/programs/transportation-planning/economics-data-management/transportation-economics/ca-household-travel-survey

- Number of vehicles owned per household (zero to four or more).
- Household residential unit type (three categories).
- Household size (one to five or more) cross-classified by household income (five categories).
- Household size (one to five or more) cross-classified by number of vehicles per household (zero to four or more).
- Household size (one to five or more) cross-classified by number of workers per household (zero to three or more).

The survey weights must be correctly applied to yield accurate summaries. There are three types of weights included with the cleaned CHTS data:

- Household-level weights (hhweight, hhexpweight, and hhexpweight_weekday)
- Trip-level weights (tripweight, tripexpweight, and tripexpweight_weekday)
- Trip correction factor (tcf)
- The relationship among the three weighting factors is:
    - *Tripweight = hhweight * tcf*
    - *Tripexpweight = hhexpweight * tcf*
    - *Tripexpweight_weekday = hhexpweight_weekday * tcf*

To use CHTS data accurately, one or more of these weights must be applied. A trip weight is used to weight trips relative to one another, and it is useful for computing percentages. At the same time, the tripexpweight factors provide estimates of the total number of trips. In this project, we implemented the tripexpweight_weekday weighting factor.

Place Type

In addition to locating households and trip ends using census tracts, Census Designated Places (CDPs), and counties, each household location and a trip end is assigned a place type category. The place type is based on the number of jobs and the working-age population accessible from the household or trip end.

CHTS Summaries for Validation

The CHTS data were summarized for trips starting and ending within Butte County for model validation purposes. The type of information from the CHTS used for validation is listed below.

- Mode share
- Mode share by trip purpose
- Total Households (for comparison and statistical purposes)
- VMT per household (and by trip purpose) for validation
- Daily vehicle trips per household (and by trip purpose) for trip generation
- Average vehicle trip length (and by trip purpose) for validation
- Average person trip length (and by trip purpose) for validation

- VMT and Person Miles Traveled (PMT) per capita/household for validation

The "simple" and "flat" summaries contain one record per geography which is suitable for joining to GIS. The "simple" summary includes a smaller number of metrics, while the "flat" summary contains many more details. The "filterable" summary provides many records per geography and is viewable in Excel.

In this project, we created a summary of trips that only start and end within Butte County. The methodology is summarized below:

- The code is CHTS_nonhighway_validation.R
- The trip unit is "personTrips"
- Region name countyList is set for 6007 which is Butte County
- Input files are households_clean.csv and trips_clean.csv for households and trips variables, respectively.
- For the home and work tracts, the geography lookup variable is set to geoglookup_full.csv
- The output is written in the CSV format.

A high-level summary of the survey records is shown below for both the SACOG region and Butte County. Detailed tables with metadata are in **Appendix B**.

Table 8: CHTS High-Level Summary

Code	Name	Type	lookup	Total Households	Total person trips
3	SACOG	region	SACOG region	816,939	6,803,865
6007	Butte	county	Butte County	85,074	664,437

Source: Fehr & Peers, 2024.

Interregional Travel

The travel model generates total person and commercial vehicle trips that travel completely internal to Butte County, and interregional trips that travel to, from, and through Butte County. These trip types are referenced as follows in the remainder of this document.

- Internal-internal (I-I) trips that originate and terminate within the model area.
- Internal-external (I-X) trips that originate within but terminate outside of the model area.
- External-internal (X-I) trips that originate outside and terminate inside of the model area.

To estimate base and future year data for the interregional trips, the California Statewide Travel Demand Model (CSTDM), California Statewide Freight Forecasting Model (CSFFM), and mobile device/connected vehicle data were used. The mobile device/connected vehicle trip estimates were obtained from StreetLight data to refine the I-I, I-X, X-I, and gateway trips for the base year (i.e., recognizing post-pandemic travel patterns), and the growth from the CSTDM and CSFFM were applied to the refined base year interregional data.

As discussed in the Data Collection section, StreetLight data from 2019 and 2022 were used to analyze changes in travel behavior in Butte County post-pandemic. The data indicate that Butte County's internalization rate increased from 88% in 2019 to 89% in 2022, with the most notable growth in home-based work (HBW) trips, which rose from 88% to 91%. However, while HBW trips accounted for 24% of total I-X and X-I trips in 2019, this percentage declined to 19% in 2022. In contrast, home-based other (HBO) and non-home-based (NHB) I-X and X-I trips both saw an increase of 2% to 3%.

California Statewide Travel Demand Model

The 2020 RTP/SCS model utilized the CSTDM to estimate base year and future year interactions with the gateways and for through trips. Since the latest version of the model has not been released, the same through trips and interregional factors from the 2020 RTP/SCS model were used as the starting point for calibration and then refined based on mobile device/connected vehicle data, count data, and the updated trip generation for passengers and commercial vehicles. Similar to the CSTDM forecast for passengers, the CSFFM was used to estimate interregional commercial vehicle travel.

Mobile Device Data (Big Data)

Travel patterns are typically expressed in terms of origins and destinations – origins being locations where trips begin, and destinations being locations where trips end. In its most basic form, a travel pattern is an origin-destination pair that represents a direct trip from one location to another. Work commute trips are among the most common origin-destination pairs, typically from a residence to a place of employment in the morning, and then back to home at the end of a workday.

StreetLight Data aggregates anonymized location-based data from smartphones, car/truck navigation systems, and connected vehicles. The data is used to estimate the distribution and quantity of trips between or through geographic areas. Conventional approaches to estimating trip distribution rely on travel demand models. The use of StreetLight data, however, casts a snapshot of origin-destination information grounded in the actual travel behavior of roadway users. The use of GPS data was to capture the auto travel separate from the commercial vehicle travel and was appropriate for distribution of internal-external (IX) and external-internal (XI) personal and commercial vehicles (medium and heavy trucks), and external-external (XX) personal and commercial vehicles since the model does not reflect interregional transit.

Two different sets of StreetLight data were used in the model calibration and validation process to develop the base year 2022 conditions for the BCAG model. The first set of data is similar to what was used for the 2020 RTP/SCS BCAG model v1.0 base year scenario, including IX, XI, and XX trip characteristics from January to April 2022 during the post-pandemic period. Given the rapid changes in travel behavior over the past three years (2019–2022) due to the pandemic, additional analysis was conducted using data from 2018 (pre-Camp Fire) and 2019 (post-Camp Fire, pre-pandemic). Comparing data from these three periods provides a deeper understanding of changes in travel behavior and helps establish more accurate calibration targets.

The second set of StreetLight data is a unique dataset released specifically for VMT analysis, including aggregated sample trip counts by trip purpose for March and April 2022. This new data, combined with CHTS data, was used to estimate vehicle trip generation rates and travel distances, further refining the calibration and validation of the base year 2022 conditions.

Travel Cost

In addition to travel time, the cost of travel influences auto ownership, trip distribution, mode choice, and route choice. Although the model allows for a link-based cost, BCAG does not have existing or planned roadway user fees based on distance traveled or for using specific roadways. If such facilities are expected in the future, this feature should be calibrated prior to use.

Parking Cost

The average parking cost per trip can be stored as a zonal attribute and can be used in both trip distribution and mode choice. However, this feature has not been activated in the model.

Auto Operating Cost

Auto operating costs are a major influence on travel. Auto operating costs include fuel price, maintenance costs, and tire replacement costs. The California Air Resources Board (CARB) has developed a spreadsheet that takes these factors into account for each MPO and for predetermined evaluation years. The spreadsheet was used to develop costs for the years corresponding to the base year and future scenario years and the model interpolates the values for other model years. **Table 11** shows the presumed auto operating costs applied in the model. The detailed auto operating costs estimates can be found in **Appendix C**.

Table 9: BCAG Auto Operating Costs

Year	Cost[1]
2022	$0.2138
2035	$0.1892
2045	$0.1825

1. Costs represented in 2018 dollars. The model input file is in cents and contains interpolated values for years between those listed in the table.

Source: California Air Resources Board spreadsheet tool, 2020.

Accessibility

The BCAG TDF model includes two accessibility pre-processors. These are Python scripts, operating on the input TAZ and network shapefiles to produce accessibility metrics.

- Intersections.py produces a count of the number of intersections per TAZ.
- RoadwayMiles.py produces the sum of walkable network miles.

These script outputs, in data base format (DBF), are used during the model input preparation stage to calculate the accessibility metrics shown in **Table 10** at the TAZ level.

A third input file, VMTseed, contains an estimate of the average commuting VMT generated per worker in the TAZ. The starting estimates can be approximate because this estimate is updated throughout the model process.

During the input preparation phase of the model, TAZ-level accessibility metrics and built environment ("D variable") metrics are produced. These metrics are updated as the model runs through its feedback loops. Some of the accessibility metrics are implemented later in the model; others are provided as model outputs. Table 10 below shows key accessibility metrics used in the model.

Table 10: Accessibility Metrics

Metric	Description	Where used
ATYPE	Place Type categorization to three categories based on trip generation difference. (Explained under Trip Generation Rate Section)	Trip Generation
LOG_EMPD	Log of employment density (jobs per developed acre)	Auto Ownership, Mode Choice
INTDEN	Intersection density (intersections per square mile)	Auto Ownership, Mode Choice
EMP_30TRN	Jobs within 30 minutes by transit	Auto Ownership, Mode Choice
COMMUTECOST	Average annual commute cost	Auto Ownership

Source: Fehr & Peers, 2024.

Data Quality Checks

The input data were reviewed and compared using statistical methods or reasonableness checks prior to calibration and validation of the model. Survey data were evaluated statistically to determine if there was a sufficient sample to use for calibration or validation, resulting in the combination of multiple sources of data for calibration to provide a larger data set and using Butte County only data for validation at an appropriate level to match the samples. Traffic count data were compared between the multiple days to identify potential outliers. If there were outliers nearby locations were compared to determine which count was most reasonable to use as a single day observation, while those without outliers were averaged. Roadway, transit, and bike/pedestrian networks and TAZ boundaries were reviewed visually using color themed maps. Land use control totals by category and totals by jurisdiction were reviewed. Transit system data were compared to published route maps and schedules. Big data was reviewed and cross-checked against the other data sources mentioned above to confirm the reasonableness.

3 Model Estimation, Calibration, and Reasonableness Checks

This section describes the model estimation, calibration, and reasonableness checks performed during the update to the model.

Model estimation is the term used to describe the process by which model inputs (e.g., trip rates, friction factors, I-X/X-I percentages) are derived from sources like survey and count data for application in the model calculations.

Model calibration refers to the adjustment of the model parameters to better replicate observed travel behavior and traffic volumes in the region. Calibration improves model accuracy and is a required step to ensure that the model reflects existing data, is sensitive to the type of projects it will be applied and meets the validation criteria described in the following section.

Reasonableness checks refer to testing of individual model components to ensure they closely replicate observed data prior to the result being used in a downstream process.

The sections below describe the calibration from the updated base year 2022 model followed by the resulting reasonableness check for each model component.

Trip Generation and Trip Balancing

Trip generation relates to the number of person trips going to/from a site based on the type of land use intensity and diversity of that particular site. With the functionality of person trips rather than total vehicle trips, separating home-work trips by income for the household and salary for the worker allowed for matching of home and work location.

The person trip generation portion of the model follows the following process:

- Daily person trip generation rates for each land use type
- Trip purpose percentages of daily person trip generation rates
- Interregional (IX and XI) trip percentages by trip purpose
- Trip productions and attractions balanced by trip purpose and income level

Trip Generation Rates

When updating the model for 2020 RTP/SCS, land use, demographic, and socio-economic factors in a cross-classified formulation. The same cross-classified formulation is used in person trip generation rate for 2024 RTP/SCS and is developed starting with the 2020 RTP/SCS rates. The following section described the change to person trip generation rates for base year 2022 condition.

Place Type

Place type is defined based on different trip generation rates within the BCAG region. As mentioned in the previous section, StreetLight VMT data is used to estimate the change in vehicle trip generation rates for all Census Block Groups (CBG) within the region, and three place types are defined based on the trip generation rate for aggregated CBGs. The three place types are listed in **Table 11** below.

Table 11: Place Types

Place Type Category	Alternate Name	Description of Place Type based on Trip Generation Rate
1	AType1	All remaining TAZs, applied a 3% higher residential trip generation rate and 1% higher non-residential rate comparing to County Average
2	AType2	Magalia, Biggs, Gridley, and Southwest of Butte County, applied a 5% lower residential trip generation rate and 1% higher non-residential rate comparing to County Average
3	Atype3	Northeast and Southeast of Butte County, applied a 12% lower residential trip generation rate and 6% lower non-residential rate comparing to County Average

Source: Fehr & Peers, 2024.

Residential Person Trip Generation

The previous update of the BCAG model for the 2020 RTP/SCS enhanced the residential trip generation sub-model from one that relied exclusively on land use as the independent variable to one that considered land use, demographic, and socio-economic factors in a cross-classified formulation. The trip generation rates for single family and multi-family homes were expanded to represent the different trip generation characteristics of a variety of households within Butte County. The cross-classification for residential land use is based on household size (1, 2, 3, or 4+) and household income (<$35K, $35K-$50K, $50K-$75K, >$75K).

Table 12 contains the cross-classified residential vehicle trip rates for occupied single family, multi-family, mobile homes and College on-campus student housing. The rates were estimated using the 2012 CHTS data and adjusted during the model calibration with StreetLight data and Census 2022 household estimations. This CHTS survey was conducted statewide and provides a complete summary of daily household trip making.

Table 12: Residential Daily Person Trip Generation Rates

Place Type	Household Type	Household Size	Income			
			< $35K	$35K – $50K	$50K – $75K	> $75K
1	Single Family	1	3.21	3.21	3.85	3.85
		2	8.39	8.39	9.07	11.79
		3	8.39	8.39	9.07	11.79
		4	12.15	12.15	13.31	14.39
		5	18.08	18.08	19.37	21.96
	Multi-Family	1	1.80	1.80	3.07	3.07
		2	5.10	5.10	5.52	7.18
		3	5.10	5.10	5.52	7.18
		4	7.79	7.79	8.10	8.76
		5	11.00	11.00	11.78	13.37
	Mobile Home	1	1.64	1.64	2.79	2.79
		2	4.64	4.64	5.02	6.52
		3	4.64	4.64	5.02	6.52
		4	7.08	7.08	7.36	7.96
		5	10.00	10.00	10.71	12.15
	College On-Campus Housing	1	1.64	1.64	2.79	2.79
		2	4.64	4.64	5.02	6.52
		3	4.64	4.64	5.02	6.52
		4	7.08	7.08	7.36	7.96
		5	10.00	10.00	10.71	12.15
2	Single Family	1	2.97	2.97	3.55	3.55
		2	7.74	7.74	8.37	10.88
		3	7.74	7.74	8.37	10.88
		4	11.21	11.21	12.28	13.28
		5	16.67	16.67	17.86	20.25
	Multi-Family	1	1.66	1.66	2.83	2.83
		2	4.70	4.70	5.09	6.62
		3	4.70	4.70	5.09	6.62
		4	7.18	7.18	7.47	8.08
		5	10.15	10.15	10.87	12.33
	Mobile Home	1	1.51	1.51	2.57	2.57
		2	4.28	4.28	4.63	6.02
		3	4.28	4.28	4.63	6.02
		4	6.53	6.53	6.79	7.35

Table 12: Residential Daily Person Trip Generation Rates

Place Type	Household Type	Household Size	Income			
			< $35K	$35K – $50K	$50K – $75K	> $75K
		5	9.22	9.22	9.88	11.21
	College On-Campus Housing	1	1.51	1.51	2.57	2.57
		2	4.28	4.28	4.63	6.02
		3	4.28	4.28	4.63	6.02
		4	6.53	6.53	6.79	7.35
		5	9.22	9.22	9.88	11.21
3	Single Family	1	2.75	2.75	3.29	3.29
		2	7.17	7.17	7.75	10.08
		3	7.17	7.17	7.75	10.08
		4	10.38	10.38	11.37	12.30
		5	15.44	15.44	16.55	18.76
	Multi-Family	1	1.54	1.54	2.62	2.62
		2	4.36	4.36	4.72	6.13
		3	4.36	4.36	4.72	6.13
		4	6.65	6.65	6.92	7.48
		5	9.40	9.40	10.07	11.42
	Mobile Home	1	1.40	1.40	2.38	2.38
		2	3.96	3.96	4.29	5.58
		3	3.96	3.96	4.29	5.58
		4	6.05	6.05	6.29	6.80
		5	8.54	8.54	9.15	10.38
	College On-Campus Housing	1	1.40	1.40	2.38	2.38
		2	3.96	3.96	4.29	5.57
		3	3.96	3.96	4.29	5.57
		4	6.05	6.05	6.29	6.80
		5	8.54	8.54	9.16	10.38

Note: To account for land use density, in addition to the trips by income and household size, the total households per zone generate an additional 0.93 trips per household.

Source: Fehr & Peers, 2024

Non-Residential Person Trip Generation

The primary source for non-residential person trip generation rates in the model was the 2016 RTP/SCS model, with the vehicle trips converted to person trips using the mode split and persons per vehicle from the 2012 CHTS. The 2016 RTP/SCS model was based on ITE 9th Edition Trip Generation[4] vehicle trip generation rates, which contains national averages of vehicle trip generation rates for a variety of land uses in what are generally suburban locations. The 2016 RTP/SCS model vehicle trip rates based on the 9th Edition were used rather than starting with rates from the 11th Edition since the travel model rates had been previously calibrated to reflect travel in Butte County, unlike the national data provided directly by ITE. The rates from the 2016 RTP/SCS model were calibrated for major non-residential land uses such as prominent retail centers and institutions within Butte County using a methodology similar to that explained above for residential uses. **Table 13** displays the final non-residential trip rates.

Table 13: Non-Residential Daily Person Trip Generation Rates

Place Type	Land Use Type	Model LU	Units	Person Rate
1	Office	OFF_KSF	Thousand Square Feet	18.05
	Medical Office	MED_KSF	Thousand Square Feet	13.47
	Hospital	HOSP_KSF	Thousand Square Feet	4.07
	Industrial	IND_KSF	Thousand Square Feet	11.81
	Public/Quasi-Public	PQP_KSF	Thousand Square Feet	27.10
	Park	PARK_AC	Acres	1.84
	Neighborhood-Serving Retail	RET_KSF	Thousand Square Feet	43.16
	Region-Serving Retail	RRET_KSF	Thousand Square Feet	54.74
	Hotels	HOTEL_RMS	Rooms	4.10
	K-12 School	K12_STU	Students	3.30
	University	UNIV_STU	Students	1.65
	Community College	CC_STU	Students	1.65*
	Casino (Special Generator)	CASINO_SLT	Slots	4.41
2	Office	OFF_KSF	Thousand Square Feet	18.05
	Medical Office	MED_KSF	Thousand Square Feet	13.47
	Hospital	HOSP_KSF	Thousand Square Feet	4.07
	Industrial	IND_KSF	Thousand Square Feet	11.81
	Public/Quasi-Public	PQP_KSF	Thousand Square Feet	27.10
	Park	PARK_AC	Acres	1.84
	Neighborhood-Serving Retail	RET_KSF	Thousand Square Feet	43.16

[4] *Trip Generation* (9th edition.). (2012). Washington, D.C.: Institute of Transportation Engineers.

