1 Technical Appendix

A. Methodological Approach

Each of the proposed projects is related to updating and enhancing the mobility network, including projects that will bridge gaps in existing active and public transportation networks and provide wayfinding, while other projects will increase the distribution of electric vehicle (EV) chargers and related infrastructure. Reductions to vehicle miles traveled (VMT) from all active transportation projects presented here were quantified following methodology described in the California Air Pollution Control Officers Association's (CAPCOA) *Handbook for Analyzing Greenhouse Gas Emissions Reductions, Assessing Climate Vulnerabilities and Advancing Health and Equity,* hereafter referred to as the Handbook.[1,2] CAPCOA is a non-profit organization formed to promote clean air and provides a forum for sharing knowledge, experience, and information among California's 35 air quality regulatory agencies.[3] The Handbook provides methods to quantify VMT reductions from specific measures based on user inputs (i.e., community or project specific information) and constants, assumptions, and default values derived from peer reviewed studies. Community specific data used to quantify VMT reductions is based on best available data from CAPCOA, City of Fresno, County of Fresno, and FCOG.

As mentioned above, the emissions estimates summarized in this report are conservative as the calculations consider the specific reductions associated with the proposed projects, and do not include the emissions reductions associated with closing gaps in the network. Many of the projects outlined below align with goals of the United States Department of Transportation (DOT), as outlined in the Fiscal Year 2022-2026 DOT Strategic Plan, which has a goal of increasing the percentage of trips by transit and active transportation modes by 50% from 2020 levels. These interconnected networks will have benefits that are far reaching, including increased safety; improved air quality through reduced traffic congestion; improved access to economic opportunity for the community; and more connected communities.[4]

Project specific data used to quantify VMT reductions was provided by the applicant (FCOG and the City of Fresno) within the project grant application. Most of the projects proposed by the Coalition include components that improve the active transportation network by increasing the length of bikeways and sidewalks, or public transportation network by expanding transit coverage. Therefore, for the purposes of this analysis, the primary equations used from the Handbook were:

- T-18 Provide Pedestrian Network Improvement
- T-19A Construct or Improve Bike Facility
- T-20 Expand Bikeway Network
- T-25 Extend Transit Network Coverage or Hours

[1] California Air Pollution Control Officers Association (CAPCOA). Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity. December, 2021. Accessed at: https://www.airquality.org/ClimateChange/Documents/Final%20Handbook_AB434.pdf

[2] While the majority of project specific VMT reductions were quantified using the Handbook's methodologies, some project applications already calculated VMT reductions which were used to quantify GHG emission reductions.

[3] CAPCOA. About CAPCOA. Accessed at: https://capcoa.org/

[4] United States Department of Transportation. Match 4, 2024. Active Transportation. Accessed at: https://www.transportation.gov/mission/office-secretary/office-policy/active-transportation/active-transportation#:~:text=Instead%20of%20connected%20networks%2C%20pedestrians,walking%2C%20biking%2C%20or%20rolling.

These equations and a description of user inputs can be found below. GHG emission reductions attributable to electric vehicle (EV) charging infrastructure for medium and heavy-duty EVs were quantified using project specific data and state- and county-level modeling tools such as the California Air Resources Board's (CARB) EMission FACtor (EMFAC) model[5] and EPA's eGRID database. Additionally, see Appendix A for a summary of calculations used.

CAPCOA Equation T-18 provides an estimate of VMT reduction associated with increased development of sidewalks within a community. User inputs B and C (sidewalk lengths) vary by project and can be found under each individual project description. The calculation is based on the increase in sidewalk length each project would provide compared with the entire length of sidewalk in each city or town. A default value for D (-0.05) was used across all calculations utilizing Equation T-18. Data used for quantification is summarized in Table 1.

