Energy Technical Memorandum

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From: Carie Montero, HNTB
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1. Introduction

This *Energy Technical Memorandum* characterizes the existing and potential direct and indirect energy consumption for both the Build Alternative and No-Build Alternative. The project description, regulatory setting, and affected environment are summarized. The potential environmental consequences of the Build Alternative are analyzed and avoidance and minimization measures (AMMs) are proposed.

2. Project Description

2.1 Project Location

The California Department of Transportation (Caltrans), in cooperation with the Alameda County Transportation Commission (Alameda CTC), proposes to improve safety, mobility, accessibility, traffic operations, and bicycle and pedestrian facilities through the Oakland Alameda Access Project on State Route 260 (SR-260) (post mile [PM] realignment [R] 0.78 to R 1.90) and on Interstate 880 (I-880) (PM 30.47 to PM 31.61) in the cities of Oakland and Alameda in Alameda County, California (Figure 1).

2.2 Existing Facilities

I-880 is a major north-south freeway that extends from San Jose at the southern end to Oakland at the northern end. The freeway serves as a major route for the movement of goods and materials, as well as commuter traffic in the San Francisco Bay Area regional transportation system. Within the project study area, I-880 is a divided freeway consisting of four mixed-flow lanes northbound (NB) and three to five mixed-flow lanes southbound (SB), and it is entirely on a viaduct (elevated bridge-like structure) or on retaining walls. Auxiliary lanes are provided for NB I-880 from the Jackson Street on-ramp to the I-980 connector and for SB I-880 from the Oak Street on-ramp toward westbound (WB) I-980.

SR-260 is a four-lane state route comprised of the Posey and Webster tubes (Tubes) that provides access between the cities of Oakland and Alameda. The SR-260/Posey Tube consists of two one-way NB lanes that provide access to Oakland from Alameda; the SR-260/ Webster Tube consists of two one-way SB lanes that provide access from Oakland to Alameda. Both Tubes are under the Oakland Inner Harbor. Two-directional pedestrian and bicycle access along this segment of SR-260 is only permitted in the Posey Tube along a walkway on the east

side (right side direction of travel). The Webster Tube does not allow pedestrian or bicycle access.

Local streets near I-880 connect to freeway on-/off-ramps and the SR-260/Tubes to and from Alameda. Multiple streets cross under the freeway and some are one-way (e.g., Madison Street), partially one-way (e.g., Webster Street), or flow into on-/off-ramps or the Tubes (e.g., Harrison Street). Freeway-bound traffic from Alameda on Oakland Chinatown streets, notably Harrison, 7th and Jackson streets (the existing "racetrack"), has resulted in numerous vehicle-pedestrian conflicts. 6th Street is a multi-lane, east-west local road that runs parallel to I-880 on the north side and mainly provides access to several local businesses, as well as the Oakland Police Department. 5th Street is a multi-lane, east-west local road that runs parallel to I-880 on the south side, and it is the main access road from SB I-880 to Alameda and the Jack London District. Neither 5th or 6th streets are continuous between Oak Street and Broadway. They are obstructed by the Broadway off-ramp viaduct on 6th Street and the Tubes on 5th Street.

Figure 1. Proposed Project Footprint

2.3 Intersection Capacity

Level of Service (LOS) is a congestion rating that varies from LOS A to F. LOS A represents stable flow and very slight delay. LOS E represents unstable flow, poor progression, and long cycle lengths, and LOS F represents forced flow or jammed conditions and is considered over capacity. LOS was used to evaluate the existing operating capacity of intersections within the project study area.

Fifty-six intersections were analyzed within the project study area to understand volumes and patterns, including 25 core intersections that fell within or adjacent to the project study area. Per the Traffic Operations Analysis Report (TOAR) (Caltrans 2020), six intersections operate at an unacceptable LOS E or F during the PM peak periods.

Vehicle miles traveled (VMT) is the total annual miles of vehicle travel divided by the total population in an urbanized area. A lower VMT can result in improved air quality or indicate a community with strong public transportation systems. VMT was estimated in the TOAR (Caltrans 2020) for both directions of I-880 in 2025. Under both the No-Build and Build Alternatives, there was a negligible difference in VMT.

VMT was estimated for both directions of I-880 in the design year (2045). In the SB direction, there is no difference in freeway performance between the two alternatives (Build and No-Build). During 2045 PM peak operations, conditions slightly degrade in the NB direction under the Build Alternative. This is the result of higher demands within the weave segment between the Jackson Street on-ramp and I-980 off-ramp.

2.4 Project Alternatives

No-Build Alternative

Under the No-Build Alternative, there would be no improvements to bicycle or pedestrian connectivity or safety. Freeway traffic to/from the cities of Oakland and Alameda would continue to use city streets through Oakland and Chinatown, which are areas with a high volume of pedestrian activity. Vehicle-pedestrian or -bicycle conflicts from traffic traveling through city streets would continue. The I-880 viaduct would continue to impede connectivity between downtown Oakland and the Jack London District, and access would not be improved for bicycles and pedestrians traveling between Oakland and Alameda.

Build Alternative

Under the Build Alternative, Caltrans and ACTC propose to remove and modify the existing freeway ramps and to modify the Posey Tube exit in Oakland. The Build Alternative would improve access to NB and SB I-880 from the Posey Tube via a right turn-only lane from the Posey Tube to 5th Street and a new horseshoe connector at Jackson Street below the I-880 viaduct that would connect to the existing NB I-880/Jackson Street on-ramp. The existing WB I-980/Jackson Street off-ramp would be reconstructed and shifted to the south.

The Webster Tube entrance at 5th Street and Broadway would be shifted to the east to create more space for trucks to make the turn from Broadway into the Webster Tube. A bulb-out would

be constructed to extend the sidewalk, reducing the crossing distance and allowing improved visibility of pedestrians on the southeast corner.

The NB I-880/Broadway off-ramp would be removed and the NB I-880/Oak Street off-ramp to 6th Street would be widened. The NB I-880/Oak Street intersection would become the main NB I-880 off-ramp to downtown Oakland and to Alameda. 6th Street would become a one-way through street from Oak Street to Harrison Street and a two-way street from Harrison Street to Broadway.

The proposed project would include the addition of a Class IV two-way cycle track on 6th Street between Oak and Washington streets and on Oak Street between 3rd and 9th streets. Bicycle and pedestrian improvements would be constructed at the Tubes' approaches in Oakland and Alameda, and it the Webster Tube westside walkway would be opened to pedestrians. This would improve connectivity to existing and future planned bicycle paths in the City of Oakland and implement various "complete streets" improvements to create additional opportunities for non-motorized vehicles and pedestrians to cross under I-880 between downtown Oakland, and Jack London District, and Alameda.

Additional details on the Build Alternative improvements:

1. Construction of a new horseshoe connector under I-880 at Jackson Street.

   Vehicles exiting the Posey Tube would have direct access to NB I-880 via the proposed horseshoe connector. Vehicles heading to NB and SB I-880 would use the right-turn-only lane at the Posey Tube exit to turn onto eastbound 5th Street. Access to a new horseshoe connector would be provided from the left side of 5th Street and would loop below the I-880 viaduct to connect to the existing NB I-880/Jackson Street on-ramp. Traffic heading to SB I-880 would continue eastbound on 5th Street to the SB I-880/Oak Street on-ramp. Figure 2 shows the new horseshoe connector under I-880 at Jackson Street.

