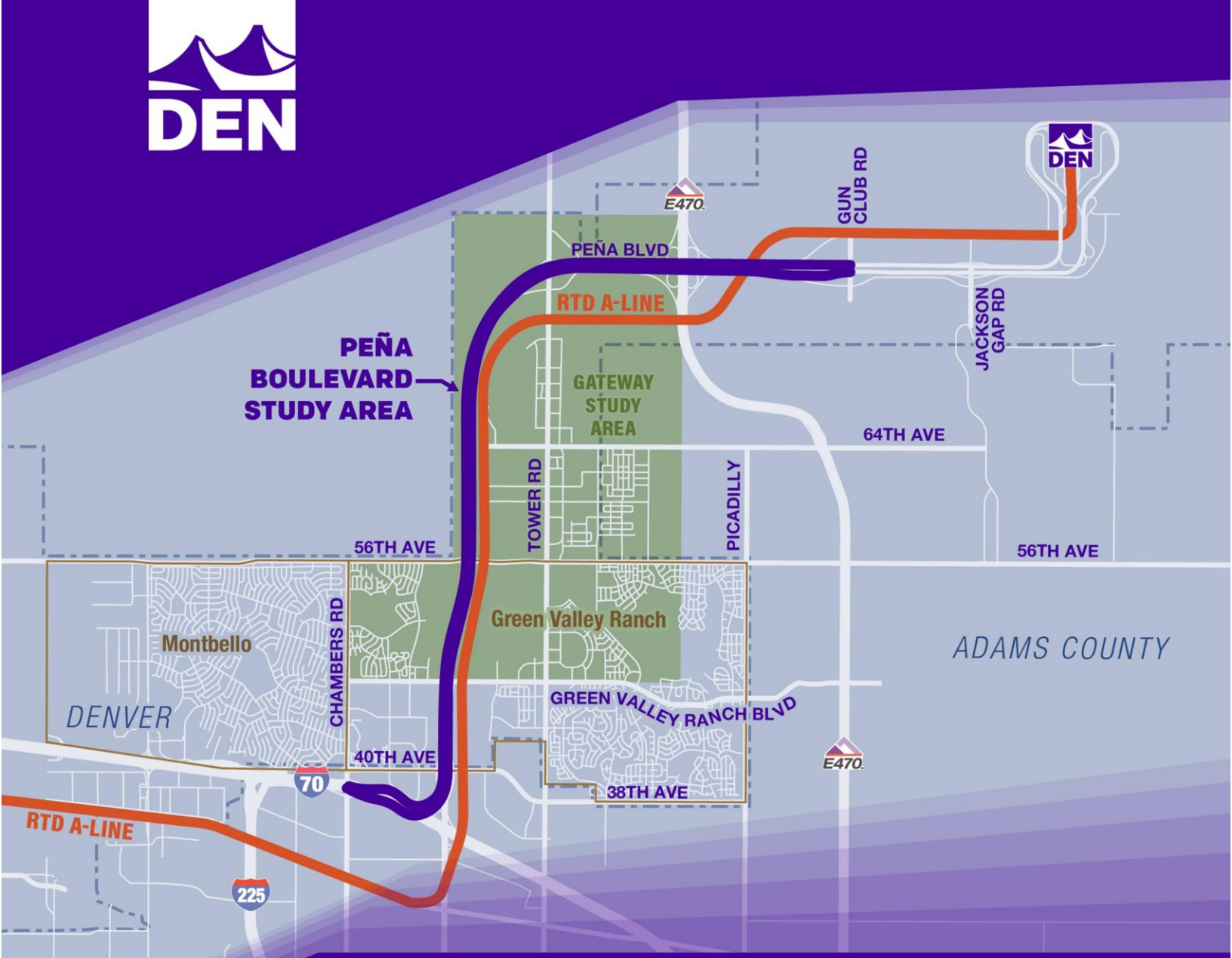


# PEÑA BOULEVARD TRANSPORTATION AND MOBILITY MASTER PLAN

## Alternatives Analysis Traffic Technical Report

Denver International Airport

February 2024

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## Tables



## Figures

## Acronyms

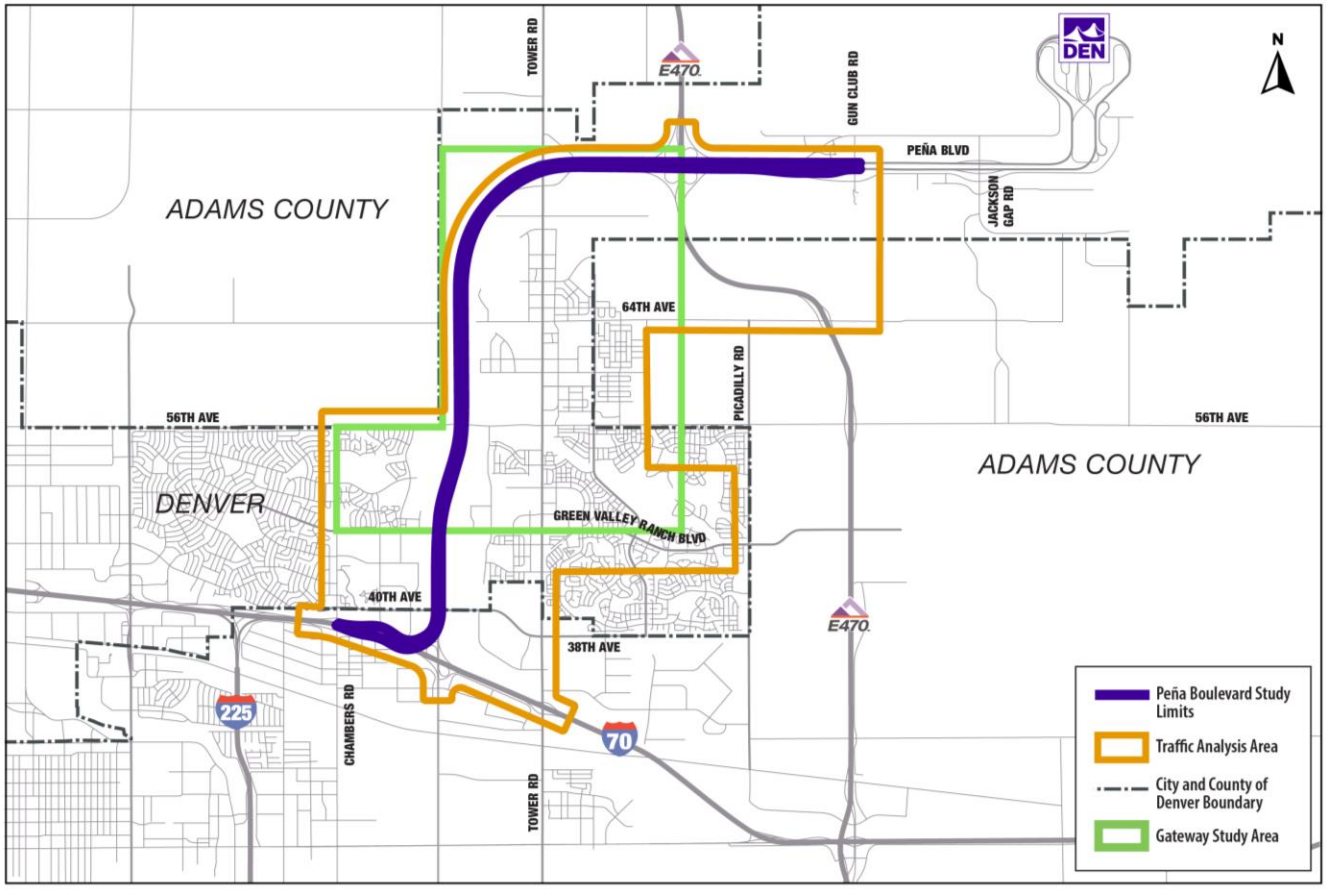
| | |
|---|---|
| CCD | City and County of Denver |
| CD | Collector-Distributor |
| DA | Drive Alone |
| DEN | Denver International Airport |
| DOTI | Department of Transportation and Infrastructure |
| DRCOG | Denver Regional Council of Governments |
| FAA | Federal Aviation Administration |
| Gateway Study | Denver Moves Gateway Area Travel Study |
| GP | General-Purpose |
| HOT | High Occupancy Toll |
| HOV2+ | High Occupancy Vehicle with Two or More People |
| HOV3+ | High Occupancy Vehicle with Three or More People |
| Peña Master Plan | Peña Boulevard Study Peña Boulevard Transportation and Mobility Master Plan |
| ML | Managed Lane |
| MOE | Measures of Effectiveness |
| RTP | Regional Transportation Plan |
| TDM | Travel Demand Model |
| VMT | Vehicle Miles Traveled |
| VPD | Vehicles Per Day |