Equation T-18 Provide Pedestrian Network Improvement

$$A = \left(\frac{C}{B} - 1\right) x\ D$$

Table 1 T-18 Equation Inputs, Constants, Assumptions, and Available Defaults

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from household vehicle travel in plan/community	0 – 6.4	%	Calculated
User Inputs				
B	Existing sidewalk length in study area	Varies by Project	Miles	User input
C	Sidewalk length in study area with project	Varies by Project	Miles	User input
Constants, Assumptions, and Available Defaults				
D	Elasticity of household VMT with respect to the ratio of sidewalks-to-streets	-0.05	Unitless	Fran et al. 2011

CAPCOA Equation T-19A provides an estimate of VMT reduction associated with increased development of single bicycle lane facilities that connect to a larger existing bikeway network within a community. User inputs B, C, and E vary by project and can be found under individual project descriptions. User input D remained the same across all calculations (0.0015) and was determined by the proximity of key destinations to each bike facility. Each project's bike facility is planned to be within a ½ mile of seven or more key destinations, offering the third highest key destination credit default[6]. User input F remained the same across all calculations (320 days) and was determined by the "bikeable" weather in the location of each project (i.e., Fresno County). User inputs G and H (2.9 VMT and 10.9 VMT, respectively) remained the same across all calculations and were determined by utilizing a Core-Based Statistical Area (CBSA) from the Handbook's Table T-10.1 most representative of Fresno County based on geography. This was Sacramento-Roseville-Arden-Arcade CBSA. Data used for quantification is summarized in Table 2.

[5] CARB. On-Road (EMFAC). Accessed at: https://ww2.arb.ca.gov/our-work/programs/msei/on-road-emfac

[6] Key destinations include place such as: banks, post offices, grocery stores, medical centers, pharmacies, office parks, places of worship, public libraries, schools, universities, colleges, and light rail stations (park & ride).

Equation T-19A Construct or Improve Bike Facility

$$A = -B\ x\ \frac{\frac{F}{I}\ x\ (C + D)\ x\ E\ x\ G}{H}$$

Table 2 T-19A Equation Inputs, Constants, Assumptions, and Available Defaults

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from displaced vehicles on roadway parallel to bicycle facility	0 – 0.8	%	Calculated
User Inputs				
B	Percent of plan/community VMT on parallel roadway	Varies by Project	%	User input
C	Active transportation adjustment factor	Varies by Project	Unitless	CARB 2020
D	Credits for key destinations near project	0.0015	Unitless	CARB 2020
E	Growth factor adjustment for facility type	Varies by Project	Unitless	CARB 2020
Constants, Assumptions, and Available Defaults				
F	Annual days of use of new facility	320	Days per year	NOAA 2017
G	Existing regional average one-way bicycle trip length	2.9	Miles per trip	FHWA 2017
H	Existing regional average one-way vehicle trip length	10.9	Miles per trip	FHWA 2017
I	Days per year	365	Days per year	Standard

CAPCOA Equation T-20 provides an estimate of VMT reductions associated with increased length of a city or community bikeway network. User inputs B and C vary by project and can be found under individual project descriptions. Defaults D and E (0.56% and 95.04%, respectively) remained the same across all calculations and were determined by utilizing a CBSA from the Handbook's Tables T-20.1 and T-3.1 most representative of Fresno County by geography. This was Sacramento-Roseville-Arden-Arcade CBSA. Similarly, Defaults F and G remained the same across all calculations and were determined by using the Sacramento-Roseville-Arden-Arcade CBSA as a proxy for Fresno County. Default H remained the same across all calculations utilizing Equation T-20 as this is a default that does not change. Data used for quantification is summarized in Table 3.

Equation T-20 Expand Bikeway Network

$$A = -1\ x\ \frac{\left(\frac{C - B}{B}\right)\ x\ D\ x\ F\ x\ H}{E\ x\ G}$$

Table 3 T-20 Equation Outputs; Inputs; and Constants, Assumptions, and Available Defaults

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from employee commute vehicle travel in plan/community	0 – 0.5	%	Calculated
User Inputs				
B	Existing bikeway miles in plan/community	Varies by Project	Miles	User input
C	Bikeway miles in plan/community with project	Varies by Project	Miles	User input
Constants, Assumptions, and Available Defaults				
D	Bicycle mode share in plan/community	0.56	%	FHWA 2017
E	Vehicle mode share in plan/community	95.04	%	FHWA 2017
F	Average one-way bicycle trip length in plan/community	2.9	Miles per trip	FHWA 2017
G	Average one-way vehicle trip length in plan/community	10.9	Miles per trip	FHWA 2017
H	Elasticity of bike commuters with respect to bikeway miles per 10,000 population	0.25	Unitless	Pucher & Buehler 2011