   Construction of the new right-turn-only lane onto 5th Street would require new retaining walls along the right side of the Posey Tube exit replacing the historic Posey Tube wall. The horseshoe connector would provide a direct route between the Posey Tube and NB I-880/ EB I-980 and SB I-880, substantially improving connectivity and minimizing the need for freeway-bound vehicles to travel through Chinatown to access the ramps. This configuration would also reduce intersection and bicycle-pedestrian conflicts.

   Posey Tube traffic heading to Chinatown and downtown Oakland would remain in the left lane and continue onto Harrison Street or turn left onto 6th Street to reach downtown via Broadway. A new left-turn pocket to accommodate the turn onto 6th Street would be constructed requiring removal of a section of the historic Posey Tube western exit wall.

2. Reconstruction of the existing WB I-980/Jackson Street off-ramp.

   To provide space for unimpeded movement from the Posey Tube to the new horseshoe connector, the WB I-980/Jackson Street off-ramp would be realigned to the south. Figure 2 shows the relocated Jackson Street off-ramp. The realigned off-ramp would touch down at-grade on 5th Street at the Alice Street intersection. Off-ramp and 5th Street traffic would continue to be separated by a landscaped median past the condominium building at 428

Alice Street. 5th Street would be converted to a two-way street to accommodate condominium residents allowing vehicles to turn left or right onto 5th Street.

3. Removal of the existing NB I-880/Broadway off-ramp viaduct structure including the bridge deck and supporting columns.

   Removing the NB I-880/Broadway off-ramp structure would provide the space for complete street improvements on 6th Street. It would also restore an element of the City of Oakland's street grid system by providing a continuous 6th Street between Oak Street and Broadway.

   Figure 2 shows where the existing NB I-880/Broadway off-ramp would be removed. This would provide for a more efficient street network, and it would allow traffic to be more evenly distributed on Oakland city streets. Also, it would improve traffic operations at the Broadway/6th Street and Broadway/5th Street intersections by eliminating the stream of traffic exiting the Broadway off-ramp and heading to the Webster Tube entrance. Instead, this traffic would use 6th Street and turn left at Webster Street to access the Webster Tube.

4. Widening of the NB I-880/Oak Street off-ramp.

   The existing Oak Street off-ramp would be widened from a one- to a two-lane exit by restriping the NB I-880 mainline and reconfiguring the ramp terminus. Figure 3 shows the proposed widening at the NB I-880/Oak Street off-ramp and restriping on NB I-880. At the Oak Street intersection, the ramp would be further widened from one left-turn-only pocket lane, one through and left-turn lane, and one through and right-turn lane to provide one left-turn-only (SB) pocket lane, one through (WB) lane, one through (WB) and right-turn (NB) lane, and one right-turn-only (NB) lane. Two new retaining walls would be constructed along the widened ramp's new edge of the shoulder. In advance of the Oak Street exit, NB I-880 would be restriped from four to five lanes, including a standard 1,400-foot-long auxiliary lane to accommodate the additional traffic resulting from the Broadway off-ramp removal.

5. Modification of 5th Street/Broadway access to the Webster Tube.

   The 5th Street/Broadway entrance to the Webster Tube would be moved slightly east (see Figure 2). Also, the 5th Street crosswalk on the east side of Broadway would be shifted east and considerably shortened, and the signal phasing would be modified to include a pedestrian-led signal phase for eastbound pedestrian traffic. This would improve safety by giving pedestrians priority over turning traffic. Also, this would improve truck access to the Webster Tube and minimize conflicts with other vehicular traffic.

6. Construction of a new through 6th Street connecting Oak Street to Broadway.

   Improvements to 6th Street would be accomplished by turning the street into a one-way street in the westbound direction from Oak Street to Harrison Street and a two-way street from Harrison Street to Broadway (see Figure 2). The lanes would be a minimum of 11 feet wide. There would be a minimum of two through lanes with additional turn pockets at intersections in the westbound direction. There would be one lane in the eastbound direction from Harrison Street to Broadway.

   A new sidewalk would be constructed along the south side between Broadway and Oak Street. Segments of the existing sidewalk along the north side between Oak Street and Broadway would be reconstructed to a minimum of 10 feet wide between Harrison and Alice streets to provide continuity for pedestrians. A continuous Class IV two-way cycle

track would also be provided between Oak and Washington streets. Parking spaces would be provided along portions of this roadway.

7. Construction of a two-way bicycle/pedestrian path and walkway from Webster Street in Alameda to 6th Street in Oakland through the Posey Tube and from 4th Street in Oakland through the Webster Tube to Mariner Square Loop in Alameda.

   The path would begin at Webster Street and Constitution Way in Alameda, would continue through the Posey Tube on the existing eastside walkway, and would exit the Tube via a new ramp with a hairpin turn at 5th Street. Figure 4 shows the proposed bicycle and pedestrian improvements. The path in Alameda connecting to the Posey Tube would be realigned and widened. The path in Oakland would wrap around the back of the Portal building on 4th Street and continue onto Harrison Street. It would continue onto a Class I two-way bicycle/pedestrian path under I-880 just west of Harrison Street and connect to the Class IV two-way cycle track on 6th Street between Oak and Washington streets. The new bicycle and pedestrian ramp exit from the Posey Tube would require removal of the existing historic Posey Tube staircase to provide street-level Americans with Disabilities Act (ADA) compliant access from the Tube.

   The proposed project would improve access between Oakland and Alameda by opening the Webster Tube maintenance walkway to bicycle and pedestrian travel. The walkway would connect to the proposed path under I-880 at 4th Street (near the Posey Tube Portal building). It would continue onto 4th Street to Webster Street, and it would turn north through the existing parking lot on the west side of the Webster Tube entrance before making a hairpin turn to connect to the westside walkway inside the tube.

   On the Alameda side, the walkway would connect to existing bicycle and pedestrian facilities at Mariner Square Loop and Willie Stargell Avenue. The existing sidewalk within Neptune Park would be widened to match the proposed sidewalk to the north. Improvements inside the tube would include widening the existing walkway, upgrading the existing railings, and relocating call boxes and fire extinguishers.

8. Modification of 5th, 7th, Madison, Jackson, Harrison, Webster, Oak, and Franklin streets.

   The street modifications (refer to Figure 2) would include replacing the dual right turns at the 7th Street/Harrison Street intersection with a single right-turn-only lane and removing the free right turn (where the island allows cars to turn right without stopping) at the 7th Street/ Jackson Street intersection. These would no longer be needed because Alameda traffic bound for NB/SB I-880 would be better served by the right turns from the Posey Tube to 5th Street. With the removal of the free right turns, vehicles would observe the traffic signal before turning right. With the curb extension proposed at this location, the pedestrian crossing distance would be shortened, which would decrease vehicle-pedestrian conflicts. In addition, a pedestrian hybrid beacon (PHB) would be installed on 7th Street across the street from the Chinese Garden Park. There would also be restrictive right-turn movements to reduce bicycle and vehicle conflicts at the 5th Street/Broadway, 6th Street/Webster Street, 6th Street/Harrison Street, 6th Street/Jackson Street, 6th Street /Madison Street, 5th Street /Jackson Street, 8th Street /Oak Street, and 7th Street/Oak Street intersections.

   A continuous sidewalk would be installed along the perimeter of Chinese Garden Park. Additional improvements, including landscaping modifications, could occur adjacent to the southern boundary of the park and would be coordinated through the City of Oakland.