Table 13: Non-Residential Daily Person Trip Generation Rates

Place Type	Land Use Type	Model LU	Units	Person Rate
	Region-Serving Retail	RRET_KSF	Thousand Square Feet	54.74
	Hotels	HOTEL_RMS	Rooms	4.10
	K-12 School	K12_STU	Students	3.30
	University	UNIV_STU	Students	1.65
	Community College	CC_STU	Students	1.65*
	Casino (Special Generator)	CASINO_SLT	Slots	4.41
3	Office	OFF_KSF	Thousand Square Feet	17.48
	Medical Office	MED_KSF	Thousand Square Feet	13.14
	Hospital	HOSP_KSF	Thousand Square Feet	3.98
	Industrial	IND_KSF	Thousand Square Feet	11.64
	Public/Quasi-Public	PQP_KSF	Thousand Square Feet	26.88
	Park	PARK_AC	Acres	1.84
	Neighborhood-Serving Retail	RET_KSF	Thousand Square Feet	43.05
	Region-Serving Retail	RRET_KSF	Thousand Square Feet	54.59
	Hotels	HOTEL_RMS	Rooms	4.04
	K-12 School	K12_STU	Students	3.30
	University	UNIV_STU	Students	1.65
	Community College	CC_STU	Students	1.65*
	Casino (Special Generator)	CASINO_SLT	Slots	4.38

* In the model, Community College students and University students are combined together with the same person rate.

Source: Fehr & Peers, 2024.

Commercial Truck Trip Generation

Along with generating person trips rather than total vehicle trips, the commercial truck trips were separated from passenger travel. The trip generation is based on the CSFFM and calibrated to local conditions. The trip generation for aggregated non-residential sectors is shown below in **Table 14**. No additional adjustments are made for commercial truck trip generation for 2024 RTP/SCS.

Table 14: Commercial Truck Daily Trip Generation

Model Industry/Commodity	NAICS 2007	Daily Trip Rate
Total Households	NA	0.61
Total Employees	NA	0.52
Ag/Farm/Fish	11	0.16
Mining	21	0.20
Construction	23	0.20
Manufactured Products	31-325	0.25
Manufactured Equipment	326-33	0.17
Transportation/Communication/Utilities	22, 48 ,492, 493, 51	0.17
Wholesale	42	0.17
Retail Trade	44-45	0.17
Finance, Insurance, Real Estate, Service	52-56, 62, 71, 72, 81	0.07
Education/Govt	491, 61, 92	0.07

Source: Fehr & Peers, 2024.

Person Trip Purposes and Income

Trip generation rates are initially defined for total trips and later split by trip purpose. Each trip has two ends, a "production" and an "attraction." By convention, trips with one end at a residence are defined as being "produced" by the residence and "attracted" to the other use (workplace, school, retail store, etc.), and are called "Home-Based" trips. Trips that do not have one end at a residence are called "Non-Home-Based" trips.

There are seven primary trip purposes used in the BCAG model.

- *Home-Based Work (HBW):* trips between a residence and a workplace, separated into low, medium, and high to improve the commute location by matching jobs and household income
- *Home-Based Shop (HBS):* trips between a residence and a store
- *Home-Based Other (HBO):* trips between a residence and any other destination
- *Work*-Based Other (WO): trips between a workplace and any other destination except a residence
- *Other-Based Other (OO):* trips that do not begin or end at a residence or workplace, such as traveling from a park to a restaurant, or from a retail store to a bank
- *School (HK):* trips to and from a school (K-12)
- *University (HC):* trips to and from a community college or university

The 2012 CHTS data and 2022 StreetLight data were used to determine the appropriate proportion of trips that represent each purpose. The University trip purpose category was added for 2020 RTP/SCS to better represent the travel patterns of students attending CSU Chico and Butte College.

Interregional (IX and XI) Trip Percentages

The interregional factors are based on CHTS for each trip purpose and refined based on StreetLight data to have an improved geographic sensitivity. Each TAZ incorporates an IX and XI percentage for each trip purpose.

Internal/External Trips Interactions

One of the important inputs to a travel model is an estimate of the amount of travel between the study area and neighboring areas outside the model. These I-X/X-I trips have one trip end in the county with the other trip end outside the county. The I-X/X-I percentages were initially estimated for each model trip purpose using the 2012 CHTS data. These estimates were then refined using the county's external station counts. **Table 15** summarizes the proportion of IX and XI trips by purpose for the base year.

Table 15: Percent of Trips by Purpose That are Interregional

Purpose	Model	StreetLight	CHTS[1]
Home-Based Work (HBW)	10.5%	7.7%	15.9%
Home-Based Other (HBO)	8.2%	10.8%	8.8%
Non-Home-Based (NHB)	8.0%	10.3%	11.4%

Note:
[1] The CHTS estimates are from 2012 and are no longer a reasonable benchmark for calibration. Instead, they are useful for understanding how interregional has changed due to major factors such as the pandemic and the shift to more telework and internet shopping.
Source: Fehr & Peers, 2024.

After the number of I-X/X-I trips are estimated, these trips are distributed to the stations around the perimeter of the model area using external station weights. External station weights are based on counts collected at each external station (these are roadway segments at the border of the model area). The number of through trips at each station was subtracted from the count and the remainder was filled in by I-X/X-I trips estimates. The resulting external station weights are presented in **Table 16**.

Table 16: External Station Weights

ID	Description	Weight
1	Hwy 99 – north of Butte County Line	20.40%
2	Cohasset Rd – north of Musty Buck Rd	0.13%
3	Hwy 32 – north of Humboldt Rd	0.66%
4	Humboldt Rd – north of Jonesville Rd	0.01%
5	Hwy 70 – north of Butte County Line	1.45%
6	Oroville Quincy Hwy – north of Haskins Valley Rd	0.13%
7	Forbestown Rd – east of Reservoir Rd	0.24%
8	La Porte Rd – northeast of Robinson Mill Rd	0.18%
9	Loma Rica Rd – south of La Porte Rd	1.01%
10	La Porte Rd – south of Butte County Line	1.61%
11	Hwy 70 – south of Butte County Line	18.80%
12	Larkin Rd – south of Butte County Line	5.50%
13	Hwy 99 – south of Butte County Line	21.59%
14	Pennington Rd – south of Rutherford Rd	0.43%
15	Colusa Hwy – west of Cherokee Canal Rd	1.05%
16	Afton Rd – west of Aguas Frias Rd	0.18%
17	Hwy 162 – west of Butte County Line	2.59%
18	Road Z – south of Road 48	0.40%
19	Ord Ferry Rd – west of Hugh Baber Ln	5.39%
20	Hwy 32 – west of Butte County Line	18.26%

Source: Fehr & Peers, 2024.

Through Trips

Through trips (also called external-external, or X-X trips) are trips that pass through the study area without stopping inside the study area. The major flows of through traffic in Butte County use Hwy 99, Hwy 70, and Hwy 32, with lower volumes of through traffic using other arterials. The CSTDM was the starting point for passenger vehicle trips and the CSFFM for commercial vehicles. The size of these flows was calibrated using StreetLight data and traffic counts collected as part of the model update.

Trip Productions and Attractions Balancing

Local trips (internal-to-internal, or I-I) are trips that both start and end in the model area. One of the basic requirements of any travel model is that the total number of local trips produced is equal to the total number of local trips attracted. It is logically assumed that if a journey begins, it must have an ending somewhere else. If the total productions and attractions are not equal, the model will typically adjust the attractions to match the productions, thus ensuring that each departing traveler finds a destination. While it is never possible to achieve a perfect match between productions and attractions prior to the automatic balancing procedure, a substantial mismatch in one or more trip purposes may indicate an error in the model land use inputs or trip generation.

Table 17 summarizes the local trip productions and attractions from the model for each trip purpose, prior to the application of the automatic balancing procedure. Guidelines published by the Travel Model Validation and Reasonableness Checking Manual [5] and the National Cooperative Highway Research Program (NCHRP) Report 716 [6] suggest that, prior to balancing, the number of productions and attractions should match to within plus or minus 10% (i.e., the production-to-attraction ratio should be within the range of 0.90 to 1.10). The results shown in Table 17 indicate that the 2022 base year model meets the published guidelines for all trip purposes.

Table 17: Person Trip Production to Attraction Ratios by Purpose

Trip Purpose	Production/Attraction
Home-Based Work (HBW)	1.00
Home-Based Shop (HBS)	1.00
Home-Based Other (HBO)[1]	1.03
Non-Home-Based (NHB)	1.03
Total	1.02

Note:
[1] The trip purposes listed are the broad categories applied in most every travel model. The more specific BCAG trip purposes are subsets of these broader trip purposes and have been aggregated here for ease of comparison. The School, Casino, and University purposes are subsets of the HBO trip purpose.
Source: Fehr & Peers, 2024.

Trip Generation Sensitivity

The BCAG TDF model contains enhancements to better capture local trip making characteristics and provides the ability to test certain policy options for future development scenarios. These features include adjustments for residential and non-residential vacancy rates and adding sensitivity for aging population, the cost of travel, smart growth development, and changes to the transit system.

[5] *Model Validation and Reasonableness Checking Manual* (2nd edition). (2001). Washington, D.C.: U.S. Dept. of Transportation, Federal Highway Administration, Federal Transit Administration, Assistant Secretary for Transportation Policy.

[6] *Travel Demand Forecasting: Parameters and Techniques* (Report 716). (2012). Washington, D.C: Transportation Research Board.

Vacancy Rates

The trip generation sub-model has the ability to reflect varying levels of occupancy for residential and non-residential buildings. However, for this update, BCAG staff elected to provide land use information already adjusted for vacancy. Therefore, the vacancy rate adjustment factors were set to 1.0.

Aging Population

It has long been recognized that households with older residents generate fewer vehicle trips than households where the residents are younger. The reason behind the reduced trip generation is generally thought to be due to the reduced number of work trips, fewer activities requiring travel, and the fact that a portion of this age group cannot drive.

For BCAG model, there is an age of head of household adjustment that applies for each trip purpose and multiplies by the calibrated trip rate to test for potential increases or decreases in travel relative to age. The factor is currently set at 1.0 to represent the 2012 CHTS data as calibrated to represent 2022 conditions in Butte County.

Trip Distribution (Gravity Model)

Once the trip generation step has estimated the number of trips that begin and end in each zone, the trip distribution process determines the specific destination of each originating trip. The destination may be within the zone itself, resulting in an intra-zonal trip. If the destination is outside of the zone of origin, it is an inter-zonal trip. Inter-zonal trips consist of II, IX, and XI trips.

The trip distribution model uses a gravity model equation to distribute trips to all TAZs. This equation estimates an accessibility index for each TAZ based on the number of attractions in each TAZ and the travel time between TAZ. Each attraction TAZ is given its share of productions based on its share of the accessibility index. This process applies to the I-I, I-X, and X-I trips. The X-X trips are added to the trip matrix prior to final assignment.

The gravity model uses the multimodal networks, matches household income locations with job locations by salary, allows for IX and XI trips to vary by individual zone rather than by land use type and trip purpose, and includes more sensitivity to gateway attractiveness by trip purpose. The trip distribution model also takes into account the impact of attractiveness based on vehicles availability to a household, and the accessibility of a location.

Friction Factors

Friction factors, also known as travel time factors, are used in calculating the relative attractiveness of each destination zone based on the travel time between TAZs and the number of potential origins and destinations in each TAZ. These factors are used in the trip distribution stage of the model. The BCAG model friction factors are based on data reported in national modeling reference documents such as

Travel Estimation Techniques for Urban Planning, NCHRP 365 [7] and are updated for base year 2022 to better match trip length and travel time estimated by the model to the data from CHTS and StreetLight.

Vehicle Availability

BCAG Model includes the feature of vehicle availability as an input to both the trip distribution and mode choice. The vehicle availability model is a disaggregate multinomial logit model which predicts the probability of a household owning 0, 1, 2, or 3, or 4+ vehicles based on the variables in **Table 18**.

Table 18: Variables in Vehicle Availability Model

Category	Variable	Description
Cost Variable	Commute Cost Ratio	Average annual commute cost divided by household income
Accessibility Variables	Intersection Density	Intersections per square mile
	Transit Accessibility	Jobs within 30 minutes via transit
	Employment Density	Log of (jobs per developed acre)
Household Demographic Variables	Household Size	Household size 1, 2, 3, 4+
	Household Income	Less than $35K, $35K – $50K, $50K – $75K, Greater than $75K
	Household Residential Unit Type	Single Family, Multi-Family, Mobile Home

Source: Fehr & Peers, 2024.

The commute cost ratio variable is an estimate of the proportion of a household's income required to own vehicles. It is derived from a county-level estimate of per-mile auto ownership costs, tract-level estimates of commuting VMT derived from the EPA's Smart Location Calculator[8], an annualization factor of 250 working days per year, and the household income. The variable is applied on a per-vehicle basis, so that owning no vehicles incurs no cost, owning two vehicles incurs twice the cost of owning one vehicle, and so on. **Table 19** below provides the coefficients of the auto ownership model.

[7] Martin, W. A., & McGuckin, N. A. (1998). *Travel Estimation Techniques for Urban Planning* (Report 365). Washington, DC: National Academy Press.

[8] https://ww2.arb.ca.gov/resources/documents/scs-evaluation-resources

Table 19: Auto Ownership Model Coefficients

	0 Vehicles	1 Vehicle	2 Vehicles	3 Vehicles	4+ Vehicles
Alternative-Specific Constant					
CommuteCostRatio	7.51	3.95	0.00	0.00	0.00
PedOrIntDens	0.009	0	0	-0.004	-0.004
TransitAccessibility (x1000)	0.009	0.010	0	-0.051	-0.112
LogEmpDensity	0.39	0.24	0	0.00	-0.19
RUGroup=RU1	0	0	0	0	0
RUGroup=RU3	1.27	0.53	0	-1.53	-1.53
RUGroup=RU6	0.27	0.27	0	0	0
RUGroup=RU4[1]	1.27	0.53	0	-1.53	-1.53
HH_size=1	-1.16	1.5	0	-3.15	-4.94
HH_size=2	-3.03	-0.42	0	-2.26	-4.19
HH_size=3	-3.37	-0.24	0	-1.34	-3.40
HH_size=4	-4.02	-0.66	0	-1.61	-3.13
HH_size=5+	-3.50	-0.89	0	-1.32	-2.44
HH_inc=IncG1	0	0	0	0	0
HH_inc=IncG2	-1.33	-0.28	0	0.86	0.98
HH_inc=IncG3	-3.87	-0.93	0	1.2	2.35
HH_inc=IncG4	-2.98	-1.55	0	1.55	2.35
HH_inc=IncG5	-4.23	-1.96	0	1.44	2.87

Notes:
1. The coefficients are added for the new land use type College on-campus student housing, and they are the same as the coefficients used for multi-family housing.
Source: Fehr & Peers, 2024.

Note the model uses owning two vehicles as its base, and calculates the relative probability of owning fewer or greater vehicles; thus, the model coefficients describe relative probabilities as in the example below:

$$\ln\left(\frac{Prob(0\ vehicles)}{Prob(2\ vehicles)}\right) = 7.51(CommuteCostRatio) + 0.0093(PedOrIntDensity) + \ \dots$$

The coefficients for this model are generally intuitive in direction and scale.

- Higher commuting cost increases the probability of owning 0 or 1 vehicles and decreases the probability of owning 3 or 4 vehicles, as compared to the baseline of 2 vehicles.

- Higher scores for the three accessibility variables, indicating generally better accessibility by non-auto modes, increase the probability of owning 0 vehicles (and sometimes also 1 vehicle) relative to owning 2; and decrease the probability of owning 3 or 4.
- Household income is the demographic variable which has the largest influence in auto ownership. Generally, as incomes go up, probabilities of owning 0 or 1 vehicles go down, and probabilities of owning 3 or 4 vehicles go up.
- Household size behaves in the expected way, with probability of owning 0 or 1 vehicles going down as household size increases and probability of owning 3 or 4 vehicles going up.
- Multi-family unit types are more likely to own 0 or 1 vehicles, and less likely to own 3 or 4 vehicles, than single family. There weren't enough records in the RUG6 "other" category (RV, mobile home, etc.) to distinguish them from single family, and they were generally more similar to single family than multi-family uses, so they share the same coefficients as single family.

An important consideration for future model development is that car sharing and transportation network companies (i.e., UBER, LYFT, etc.) are changing auto availability dynamics and, potentially, long-term auto ownership. As more data becomes available it may be appropriate to modify the auto ownership model to recognize these changes and focus more on auto availability across multiple sub modes and costs per mile. **Table 20** summarizes the autos owned for both the model and the CHTS.

Table 20: Percent of Autos Owned

Autos Owned	Model	CHTS
0	7%	9%
1	39%	37%
2	40%	34%
3+	14%	20%

Source: Fehr & Peers, 2024.

Mode Choice

With the addition of vehicle availability, person trips, and a multimodal network with simplified transit, the model implemented a full multinomial logit mode choice model that was developed for the San Joaquin Valley MPOs due to the similar rural character and transportation options. A nested logit form might have been preferred for theoretical reasons, given the strong relationships among drive, transit, and active modes. However, no satisfactory nested logit models were estimated, likely because of severe constraints on the amount of transit data available. Multinomial logit models produced generally more sensible results and were used instead. The mode choice model is segmented by trip purpose and vehicle availability, using three vehicle availability categories as described in **Table 21**.

Table 21: Vehicle Availability Segments in Mode Choice Model

Name	Description
0veh	Households which own no vehicles
1veh	Households which have one vehicle but more than one person
Others	Households with either one vehicle and one person, or more than one vehicle

Source: Fehr & Peers, 2024.

Table 22 below lists the modes available in the model.

Table 22: Modes Available in Mode Choice Models

Category	Name	Segments Available	Trip Purposes	Description
Auto	da	1Veh, Other	All	Drive-alone
	s2	All	All	Shared ride, 2 persons
	s3	All	All	Shared ride, 3+ persons
Transit	twb	All	All	Transit, walk-access, bus
	tdb	All	All	Transit, drive-access, bus
	twr	All	All but HBK, HBC	Transit, walk-access, rail
	tdr	All	All but HBK, HBC	Transit, drive-access, rail
	sb	All	HBK only	School bus
Active	walk	All	All	Walk
	bike	All	All	Bike

Source: Fehr & Peers, 2024.

The variables used in each of the modes in the choice model are listed in **Table 23** below. Not all variables are used in all trip purposes models. For the accessibility and built environment variables, the table notes whether the variable is measured at the trip production (P) or trip attraction (A). Note that value of time is a direct consequence of the relationship between in-vehicle time and cost. As such, it is not estimated directly but is instead a consequence of the in-vehicle time (IVT) and cost coefficients. For model implementation purposes, only value of time (VOT) is used in the mode choice utility equation; for clarity, both are reported in the tables below.

Table 23: Variables in Mode Choice Models

Variable	Purposes	Description
(Constants)	All	Alternative-specific constants
IVT	All	In-vehicle time
OVT	All	Out-of-vehicle time (access, transfer, egress, and waiting times)
Cost	All	Total cost, including auto operating cost, parking cost and tolls, and transit fares.
VOT	All	Value of time (conversion between cost variables and time variables)
TransitAccess	HBW, WBO, OBO	Jobs available within 30 minutes via transit, decay-weighted (P)
LogEmpDensity	HBW, HBS, HBO	Log (employment density of block group) (A)
IntDensity	HBK, HBC	Pedestrian-oriented intersection density (A)

Source: Fehr & Peers, 2024.

Home-Based Work

Table 24 lists model coefficients for HBW segments. Drive-alone was used as a reference mode for all trip purposes including the 0-vehicle segment where this mode is not permitted. In this segment, utility calculations were carried out without the drive-alone mode.