# 1. Introduction

Denver International Airport (DEN) originally scoped the Peña Boulevard Transportation and Mobility Master Plan (Peña Master Plan) to investigate potential improvements in mobility and safety along Peña Boulevard for passengers, employees, freight, and visitors and to future-proof Peña Boulevard to accommodate DEN growth and development. The City and County of Denver's (CCD) Department of Transportation and Infrastructure (DOTI) simultaneously scoped The Denver Moves Gateway Area Travel Study (Gateway Study) to better understand the travel demands and needs in the Gateway Area with more recent changes in land usage, current/planned transit services, current/planned bike network, and growing traffic volumes. DEN and DOTI recognized that there was significant overlap between these two studies and agreed to combine them into one study, co-managed by these two agencies.

The study areas for both the Peña Boulevard Study and the Gateway Study are shown in Figure 1-1. Given the desire to understand the linkages between Peña Boulevard and local transportation facilities within the Gateway Study area, a traffic analysis was completed by using a single, expanded traffic analysis area that encompassed the limits of both studies. The boundary of this traffic analysis area is also shown in Figure 1-1.

**Figure 1-1 – Study Areas for the Peña Boulevard and Gateway Area**



The combined study area spans jurisdictions of CCD and City of Aurora. The proposed solutions for Peña Boulevard and the Gateway Area will be developed holistically to ensure they complement each other and provide regional benefits by considering other plans for the area, such as the *Advancing Adams Comprehensive Plan* (Adams, 2022), *Aurora Places: Planning Tomorrow's City* (Aurora, 2018a), the draft *Commerce City 2045 Comprehensive Plan*, CCD's *Far Northeast Area Plan* (CCD, 2019), and the City of Aurora's *Northeast Area Transportation Study* (Aurora, 2018b).

This report documents the results of the traffic analysis for Peña Boulevard alternative concepts. The information presented within this report builds upon information presented in previous study documents prepared by the project team. A list of these documents is provided below. Relevant information from these documents is repeated within this report, as needed, and reference to these documents are made throughout this report.

- *Peña Boulevard Transportation and Mobility Master Plan Study Data Collection Plan Memorandum* (May 2022)
- *Peña Boulevard and Gateway Study Traffic Modeling Methodology and Land Use Assessment Memorandum* (September 2022)
- *Peña Boulevard Transportation and Mobility Master Plan Data Collection Summary and Existing Conditions Report* (September 2022)
- *Peña Boulevard Master Plan Study Origin-Destination Data Result for Denver International Airport Memorandum* (May 2023)
- *Peña Boulevard Master Plan Study Vehicle Occupancy Data Results Memorandum* (May 2023)
- *Peña Boulevard Existing Conditions and Needs Assessment Traffic Technical Report* (December 2023)

# 2. Alternative Concepts Evaluated

A total of 15 distinct alternative concepts were evaluated from a traffic perspective to understand how different layouts for Peña Boulevard would affect travel demand, travel patterns, and operations, both along Peña Boulevard and on adjacent local roadways. Due to the number of concepts evaluated, they have been grouped together into "families." Each family represents a distinct type of concept and allows for a more focused comparison of results and to provide a better understanding of how minor changes to layouts affect overall operations. A list of all alternative concepts evaluated, as well as their family groupings, is provided below. An additional discussion about each family and the alternative concepts within them are provided in the following sections.