Jackson Street between 5th and 6th streets would be converted from two- to one-way travel lanes in the NB direction, and it would provide an emergency-only access lane.

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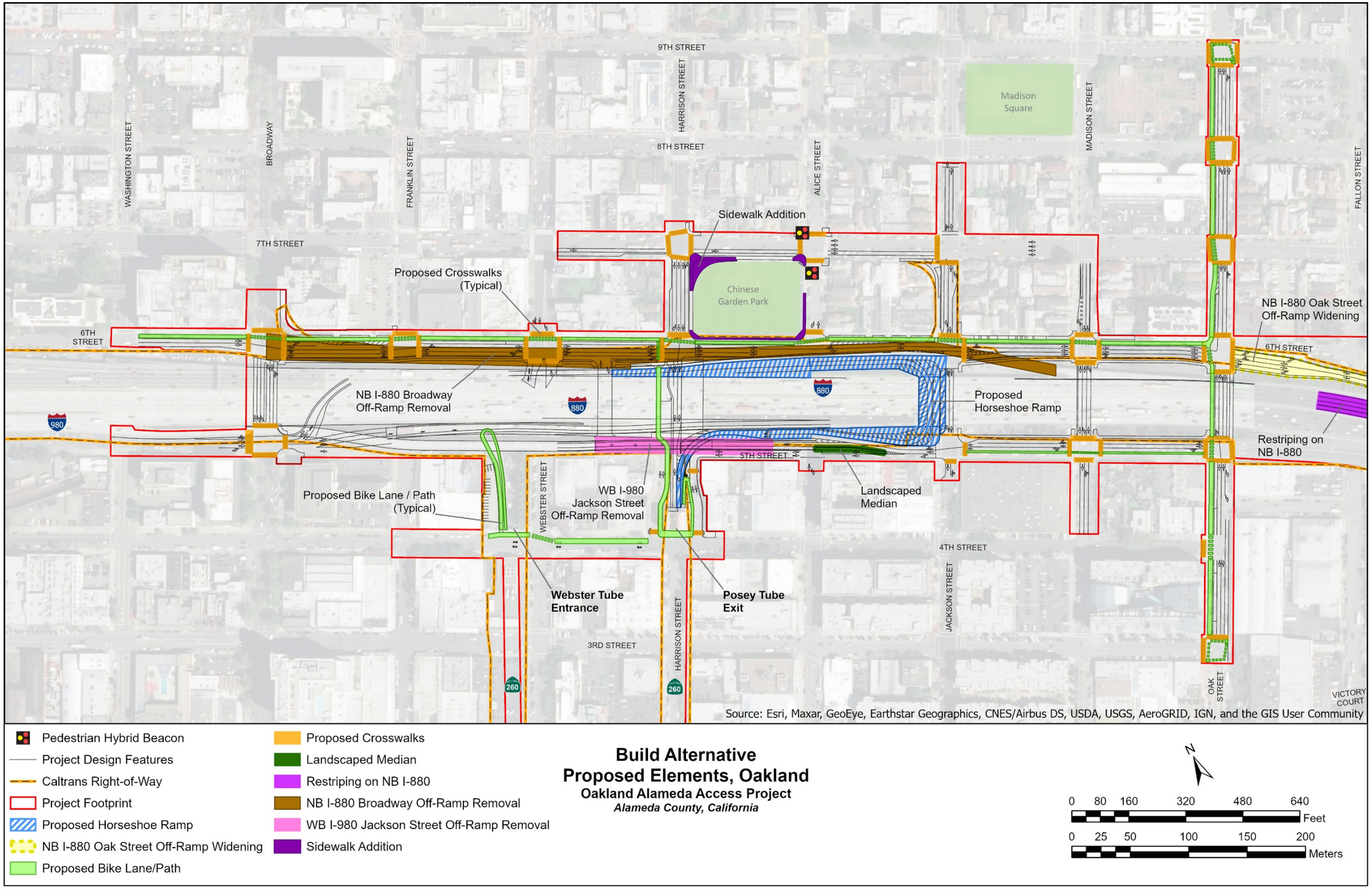

Figure 2. Build Alternative Proposed Elements, Oakland (West)

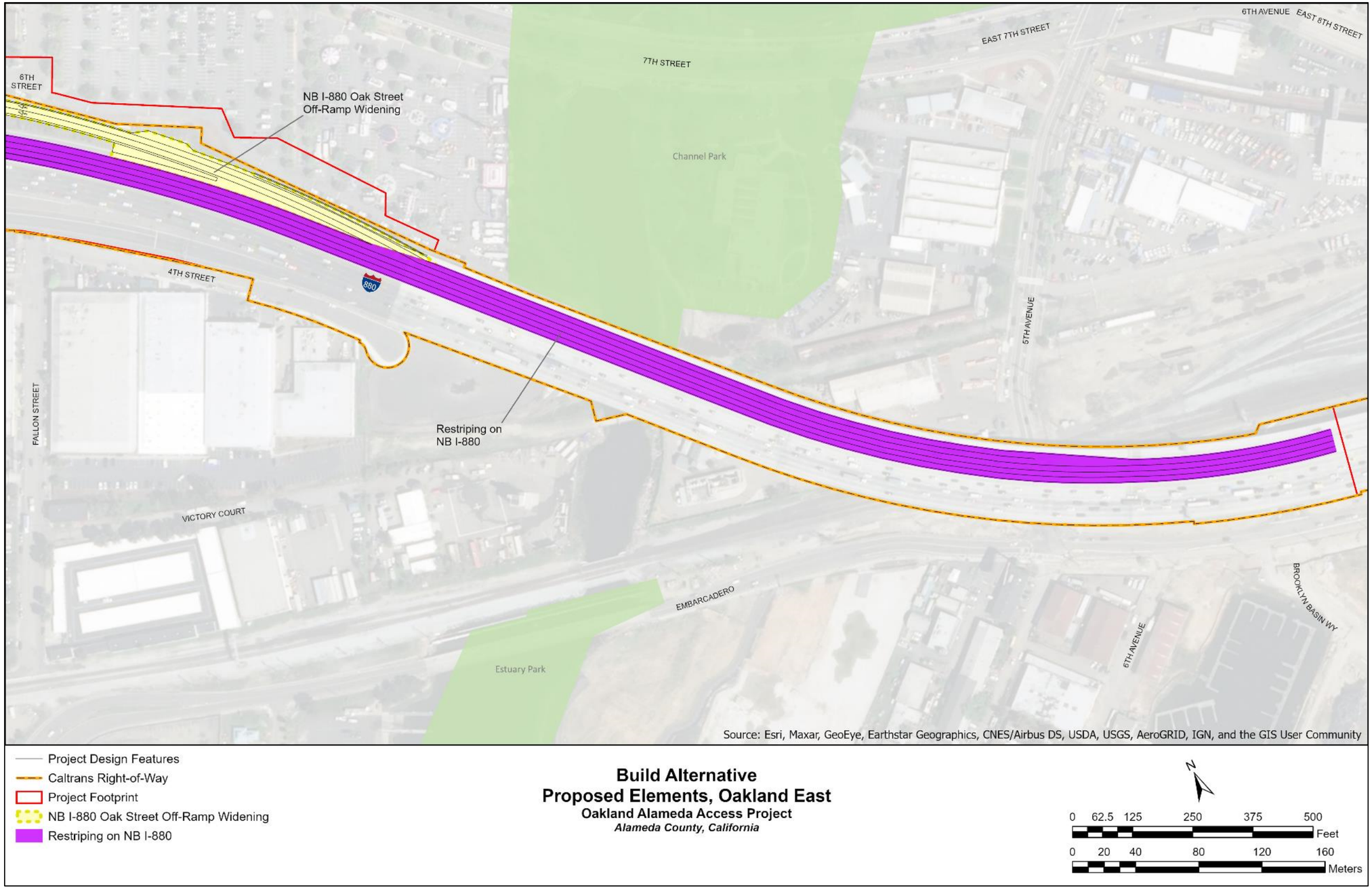

Figure 3. Build Alternative Proposed Elements, Oakland (East)