Table 24: HBW Mode Choice Model Coefficients

Variable	Mode	0-Vehicle	1-Vehicle, 2+ person HH	All Others
Constant	da	-0.16	0.53	2.265
	s2	0.6	-0.06	-0.32
	s3	0	-3	-3.3
	twb	2.614	-1.26	-1.899
	tdb	1.361	-1.26	-2.866
	twr	2.614	-1.26	-1.899
	tdr	1.361	-1.26	-2.866
	bike	1	-3	-3.5
	walk	0.974	-3.633	-3.822
IVT	All	-0.03	-0.03	-0.074
OVT	All	-0.06	-0.06	-0.148
OVT/IVT	All	2	2	2
Cost	All	-0.004	-0.003	-0.005
VOT	All	6.5394	7.56	11.34

Table 24: HBW Mode Choice Model Coefficients

Variable	Mode	0-Vehicle	1-Vehicle, 2+ person HH	All Others
LogEmpDensity	da	0	0	0
	s2	-0.005	-0.005	0
	s3	-0.02	-0.02	0
	twb	0.04	0.04	0.025
	tdb	0.04	0.04	0.025
	twr	0.04	0.04	0.025
	tdr	0.04	0.04	0.025
	bike	0.03	0.03	0
	walk	0.039	0.039	0.039
TransitAccess	da	0	0	0
	s2	0.013	0.013	0.005
	s3	0.013	0.013	0.005
	twb	0.03	0.027	0.013
	tdb	0.03	0.027	0.013
	twr	0.03	0.027	0.013
	tdr	0.03	0.027	0.013
	bike	0.03	0.031	0.015
	walk	0.04	0.031	0.015

Source: Fehr & Peers, 2024.

Home-Based Shop

Table 25 below lists model coefficients for HBS segments. Drive-alone was used as a reference mode for the 1-vehicle and 2-vehicle segments, while walk was used as a reference mode for the 0-vehicle segment.

Table 25: HBS Mode Choice Model Coefficients

Variable	Mode	0-Vehicle	1-Vehicle, 2+ person HH	All Others
Constant	da	-0.2	-0.1	0
	s2	-0.5	-0.7	-0.9
	s3	-1.5	-1.6	-1.8
	twb	-4.036	-3.901	-1.915
	tdb	-3.249	-3.114	-2.747
	twr	-4.036	-3.901	-1.915
	tdr	-3.249	-3.114	-1.959
	bike	-1	-2	-3
	walk	-2	-2	-2
IVT	All	-0.035	-0.035	-0.03
OVT	All	-0.088025	-0.088025	-0.07545
OVT/IVT	All	2.515	2.515	2.515
Cost	All	-0.004	-0.001	-0.001
VOT	All	6.08	16.62	18
LogEmpDensity	da	0	0	0
	s2	0.506	0.506	0.506
	s3	0.408	0.408	0.408
	twb	0.5	0.5	0.5
	tdb	0.5	0.5	0.5
	twr	0.5	0.5	0.5
	tdr	0.5	0.5	0.5
	bike	0.506	0.506	0.506
	walk	0.5	0.178	0.005

Source: Fehr & Peers, 2024.

Home-Based School (K-12)

Table 26 below lists model coefficients for SCHOOL segments. The reference mode for the 0- and 1-vehicle segments is walk; the reference mode for the 2-vehicle segment is shared ride 3.

Table 26: SCHOOL Mode Choice Model Coefficients

Variable	Mode	0-Vehicle	1-Vehicle, 2+ person HH	All Others
Constant	da	0	0	0
	s2	2	1	-0.5
	s3	2.813	2.884	1.033
	twb	0.614	-5.873	-6.902
	tdb	-7.06	-8.09	-9.119
	twr	0.614	-5.873	-6.902
	tdr	-7.06	-8.09	-9.119
	bike	1.306	1.75	1.01
	walk	5.383	5.076	4.206
	sb	1.306	1.75	1.01
IVT	All	-0.025	-0.025	-0.025
OVT	All	-0.05	-0.05	-0.05
OVT/IVT	All	2	2	2
Cost	All	-0.005	-0.003	-0.002
VOT	All	3	6	9
IntDensity	da	0	0	0
	s2	0.006	0.006	0.006
	s3	0.008	0.008	0.008
	twb	0.008	0.008	0.008
	tdb	0	0	0
	twr	0.008	0.008	0.008
	tdr	0	0	0
	bike	0.008	0.008	0.008
	walk	0.004	0.004	0.004
	sb	0	0	0

Source: Fehr & Peers, 2024.

Home-Based University

Table 27 below lists model coefficients for UNIV segments. Because of the very small number of trips in the household survey data, all vehicle ownership segments were pooled for model estimation purposes, with distinctions between segments left for adjustment during model calibration. Drive-alone was used as a reference mode. In the 0-vehicle segment, utility calculations were carried out without the drive-alone mode.

Table 27: UNIV Mode Choice Model Coefficients

Variable	Mode	0-Vehicle	1-Vehicle, 2+ person HH	All Others
Constant	da	0	0	0
	s2	-2.5	-2.4	-2.3
	s3	-4	-5	-5.5
	twb	-1.44	-1.9	-2.36
	tdb	-5.919	-6.379	-6.839
	twr	-1.44	-1.9	-2.36
	tdr	-5.919	-6.379	-6.839
	bike	-6	-7	-8
	walk	-8.494	-7.299	-8.494
IVT	All	-0.025	-0.025	-0.025
OVT	All	-0.05	-0.05	-0.05
OVT/IVT	All	2	2	2
Cost	All	-0.005	-0.003	-0.002
VOT	All	3	6	9
IntDensity	da	0	0	0
	s2	0.004	0.004	0
	s3	-0.019	-0.019	0
	twb	0.004	0.004	0
	tdb	0	0	0
	twr	0	0	0
	tdr	0	0	0
	bike	0.005	0.005	0.005
	walk	0.005	0.005	0.005

Source: Fehr & Peers, 2024.

Home-Based Other

Table 28 below lists model coefficients for HBO segments. Drive-alone was used as a reference mode for the 2-vehicle segment, while walk was used as a reference mode for the 0- and 1-vehicle segments.

Table 28: HBO Mode Choice Model Coefficients

Variable	Mode	0-Vehicle	1-Vehicle, 2+ person HH	All Others
Constant	da	-0.2	-0.1	0
	s2	-0.5	-0.7	-0.9
	s3	-1.5	-1.6	-1.8
	twb	-4.036	-3.901	-1.915
	tdb	-3.249	-3.114	-2.747
	twr	-4.036	-3.901	-1.915
	tdr	-3.249	-3.114	-1.959
	bike	-1	-2	-3
	walk	-2	-2	-2
IVT	All	-0.035	-0.035	-0.03
OVT	All	-0.088025	-0.088025	-0.07545
OVT/IVT	All	2.515	2.515	2.515
Cost	All	-0.004	-0.001	-0.001
VOT	All	6.08	16.62	18
LogEmpDensity	da	0	0	0
	s2	0.506	0.506	0.506
	s3	0.408	0.408	0.408
	twb	0.5	0.5	0.5
	tdb	0.5	0.5	0.5
	twr	0.5	0.5	0.5
	tdr	0.5	0.5	0.5
	bike	0.506	0.506	0.506
	walk	0.5	0.178	0.005

Source: Fehr & Peers, 2024.

Work-Based Other

Table 29 below lists model coefficients for WO segments. Walk was used as a reference mode for the 0- and 1-vehicle segments; drive-alone was used as a reference mode for the 2-vehicle segment.

Table 29: WO Mode Choice Model Coefficients

Variable	Mode	0-Vehicle	1-Vehicle, 2+ person HH	All Others
Constant	da	0	0	0
	s2	-1.53	-1.682	-1.915
	s3	-1.77	-1.798	-1.939
	twb	-4.036	-3.901	-1.915
	tdb	-3.249	-3.114	-2.747
	twr	-4.036	-3.901	-1.915
	tdr	-3.249	-3.114	-1.959
	bike	-4.704	-5.343	-7.99
	walk	-2.62	-2.553	-2.665
IVT	All	-0.035	-0.035	-0.03
OVT	All	-0.088025	-0.088025	-0.07545
OVT/IVT	All	2.515	2.515	2.515
Cost	All	-0.004	-0.001	-0.001
VOT	All	6.08	16.62	18
TransitAccess	da	0	0	0
	s2	0	0	0
	s3	0	0	0
	twb	0.023	0.023	0.023
	tdb	0.023	0.023	0.023
	twr	0.023	0.023	0.023
	tdr	0.023	0.023	0.023
	bike	0.03	0.03	0.03
	walk	0.04	0.04	0.04

Source: Fehr & Peers, 2024.

Other-Based Other

Table 30 below lists model coefficients for OO segments. Walk was used as a reference mode for the 0- and 1-vehicle segments; drive-alone was used as a reference mode for the 2-vehicle segment.

Table 30: OO Mode Choice Model Coefficients

Variable	Mode	0-Vehicle	1-Vehicle, 2+ person HH	All Others
Constant	da	0	0	0
	s2	2.351	0.838	0.211
	s3	2.245	0.507	0.135
	twb	2.614	-1.26	-1.899
	tdb	1.361	-1.26	-2.866
	twr	2.614	-1.26	-1.899
	tdr	1.361	-1.26	-2.866
	bike	0.974	-3.633	-3.822
	walk	4.293	0.911	-0.258
IVT	All	-0.03	-0.03	-0.074
OVT	All	-0.06	-0.06	-0.148
OVT/IVT	All	2	2	2
Cost	All	-0.004	-0.003	-0.005
VOT	All	5.19	6	9
TransitAccess	da	0	0	0
	s2	-0.007	-0.007	0
	s3	-0.01	-0.01	0
	twb	0.04	0.04	0.025
	tdb	0.04	0.04	0.025
	twr	0.04	0.04	0.025
	tdr	0.04	0.04	0.025
	bike	0.03	0.03	0
	walk	0.039	0.039	0.039

Source: Fehr & Peers, 2024.

Table 31 summarizes the aggregated mode choice for both the model and the CHTS. Note that while the model produces results for each individual mode by purpose, due to sample size in the CHTS the aggregated mode shares are used for validation. Prior to using the detailed mode choice by purpose and mode, a sub-area validation and potential calibration should be undertaken.

Table 31: Mode Choice Results

Mode	Model	CHTS
Drive-alone	47.4%	43%
Shared Ride	43.6%	46%
Transit	1.9%	3%
Walk/Bike/Other	7.1%	8%

Note: Other includes school bus, taxi, and other specialized modes accounted for in the CHTS.
Source: Fehr & Peers, 2024.

Trip Assignment

The trip assignment process determines the route each vehicle trip takes from a particular origin to a particular destination. It uses an iterative, capacity-restrained assignment routine to determine a travel path that minimizes travel time, while considering congestion delays caused by the other simulated trips in the model. The model added new capabilities to account for the number of passengers in the car for passenger trips, the type of truck being used (small, medium, and large) for commercial trips, and the potential for roadway pricing on a roadway segment on a per mile basis or spot location for a single charge.

The general assignment process includes the following steps.

- Assign all trips to the links along their selected paths
- After all assignments, examine the volume on each link and adjust its impedance based on the volume-to-capacity ratio
- Repeat the assignment process for a set number of iterations or until specified criteria related to minimizing travel delays are satisfied

Calibration of the roadway network included modification of the centroid connectors to more accurately represent the location that traffic accesses local roads; adjustment of speeds from posted speed limits to reflect the attractiveness of the route and the prevailing speed of traffic; and adjustment of capacities to reflect the attractiveness of the route.

Time Periods

The model estimates travel for the average weekday (Monday through Friday). The daily roadway volumes are aggregated from the AM and PM peak period, and Mid-day and Evening off-peak period assignments. Descriptions of each assignment time period are presented in **Table 32**. The specific time periods represented in the model were developed by reviewing the distribution of existing traffic counts across a 24-hour period as well as reviewing the time period distributions of travel models in neighboring jurisdictions (i.e., NCTC, SACOG, TRPA).

Table 32: Time Periods

Description	Duration	Time
AM Peak Period	3 Hours	6:00 – 8:59 AM
Mid-day Period	7 Hours	9:00 AM – 3:59 PM
PM Peak Period	3 Hours	4:00 – 6:59 PM
Off-Peak Period	11 Hours	7:00 PM – 5:59 AM
AM Peak Hour	1 Hour	7:00 – 7:59 AM
PM Peak Hour	1 Hour	5:00 – 5:59 PM

Source: Fehr & Peers, 2024.

Turn Penalties

Turn penalties are used to prohibit or add delay to certain turning movements. The BCAG model prohibits traffic from making turns across impassable medians. In addition, the model may prohibit U-turns at some locations to avoid counterintuitive traffic routing. Turn penalties may be in effect during the entire day, during one or all peak periods, or only at the peak hour level. Currently the turn penalties apply to all vehicles and there are no specific truck only turn penalties or prohibitions.

Vehicle Miles of Travel

A major focus of recent transportation related legislation in California focuses on VMT. In addition to Air Quality Conformity determinations, SB 375 and subsequent legislation such as SB 743 have highlighted the need to have a reliable method for forecasting VMT for regional planning. The traditional reasonableness check for VMT is to compare the regional model to HPMS for VMT on the roadways with the model area. **Table 33** below shows that the VMT for the model is about 13.6% lower than Year 2019 HPMS, 5.5% higher than Year 2021 HPMS, and 9% higher than Year 2022 HPMS, which exceeds the 3% suggested error.

However, the HPMS estimates do not match traffic count or StreetLight traffic volume estimate trends between 2019 and 2022. While HPMS VMT estimates appear to capture changes due to the COVID 19 pandemic effects in terms of the decrease between 2019 and 2021. No rebound effect is shown for 2022. The traffic counts and StreetLight estimates both show the expected rebound effect, which also includes the active re-development of the Town of Paradise after the Camp Fire. Hence, the model-wide VMT estimate for Year 2022 is considered reasonable.

Table 33: Model-wide VMT

Year	HPMS	Model	% Deviation	% Through trip VMT
2019	5,349,710	4,620,750	-13.6	1.9%
2021	4,379,640		5.5%	
2022	4,239,790		9.0%	

Note:
HPMS estimates from 2019, 2021 and 2022 for all roadways in Butte County
Source: Fehr & Peers, 2024.

Transit Forecasting

Although the simplified representation of transit in terms of access and headway is validated at the regional mode share level, the mode choice and distribution processes allow for evaluation of mode share at the zone-to-zone and individual zone levels. Interregional transit must be done off-model. The regional mode share for transit from the travel model and CHTS are shown in **Table 31.**

4 Model Validation

Model validation is the term used to describe model performance in terms of how closely the model's output matches existing travel data in the base year. The extent to which model outputs match existing travel data validates the model algorithms and inputs.

Traditionally, most model validation guidelines have focused on the performance of the trip assignment function in accurately assigning trips to the roadway network. This method is called static validation, and it remains the most common means of measuring model's ability to replicate base year observed conditions.

Models, however, are seldom used for static applications. By far the most common use of models is to forecast how a change in inputs would result in a change in traffic conditions. Therefore, another test of a model's accuracy focuses on the model's ability to predict realistic differences in outputs as inputs are changed. This method is referred to as dynamic validation. This section describes the highest-level validation checks that have been performed for the model.

Static Validation

The 2024 *California Regional Transportation Plan Guidelines* [9], contains the following specific static validation criteria and thresholds.

- *At least 75 percent of the roadway links for which counts are available should be within the maximum desirable deviation*, which ranges from approximately 15 to 60 percent depending on total volume (the larger the volume, the less deviation is permitted).
- *A correlation coefficient of at least 0.88* – The correlation coefficient estimates the overall level of accuracy between observed traffic counts and the estimated traffic volumes from the model. These coefficient ranges from 0 to 1.0, where 1.0 indicates that the model perfectly fits the data.
- *The percent root mean squared error (%RMSE) below 40%* – The %RMSE is the square root of the model volume minus the actual count squared, divided by the number of counts. In other words, it is the average of all the link-by-link percent differences, and it is an indicator of how far the model volumes differ from the counts, on a link-by-link average, expressed as a percent. It is a measure similar to standard deviation in that it assesses the accuracy of the entire model.

In addition to these criteria, the model-wide volume-to-count ratio was checked against a desired maximum threshold of no more than a 10 percent deviation. The static validation results for the model are show in **Table 34** and reveal that the model passed all thresholds for daily and closed to the other threshold for AM and PM peak hour. It is important to pre-validate the model with local counts if it is

[9] *California Regional Transportation Plan Guidelines.* (2024). Sacramento, CA: California Transportation Commission.

used for a focus-area project. Further refinement of the access point of centroid connectors can help with focus-area validation.

Table 34: Results of Model Validation

Validation Item	Criterion of Acceptance	Daily	AMPH	PMPH
Model-wide Volume-to-Count Ratio	Within ± 10%	0.99	0.97	1.00
Percent of Links Within Deviation Allowance	At Least 75%	76%	82%	83%
Correlation Coefficient	At Least 88%	96%	90%	93%
RMSE	40% or Less	37%	47%	41%

Source: Fehr & Peers, 2024.

Dynamic Validation and CARB Model Sensitivity Tests

The tests below were conducted to evaluate the functionality of the model directly related to the scenarios being evaluated as part of the 2024 RTP/SCS, and to provide both BCAG and CARB information for determining the capabilities and sensitivity to the different features of the model. The results of the dynamic validation do not fully match with static validation. Static validation was slightly adjusted after the dynamic validation was done. Based on our conversation with CARB on February 3rd, 2023, the model dynamic sensitivity test for active transportation and transit enhancement was not repeated for the 2024 RTP/SCS, as similar testing was performed for the 2020 RTP/SCS. Since no major structural changes were made to the BCAG model between the 2020 and 2024 RTP/SCS, the dynamic test results documented for 2020 RTP/SCS are expected to yield similar results as previously documented.

Beyond what was documented for the 2020 RTP/SCS, and as recommended by CARB, short-term induced vehicle travel, and additional land use sensitivity tests were conducted to evaluate how the model responds to potential strategies for the 2024 RTP/SCS.

Induced Vehicle Travel

The balance between traveler convenience and increased auto dependency is at the core of many legislative initiatives in California. MPOs expected to manage congestion while also reducing VMT. As such, induced vehicle travel effects are an essential consideration in forecasting VMT especially when future conditions included through expansion of roadway capacity. To evaluate the model sensitivity to induced vehicle travel, short-term effects of increased roadway capacity listed below were evaluated by comparing different combinations of roadway network and socioeconomics.

Short-term responses

1. New vehicle trips that would otherwise would not be made

2. Longer vehicle trips to more distant destinations
3. Shifts from other modes to driving
4. Shifts from one driving route to another

Long-term induced vehicle travel responses listed below are not directly included in the model. Instead, the model's inputs would have to be modified to capture these changes.

5. Changes in land use development patterns (these are often more dispersed, low-density patterns that are auto dependent)
6. Changes in overall growth

Short-Term Induced Vehicle Travel

Short-term induced travel is caused by the immediate change in speeds and travel when a new roadway capacity expansion project is open to traffic (i.e. a Build compared to a No Build scenario). To reflect the short-term induced vehicle travel, additional lane miles were added to the base year roadway network to assess the effect on VMT. Based on CARB's research on induced travel [10] , two tests were developed to evaluate how the model responds to short-term induced vehicle travel resulting from capacity changes on state highway facilities.

- *Test 1* added one lane in each direction on SR 70 between Ophir Road and SR 149, resulting in an 18-lane mile increase.
- *Test 2* added one lane in each direction on SR 99 between SR 149 and Garner Ln, resulting in a 51-lane mile increase.

Full model runs are conducted for both tests, which may overstate the short-term effects of these capacity increases because work and school locations would not realistically change.

Based on the 2024 RTP/SCS 2022 base year run assignment results, SR 70 is operating at near free-flow conditions, with a volume-to-capacity (VC) ratio between 0.3 and 0.7. In contrast, SR 99 is experiencing congestion, with a VC ratio ranging from 0.3 to 1.2, and about 37% of the segment operating above 0.8. Thus, these two state route segments were selected for the tests to understand how the starting congestion context influences the outputs. As shown in **Table 35**, the VMT changes for both tests are in the expected direction, and the differences in short-term elasticity align with the model test setup.