CAPCOA Equation T-25 provides an estimate of VMT reductions associated with increased transit network coverage resulting from, for example, increasing the frequency of service or extending service to cover new areas and times. User inputs B and C vary by project and can be found under individual project description. Default D (2.9%) was determined by utilizing a CBSA from the Handbook's Table T-3.1 most representative of Fresno County by geography. This was Sacramento-Roseville-Arden-Arcade CBSA. Default E and F remained the same across all calculations utilizing Equation T-25 as these are defaults that do not change. Data used for quantification is summarized in Table 4.

Equation T-25 Extend Transit Network Coverage or Hours

$$A = \left(\frac{C - B}{B}\right) x\ D\ x\ E\ x\ F\ x\ G$$

Table 4 T-25 Equation Outputs; Inputs; and Constants, Assumptions, and Available Defaults

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from plan/community VMT	0 – 4.6	%	Calculated
User Inputs				
B	Total transit service miles or service hours in plan/community before expansion	Varies by Project	Miles	User input
C	Total transit service miles or service hours in plan/community after expansion	Varies by Project	Miles	User input
D	Transit mode share in plan/community	2.9	%	FHWA 2017

ID	Variable	Value	Unit	Source
Constants, Assumptions, and Available Defaults				
E	Elasticity of transit demand with respect to service miles or service hours	0.7	Unitless	Handy et al. 2013
F	Statewide mode shift factor	57.8	%	FHWA 2017
G	Ratio of vehicle trip reduction to VMT	1	Unitless	Assumption

FAX Fleet Conversion Methodology

GHG emissions reductions achievable through this project were calculated by modeling the comparative full scope emissions of the fleet in its current composition against the comparative electrical energy consumption of a battery electric replacement. Full well-to-wheel carbon intensity (CI) values were used to estimate the total emissions of both the baseline (business as usual) internal combustion fleet and the potential EV replacements.

To model these values, each vehicles estimated daily energy demand was calculated from the daily miles travelled, fuel consumption, and operating days over a 12-month period. This values was interpreted as a total MJ of energy under its current fuel type and was then further converted to the equivalent kWh of electrical energy consumption required by a battery electric vehicle to perform the same daily operations. A standard energy efficiency ratio (EER) was applied to each vehicle's daily energy conversion to account for the variable efficiencies of different fuel types as compared to battery electric operations.

LNG vehicles were not included in GHG calculations as they apply strictly to refuse collection vehicles that are covered under ACF and will not be transitioned until later years of the compliance plan, outside of the scope of this grant application.

MODELS/TOOLS USED

For the fleet-based GHG reduction analysis, the following tools were utilized:

- Internally developed spreadsheet-based energy demand analysis tool.
- California Air Resources Board (CARB) GREET 3.0 carbon intensity calculator.
- US Energy Information Administration (EIA) fuel efficiency projections.

MEASURE IMPLEMENTATION ASSUMPTIONS

Certain assumptions were made regarding the operations and replacement strategy for the Fresno fleet that impact the phasing and overall GHG reduction estimates that can be achieved:

- Assumed vehicles of similar make/model/type have comparable duty cycles in terms of fuel consumption and daily miles travelled.
    - Applied where existing fuel consumption and milage data was unavailable or inaccurate.
- Assumed all vehicles will be replaced at the end of their currently expected useful life (10 years).
    - For all units already past their expected use-life, their scheduled replacement was assigned to 2025.
- For purposes of annual emissions reduction, assumed vehicles will be on a battery electric platform on January 1st of their transition year.

REFERENCE CASE SCENARIO

Emissions reductions are calculated as the comparison between full scope well-to-wheels $MTCO_2e$ emitted by vehicles in the project scope operating on a current business-as-usual basis, minus the comparative well-to-wheels emissions of the same group of vehicles operating in the same manner under a battery electric vehicle platform. To calculate the annual emissions improvements, light-duty vehicles are assumed to be transitioned to the EV platform at the end of the currently expected useful life cycle. Since the medium-/heavy-duty vehicles in the scope are accelerated purchases, their expected emissions reduction are applied 5 years ahead of their currently expected useful life end.