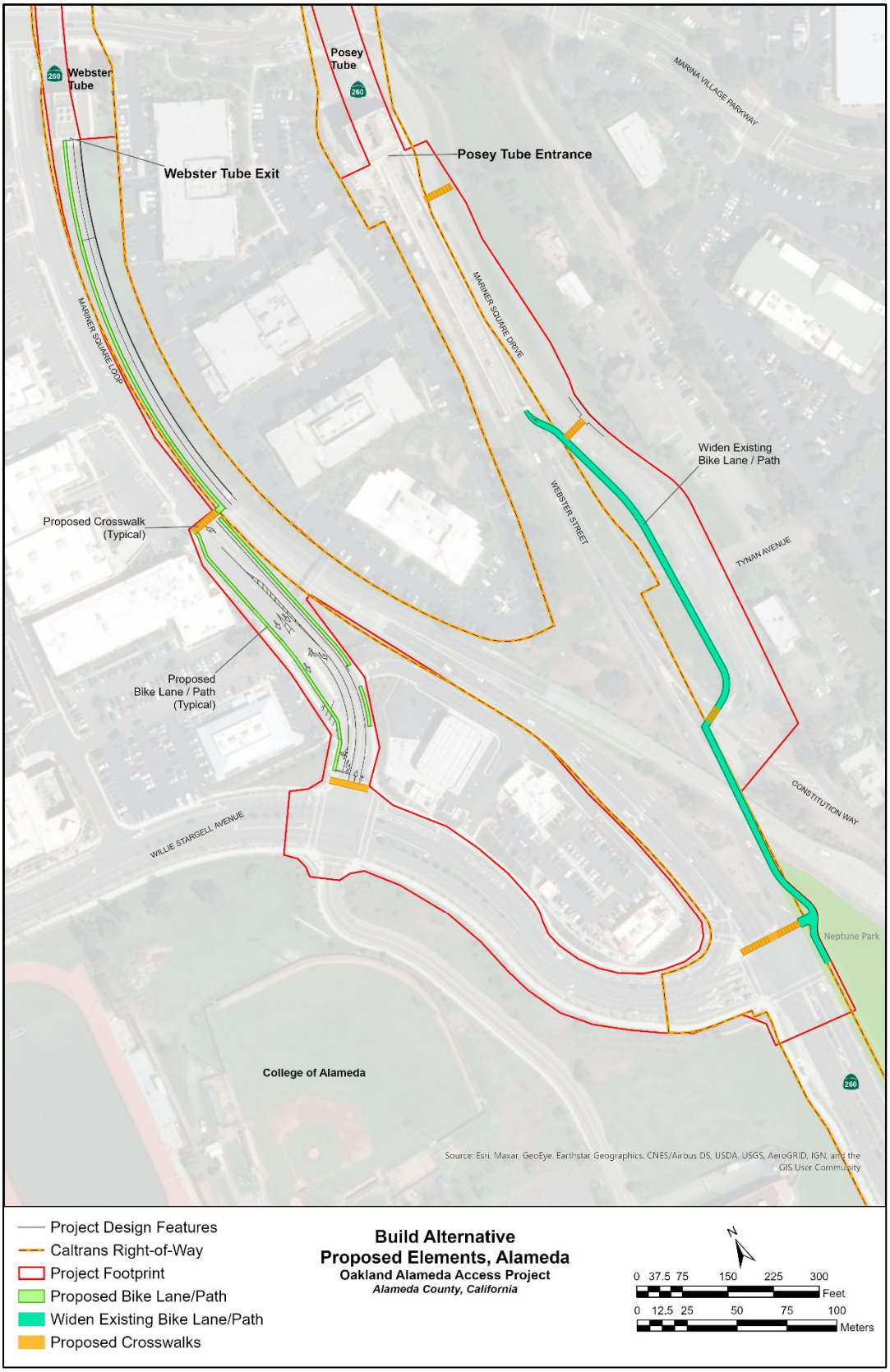

Figure 4. Build Alternative Elements, Alameda

2.5 Regulatory Setting

The National Environmental Policy Act (NEPA) (42 United States Code [USC] Part 4332) requires the identification of all potentially significant impacts to the environment, including energy impacts.

The California Environmental Quality Act (CEQA) Guidelines section 15126.2(b) and Appendix F Energy Conservation require an analysis of a project's energy use to determine if the project may result in significant environmental effects due to wasteful, inefficient, or unnecessary use of energy, or wasteful use of energy resources. This analysis is required for all Environmental Impact Report (EIR) level CEQA documents.

3. Methodology

3.1 Direct Energy

Direct energy involves all energy consumed by vehicle propulsion. This is a function of traffic characteristics such as VMT, vehicle speed, and vehicle mix. New (or replaced) lighting or other features requiring electricity are also a source of direct energy consumption. The one-time energy expenditure to construct the project is also considered direct energy.

Direct energy consumption was evaluated through both quantitative and qualitative methods. Mobile sources of direct energy consumption were calculated using the Caltrans Emission Factor (EMFAC) 2017 model. This emissions model calculates project-level emissions and fuel consumption using data from the California Air Resources Board (CARB). Fuel consumption was derived from the model run prepared for the criteria pollutant and greenhouse gas (GHG) emissions analysis.

Direct energy consumption during construction was calculated by converting carbon dioxide (CO_2) emissions generated by diesel equipment into consumed energy. CO_2 emissions were quantified using the Road Construction Emissions Model (RCEM) Version 9.0.0.

Finally, direct energy consumption was also qualitatively assessed for several proposed project features. Transportation System Management (TSM) features, pedestrian and bicycle infrastructure improvements, and lighting/traffic signal improvements were considered using this approach.

3.2 Indirect Energy

Indirect energy includes fuel consumed for the periodic maintenance of the project elements and the life-cycle energy consumption associated with the project (for example, refining the raw materials used during project construction). Indirect energy consumption was qualitatively evaluated. Both the long-term maintenance and operation of the project were considered.

4. Energy Analysis

4.1 Affected Environment

Statewide Energy Consumption

According to the U.S. Energy Administration (2018), the transportation sector in California consumed more energy than any other sector (residential, commercial, and industrial), representing nearly 40% of the total statewide energy consumed (Table 1). Automobiles, airports, and public transportation were key consumers of energy within this sector, with automobiles listed as the leading contributor. This is due, in part, to the total number of automobiles statewide. Per the Federal Highway Administration (FHWA), California leads the nation in the number of motor vehicles. In addition, several of the state's major metropolitan areas (including the San Francisco Bay Area) experience long commutes and/or delays associated with traffic congestion, resulting in increased energy consumption.