For Test 1, adding new lane miles on SR 70 has a limited impact on total VMT, which is consistent with the low levels of congestion on SR 70 and no travel time benefit of the network modification. However, for Test 2, where additional lane miles were added to the more congested SR 99, the total VMT change is significantly higher than in Test 1. This outcome aligns with the expected response to increased roadway capacity on congested facilities. Therefore, the model output demonstrates an appropriate sensitivity to

[10] https://ww2.arb.ca.gov/sites/default/files/2020-06/Impact_of_Highway_Capacity_and_Induced_Travel_on_Passenger_Vehicle_Use_and_Greenhouse_Gas_Emissions_Policy_Brief.pdf

short-term induced travel in terms of the direction of change. However, the ARB research on short-term induced effect size suggests a reasonable range of 0.1 to 0.6. The lower values reported for the BCAG model may be reasonable given that existing congestion in the county is not sufficient to suppress vehicle trip making given that the model's calibrated and validated rates are similar to ITE trip rates from suburban areas where trip making occurs at full demand levels with little to no constraints due to congestion.

Table 35: Short-Term Induced Vehicle Travel Elasticity Check

Scenarios	Base Year	Test 1	Change	Test 2	Change
Lane Miles	392	410	-4.82%	443	-13.05%
Total VMT	2,804,315	2,804,683	-0.01%	2,812,936	-0.31%
Model VMT Change	-	368		8,621	
Short Term Elasticity	-	0.003		0.024	

Note:

1. The total lane miles and total VMT calculations include only the Federal Highway Administration (FHWA) functional classification (FC) 1-3 roadway facilities in Butte County. This approach is consistent with the discussion on the impact of highway capacity and induced travel in estimating short-term induced VMT. https://dot.ca.gov/programs/research-innovation-system-information/office-of-highway-system-information-performance/functional-classification

Source: Fehr & Peers, 2024.

Long-Term Induced Vehicle Travel

Long-term induced vehicle travel effects consider the influence on land use and growth patterns over time. Travel models are typically used to compare a Build and No Build condition and combine the influence of land use, demographics, socioeconomic conditions, and travel. As such, they produce forecasts of short-term induced vehicle travel effects. For long-term induced vehicle travel effects, the model land use and trip generation rates would need to be changed for each alternative. Alternatively, an off-model elasticity method such as that applied through California induced travel calculator[11] developed by National Center for Sustainable Transportation Center can be used.

Auto Operating Cost

The recommended CARB auto operating cost (AOC) methodology changed from including only petroleum-based vehicles to all energy sources. To test model sensitivity to the changes, the auto operating cost is increased by 20% from what was recommended based on the updated method. The published literature presents the demand for fuel or the VMT and has only the impact of gas price not total auto operating cost as used in the model to determine auto ownership, distribution, travel mode, and route choice. The literature reports a short-term elasticity of VMT change relative to fuel price of -0.24 for low-income groups to -0.40 for high income groups.

[11] California Induced Travel Calculator: https://travelcalculator.ncst.ucdavis.edu/

Table 36 below shows the results for the base year with a similar VMT elasticity in both magnitude and direction. The negative on the elasticity indicates the VMT changes in the opposite direction than the auto operating cost. Although the magnitude of change is less than the expected range for fuel price, the recommended CARB parameter of auto operating cost accounts for more than fuel price and the past literature based on empirical data does not account for the non-petroleum vehicles currently included in the auto operating cost. As the fuel price decreases due to more efficient vehicles, the fixed costs become a larger percentage of the auto operating cost. Since the model is not overly sensitive to auto operating cost but does show reasonable sensitivity, the model is appropriate for RTP/SCS scenarios that do not include change of fleet or fuel sources. If the scenario being evaluated changes the auto operating cost or fuel cost as a scenario specific policy, it is recommended that additional calibration be considered. As noted in the CARB technical document, these results highlight the importance of considering equity impacts in analyzing the effects of changes in gas prices (and gas taxes).

Table 36: Auto Operating Cost Elasticity Check

2022	Updated	Test	Change
AOC	21.38	25.66	20.00%
Total VMT	4,825,405	4,821,531	-0.08%
Model Elasticity	-0.004		
Literature Elasticity [1]	-0.24 to -0.40		

Note:
1. The CARB research for short-term elasticity only accounts for the fuel cost and excludes the fixed and maintenance costs.
Source: Fehr & Peers, 2024.

Land Use Tests

The BCAG Model has been developed to be used as a tool to evaluate land use scenarios in planning efforts such as EIRs, City General Plans, and the Regional Transportation Plan. The specific dynamic validation tests completed for this model update are listed below.

- Add 10, 100, and 1000 dwelling units to a TAZ in Eastern Chico
- Add 10, and 100 thousand square feet of retail to a TAZ in City of Oroville
- Shift growth out of Town of Paradise to Eastern Chico with 500 single family dwelling units
- Adjust income levels by increasing high income households and reducing low-income households with total households remaining the same for TAZs in City of Chico, Paradise, Oroville, Biggs, and Gridley
- Change land use ratio by adding 500 multi family dwelling units and removing 500 single family dwelling units in City of Oroville

The first two tests are generic model dynamic tests designed to ensure that the model consistently produces accurate trip generation estimates for different land use inputs. The key model in these dynamic validation tests is the number of daily vehicle trips (VT) generated. These tests are intended to verify that the model output changes in the correct direction and magnitude. The dynamic validation results for the land use changes, summarized in **Table 37,** indicate that the model responds appropriately to variations in both residential and non-residential land uses. For example, when altering residential uses, the overall vehicle trip generation remains stable across the entire range, yielding reasonable results (i.e., 4.6 to 5.0 vehicle trips per household). Additionally, the change in trip generation at the TAZ level aligns with expectations, with increase or decrease corresponding to changes in the number of households. The magnitude of vehicle trip generation at the TAZ level is also reasonable, considering the socioeconomic characteristics of the test area located in Chico.

Table 37: Land Use Sensitivity Check

Land Use Change	Unit Change	VT Change	VT Change/Unit Change
Residential (Dus)	+10	46.29	4.63
	+100	495.50	4.96
	+1000	4987.53	4.99
	+10	263.83	26.38
	+100	2601.84	26.02

Source: Fehr & Peers, 2024.

The latter three land use dynamic tests were requested by CARB to further evaluate the model's sensitivity to different types of land use changes and to better understand how the location of these land uses affects the model results.

The dynamic test results for land use shifts are summarized in **Table 38**. In this scenario, 500 single-family dwelling units were relocated from the Town of Paradise to the City of Chico. The results indicate a decrease in auto trips and an increase in non-auto trips in the mode split outputs, along with a reduction in total VMT. These changes in the model outputs align with expectations, reflecting the impact of relocating household developments to a more urbanized area like the City of Chico.

Table 38: Land Use Allocation

Trips/VMT	Base Year	Land Use Allocation	Change	Change %
Person Trips - Drive Alone	332,946	332,616	-330	-0.10%
Person Trips - Shared Ride 2	228,781	228,852	71	0.03%
Person Trips - Shared Rid 3+	179,348	179,376	28	0.02%
Person Trips - Transit/Walk/Bike/Other	84,521	85,308	787	0.93%
Person Trips – Total	825,596	826,152	+556	0.07%
Passenger Vehicle Trips	551,168	550,840	-328	-0.06%
Total VMT	4,897,545	4,895,916	-1,629	-0.03%

Source: Fehr & Peers, 2024.

The dynamic test results for income level adjustments are summarized in **Table 39**. When households were shifted from a lower income group to a higher income group, the total number of passenger vehicle trips increased, but total VMT decreased. Higher-income households tend to generate more vehicle trips but travel shorter distances, as they often have the option to live closer to their desired destinations. The model results demonstrate appropriate sensitivity to these income level adjustments.

Table 39: Income Adjustments

Trips/VMT	Base Year	Income Adjustments	Change	Change %
Person Trips - Drive Alone	332,946	333,317	371	0.11%
Person Trips - Shared Ride 2	228,781	228,891	110	0.05%
Person Trips - Shared Rid 3+	179,348	179,441	93	0.05%
Person Trips - Transit/Walk/Bike/Other	84,521	84,510	-11	-0.01%
Person Trips – Total	825,596	826,159	+563	0.07%
Passenger Vehicle Trips	551,168	551,622	454	0.08%
Total VMT	4,897,545	4,896,748	-797	-0.02%

Source: Fehr & Peers, 2024.

The final land use dynamic test involves adjusting the residential land use ratio by shifting single-family dwelling units to multi-family dwelling units. The model results are summarized in **Table 41.** As discussed in the trip generation section, the model's trip generation considers various factors such as land use type, household size, household income level, auto ownership, and more. Rather than relying on a single trip generation rate, the model accounts for the complex nature of socioeconomic data.

With the adjustment in the residential land use ratio, there is a reduction in the total number of person trips and passenger vehicle trips, which is similarly reflected in the total VMT. Since multi-family households have a lower trip generation rate compared to single-family households, the decrease in person trips, vehicle trips, and VMT aligns with the land use ratio adjustments. This demonstrates the model's sensitivity to changes in residential land use ratios.

It's important to note that when applying the model to residential land use projects, additional adjustments should be made for household size, income level, and other relevant inputs.

Table 40: Residential Land Use Ratio Adjustments

Trips/VMT	Base Year	Ratio Adjustments	Change	Change %
Person Trips - Drive Alone	399,588	398,714	-873	-0.22%
Person Trips - Shared Ride 2	246,470	246,044	-425	-0.17%
Person Trips - Shared Rid 3+	108,753	108,631	-122	-0.11%
Person Trips - Transit/Walk/Bike/Other	71,236	71,166	-70	-0.10%
Person Trips - Total	826,046	824,556	-1,490	-0.18%
Passenger Vehicle Trips	590,960	589,848	-1,111	-0.20%
Total VMT	4,745,942	4,737,101	-8,841	-0.19%

Source: Fehr & Peers, 2024.

5 Future Year Model

This section describes the future year model data that were developed, with the following section combining the input data into scenarios for the 2024 RTP/SCS. The inputs that were developed for the future year model include the land use, transportation system, and interregional travel.

Future Land Use

Once the base year model calibration and validation was complete, Fehr & Peers received TAZ growth projections provided by BCAG staff and developed one future year (2045) and one interim (2035) model scenario. **Table 41** reports the land use totals for the base year, interim year, and future year, along with the growth projections.

Table 41: Model Land Use Totals by Scenario Year

Land Use Type	Units	2022	2035	2045
Population	People	197,020	236,433	243,499
Single Family Residential	DU	49,798	58,911	60,522
Multi-Family Residential	DU	25,305	32,441	33,822
Mobile Home Residential	DU	9,055	9,811	9,844
Office	KSF	6,593	8,630	8,677
Medical Office	KSF	2,029	2,558	2,558
Hospitals	KSF	951	1,142	1,148
Industrial	KSF	12,903	15,729	15,729
Public/Quasi-Public	KSF	2,333	2,874	2,939
Park	Acres	491	526	526
Neighborhood-Serving Retail	KSF	11,060	11,764	11,761
Regional-Serving Retail	KSF	884	965	965
Hotels	Rooms	2,270	2,800	2,815
K-12 School	Students	29,040	31,031	31,195
University	Students	12,869	17,892	18,886
Community College	KSF	12,185	17,416	17,508
Casino (CASINO_SLT)	Slots	1,450	1,950	1,974
On Campus Student Housing	Dwelling Units	606	1,098	1,098

Source: BCAG, 2024 RTP/SCS Land Use Forecast.

Future Transportation System

The master network contains the planned and programmed transportation improvements for roadway and bike/pedestrian facilities with attributes related to the number of lanes, facility type, and type of travel allowed to use the facility along with scenario year details. The TAZ file contains the future transit accessibility and headway representing the simplified transit approach described previously. The list of planned and programmed projects can be found in **Appendix D**. It should be noted that this is not a complete listing of projects included in the 2024 RTP/SCS, rather, only projects which include changes to roadway capacity, effect the volume of the roadways, relate to bike/pedestrian facilities, or transit system characteristics.

Future Interregional Travel

For the future year, the production and attraction ratio for all purposes were within the 10% guideline for 2045, and minor imbalance was observed for home-based work trips for 2035 (12% difference between production and attraction). Compared to the base year, the future year job-housing balance remains nearly the same, but the distribution of employment types is significantly different. With the continued increase in online shopping, the growth in retail land use is relatively smaller than in other non-residential land use types, reflecting changes in the interregional trip percentages used for the future scenarios. The adjusted interregional trip percentages remain consistent across the future scenarios.

6 Alternatives Analysis

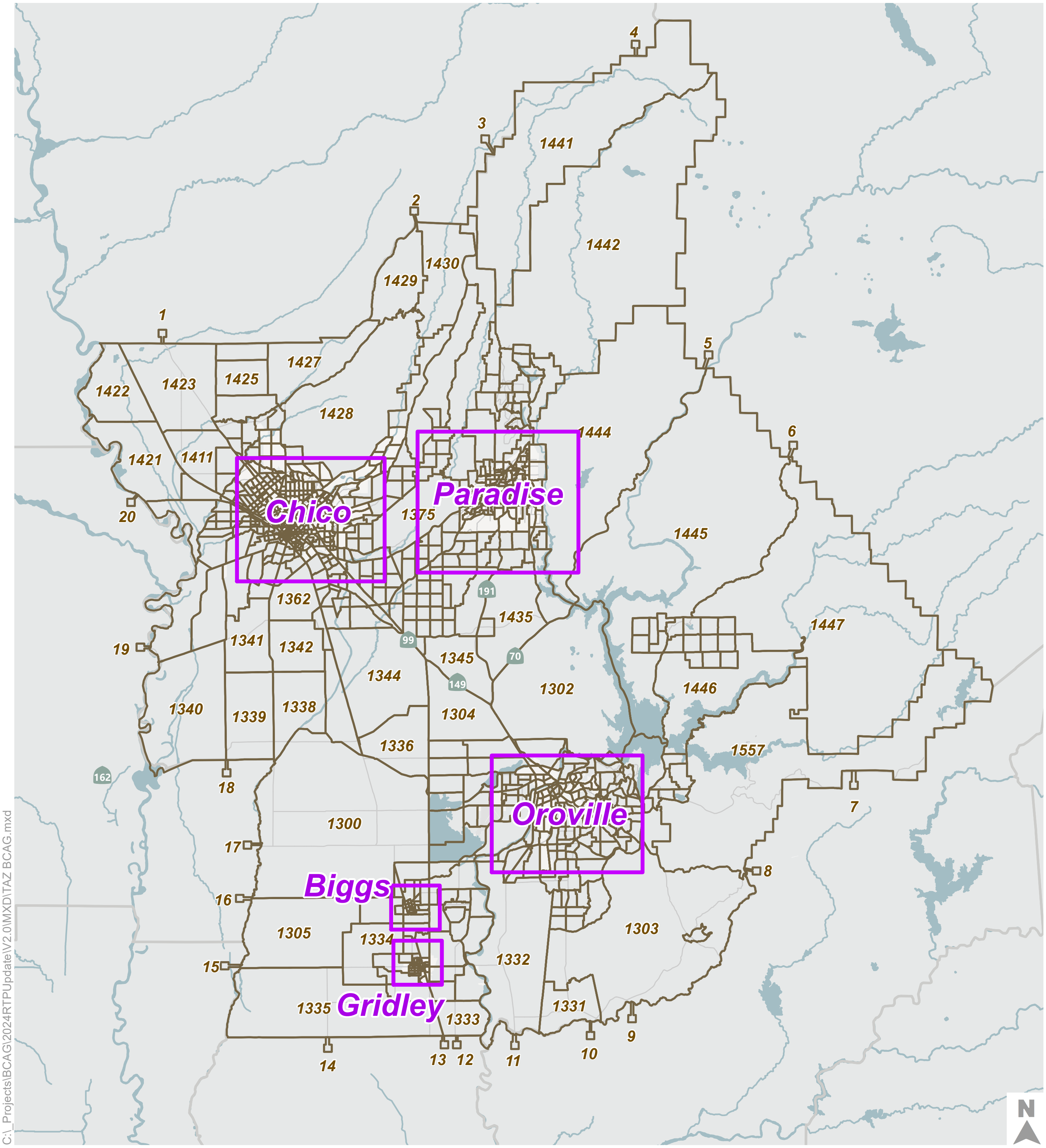
To develop the preferred scenario for the 2024 RTP/SCS, four different scenarios were evaluated for Year 2035. A summary of the roadway projects modeled in scenario 2 and 3, along with the corresponding model results for the four scenarios, can be found in **Appendix E**. Scenario 1 is consistent with 2020 RTP/SCS 2035 preferred scenario and the details can be found in the 2020 RTP/SCS. Scenario 4 is the selected preferred scenario for 2024 RTP/SCS and the details are documented in Chapter 5. The technical methodology employed in developing the land use allocation model, which was used to create the land use inputs for each alternative, is documented in the *Butte County Association of Governments Technical Methodology for Preparing 2024 RTP/SCS Land Use Allocation* (BCAG, 2024). Four land use scenarios were developed for Year 2035, and the land use details are summarized in **Table 42.**

Table 42: Model Land Use for 2035 Alternatives

Land Use Type	Units	S1 (2035)	S2 (2035)	S3 (2035)	S4 (2035)
Population	People	251,863	236,433	236,433	236,433
Single Family Residential	DU	64,197	60,262	59,293	58,911
Multi-Family Residential	DU	27,924	30,724	32,055	32,441
Mobile Home Residential	DU	11,419	10,140	9,811	9,811
Office	KSF	7,748	7,901	8,559	8,630
Medical Office	KSF	2,427	2,471	2,506	2,558
Hospitals	KSF	1,272	1,142	1,142	1,142
Industrial	KSF	13,631	15,628	15,729	15,729
Public/Quasi-Public	KSF	2,598	2,804	2,804	2,874
Park	Acres	540	555	555	526
Neighborhood-Serving Retail	KSF	13,012	13,268	12,177	11,764
Regional-Serving Retail	KSF	934	1,119	1,052	965
Hotels	Rooms	2,450	2,800	2,835	2,800
K-12 School	Students	34,484	31,031	31,031	31,031
University	Students	18,710	15,463	15,463	17,892
Community College	KSF	14,686	14,641	14,641	17,416
Casino (CASINO_SLT)	Slots	2,257	1,950	1,950	1,950
On Campus Student Housing	Dwelling Units	0	1,098	1,098	1,098

Source: BCAG, 2024 RTP/SCS Land Use Forecast.

Appendix A:
TAZ Maps



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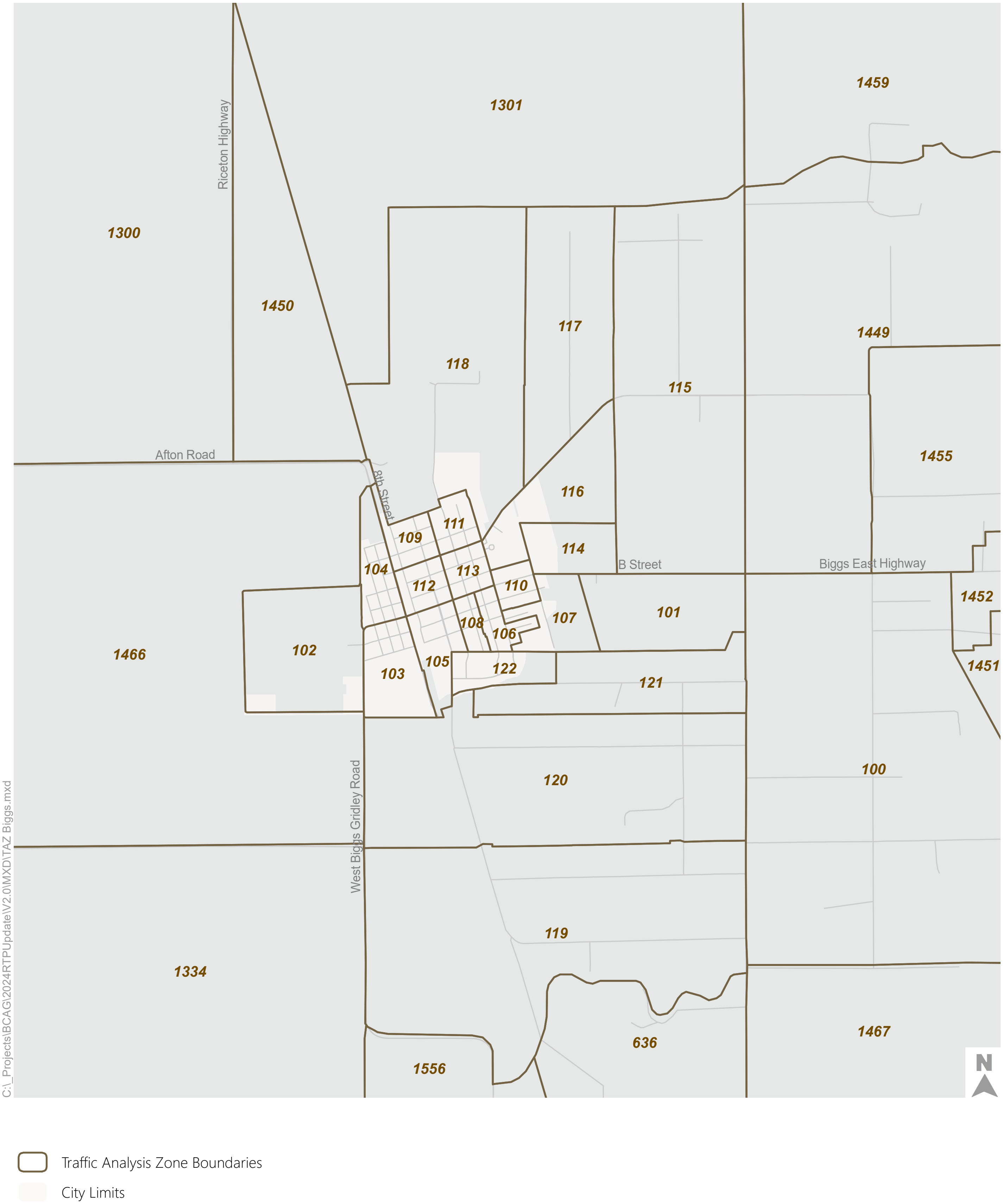
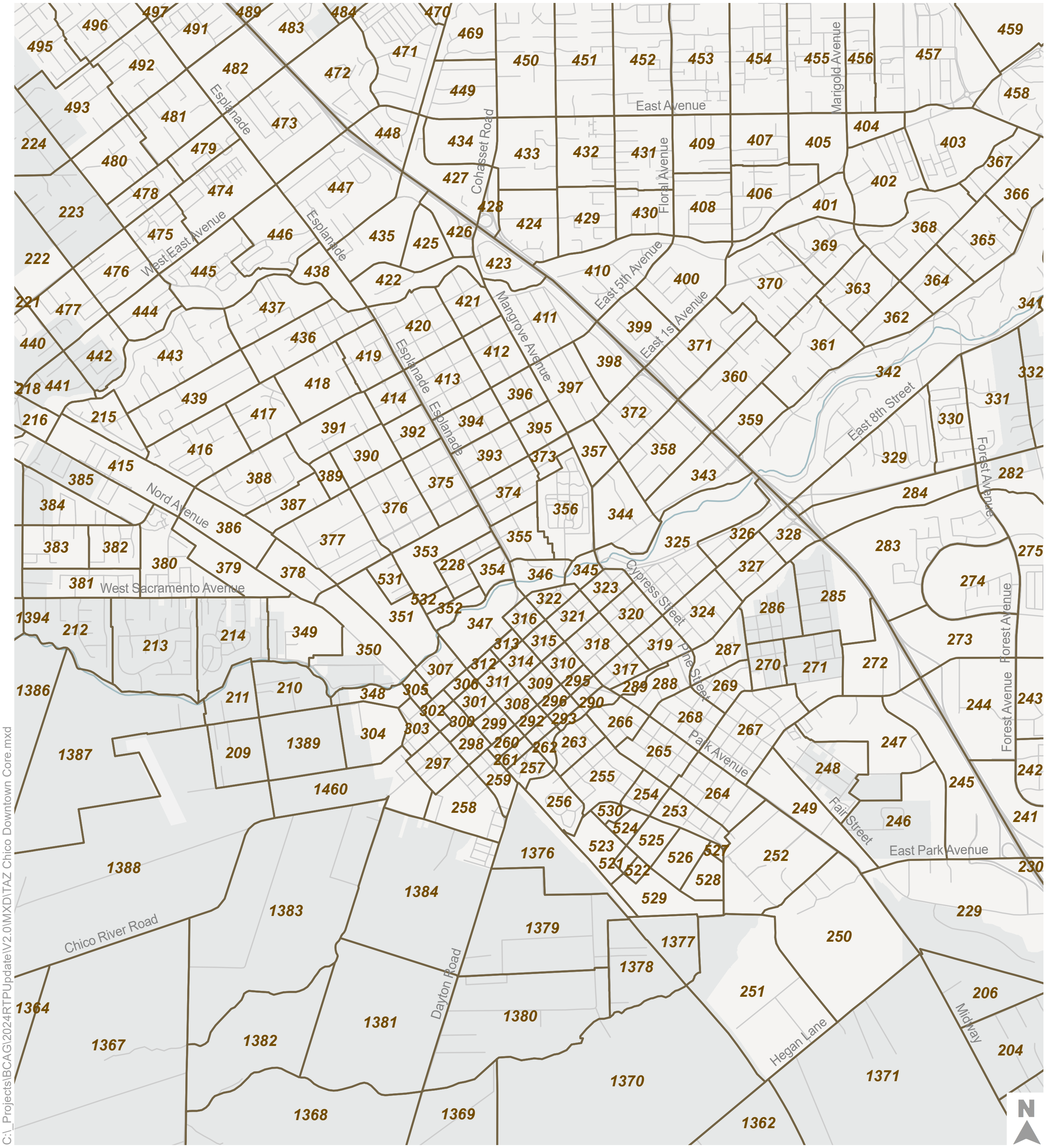
Traffic Analysis Zone Boundaries

City Limits

BCAG Model V2.0 - Traffic Analysis Zone Boundaries



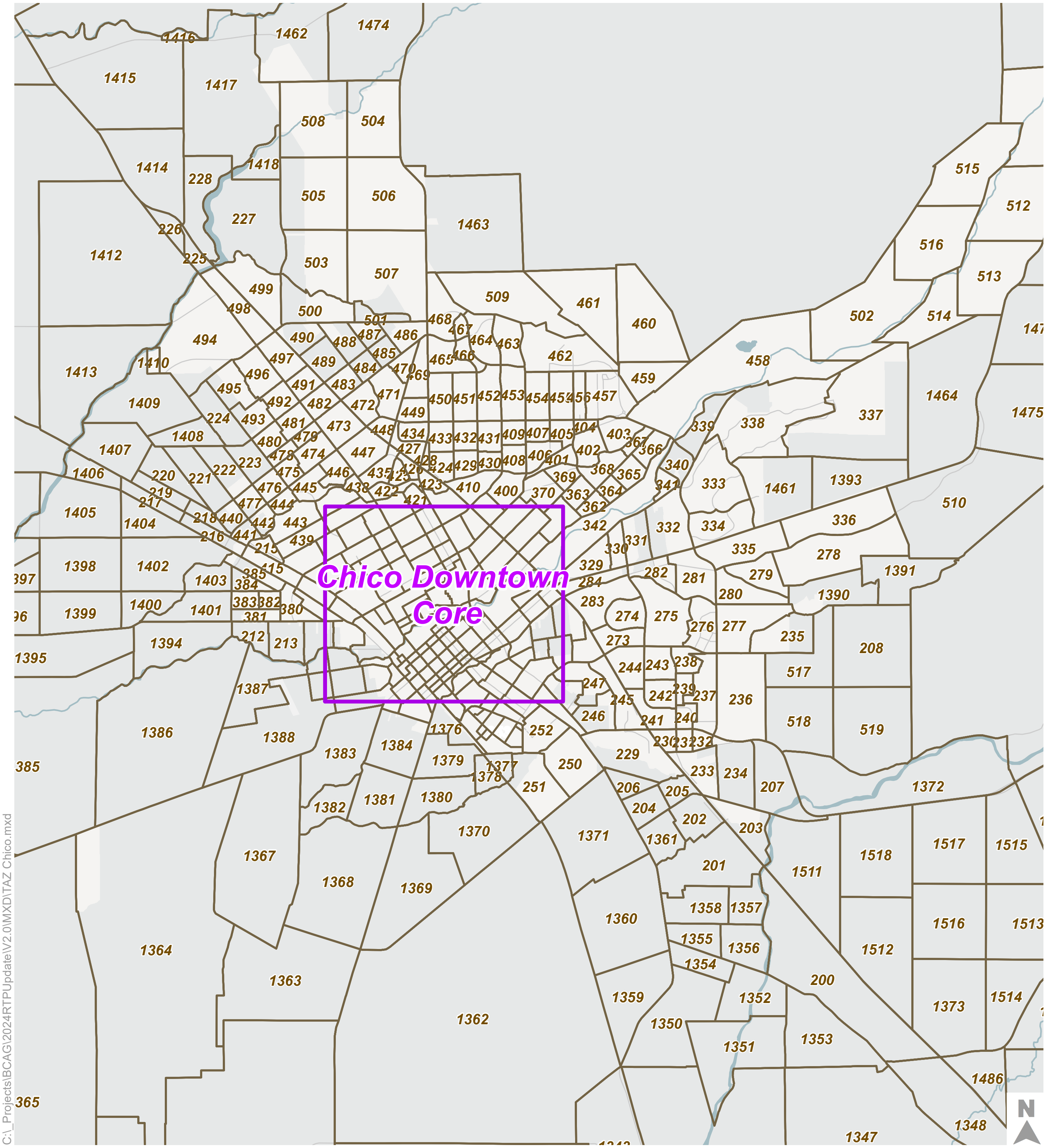
BCAG Model V2.0 - Biggs TAZ Boundaries



Traffic Analysis Zone Boundaries

City Limits

BCAG Model V2.0 - Chico Downtown Core TAZ Boundaries



- Traffic Analysis Zone Boundaries
- City Limits

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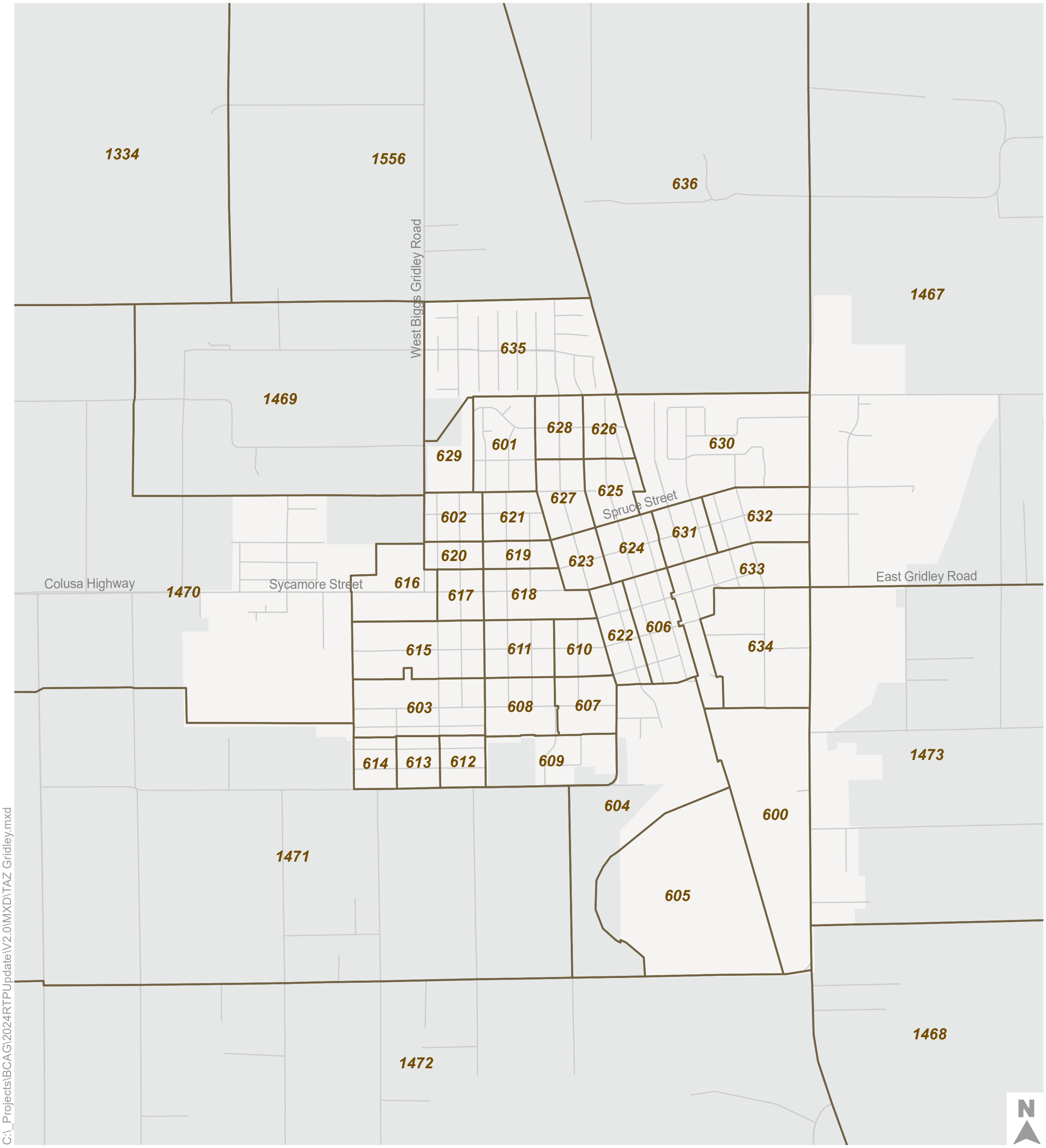
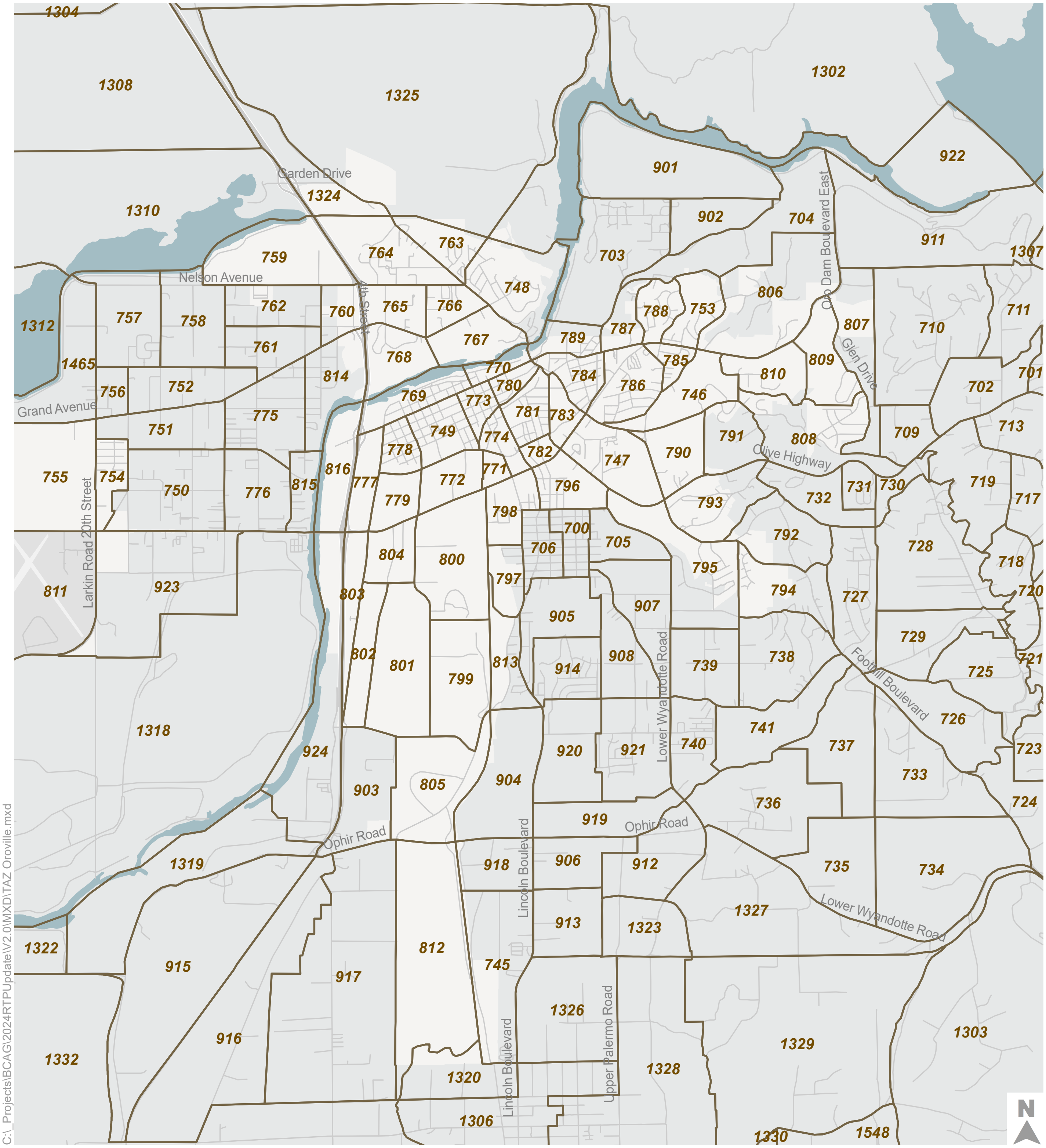
BCAG Model V2.0 - Chico TAZ Boundaries



Traffic Analysis Zone Boundaries

City Limits

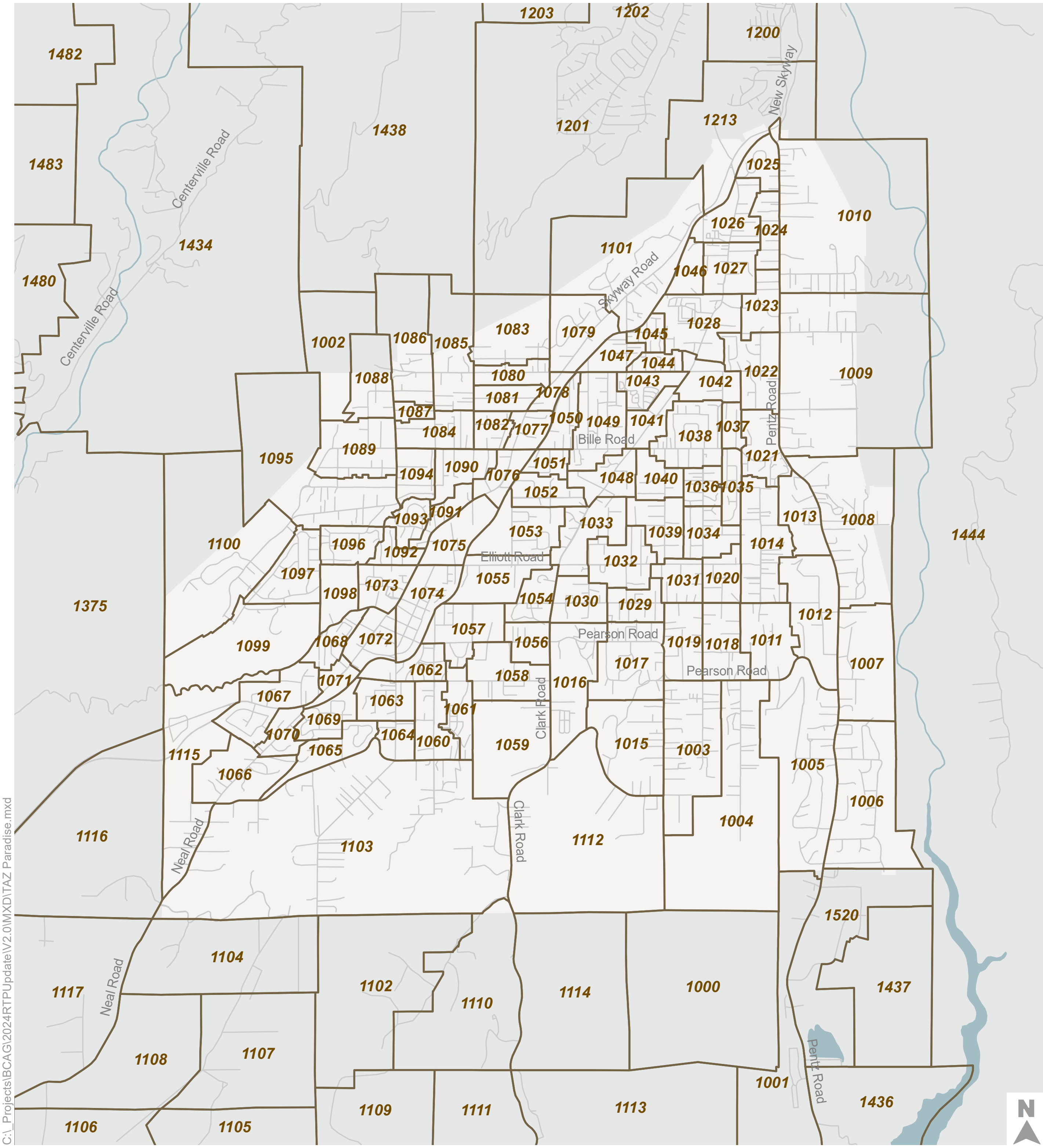
BCAG Model V2.0 - Gridley TAZ Boundaries



Traffic Analysis Zone Boundaries

City Limits

BCAG Model V2.0 - Oroville TAZ Boundaries



Traffic Analysis Zone Boundaries

City Limits

BCAG Model V2.0 - Paradise TAZ Boundaries

Appendix B:
California Household Travel Survey Data

This appendix contains metadata and data from the CHTS that were used for overall comparisons and validation for the 2018 BCAG TDF Model.