Table 1. California Energy Consumption by End-Use Sector

End-Use Sector	Energy Consumption (Trillion BTU*)	Percent of Total Energy Consumption
Residential	1,439.2	18.07
Commercial	1,509.2	18.94
Industrial	1,848.2	23.20
Transportation	3,170.0	39.79
TOTAL	7,966.6	100.00

** BTU (British thermal unit)*

Source: U.S. Energy Administration (2018)

The U.S. Energy Administration (2018) listed gasoline as the dominant energy source used by the transportation sector, representing 55.66% of the energy consumed by the sector (Table 2). Gasoline also represented nearly a quarter (22.15%) of the total energy consumed statewide across all sectors. Based on the large influence of automobiles on energy consumption, existing and proposed traffic conditions within the project footprint are a key consideration when evaluating direct energy consumption.

Table 2. Transportation Sector Energy Consumption in California

Fuel Type	Energy Consumption (Trillion BTU)	Percent of Total Energy Consumption
Coal	0.0	0.00
Natural Gas	44.8	1.41
Aviation Gasoline	2.2	0.07
Distillate Fuel Oil	483.8	15.26
Propane	0.7	0.02
Jet Fuel	684.8	21.60
Lubricants	13.2	0.42
Motor Gasoline	1,764.4	55.66
Residual Fuel Oil	168.8	5.32
Electricity	7.3	0.24
TOTAL	3,170.0	100.00

Source: U.S. Energy Administration (2018)

Energy consumption data is not available for Alameda County, California. However, a county study in 2008 considered all GHG emissions by end-use sector (Table 3). The transportation sector represented nearly 46.24% of total emissions. While this information is dated, it suggests that the dominance of the transportation sector statewide likely applies at the county level.

Table 3. Greenhouse Gas Emissions by Sector in Alameda County, California

End-Use Sector	Percent of Total Emissions*
Residential	26.77
Commercial/Industrial	23.02
Transportation	46.24
Waste	3.97
TOTAL	100.00

** Based upon CO_2e (carbon dioxide equivalents) emission data*

Source: Alameda County (2008)

Existing Conditions

Traffic

Existing traffic conditions along I-880 were evaluated. Trucks represented approximately 12% of the total vehicle mix. Traffic bottlenecks occur along NB I-880 within the project footprint during the peak AM hour between the 23rd Avenue on-ramp and the 5th Street off-ramp. During the PM

peak hour, a bottleneck forms along SB I-880 south of the project footprint which ultimately extends into the project footprint. These bottlenecks result from constrained roadway geometry, high traffic demand, and non-standard roadway features. Bottlenecks result in a LOS F during peak hours for both NB and SB I-880.

Local streets in the project footprint are congested during AM and PM peak commute hours, as well. Currently, motorists traveling between I-880, I-980, and the Tubes must take circuitous routes through Oakland's city streets. This results in local congestion and travel delays. Several local intersections operate at deficient LOS due to high traffic volumes. Congested traffic conditions contribute to increased energy consumption as vehicles use extra fuel while in stop-and-go traffic or while moving at slow speeds.

TSM Elements

Within the project footprint, TSM elements are limited. These elements, such as ramp metering, transit, ridesharing programs, and bicycle/pedestrian infrastructure, help decrease energy consumption. None of the existing I-880 on-ramps within the project footprint are currently metered. Ramp metering is an energy efficient feature because it can reduce travel times and associated fuel consumption (FHWA 2020).

Within the project footprint, gaps or deficiencies exist in pedestrian and bicycle facilities. Pedestrian and bicycle access between Oakland and Alameda are only available via a two-directional walkway within the Posey Tube. The Webster Tube allows no access for either walking or bicycling. In Oakland, several sidewalks, particularly along 5th and 6th streets, have substandard dimensions. Additionally, there are limited bicycle facilities south of 8th Street and under I-880, which impedes bicycle connectivity between neighborhoods to the north and south of I-880. In Alameda, bike lanes and sidewalks are available along most roadways. Overall, these existing deficiencies within the project footprint could discourage walking and biking, two modes of transportation which consume no fossil fuel related energy.

Pavement Condition

Poor driving surfaces can contribute to increased fuel consumption. Caltrans researchers estimate that poor pavement-vehicle interaction could account for 1% of the overall fuel consumption on California highways (Caltrans and the Massachusetts Institute of Technology [MIT] Concrete Sustainability Hub 2016). Based upon this estimate and statewide energy consumption in the transportation sector, in 2018 poor driving surfaces would have equated to approximately 17.7 trillion BTUs of lost energy.

A desktop review of the project footprint was conducted to evaluate existing pavement conditions. The majority of roadways in the project footprint, including I-880 and its associated ramps and local roadways in Alameda, appear to be in good condition with limited deterioration (prevalent cracking, patching, and/or potholing). However, during the desktop evaluation, eight of the 28 city blocks (28.6%) within downtown Oakland appeared to be in poor condition. Deteriorated pavement was noted on portions of 6th, Harrison, and Oak streets. Fuel consumption within those segments would likely be elevated due to poor pavement-vehicle interaction.

Lighting and Traffic Signals

Lighting is present throughout the project footprint. Based on a desktop evaluation, highway lighting is provided along the mainline of I-880 and its associated ramps. Highway lighting is assumed to use high-pressure sodium bulbs. Pedestrian-scale street lighting is present along all Alameda local roadways within the project footprint, including the ingress/egress roadways associated with the Tubes. However, desktop evaluation revealed that pedestrian-scale street lighting was absent from five of the 28 city blocks (17.9%) within the downtown Oakland portion of the project footprint. Pedestrian-scale street lights were missing along portions of 5th, Madison, and Oak streets. Existing pedestrian-scale street lighting is assumed to be either low- or high-pressure sodium lamps.

Within the project footprint, traffic signals are present at 16 intersections within the City of Oakland and two intersections within the City of Alameda. It is assumed that these traffic signals use incandescent bulbs.

5. Environmental Consequences

5.1 Planning Strategies

The proposed project is funded under the State Transportation Improvement Program (STIP). It is also included in the Metropolitan Transportation Commission's (MTC) Regional Transportation Plan (RTP), 2019 Transportation Improvement Program (TIP), and *Plan Bay Area 2040.* Therefore, the proposed project would not obstruct or conflict with statewide or regional planning strategies, including their requirements regarding energy usage and efficiency.

CEQA guidelines require that an EIR include an analysis of a project's potential for significant environmental effects resulting from wasteful, inefficient, or unnecessary use of energy. A quantitative analysis is required for projects that increase capacity or provide congestion relief, both of which could affect the ability of a transportation facility to accommodate existing and future traffic demand. The proposed project was not classified as a capacity increasing project and is not expected to change the existing vehicle mix. Examples of capacity increasing projects include new highways, added travel or auxiliary lanes, and new or reconfigured interchanges. However, the project will relieve congestion on local roadways. An assessment of the proposed project's potential direct and indirect energy consumption was performed. Direct energy includes operational energy use and the one-time energy expenditure from project construction. Indirect energy includes maintenance activities required to operate or maintain the project.

5.2 Direct Energy Usage

Operations

Roadway Improvements

Mobile sources of direct energy consumption were calculated using the Caltrans EMFAC 2017 model. Energy consumption was compared under both alternatives for the end construction year (2025) and design year (2045) (see Table 4). Fuel consumption was converted to energy consumption using United States Energy Information Administration (EIA) conversion rates.