CHTS Detailed Summaries

The tables below contain the metadata for the results of the CHTS processing. The raw summary files are included with the model files and the data used for validation are summarized in the 2018 BCAG Model Validation spreadsheet. Since the model was validated to the county level data, the warning levels are provided for the potential use at a more detailed level.

Table 1: Daily Trip Mode Shares – Metadata

Label	Field Type	Description	Notes
Geography Name	Text	Name of geographic unit whose residents are being summarized	
Geography Type	Text	Type of geography: state, region, county, or city	
Total Trips (all purposes)	Numeric	Total number of person-trips in this geography.	
Sample Trips (all purposes)	Numeric	Number of person-trips surveyed by CHTS in this geography	
Warning Level (all purposes)	Numeric (0, 1, 2)	Warning level 0: All-purpose mode shares can be used with confidence. Warning level 1: All-purpose mode shares should be used with caution and cross-referenced with other sources. Warning level 2: All-purpose mode shares should not be used alone, but can be aggregated with other geographies of the same type to achieve a larger sample size.	Warning level 0: Over 100 trips; warning level 1: 51-100 trips; warning level 2: 50 or fewer trips.
Drive-alone mode share (all trips)	Percentage	Percentage of drive-alone trips among all trips within the geography.	
Shared Ride 2 mode share (all trips)	Percentage	Percentage of 2-person carpool trips among all trips within the geography.	
Shared Ride 3+ mode share (all trips)	Percentage	Percentage of 3-or-more person carpool trips among all trips within the geography.	
Transit mode share (all trips)	Percentage	Percentage of transit trips among all trips within the geography.	
Bike mode share (all trips)	Percentage	Percentage of bike trips among all trips within the geography.	
Walk mode share (all trips)	Percentage	Percentage of walk trips among all trips within the geography.	
Other mode share (all trips)	Percentage	Percentage of other mode trips among all trips within the geography.	

Table 1: Daily Trip Mode Shares – Metadata			
Label	**Field Type**	**Description**	**Notes**
Total Trips (HBO trips)	Numeric	Total number of HBO person-trips in this geography.	
Sample Trips (HBO trips)	Numeric	Number of HBO person-trips surveyed by CHTS in this geography	
Warning Level (HBO trips)	Numeric (0, 1, 2)	Warning level 0: HBO mode shares can be used with confidence. Warning level 1: HBO mode shares should be used with caution and cross-referenced with other sources. Warning level 2: HBO mode shares should not be used alone, but can be aggregated with other geographies of the same type to achieve a larger sample size.	Warning level 0: Over 100 trips; warning level 1: 51-100 trips; warning level 2: 50 or fewer trips.
Drive-alone mode share (HBO)	Percentage	Percentage of drive-alone trips among HBO trips within the geography.	
Shared Ride 2 mode share (HBO)	Percentage	Percentage of 2-person carpool trips among HBO trips within the geography.	
Shared Ride 3+ mode share (HBO)	Percentage	Percentage of 3-or-more person carpool trips among HBO trips within the geography.	
Transit mode share (HBO)	Percentage	Percentage of transit trips among HBO trips within the geography.	
Bike mode share (HBO)	Percentage	Percentage of bike trips among HBO trips within the geography.	
Walk mode share (HBO)	Percentage	Percentage of walk trips among HBO trips within the geography.	
Other mode share (HBO)	Percentage	Percentage of other mode trips among HBO trips within the geography.	Other modes include school bus, taxi, private shuttles, etc.
Total Trips (HBW trips)	Numeric	Total number of HBW person-trips in this geography.	
Sample Trips (HBW trips)	Numeric	Number of HBW person-trips surveyed by CHTS in this geography	
Warning Level (HBW trips)	Numeric (0, 1, 2)	Warning level 0: HBW mode shares can be used with confidence. Warning level 1: HBW mode shares should be used with caution and cross-referenced with other sources. Warning level 2: HBW mode shares should not be used alone, but can be aggregated with other geographies of the same type to achieve a larger sample size.	Warning level 0: Over 100 trips; warning level 1: 51-100 trips; warning level 2: 50 or fewer trips.
Drive-alone mode share (HBW)	Percentage	Percentage of drive-alone trips among HBW trips within the geography.	
Shared Ride 2 mode share (HBW)	Percentage	Percentage of 2-person carpool trips among HBW trips within the geography.	

Table 1: Daily Trip Mode Shares – Metadata			
Label	**Field Type**	**Description**	**Notes**
Shared Ride 3+ mode share (HBW)	Percentage	Percentage of 3-or-more person carpool trips among HBW trips within the geography.	
Transit mode share (HBW)	Percentage	Percentage of transit trips among HBW trips within the geography.	
Bike mode share (HBW)	Percentage	Percentage of bike trips among HBW trips within the geography.	
Walk mode share (HBW)	Percentage	Percentage of walk trips among HBW trips within the geography.	
Other mode share (HBW)	Percentage	Percentage of other mode trips among HBW trips within the geography.	Other modes include school bus, taxi, private shuttles, etc.
Total Trips (NHB trips)	Numeric	Total number of NHB person-trips in this geography.	
Sample Trips (NHB trips)	Numeric	Number of NHB person-trips surveyed by CHTS in this geography	
Warning Level (NHB trips)	Numeric (0, 1, 2)	Warning level 0: HBO mode shares can be used with confidence. Warning level 1: HBO mode shares should be used with caution and cross-referenced with other sources. Warning level 2: HBO mode shares should not be used alone, but can be aggregated with other geographies of the same type to achieve a larger sample size.	Warning level 0: Over 100 trips; warning level 1: 51-100 trips; warning level 2: 50 or fewer trips.
Drive-alone mode share (NHB)	Percentage	Percentage of drive-alone trips among NHB trips within the geography.	
Shared Ride 2 mode share (NHB)	Percentage	Percentage of 2-person carpool trips among NHB trips within the geography.	
Shared Ride 3+ mode share (NHB)	Percentage	Percentage of 3-or-more person carpool trips among NHB trips within the geography.	
Transit mode share (NHB)	Percentage	Percentage of transit trips among NHB trips within the geography.	
Bike mode share (NHB)	Percentage	Percentage of bike trips among NHB trips within the geography.	
Walk mode share (NHB)	Percentage	Percentage of walk trips among NHB trips within the geography.	
Other mode share (NHB)	Percentage	Percentage of other mode trips among NHB trips within the geography.	Other modes include school bus, taxi, private shuttles, etc.

Table 2: Daily Vehicle Trip Metrics per Household – Metadata			
Label	**Field Type**	**Description**	**Notes**
Geography Name	Text	Name of geographic unit whose residents are being summarized	
Geography Type	Text	Type of geography: state, region, county, or city	
Total Households	Numeric	Total number of households in this geography	CHTS is weighted at county level to match household totals from 2012 5-year ACS. For city geography, this total reflects the CHTS city households, weighted and expanded.
Sample Households	Numeric	Number of households surveyed by CHTS in this geography	
Warning Level	Numeric (0, 1, 2)	Warning level 0: Household metrics can be used with confidence. Warning level 1: Household metrics should be used with caution and cross-referenced with other sources. Warning level 2: Household metrics should not be used alone, but can be aggregated with other geographies of the same type to achieve a larger sample size.	Warning level 0: Over 100 households; warning level 1: 51-100 households; warning level 2: 50 or fewer households.
VMT per Household, total	Numeric	Vehicle Miles Travelled generated per household, all trip purposes.	
VMT per Household, HBO	Numeric	Vehicle Miles Travelled generated per household, Home-Based Other trips only.	
VMT per Household, HBW	Numeric	Vehicle Miles Travelled generated per household, Home-Based Work trips only.	
VMT per Household, NHB	Numeric	Vehicle Miles Travelled generated per household, Non-Home-Based trips only.	
Vehicle Trips per Household, Total	Numeric	Vehicle Trips generated per household, all trip purposes.	
Vehicle Trips per Household, Total	Numeric	Vehicle Trips generated per household, Home-Based Other trips only.	
Vehicle Trips per Household, Total	Numeric	Vehicle Trips generated per household, Home-Based Work trips only.	
Vehicle Trips per Household, Total	Numeric	Vehicle Trips generated per household, Non-Home-Based trips only.	
Vehicle Trip Length, Total	Numeric	Average Vehicle Trip distance, all trip purposes.	Calculation: Total VMT per HH / Total VT per HH
Vehicle Trip Length, HBO	Numeric	Average Vehicle Trip distance, Home-Based Other trips only.	Calculation: HBO VMT per HH / HBO VT per HH
Vehicle Trip Length, HBW	Numeric	Average Vehicle Trip distance, Home-Based Work trips only.	Calculation: HBW VMT per HH / HBW VT per HH
Vehicle Trip Length, NHB	Numeric	Average Vehicle Trip distance, Non-Home-Based trips only.	Calculation: NHB VMT per HH / NHB VT per HH

Table 3: Daily Vehicle Trip Metrics per Capita – Metadata			
Label	**Field Type**	**Description**	**Notes**
Geography Name	Text	Name of geographic unit whose residents are being summarized	
Geography Type	Text	Type of geography: state, region, county, or city	
Total Persons	Numeric	Total number of persons living in capitas in this geography	Persons not living in capitas (e.g., persons living in group quarters such as university dorms) are not included in this total. CHTS is weighted by capitas at county level to match capita totals from 2012 5-year ACS. For city geography, this total reflects the CHTS city persons, weighted and expanded.
Sample Persons	Numeric	Number of persons in CHTS-surveyed capitas in this geography	
Warning Level	Numeric (0, 1, 2)	Warning level 0: Capita metrics can be used with confidence. Warning level 1: Capita metrics should be used with caution and cross-referenced with other sources. Warning level 2: Capita metrics should not be used alone, but can be aggregated with other geographies of the same type to achieve a larger sample size.	Warning level 0: Over 100 persons; warning level 1: 51-100 persons; warning level 2: 50 or fewer persons.
VMT per Capita, total	Numeric	Vehicle Miles Travelled generated per capita, all trip purposes.	
VMT per Capita, HBO	Numeric	Vehicle Miles Travelled generated per capita, Home-Based Other trips only.	
VMT per Capita, HBW	Numeric	Vehicle Miles Travelled generated per capita, Home-Based Work trips only.	
VMT per Capita, NHB	Numeric	Vehicle Miles Travelled generated per capita, Non-Home-Based trips only.	
Vehicle Trips per Capita, Total	Numeric	Vehicle Trips generated per capita, all trip purposes.	
Vehicle Trips per Capita, Total	Numeric	Vehicle Trips generated per capita, Home-Based Other trips only.	
Vehicle Trips per Capita, Total	Numeric	Vehicle Trips generated per capita, Home-Based Work trips only.	
Vehicle Trips per Capita, Total	Numeric	Vehicle Trips generated per capita, Non-Home-Based trips only.	
Vehicle Trip Length, Total	Numeric	Average Vehicle Trip distance, all trip purposes.	Calculation: Total VMT per capita / Total VT per capita
Vehicle Trip Length, HBO	Numeric	Average Vehicle Trip distance, Home-Based Other trips only.	Calculation: HBO VMT per capita / HBO VT per capita

Table 3: Daily Vehicle Trip Metrics per Capita – Metadata			
Label	**Field Type**	**Description**	**Notes**
Vehicle Trip Length, HBW	Numeric	Average Vehicle Trip distance, Home-Based Work trips only.	Calculation: HBW VMT per capita / HBW VT per capita
Vehicle Trip Length, NHB	Numeric	Average Vehicle Trip distance, Non-Home-Based trips only.	Calculation: NHB VMT per capita / NHB VT per capita

Table 4: Daily Person Trip Metrics per Household – Metadata			
Label	**Field Type**	**Description**	**Notes**
Geography Name	Text	Name of geographic unit whose residents are being summarized	
Geography Type	Text	Type of geography: state, region, county, or city	
Total Households	Numeric	Total number of households in this geography	CHTS is weighted at county level to match household totals from 2012 5-year ACS. For city geography, this total reflects the CHTS city households, weighted and expanded.
Sample Households	Numeric	Number of households surveyed by CHTS in this geography	
Warning Level	Numeric (0, 1, 2)	Warning level 0: Household metrics can be used with confidence. Warning level 1: Household metrics should be used with caution and cross-referenced with other sources. Warning level 2: Household metrics should not be used alone, but can be aggregated with other geographies of the same type to achieve a larger sample size.	Warning level 0: Over 100 households; warning level 1: 51-100 households; warning level 2: 50 or fewer households.
PMT per Household, total	Numeric	Person Miles Travelled generated per household, all trip purposes.	
PMT per Household, HBO	Numeric	Person Miles Travelled generated per household, Home-Based Other trips only.	
PMT per Household, HBW	Numeric	Person Miles Travelled generated per household, Home-Based Work trips only.	
PMT per Household, NHB	Numeric	Person Miles Travelled generated per household, Non-Home-Based trips only.	
Person Trips per Household, Total	Numeric	Person Trips generated per household, all trip purposes.	
Person Trips per Household, Total	Numeric	Person Trips generated per household, Home-Based Other trips only.	
Person Trips per Household, Total	Numeric	Person Trips generated per household, Home-Based Work trips only.	
Person Trips per Household, Total	Numeric	Person Trips generated per household, Non-Home-Based trips only.	
Person Trip Length, Total	Numeric	Average Person Trip distance, all trip purposes.	Calculation: Total PMT per HH / Total PT per HH
Person Trip Length, HBO	Numeric	Average Person Trip distance, Home-Based Other trips only.	Calculation: HBO PMT per HH / HBO PT per HH
Person Trip Length, HBW	Numeric	Average Person Trip distance, Home-Based Work trips only.	Calculation: HBW PMT per HH / HBW PT per HH
Person Trip Length, NHB	Numeric	Average Person Trip distance, Non-Home-Based trips only.	Calculation: NHB PMT per HH / NHB PT per HH

Geography Name			California	SACOG	Butte
Geography Type			state	region	county
All Trips	Trip Data	Total Trips	121,791,338	7,591,534	704,387
		Sample Trips	248,398	12,657	2,055
		Warning Level	0	0	0
	Mode Share, all trips	Drive Alone	40.1%	42.9%	42.9%
		Shared Ride 2	22.6%	23.3%	27.8%
		Shared Ride 3+	20.1%	20.9%	18.1%
		Transit	3.6%	2.0%	3.1%
		Bike	1.6%	2.8%	2.1%
		Walk	10.9%	7.1%	5.6%
		Other	1.0%	1.0%	0.3%
HBO Trips	Trip Data	Total Trips	17,630,532	1,055,514	92,052
		Sample Trips	39,865	1,974	311
		Warning Level	0	0	0
	Mode Share, HBO trips	Drive Alone	30.2%	33.1%	31.5%
		Shared Ride 2	25.4%	25.8%	29.9%
		Shared Ride 3+	24.6%	26.7%	23.8%
		Transit	3.3%	1.2%	4.7%
		Bike	1.8%	3.6%	3.0%
		Walk	13.3%	8.2%	6.7%
		Other	1.4%	1.5%	0.3%
HBW Trips	HBW Trips	Total Trips	68,518,400	4,393,210	392,226
		Sample Trips	135,701	6,892	1,066
		Warning Level	0	0	0
	Mode Share, HBW trips	Drive Alone	76.1%	76.8%	79.7%
		Shared Ride 2	7.9%	6.0%	15.5%
		Shared Ride 3+	2.4%	3.9%	0.8%
		Transit	8.1%	7.6%	2.2%
		Bike	1.9%	3.0%	1.7%
		Walk	3.4%	2.1%	0.0%
		Other	0.2%	0.6%	0.0%
NHB Trips	NHB Trips	Total Trips	35,642,406	2,142,810	220,108
		Sample Trips	72,832	3,791	678
		Warning Level	0	0	0
	Mode Share, NHB trips	Drive Alone	41.5%	46.3%	47.6%
		Shared Ride 2	24.5%	26.6%	29.2%
		Shared Ride 3+	20.4%	17.6%	15.3%
		Transit	0.8%	1.1%	0.7%
		Bike	2.1%	1.1%	0.7%
		Walk	10.1%	7.1%	6.1%
		Other	0.6%	0.2%	0.3%

Geography Name			California	SACOG	Butte
Geography Type			state	region	county
Household Metrics		Total Households	12,465,947	816,939	85,074
		Sample Households	30,215	1,438	222
		Warning Level	0	0	0
Daily Vehicle Trip Metrics	MT per Househo	Total	41.6	42.9	39.3
		HBO	15.4	18.1	15.8
		HBW	14.1	12.4	8.7
		NHB	11.2	11.6	14.3
	e Trips per Hou	Total	5.3	5.3	4.8
		HBO	2.5	2.6	2.2
		HBW	1.2	1.1	0.9
		NHB	1.6	1.6	1.7
	ge Vehicle Trip I	Total	7.9	8.1	8.3
		HBO	6.1	6.9	7.1
		HBW	12.2	11.6	9.4
		NHB	6.9	7.2	8.6