Table 4. Annual Fuel Consumption within the Project Area

Year	Alternative	Gasoline		Diesel		Total Energy (100,000 BTU/ year)	Net from No-Build (100,000 BTU/year)	Net from Non-Build (%)
		Gallons /year	Energy* (100,00 BTU/year	Gallons /year	Energy** (100,00 BTU/year			
2015	Baseline	4,794	5,766.5	1,463	2,009.9	7,776.4	N/A	N/A
2025	No-Build	3,975	4,781.4	1,315	1,806.6	6,587.9	N/A	N/A
2025	Build	3,972	4,777.8	1,313	1,803.8	6,581.6	- 6.4	- 0.10
2045	No-Build	3,361	4,042.8	1,179	1,619.7	5,662.5	N/A	N/A
2045	Build	3,357	4,038.0	1,177	1,617.0	5,655.0	- 7.6	-0.13

** EIA (2020) conversion rate 1 gallon gasoline = 120,286 BTUs*
*** EIA (2020) conversion rate 1 gallon diesel= 137,381 BTUs*
N/A = not applicable

Source: Caltrans EMFAC

The Build Alternative in both 2025 and 2045 represent decreased fuel consumption as compared to 2015. In addition, under the Build Alternative fuel usage and energy consumption would slightly decrease as compared to the No-Build Alternative in both 2025 and 2045. Based on this, the proposed project would not result in increased energy consumption but rather result in decreased energy expenditures.

In general, vehicles traveling at an optimum speed are more fuel efficient. Therefore, projects that improve traffic flow during peak travel demand periods or reduce stop-and-go conditions improve vehicle fuel economies. Improved fuel economies result in decreased energy consumption. Under the Build Alternative, traffic operations would generally improve, thus reducing overall energy consumption. The proposed project would substantially reduce out-of-direction travel by providing more direct connections between Alameda and I-880 via the Tubes. This would reduce travel distance, traffic congestion, stop-and-go at traffic signals, and the number of vehicles traveling to/from Alameda on local streets in downtown Oakland.

Specifically, travel times will improve between the Tubes and I-880. In the AM peak hour, travel times through the Posey Tube to I-880 would decrease by up to three minutes (Figure 5). Travel times to the Webster Tube from various points can decrease by up to eight minutes during the PM peak hour with the project (Figure 5). Reduced travel times would equate to reduced energy consumption on local roadways.

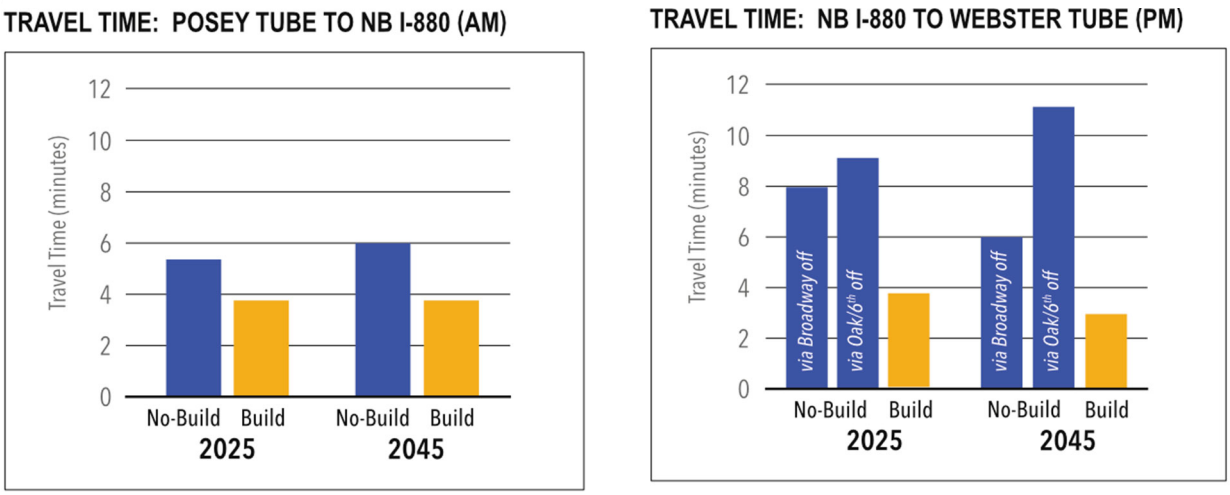

Figure 5. Travel Time Comparisons for the Tubes

With respect to mobility in downtown Oakland, operating conditions on local streets improve as a greater number of core intersections improve from LOS E or F to LOS D or better (Figure 6). By improving the flow of traffic within the project footprint, the Build Alternative would decrease energy consumption associated with the existing congested traffic conditions.

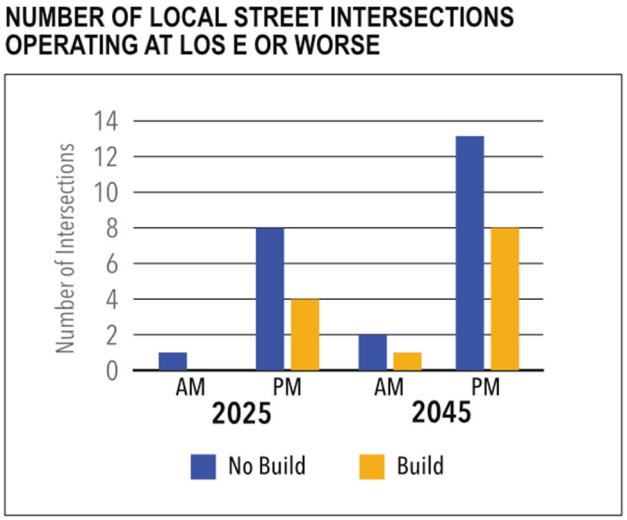

Figure 6. LOS Comparisons between Project Alternatives

VMT in 2025 was estimated for both directions of I-880 (TOAR 2020). When the No-Build Alternative and Build Alternative were compared, there was a negligible difference in VMT. The Build Alternative would result in no change in performance along SB I-880.

Per the Executive Summary (July 2020), traffic conditions along NB I-880 would degrade slightly for the AM and PM peak hours as a result of closing the NB off-ramp to Broadway and the improved connection to the Jackson Street on-ramp. This would slightly add to congestion and queuing along mainline I-880. Average vehicle speed would slightly decrease, and average vehicle hours traveled would slightly increase (Figure 7). The average speed on NB I-880 through the project footprint would decrease by less than two miles per hour (mph) during the

AM peak period (worst case). In terms of travel times through the entire study section, the net change would be approximately 15 seconds of additional travel time for northbound freeway drivers during the AM peak hour. However, freeway LOS would remain unchanged. Therefore, this change was considered to be negligible in comparison to the traffic congestion alleviated along local roadways within the project footprint and is not anticipated to negate the decreased energy consumption associated with the local roadway improvements.

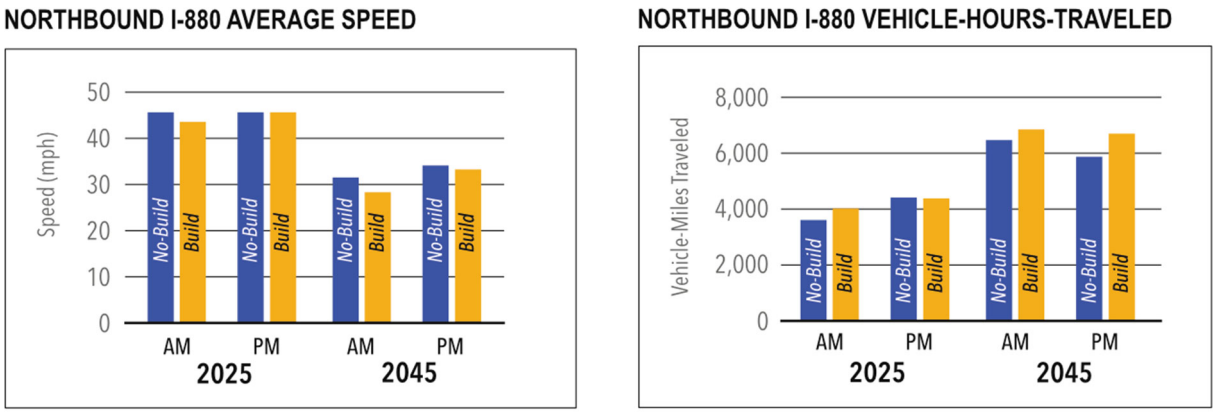

Figure 7. Proposed Project Impacts to Northbound I-880

Pavement condition was generally classified as good within the project footprint. However, within the downtown Oakland portion of the project footprint there were some roadway segments in deteriorated condition. These segments would likely be rehabilitated as a result of the Build Alternative. Freshly paved roadways would improve pavement-vehicle interactions, thereby reducing vehicle fuel consumption. During the design phase, the existing pavement condition for every roadway in the project footprint would be evaluated to determine any rehabilitation or replacement needs.

Over time, drivers with newer and more fuel-efficient vehicles would use roadways within the project footprint. In addition to the roadway improvements associated with the Build Alternative, this would contribute to reduced direct energy consumption. Note that this decrease in energy consumption would also be achieved under the No-Build Alternative.

Other Improvements

The Build Alternative includes several TSM elements. Existing bicycle and pedestrian networks would both be expanded within the project footprint. New cycle tracks would be constructed on 6th Street and Oak Street to improve connections within neighborhoods. Improved pedestrian and bicycle facilities in the Tubes would promote connectivity between the cities of Oakland and Alameda. Pedestrian facilities on 6th Street between Oak Street and Broadway would be upgraded, and new sidewalks would be installed to close existing gaps and meet ADA compliance standards. Improvements to bicycle and pedestrian networks would help reduce VMT by encouraging walking and bicycling within the project footprint and Oakland and Alameda. These alternative modes of transportation consume no energy and would, therefore, reduce the proposed project's overall energy consumption.

Improved bicycle and pedestrian networks would also provide linkages to public transportation within (or near) the project footprint including Alameda-Contra Costa Transit District (AC Transit), San Francisco Bay Area Rapid Transit (BART), San Francisco Bay Area Water Emergency Transportation Authority (WETA), and Amtrak. Increased use of public transportation would help reduce local and regional automobile traffic, support mode shift, and further reduce energy consumption.

Other TSM measures have been incorporated into the Build Alternative to ensure efficient traffic movement. An auxiliary lane would be added on NB I-880 in advance of the Oak Street off-ramp widening. Ramp meters would be installed on the Jackson Street NB I-880 and Broadway SB I-880 on-ramps. Traffic signals would be coordinated on 6th Street from Oak Street to Broadway. These measures would promote the efficient flow of traffic, resulting in less fuel consumption and an overall energy savings.

Five traffic signals would be installed under the Build Alternative: four signals along 6th Street at its intersections with Jackson, Webster, Franklin, and Oak streets and at the intersection of 7th Street/Alice Street. Within the project footprint, this represents a net increase of three traffic signals. In addition, 11 existing signals within the project footprint would be modified. Energy efficient light-emitting diode (LED) lighting would be used for any new or replaced traffic signals. This technology consumes up to 85% less energy per year as compared to incandescent bulbs (C40 Cities 2020). Despite the net increase in number of traffic signals, implementing this technology would result in energy savings. During the design phase, a formal survey within the project footprint would document the condition and type of all traffic signals.

Pedestrian-scale street lighting would be replaced at four intersections. Additional pedestrian-scale street lighting may require replacement wherever light poles require relocation, such as along 5th and 6th streets. Lighting would be considered along the extension of 6th Street between Alice Street and Harrison Street. LED lighting would be used wherever pedestrian-scale street lights would be installed or replaced. As noted earlier, this lighting technology consumes less energy than the existing technology, thereby reducing the proposed project's overall energy consumption. Existing light poles will be reused, where feasible, with only the heads replaced helping to recycle materials and reduce wastefulness.

Construction

The No-Build Alternative does not include construction of any of the improvements associated with the Build Alternative. Therefore, it would not have the one-time consumption of direct energy that would occur under the Build Alternative.

Direct energy consumption during construction was calculated by converting CO_2 emissions into fuel consumption during construction. CO_2 emissions were quantified using RCEM Version 9.0.0, which included itemization of emissions per phase of construction. Metric tons of CO_2 were then converted to fuel using GHG equivalencies (United States Environmental Protection Agency [EPA] 2020). Note that Table 5 includes the conversion of $C0_2$ into gallons of diesel fuel, which is anticipated to be dominate fuel source used during construction. Gallons of diesel fuel were then converted to BTUs using the EIA (2020) conversion rate.

Table 5. Direct Energy Consumption Per Construction Phase

Phase	Summary of Work	CO_2 (U.S. tons)	Diesel (gallons)*	Energy Consumption (Billion BTU)**
1A	Clearing/grubbing and mobilization; construction of the Webster Tube walkway.	869	77,440	10.64
1B	Construction of the horseshoe connector at Jackson Street and retaining walls; reconstruction of Jackson Street off-ramp.	2,545	226,796	31.16
1C	Construct 5th Street pavement, sidewalk, and curb/gutter.	68	6,060	0.83
1D	Retaining wall construction; Restriping of Harrison Street and Posey Tube.	315	28,071	3.86
2A	Widen Oak Street off-ramp and prepare 6th Street; retaining wall construction.	1,297	115,581	15.88
2B	Remove Broadway off-ramp structure and approach.	457	40,725	5.59
2C	Construction of 6th Street.	976	86,976	11.95
2D	Construction of bicycle paths and cycle tracks on local streets; traffic signal installation.	388	34,576	4.75
2E	Landscaping.	27	2,406	0.33
TOTAL		6,942	618,631	84.99

Note: The construction window for the proposed project extends over a three-year period.
** EPA (2020) conversion rates: 10.180 × 10^{-3} metric tons CO_2/gallon of diesel*
*** EIA (2020) conversion rate 1 gallon diesel = 137,381 BTUs*

Source: RCEM Model Version 9.0.0

Energy consumed during construction of the proposed project would be temporary and would not result in a permanent increase in statewide annual energy consumption. When compared to California's annual energy consumption in the transportation sector (Table 1), the energy expended to construct the proposed project would represent approximately 0.001% of the annual statewide energy consumption. Additionally, the construction window for the proposed project extends over a three-year window. This would result in even smaller annual energy expenditures, representing an even smaller annual energy consumption per year. It is anticipated that the energy expenditure required to construct the Build Alternative would be partially offset by the long-term operational reductions in energy consumption realized through more efficient traffic operations and proposed project elements such as improved pavement

conditions, new TSM elements (including bicycle/pedestrian infrastructure), and lighting/traffic signal improvements.

Energy consumption during construction would be minimized to the maximum extent feasible. An effective traffic management plan (TMP) would reduce overall energy consumption by limiting traffic congestion and reducing the length of detours. Best management practices (BMP) would also be implemented to reduce energy consumption during construction. These would include limiting the idling time for construction equipment, maintaining in proper working order, sourcing construction materials locally, and disposing of construction-generated waste at local disposal sites.