Geography Name			California	SACOG	Butte
Geography Type			state	region	county
Capita Metrics		**Total Persons**	34,153,524	2,120,050	195,774
		Sample Persons	77,587	3,648	534
		Warning Level	0	0	0
Daily Vehicle Trip Metrics	**VMT per Capita**	**Total**	15.1	16.6	17.2
		HBO	5.8	7.2	7.0
		HBW	5.1	4.7	3.8
		NHB	4.2	4.6	6.4
	Vehicle Trips per Capita	**Total**	2.0	2.1	2.1
		HBO	1.0	1.1	1.0
		HBW	0.4	0.4	0.4
		NHB	0.6	0.6	0.7
	Average Vehicle Trip Length	**Total**	7.6	7.9	8.1
		HBO	6.0	6.8	7.1
		HBW	12.1	11.5	9.3
		NHB	6.8	7.2	8.6

Geography Name			California	SACOG	Butte
Geography Type			state	region	county
Household Metrics		Total Households	12,465,947	816,939	85,074
		Sample Households	30,215	1,438	222
		Warning Level	0	0	0
Daily Person Trip Metrics	PMT per Household	Total	63.0	69.3	58.7
		HBO	28.0	36.6	26.8
		HBW	17.0	14.9	10.0
		NHB	16.7	16.4	21.3
	Person Trips per Household	Total	8.9	8.5	7.5
		HBO	4.9	4.9	4.2
		HBW	1.4	1.3	1.0
		NHB	2.6	2.4	2.4
	Average Person Trip Length	Total	7.1	8.1	7.8
		HBO	5.7	7.5	6.4
		HBW	11.8	11.4	9.7
		NHB	6.4	6.9	8.8

PersonTripCapita

Geography Name			California	SACOG	Butte
Geography Type			state	region	county
Capita Metrics		Total Persons	34,153,524	2,120,050	195,774
		Sample Persons	77,587	3,648	534
		Warning Level	0	0	0
Daily Person Trip Metrics	PMT per Capita	Total	22.4	26.2	25.1
		HBO	10.2	14.1	11.7
		HBW	6.1	5.7	4.4
		NHB	6.2	6.4	9.2
	Person Trips per Capita	Total	3.3	3.3	3.3
		HBO	1.8	1.9	1.8
		HBW	0.5	0.5	0.5
		NHB	1.0	0.9	1.1
	Average Person Trip Length	Total	6.8	7.9	7.7
		HBO	5.6	7.4	6.4
		HBW	11.8	11.4	9.7
		NHB	6.4	6.8	8.7

Appendix C:
Auto Operating Cost Estimations

Auto Operation Cost Calculator (Draft For Comments Only)

Select MPO	BCAG
Select Calendar Year	2022

	GASOLINE			DIESEL			ELECTRIC			HYDROGEN			PHEV		
		Value			Value			Value			Value			Value	
	Data Source	Default	Custom	Data Source	Default	Custom	Data Source	Default	Custom	Data Source	Default	Custom	Data Source	Default	Custom
Fuel Cost (dollar/gasoline gallon equivalent)[1]	Default	3.72		Default	3.55		Default	6.48		Default	13.91			5.03	5.03
Non-fuel Cost (cents per mile) [2]	Default	7.95		Default	7.95		Default	6.55		Default	7.95			6.99	6.99
VMT	Default	5,200,045		Default	72,536		Default	25,451		Default	6,917		Default	63,454	
Fuel Efficiency (mile/gasoline gallon equivlent)	Gasoline	27.34		Diesel	37.55		Electric	116.01		Hydrogen	75.53		PHEV	59.24	
Auto Operating Cost by Fuel Type (Cents/Mile)	Gasoline	21.56		Diesel	17.40		Electric	12.14		Hydrogen	26.36		PHEV	14.37	

Calendar Year	2022
Auto Operating Cost (Cents/Mile)	21.38

Steps:
1. Select MPO and Calender Year from the drop-down list.
2. Select "Default" or "Custom" mode for each parameter from the drop-down list
3. Enter custom value(s) after selecting "Custom" mode for fuel cost, non-fuel cost and VMT

Note:
1- Input as 2017 dollars/cents
2- Include maintenace, repair and tire cost

Auto Operation Cost Calculator (Draft For Comments Only)

Select MPO	BCAG
Select Calendar Year	2035

	GASOLINE			DIESEL			ELECTRIC			HYDROGEN			PHEV		
		Value			Value			Value			Value			Value	
	Data Source	Default	Custom	Data Source	Default	Custom	Data Source	Default	Custom	Data Source	Default	Custom	Data Source	Default	Custom
Fuel Cost (dollar/gasoline gallon equivalent)[1]	Default	4.18		Default	4.16		Default	6.61		Default	10.32			5.53	5.53
Non-fuel Cost (cents per mile) [2]	Default	7.95		Default	7.95		Default	6.55		Default	7.95			6.99	6.99
VMT	Default	5,634,462		Default	80,964		Default	106,950		Default	56,598		Default	223,976	
Fuel Efficiency (mile/gasoline gallon equivlent)	Gasoline	36.82		Diesel	48.32		Electric	135.64		Hydrogen	88.65		PHEV	76.28	
Auto Operating Cost by Fuel Type (Cents/Mile)	Gasoline	19.31		Diesel	16.56		Electric	11.42		Hydrogen	19.60		PHEV	13.47	

Calendar Year	2035
Auto Operating Cost (Cents/Mile)	18.92

Steps:
1. Select MPO and Calender Year from the drop-down list.
2. Select "Default" or "Custom" mode for each parameter from the drop-down list
3. Enter custom value(s) after selecting "Custom" mode for fuel cost, non-fuel cost and VMT

Note:
1- Input as 2017 dollars/cents
2- Include maintenace, repair and tire cost

Auto Operation Cost Calculator (Draft For Comments Only)

Select MPO	BCAG
Select Calendar Year	2045

	GASOLINE			DIESEL			ELECTRIC			HYDROGEN			PHEV		
		Value			Value			Value			Value			Value	
	Data Source	Default	Custom	Data Source	Default	Custom	Data Source	Default	Custom	Data Source	Default	Custom	Data Source	Default	Custom
Fuel Cost (dollar/gasoline gallon equivalent)[1]	Default	4.18		Default	4.16		Default	6.61		Default	10.32			5.55	5.55
Non-fuel Cost (cents per mile) [2]	Default	7.95		Default	7.95		Default	6.55		Default	7.95			6.99	6.99
VMT	Default	5,941,511		Default	85,372		Default	130,128		Default	71,794		Default	265,662	
Fuel Efficiency (mile/gasoline gallon equivlent)	Gasoline	38.97		Diesel	50.72		Electric	151.82		Hydrogen	100.56		PHEV	80.93	
Auto Operating Cost by Fuel Type (Cents/Mile)	Gasoline	18.68		Diesel	16.15		Electric	10.90		Hydrogen	18.22		PHEV	13.06	

Calendar Year	2045
Auto Operating Cost (Cents/Mile)	18.25

Steps:
1. Select MPO and Calender Year from the drop-down list.
2. Select "Default" or "Custom" mode for each parameter from the drop-down list
3. Enter custom value(s) after selecting "Custom" mode for fuel cost, non-fuel cost and VMT

Note:
1- Input as 2017 dollars/cents
2- Include maintenace, repair and tire cost

Appendix D:

Planned and Programmed Project List

Capacity Projects 2022-2045 (2024 RTP/SCS) - Scenario #4

Jurisdiction	TITLE	PROJECT DESCRIPTION	New Lane Miles	Roadway Classification	Speed	2024 RTP Analysis Year				
						2022 - Model Base Year	2024 RTP Base Year	2030 Mile-stone Year	2035 GHG Year	2045 RTP Horizon
Butte County	Central House Rd Bridge Widening (at Wyman Ravine)	Widen Central House Rd Bridge from 1 to 2 lanes at Wyman Ravine	0.04	Local	35			x	x	x
Butte County	SR 70 Widening (Lower Honcut Rd to Butte County Line)	Widen SR 70 from 2 to 4 lanes from Lower Honcut Rd to Butte County Line.	2.02	Principal Arterial	65		x	x	x	x
Chico	Guynn Rd Bridge Widening (at Lindo Channel)	Widen Guynn Rd Bridge from 1 to 2 lanes at Lindo Channel	0.03	Local	25			x	x	x
Chico	Cohasset Rd Widening (Airport Blvd to Eaton Rd)	Widen Cohassett Rd from 2 to 4 lanes from Airport Blvd to Eaton Rd	3.61	Minor Arterial	55		x	x	x	x
Chico	Bruce Rd Widening (Skyway to SR 32)	From Skyway to SR 32, widen Roadway (Bridge included as separate project)	4.09	Minor Arterial	45			x	x	x
Chico	Commerce Ct Extension (Ivy St to Park Ave)	Construct 2 lane roadway connecting Ivy St to Park Ave	0.06	Local	25			x	x	x
Chico	E. 20th St Widening (Forest Ave to Bruce Rd)	Widen E. 20th St from 2 to 4 lanes from Forest Ave to Bruce Rd	0.98	Minor Arterial	40					x
Chico	Eaton Rd Widening (Hicks Ln to Cohasset Rd)	Widen Eaton Rd from 2 to 4 lanes from Hicks Ln to Cohasset Rd	3.05	Minor Arterial	45					x
Chico	Eaton Rd Widening (Ceanothus Ave to Marogold Ave)	Widen Eaton Rd from 3 to 4 lanes from Ceanothus Ave to Marigold Ave	0.25	Minor Arterial	45					x
Chico	Eaton Rd Widening (Cohasset to Lassen Ave)	Widen Eaton Rd from 2 to 4 lanes from Cohasset Rd to Lassen Ave	1.26	Minor Arterial	40					x
Chico	Eaton Rd Widening (Marigold Ave to Lance Terr)	Widen Eaton Rd from 3 to 4 lanes from Marigold Ave to Lance Terr	0.52	Minor Arterial	45					x
Chico	Esplanade Widening (Eaton Rd to Nord Hwy)	Widen Esplanade from 2 to 4 lanes from Eaton Rd to Nord Hwy	1.34	Major Collector	35			x	x	x
Chico	Yosemite Dr extension (Native Oak Dr to Humboldt Rd)	Construct 2 lane roadway connecting Native Oak Dr to Humboldt Rd	0.31	Major Collector	35			x	x	x
Chico	Notre Dame Extension (@ Little Chico Creek)	Construct 2 lane bridge @ Little Chico Creek	0.16	Major Collector	25			x	x	x
Chico	Midway Widening (Hegan Ln to E. Park Ave)	Widen Midway from 2 to 4 lanes from Hegan Ln to E. Park Ave	0.86	Minor Arterial	45					x
Chico	SR 32 Widening (El Monte Ave to Bruce Rd)	Widen SR 32 from 2 to 4 lanes from El Monte Ave to Bruce Rd	0.89	Principal Arterial	55					x
Chico	SR 32 Widening (Bruce Rd to Yosemite Dr)	Widen SR 32 from 2 to 4 lanes from Bruce Rd to Yosemite Dr	1.32	Minor Arterial	55					x
Chico	Eaton Rd Widening (@ SR 99)	Widen Eaton Rd from 2 to 4 lanes from Esplanade to SR 99	0.33	Minor Arterial	35				x	x
Chico	SR 99 on-ramp at Cohasset Rd	Construct Southbound direct on-ramp	0.12	Principal Arterial	65					x
Chico	MLK Blvd Widening (E. Park Ave to 20th St)	Widen MLK Blvd from 2 to 4 lanes from E. Park Ave to 20th St	1.62	Major Collector	35					x
Chico	Fair St Lane Reduction (E. Park Ave to E 20th St)	Reduce vehicle travel lanes from 4 to 2 from E. Park Ave to 20th St	-1.38	Principal Arterial	35			x	x	x
Paradise	Roe Rd Extension (Pentz Rd to S. Libby Rd) - Phase 1	Construct 2 lane roadway for extension of Roe Rd from Pentz Rd to South Libby Rd	2.28	Major Collector	25			x	x	x
Paradise	Roe Rd Extension (S. Libby Rd to SR 191) - Phase 2	Construct 2 lane roadway for extension of Roe Rd from South Libby Rd to SR 191	0.79	Major Collector	25			x	x	x
Paradise	Roe Rd Extension (SR 191 to Scottwood Rd) - Phase 3	Construct 2 lane roadway for extension of Roe Rd from SR 191 to Scottwood Rd	1.02	Major Collector	25				x	x
Paradise	Roe Rd Extension (Neal Rd to Skyway) - Phase 4	Construct 2 lane roadway for extension of Roe Rd from Neal Rd to Skyway	0.86	Major Collector	25					x

Bike Network Updates 2022-2045 (2024 RTP/SCS) - Scenario #4

Jurisdiction	TITLE	PROJECT DESCRIPTION	Facility Miles	Facility Classification	2024 RTP Analysis Year				
					2022 - Model Base Year	2024 RTP Base Year	2030 Mile-stone Year	2035 GHG Year	2045 RTP Horizon
Biggs	SR2S 2nd St Class II	Class II along 2nd & E Streets.	0.32	Class II			x	x	x
Butte County	Autry Lane & Monte Vista Safe Routes to Schools Gap Closure Project	Curb, gutter, sidewalk, and crossing enhancements along Autrey Ln. and Monte Vista Ave. on Autry from Las Plumas to Monte Vista and along Monte Vista from Autry Ln to Lincoln Blvd.	3.15	Class II			x	x	x
Butte County	State Route 162 Class II	Class II along SR 162 from Monument Hill Rd to Wildlife Area Rd	4.38	Class II				x	x
Butte County	Noth Chico Specific Plan Area Class I & II	Class I bike facilities consistent with North Chico Specific Plan	2.73	Class I				x	x
		Class II bike facilities consistent with North Chico Specific Plan	1.55	Class II				x	x
Butte County	Rio D' Oro Specific Plan Area Class I & II - Phase 1	Class I bike facilities consistent with Rio D' Oro Specific Plan - Phase 1	1.03	Class I				x	x
		Class II bike facilities consistent with Rio D' Oro Specific Plan - Phase 1	0.38	Class II				x	x
Chico	SR 99 Corridor Bikeway Phase 5 - 20th Street Crossing	SR 99 Corridor Bikeway Project Phase 5 completes the gap adjacent to SR 99 from Chico Mall across 20th Street to the south end of Business Lane. Scope of project is develop a new bicycle and pedestrian crossing (bridge) over 20th Street in Chico.	0.49	Class IV			x	x	x
Chico	Whittmeier Dr Class II (Bikeway 99 connector)	From SR99 Phase 4 end to Forest Ave and Talbert. Class 2 bike facility (0.18 miles)	0.19	Class II			x	x	x
Chico	Humboldt Rd Class 1	From Morning Rose Way to Bruce Rd. Class 1 bike facility (0.51 miles)	0.56	Class I			x	x	x
Chico	Esplanade Class 1	From Eaton Rd to Nord Hwy. Class 1 bike facility (0.67 miles)	0.67	Class I			x	x	x
Chico	Esplanade Class 2	From W 11th Ave to East Ave. Class 2 bike facility (1.09 miles)	1.20	Class II			x	x	x
Chico	Bruce Rd Class 1	From HWY 32 to Remington Dr. Class 1 bike facility (0.65 miles)	0.99	Class I			x	x	x
Chico	Lower Bidwell Park - Downtown Chico Connection	Class II buffered bike lanes along E 4th St from Main St to Cypress St and along E 3rd St from Main St to Pine St.	0.73	Class II			x	x	x
Chico	Chico Station - Downtown Chico Connection	Class II buffered bike lanes along W 4th St from Orange St to Main St and along W 3rd St from Walnut St to Main St.	1.18	Class II			x	x	x
Chico	Vallombrosa Avenue Bikeway	Class IV bikeway along Vallombrosa Ave from Manzanita Ave to Camellia Way.	2.85	Class IV			x	x	x
Chico	Chico River Road to Downtown Chico Connection	Class II bike lane along W 5th St from Chico River Rd to Broadway St	0.94	Class II			x	x	x
Chico	Lindo Channel Bikepath	Class I shared-use path along Lindo Channel from Nord Ave to SR99.	2.65	Class I			x	x	x
Chico	Little Chico Creek Bikepath	Class I shared-use path along Little Chico Creek from Pomona Ave to SR99.	2.12	Class I			x	x	x
Chico	Vallombrosa - Manzanita Connection	Class I shared-use path along SR99 from Vallombrosa Ave to Manzanita Ave.	1.11	Class I			x	x	x
Chico	Mangrove Avenue Bike Improvements	Class II buffered bike lane along Mangrove Ave from Pine St/Cypress St to Cohasset Rd.	1.48	Class II			x	x	x
Chico	East 1st Avenue/Longfellow Avenue Bike Improvements	Class II buffered bike lane on East 1st/Longfellow Ave from Esplanade to Manzanita Ave.	1.60	Class II			x	x	x
Chico	Downtown Chico Complete Streets Project	Class IV parking-buffered bikeway along Main St from E 9th St to E 1st St	0.54	Class IV			x	x	x
		Class IV bikeway along Main St from E 1st St to Main St end.	0.17	Class IV			x	x	x
		Class II bike lanes along Broadway St from W 1st St to W 9th St.	0.52	Class II			x	x	x
Chico	Cohasset Road Bikeway	Class IV bikeway along Cohasset Rd from Manzanita Ct to Eaton Rd.	1.65	Class IV			x	x	x
Chico	Annie's Glen Bike Path Connector	Class I shared-use path at Annie's Glen bike path access point connector from south of Vallombrosa to Mangrove Ave/Annie's Glen bike path.	0.10	Class I			x	x	x
Chico	Nord Avenue Bikeway	Construct Class IV bikeway along Nord Ave from W Sacramento Ave to W 8th Ave	0.69	Class IV			x	x	x
Chico	Wall Street Bike Improvements	Class I shared-use path along Wall St from E 4th St to E 5th St.	0.06	Class I			x	x	x
Chico	W. Sacramento Avenue Bike Improvements	Class II buffered bike lane with green paint along W Sacramento Ave from Warner St to Esplanade.	0.42	Class II			x	x	x
Chico	Eaton Rd Widening - Class IV bike path	Class IV bike path along Eatn Rd from SR 99 to Cohasset Rd	1.52	Class IV					x
Chico	Notre Dame Boulevard Connection - Class II	Class II bike lane along Notre Dame Blvd over Little Chico Creek	0.10	Class II			x	x	x
Chico	Midway Class II	Class II bike lane along Midway Aver from Hegan Ln to E Park Ave	0.43	Class II			x	x	x
Chico	Yosemite Dr Class I	Class I bike path along Yosemite Dr from Native Oak Dr to Humboldt Rd	0.16	Class I			x	x	x
Chico	Little Chico Creek Bike Bridge Class I	Class I bike path at new bridge crossing Little Chico Creek near 20th St Park	0.05	Class I		x	x	x	x
Chico	Mariposa Ave Class II	Class II bike lane along Mariposa Ave from Eaton Rd to Whitewood Way	0.08	Class II		x	x	x	x
Chico	Mulberry, Pine, and Cypress St Class II	Class II along Mulberry, Pine, and Cypress Streets from 9th St to 20th St	0.98	Class II		x	x	x	x
Chico	North Cedar St Reconstruction Project	Class II along North Cedar St from W. Sacramento Ave to 4th Ave	0.34	Class II			x	x	x
Chico	Barber Yard Specific Plan Phase 1	Class I bike facilities consistent with Barber Yard Specific Plan - Phase 1	0.48	Class I			x	x	x
Chico	Barber Yard Specific Plan Phase 2	Class I bike facilities consistent with Barber Yard Specific Plan - Phase 2	1.12	Class I				x	x
Chico	Barber Yard Specific Plan Phase 3	Class I bike facilities consistent with Barber Yard Specific Plan - Phase 3	0.19	Class I					x
Chico	Valley's Edge Specific Plan Phase 1	Class I bike facilities consistent with Valley's Edge Specific Plan - Phase 1	2.73	Class I					
		Class II bike facilities consistent with Valley's Edge Specific Plan - Phase 1	0.43	Class II					
Chico	Valley's Edge Specific Plan Phase 2	Class I bike facilities consistent with Valley's Edge Specific Plan - Phase 2	2.25	Class I					
Chico	Chico - Paradise Bikeway Project	Class I bike path along Skyway from Honey Run Rd to Paradise Trailway	8.78	Class I				x	x
Chico	Bruce Rd Class 1 (Skyway to 20th St)	Class I bike path along Bruce Rd from Skyway to 20th St	1.06	Class I			x	x	x