5.3 Indirect Energy Usage

Maintenance

Long-term maintenance of the various roadways with the project footprint would occur under either the Build Alternative or No-Build Alternative. Under the No-Build Alternative, traffic congestion and deficiencies in bicycle/pedestrian infrastructure would persist. The flow of traffic onto I-880 would continue to be un-metered. Pavement conditions would continue to deteriorate, and less efficient technology would continue to be used for traffic signals and pedestrian-scale street lights for a longer period of time.

The Build Alternative would address these deficiencies by alleviating local traffic congestion, controlling the flow of traffic onto I-880, and promoting alternative (and zero energy) modes of transportation such as walking and biking. More efficient LED lighting technology would be employed in new or replaced elements. This technology has a longer lifetime than is currently used in existing traffic signals and pedestrian-scale lighting, further reducing future maintenance needs. Based on this, operationally the Build Alternative would have an energy savings as compared to the No-Build Alternative.

6. Avoidance and Minimization Measures

6.1 Project Features

The following project feature (PF) will be implemented to reduce energy consumption:

- TMP:
  - Caltrans will communicate with emergency service providers through the public information program to avoid emergency service delays by ensuring all providers are aware of lane closures well in advance of implementation. Proactive public information systems, such as changeable message signs, will notify travelers of pending construction activities. Also, a TMP will be developed as part of the project to address traffic impacts from staged construction, lane closures, and specific traffic handling concerns, such as emergency access during construction.
  - During the design phase of the project, a TMP will be prepared that includes plans for traffic rerouting, a detour plan (if required), and public information procedures with participation from local agencies, transit services, local communities, business associations, and affected drivers.

- Early and well-publicized announcements and other public information measures will be implemented prior to and during construction to minimize confusion, inconvenience, and traffic congestion.
- Detours will be required. Detour routes will be planned in coordination with Caltrans and the cities of Oakland and Alameda traffic departments and will be noticed to emergency service providers, transit operators, and I-880, SR-260, and I-980 users in advance.
- Caltrans will coordinate with the cities of Oakland and Alameda to develop and implement a TMP.
- The TMP will identify the strategies to be implemented to minimize impacts on those traveling to and through the project footprint during construction.
- Strategies such as changeable message signs, will notify travelers of pending construction activities.

Implementation of a TMP would minimize traffic disruptions, traffic congestion, and detour length, thereby limiting energy consumption.

6.2 Avoidance and Minimization Measures

The following AMMs will be implemented to reduce energy consumption:

- Caltrans will coordinate with AC Transit to coordinate and provide advance public notifications of temporary bus stop relocations.
- Measures to reduce exhaust emissions and PM10, PM2.5, and diesel PM from construction will be incorporated to the extent feasible to ensure that short-term health impacts to nearby sensitive receptors are avoided. Such measures may include:
  - Idling time of diesel-powered construction equipment and trucks shall be limited to no more than two minutes to the extent practicable. Clear signage of this idling restriction shall be provided for construction workers at all access points.
  - All construction equipment will be maintained and properly tuned in accordance with manufacturer’s specifications. All equipment will be checked by a certified mechanic and determined to be running in proper condition prior to operation.
  - All construction equipment will use low sulfur fuel as required by CA Code of Regulations Title 17, Section 93114.
  - All off-road equipment over 25 horsepower that will be operated for more than 20 hours over the entire duration of construction will either be zero emissions or have engines that meet or exceed either U.S. EPA or CARB’s Tier 2 off-road emission standards. This equipment will also have engines that are retrofitted with a CARB Level 3 Verified Diesel Emissions Control Strategy (VDECS), if one is available for the equipment being used. Equipment with engines that meet Tier 4 Interim or Tier 4 Final emission standards automatically meet this requirement; therefore, a VDECS will not be required.
  - To the extent feasible, construction traffic will be scheduled and routed to reduce congestion and related air quality impacts caused by idling vehicles along local roads during peak travel times.

  - Portable diesel generators will not be used. Grid power electricity will be used to provide power at construction sites; or propane and natural gas generators may be used when grid power electricity is not feasible.

- All motor vehicles used as part of the project, including haul trucks and off-road equipment, will maintain proper tire pressures.
- The contractor will maximize waste diversion to recycling and composting, including construction materials, landscape materials, and food waste. The contractor will provide recycling and composting for use by on-site workers. The contractor will also maximize the use of recycled materials in project construction, such as recycled fiber for erosion control, concrete, water, steel, polyvinyl chloride, and paint, that meet the requirements of Caltrans Standard Specifications.
- The contractor will, where feasible, use local sources of materials and local disposal sites to reduce emissions associated with transport of construction materials to and from the site.
- The proposed project will incorporate the use of energy-efficient lighting and traffic signals.

Coordination with AC Transit will ensure limited disruption to bus service, which represents a mode of transportation with reduced energy consumption as compared to motor vehicle use. No permanent relocation of transit stops are proposed. Limiting equipment idling times and requiring equipment to in proper running condition will limit energy consumption during construction. Promoting recycling, local sourcing of materials, local disposal of waste, and energy-efficient lightening will further reduce energy consumption.

7. Summary

The proposed project would not result in wasteful, inefficient, or unnecessary consumption for the following reasons:

- The proposed project would not add roadway capacity. It would reduce local traffic congestion and shorten travel distances between I-880 and Alameda. The addition of ramp metering would improve the flow of traffic entering I-880.
- By addressing existing deficiencies in pedestrian and bicycle facilities, the proposed project would encourage walking and biking within the project footprint and between the cities of Oakland and Alameda.
- New traffic signals and pedestrian-scale lighting would utilize high-efficiency LED technology. Any replaced or modified traffic signals or pedestrian-scale lighting would also utilize LED technology.
- Existing light poles would be reused, where feasible, with only the heads replaced.
- Materials will be locally sources and waste will be locally disposed of, where feasible.
- The proposed project's construction-related energy consumption would be temporary and would likely be offset by the proposed long-term energy savings associated with all the proposed project elements.

8. References

Alameda County. 2008. Greenhouse Gas Emissions Analysis. https://www.acgov.org/sustain/documents/Full_Report_Emissions_Inventory.pdf

C40 Cities. 2020. LED Traffic Lights Reduce Energy Use in Chicago by 85%. https://www.c40.org/case_studies/led-traffic-lights-reduce-energy-use-in-chicago-by-85

California Department of Transportation. 2020. Executive Summary.

California Department of Transportation. 2020. Traffic Operations Analysis Report.

California Department of Transportation and the Massachusetts Institute of Technology Concrete Sustainability Hub. 2016. Pavement Vehicle Interaction: Well-Maintained Roadways Improve Fuel Efficiency, Reduce Greenhouse Gas Emission Across Networks. https://cshub.mit.edu/sites/default/files/documents/PVI_Summary_CSHub%26Caltrans.pdf

Federal Highway Administration. 2020. Freeway Management Program. https://ops.fhwa.dot.gov/freewaymgmt/ramp_metering/goals_benefits.htm

United States Department of Energy. 2018. 2018 Consumption Summary Tables. https://www.eia.gov/state/seds/seds-data-complete.php?sid=US#Consumption

United States Energy Information Administration. 2020. Units and Calculators Explained – British Thermal Units (BTU). https://www.eia.gov/energyexplained/units-and-calculators/british-thermal-units.php

United States Environmental Protection Agency. 2020. Greenhouse Gases Equivalences Calculation – Calculations and References. https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references

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