Jurisdiction	TITLE	PROJECT DESCRIPTION	Facility Miles	Facility Classification	2024 RTP Analysis Year				
					2022 - Model Base Year	2024 RTP Base Year	2030 Mile-stone Year	2035 GHG Year	2045 RTP Horizon
Chico	Fair St Class II (E Park Ave to 20th St)	Class II bike lanes along Fair St from E Park Ave to 20th St	0.69	Class II			x	x	x
Gridley	Gridley Bike & Pedestrian SR 99 Corridor Facility Project	Class I bike path along State Route 99 from Township Road to Archer Avenue.	0.97	Class I			x	x	x
Gridley	Magnolia St Class II	From Idaho St to Vermont St. New Class 2 bike facilities (0.42 miles)	0.42	Class II			x	x	x
Gridley	Gridley Rd Class II	From Jackson St to SR99. New Class 2 bike facilities (0.25 miles)	0.25	Class II				x	x
Oroville	Washington Ave. Complete Streets Project	between Oroville Dam Boulevard East and the railroad bridge just past Orange Avenue. Construct new bike/ped facilities & ADA treatment	0.59	Class II			x	x	x
Oroville	Table Mountain Boulevard Complete Streets Project	from the Montgomery Street Roundabout to the Thermalito Power Canal. Construct new bike/ped facilities, ADA treatment, gap closures.	1.50	Class II			x	x	x
Oroville	SR 162 Class II	Class II along SR 162 from Feather River Bridge to Foothill Blvd	2.76	Class II			x	x	x
Oroville	City of Oroville AHSC Application (24/25)	Class II along Nelson Ave and 2nd St consistent with City of Oroville AHSC Application (24/25)	1.09	Class II			x	x	x
Paradise	Go Paradise: Oliver-Park Connection Project (AKA Oliver Curve Pathway Phase 1)	Oliver Road between Skyway and Bille Road, Bille Road between Oliver Road and Bille Park. Construct a grade separated, Class I, bike-ped facility along the west side of Oliver Road and north side of Bille Road within the project limits.	1.09	Class I			x	x	x
Paradise	Go Paradise: Neal Gateway ATP Project (AKA Paradise ATP Gateway Project)	Neal Road between Town Limits and Skyway (1.62 miles). Along Neal Road, construct a grade separated, Class I, bike-ped facility along the west side of Neal Road within the project limits.	1.62	Class I			x	x	x
Paradise	Pentz Rd Trailway Class I	Class I along Pentz Rd between Pearson Rd and Bille Rd and Wagstaff Rd and Skyway	3.16	Class I			x	x	x
Paradise	Roe Rd Extension Phase 1 - Class I	Class I along Roe Rd from Pentz Rd to South Libby Ln	1.33	Class I			x	x	x
Paradise	Roe Rd Extension Phase 2 - Class I	Class I along Roe Rd from South Libby Ln to SR 191	0.80	Class I			x	x	x
Paradise	Roe Rd Extension Phase 3 - Class I	Class I along Roe Rd from SR 191 to Scottwood Dr	0.76	Class I				x	x
Paradise	Roe Rd Extension Phase 4 - Class I	Class I along Roe Rd from Neal Rd to Skyway	0.43	Class I					x
Paradise	Roe Rd Extension Phase 5 - Class I	Class I along Roe Rd from Scottwood Dr to Neal Rd	1.65	Class I					x
Paradise	Gap Closure Complex Project and Almond St Multimodal	Class I along Almond St from Fir St to Elliott Rd	0.29	Class I		x	x	x	x
		Class II along portions of Almond St, Fir St, Birch St, and Black Olive Dr in downtown.	0.67	Class II		x	x	x	x
Paradise	Elliott Rd Class II	Class II along Elliot Rd from Skyway to Clark Rd	0.92	Class II		x	x	x	x
Paradise	Ponderosa Elementary SRTS - ATP	Class II along Pentz Rd from Bille Rd to Wagstaff Rd	0.60	Class II		x	x	x	x
Paradise	Go Paradise - Skyway Link Project (Skyway Connectivity)	The Skyway Link/Skyway Connectivity Project will stripe 3,165 linear feet of on-street bicycle lanes between Wagstaff Road and Bille Road.	0.61	Class II			x	x	x

Appendix E:
Model Scenario Reporting Tables

Additional Capacity 2022-2045 (2024 RTP/SCS) - Scenario #2

Jurisdiction	TITLE	PROJECT DESCRIPTION	New Lane Miles	Roadway Classification	Speed	2024 RTP Analysis Year				
						2022 - Model Base Year	2024 RTP Base Year	2030 Mile-stone Year	2035 GHG Year	2045 RTP Horizon
Butte County	Central House Rd Bridge Widening (at Wyman Ravine)	Widen Central House Rd Bridge from 1 to 2 lanes at Wyman Ravine	0.04	Local	35			x	x	x
Butte County	SR 70 Widening (Lower Honcut Rd to Butte County Line)	Widen SR 70 from 2 to 4 lanes from Lower Honcut Rd to Butte County Line.	2.02	Principal Arterial	65		x	x	x	x
Chico	Guynn Rd Bridge Widening (at Lindo Channel)	Widen Guynn Rd Bridge from 1 to 2 lanes at Lindo Channel	0.03	Local	25			x	x	x
Chico	Cohasset Rd Widening (Airport Blvd to Eaton Rd)	Widen Cohassett Rd from 2 to 4 lanes from Airport Blvd to Eaton Rd	3.61	Minor Arterial	55		x	x	x	x
Chico	Bruce Rd Widening (Skyway to SR 32)	From Skyway to SR 32, widen Roadway (Bridge included as separate project)	4.09	Minor Arterial	45			x	x	x
Chico	Commerce Ct Extension (Ivy St to Park Ave)	Construct 2 lane roadway connecting Ivy St to Park Ave	0.06	Local	25			x	x	x
Chico	E. 20th St Widening (Forest Ave to Bruce Rd)	Widen E. 20th St from 2 to 4 lanes from Forest Ave to Bruce Rd	0.98	Minor Arterial	40			x	x	x
Chico	Eaton Rd Widening (Hicks Ln to Cohasset Rd)	Widen Eaton Rd from 2 to 4 lanes from Hicks Ln to Cohasset Rd	2.71	Minor Arterial	45					x
Chico	Eaton Rd Widening (Ceanothus Ave to Marogold Ave)	Widen Eaton Rd from 3 to 4 lanes from Ceanothus Ave to Marigold Ave	0.25	Minor Arterial	45					x
Chico	Eaton Rd Widening (Cohasset to Lassen Ave)	Widen Eaton Rd from 2 to 4 lanes from Cohasset Rd to Lassen Ave	1.26	Minor Arterial	40					x
Chico	Eaton Rd Widening (Marigold Ave to Lance Terr)	Widen Eaton Rd from 3 to 4 lanes from Marigold Ave to Lance Terr	0.52	Minor Arterial	45					x
Chico	Esplanade Widening (Eaton Rd to Nord Hwy)	Widen Esplanade from 2 to 4 lanes from Eaton Rd to Nord Hwy	1.34	Major Collector	35			x	x	x
Chico	Yosemite Dr extension (Native Oak Dr to Humboldt Rd)	Construct 2 lane roadway connecting Native Oak Dr to Humboldt Rd	0.31	Major Collector	35			x	x	x
Chico	Notre Dame Extension (@ Little Chico Creek)	Construct 2 lane bridge @ Little Chico Creek	0.16	Major Collector	25			x	x	x
Chico	Midway Widening (Hegan Ln to E. Park Ave)	Widen Midway from 2 to 4 lanes from Hegan Ln to E. Park Ave	0.86	Minor Arterial	45			x	x	x
Chico	SR 32 Widening (El Monte Ave to Bruce Rd)	Widen SR 32 from 2 to 4 lanes from El Monte Ave to Bruce Rd	0.89	Principal Arterial	55			x	x	x
Chico	SR 32 Widening (Bruce Rd to Yosemite Dr)	Widen SR 32 from 2 to 4 lanes from Bruce Rd to Yosemite Dr	1.32	Minor Arterial	55				x	x
Chico	SR 99 Overpass Widening (@ Eaton Rd)	Widen SR 99 overpass at Eaton Rd from 2 to 4 lanes	0.97	Minor Arterial	35				x	x
Chico	SR 99 on-ramp at Cohasset Rd	Construct Southbound direct on-ramp	0.12	Principal Arterial	65				x	x
Chico	MLK Blvd Widening (E. Park Ave to 20th St)	Widen MLK Blvd from 2 to 4 lanes from E. Park Ave to 20th St	1.62	Major Collector	35			x	x	x
Chico	SR 99 Aux Lanes (20th St to SR 32)	Constuct auxillary lanes on Hwy 99 from 20th st to SR 32	0.78	Freeway	65				x	x
Chico	SR 99 Aux Lanes (Skyway to 20th St)	Constuct auxillary lanes on Hwy 99 from Skyway to 20th St	0.56	Freeway	65				x	x
Oroville	Olive Hwy Widening (Oro-Dam Blvd to Foothill Blvd)	Construct additional eastbound lane on Olive Hwy (SR 162) from Oro-Dam Blvd to Foothill Blvd	0.90	Principal Arterial	35				x	x
Paradise	Roe Rd Extension (Pentz Rd to S. Libby Rd) - Phase 1	Construct 2 lane roadway for extension of Roe Rd from Pentz Rd to South Libby Rd	2.28	Major Collector	25			x	x	x
Paradise	Roe Rd Extension (S. Libby Rd to SR 191) - Phase 2	Construct 2 lane roadway for extension of Roe Rd from South Libby Rd to SR 191	0.79	Major Collector	25			x	x	x
Paradise	Roe Rd Extension (SR 191 to Scottwood Rd) - Phase 3	Construct 2 lane roadway for extension of Roe Rd from SR 191 to Scottwood Rd	1.02	Major Collector	25					
Paradise	Roe Rd Extension (Neal Rd to Skyway) - Phase 4	Construct 2 lane roadway for extension of Roe Rd from Neal Rd to Skyway	0.86	Major Collector	25					

Additional Capacity 2022-2045 (2024 RTP/SCS) - Scenario #3

Jurisdiction	TITLE	PROJECT DESCRIPTION	New Lane Miles	Roadway Classification	Speed	2024 RTP Analysis Year				
						2022 - Model Base Year	2024 RTP Base Year	2030 Mile-stone Year	2035 GHG Year	2045 RTP Horizon
Butte County	Central House Rd Bridge Widening (at Wyman Ravine)	Widen Central House Rd Bridge from 1 to 2 lanes at Wyman Ravine	0.04	Local	35			x	x	x
Butte County	SR 70 Widening (Lower Honcut Rd to Butte County Line)	Widen SR 70 from 2 to 4 lanes from Lower Honcut Rd to Butte County Line.	2.02	Principal Arterial	65		x	x	x	x
Chico	Guynn Rd Bridge Widening (at Lindo Channel)	Widen Guynn Rd Bridge from 1 to 2 lanes at Lindo Channel	0.03	Local	25			x	x	x
Chico	Cohasset Rd Widening (Airport Blvd to Eaton Rd)	Widen Cohassett Rd from 2 to 4 lanes from Airport Blvd to Eaton Rd	3.61	Minor Arterial	55		x	x	x	x
Chico	Bruce Rd Widening (Skyway to SR 32)	From Skyway to SR 32, widen Roadway (Bridge included as separate project)	4.09	Minor Arterial	45			x	x	x
Chico	Commerce Ct Extension (Ivy St to Park Ave)	Construct 2 lane roadway connecting Ivy St to Park Ave	0.06	Local	25			x	x	x
Chico	E. 20th St Widening (Forest Ave to Bruce Rd)	Widen E. 20th St from 2 to 4 lanes from Forest Ave to Bruce Rd	0.98	Minor Arterial	40			x	x	x
Chico	Eaton Rd Widening (Hicks Ln to Cohasset Rd)	Widen Eaton Rd from 2 to 4 lanes from Hicks Ln to Cohasset Rd	3.05	Minor Arterial	45					x
Chico	Eaton Rd Widening (Ceanothus Ave to Marogold Ave)	Widen Eaton Rd from 3 to 4 lanes from Ceanothus Ave to Marigold Ave	0.25	Minor Arterial	45				x	x
Chico	Eaton Rd Widening (Cohasset to Lassen Ave)	Widen Eaton Rd from 2 to 4 lanes from Cohasset Rd to Lassen Ave	1.26	Minor Arterial	40				x	x
Chico	Eaton Rd Widening (Marigold Ave to Lance Terr)	Widen Eaton Rd from 3 to 4 lanes from Marigold Ave to Lance Terr	0.52	Minor Arterial	45				x	x
Chico	Esplanade Widening (Eaton Rd to Nord Hwy)	Widen Esplanade from 2 to 4 lanes from Eaton Rd to Nord Hwy	1.34	Major Collector	35			x	x	x
Chico	Yosemite Dr extension (Native Oak Dr to Humboldt Rd)	Construct 2 lane roadway connecting Native Oak Dr to Humboldt Rd	0.31	Major Collector	35			x	x	x
Chico	Notre Dame Extension (@ Little Chico Creek)	Construct 2 lane bridge @ Little Chico Creek	0.16	Major Collector	25			x	x	x
Chico	Midway Widening (Hegan Ln to E. Park Ave)	Widen Midway from 2 to 4 lanes from Hegan Ln to E. Park Ave	0.86	Minor Arterial	45			x	x	x
Chico	SR 32 Widening (El Monte Ave to Bruce Rd)	Widen SR 32 from 2 to 4 lanes from El Monte Ave to Bruce Rd	0.89	Principal Arterial	55				x	x
Chico	SR 32 Widening (Bruce Rd to Yosemite Dr)	Widen SR 32 from 2 to 4 lanes from Bruce Rd to Yosemite Dr	1.32	Minor Arterial	55					x
Chico	Eaton Rd Widening (@ SR 99)	Widen Eaton Rd from 2 to 4 lanes from Esplanade to SR 99	0.33	Minor Arterial	35				x	x
Chico	SR 99 on-ramp at Cohasset Rd	Construct Southbound direct on-ramp	0.12	Principal Arterial	65					x
Chico	MLK Blvd Widening (E. Park Ave to 20th St)	Widen MLK Blvd from 2 to 4 lanes from E. Park Ave to 20th St	1.62	Major Collector	35				x	x
Paradise	Roe Rd Extension (Pentz Rd to S. Libby Rd) - Phase 1	Construct 2 lane roadway for extension of Roe Rd from Pentz Rd to South Libby Rd	2.28	Major Collector	25			x	x	x
Paradise	Roe Rd Extension (S. Libby Rd to SR 191) - Phase 2	Construct 2 lane roadway for extension of Roe Rd from South Libby Rd to SR 191	0.79	Major Collector	25			x	x	x
Paradise	Roe Rd Extension (SR 191 to Scottwood Rd) - Phase 3	Construct 2 lane roadway for extension of Roe Rd from SR 191 to Scottwood Rd	1.02	Major Collector	25				x	x
Paradise	Roe Rd Extension (Neal Rd to Skyway) - Phase 4	Construct 2 lane roadway for extension of Roe Rd from Neal Rd to Skyway	0.86	Major Collector	25					x

Modeling Data	2022	S1 (2035)	S2 (2035)	S3 (2035)	S4 (2035)	2045
Vehicle Operating Costs ($/mile)	0.214	0.189	0.189	0.189	0.189	0.183
Average Auto Trip Length (miles)	7.13	7.76	7.21	7.22	7.24	7.29
Average Auto Travel Time (minutes)	10.47	11.37	10.67	10.55	10.54	10.59
Percent Passenger Travel Mode Share						
Auto	91.7%	89.3%	89.5%	89.2%	87.6%	87.4%
SOV	48.3%	47.8%	46.3%	45.9%	45.0%	44.8%
HOV	43.4%	41.5%	43.3%	43.3%	42.7%	42.6%
All Other (transit & non-motorized)	8.3%	10.7%	10.5%	10.8%	12.4%	12.6%
Public Transit (Fixed Route Bus)	1.7%	3.9%	3.4%	3.5%	4.7%	4.8%
Non-Motorized (Bike and Walk)	6.4%	6.5%	6.8%	7.0%	7.4%	7.5%
Other (i.e. School Bus)	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%

Butte County VMT Summary

Scenario	II VMT	IX-XI VMT	XX VMT	Total VMT (w/o XX Trips)	Population	VMT / Capita
2022	3,821,174	712,221	87,355	4,533,395	197,020	23.0
S1 (2035)	4,858,924	809,531	108,357	5,668,455	251,863	22.5
S2 (2035)	4,490,299	637,055	108,247	5,127,354	236,433	21.7
S3 (2035)	4,448,439	640,957	108,247	5,089,395	236,433	21.5
S4 (2035)	4,406,984	579,761	108,255	4,986,745	236,433	21.1
2045	4,517,758	591,891	124,833	5,109,649	243,499	21.0

Butte County VMT Summary by Speed Bin

Speed Bin	2022	S1 (2035)	S2 (2035)	S3 (2035)	S4 (2035)	2045
0-5	2,625	4,022	8,723	5,552	4,597	4,585
5-10	9,105	9,594	11,927	11,188	11,106	11,092
10-15	6,637	15,314	4,247	5,373	5,512	6,472
15-20	12,523	37,200	23,066	20,586	17,223	13,032
20-25	465,792	605,524	538,648	521,415	507,905	521,642
25-30	138,768	190,784	157,763	146,038	152,083	152,428
30-35	979,212	1,166,981	1,095,469	1,075,225	1,057,176	1,073,875
35-40	151,403	249,154	210,853	176,041	167,668	168,033
40-45	675,368	869,883	763,547	732,533	726,985	763,081
45-50	111,635	144,580	150,435	126,494	123,891	146,495
50-55	377,552	595,722	493,107	533,598	520,459	531,924
55-60	143,649	200,627	143,696	168,985	181,289	185,932
60-65	1,546,482	1,687,428	1,634,120	1,674,615	1,619,106	1,655,891
65-70	0	0	0	0	0	0
70-75	0	0	0	0	0	0
>75	0	0	0	0	0	0
VMT (w/o XX Trips)	4,533,395	5,668,455	5,127,354	5,089,395	4,986,745	5,109,649
XX VMT	87,355	108,357	108,247	108,247	108,255	124,833
VMT (w/ XX Trips)	4,620,750	5,776,812	5,235,602	5,197,643	5,095,000	5,234,482
% XX VMT	1.9%	1.9%	2.1%	2.1%	2.1%	2.4%
IX-XI VMT	712,221	809,531	637,055	640,957	579,761	591,891
Population	197,020	251,863	236,433	236,433	236,433	243,499
VMT per Capita	3.6	3.2	2.7	2.7	2.5	2.4