- Family A – No/Limited Additional Vehicle Capacity
  - Alt 1: No Build
  - Alt 12: Bus Only Lanes
  - Alt 15: No Build Without Managed Lane Direct Connects to/from I-70
- Family B – For Comparison
  - Alt 7: Four General-Purpose Lanes
- Family C – Managed Lanes (MLs)
  - Alt 2: High Occupancy Toll (HOT) to Jackson Gap Street
  - Alt 3: High Occupancy Vehicle with Two or More People (HOV2+) from I-70 to E-470
  - Alt 4: High Occupancy Vehicle with Three of More People (HOV3+) from I-70 to E-470
  - Alt 13: HOV2+ from I-70 to Jackson Gap Street
  - Alt 14: HOV3+ from I-70 to Jackson Gap Street
- Family D – Frontage Roads
  - Alt 5: Two-Lane Frontage Road with Limited Access at GVR Boulevard, 56$^{th}$ Avenue, and Tower Road with HOT Lanes From I-70 to Jackson Gap Street
  - Alt 8: Two-Lane Frontage Road with No Access at GVR Boulevard and 56$^{th}$ Avenue and no MLs
  - Alt 8.01: Four-Lane Frontage Road with No Access at GVR Boulevard and 56$^{th}$ Avenue and no MLs
- Family E – Collector-Distributor (CD) Roads
  - Alt 6: One-Lane CD Roads between 40$^{th}$ Avenue and 56$^{th}$ Avenue with HOT Lanes from I-70 to Jackson Gap Street
  - Alt 9: One-Lane CD Roads between 40$^{th}$ Avenue and Tower Road with HOT Lanes from I-70 to Jackson Gap Street

- Alt 10: One-Lane CD Roads between 40th Avenue and Tower Road without MLs
- Alt 10.01: Two-Lane CD Roads between 40th Avenue and Tower Road without MLs

- Family F – New Interchanges
  - Alt 11: HOT Lanes from I-70 to Jackson Gap Street with a New Interchange at 64th Avenue

All alternative concepts were evaluated assuming changes only along Peña Boulevard were made. All local roadways (except for the new Peña Frontage Road proposed in Family D) were assumed to remain the same across all alternative concepts. Future local roadway configurations were taken from DRCOG's Metro Vision Regional Transportation Plan and DRCOG's 2050 regional travel demand model (TDM). Note, the regional TDM includes some additional minor changes to the transportation network, such as the extension of local roadways, which are important to the traffic analysis area but are not considered regionally significant and therefore are not included in the RTP. Table 2-1 summarizes the local roadway changes assumed in all alternative concepts.

**Table 2-1 – Local Roadway Changes from Existing Conditions to 2050 Assumed in All Alternative Concepts**

| Table | Changes | Source |
|---|---|---|
| Tower Road | Widen from four to six lanes from 45th Avenue to 106th Avenue | DRCOG 2050 RTP |
| 40th Avenue | Widen from four to six lanes from Chambers Road to Tower Road | DRCOG 2050 RTP |
| 56th Avenue | Widen from four to six lanes from Havana Street to Tower Road<br>Widen to a consistent six lanes from Genoa Street to Powhaton Road | DRCOG 2050 RTP |
| 64th Avenue | Widen from two to four lanes from Tower Road to Dunkirk Road<br>Widen from four to six lanes from Dunkirk Road to Harvest Mile Road | DRCOG 2050 RTP |
| Telluride Way | Extended to be continuous from 40th Avenue to 71st Avenue | DRCOG 2050 RTP |
| Yampa Street | Extended to be continuous from 45th Avenue to 71st Avenue | DRCOG 2050 RTP |
| Airport Way | Extended to be continuous from 40th Avenue to 56th Avenue | DRCOG 2050 RTP |

## 2.1. Family A – No/Limited Additional Vehicle Capacity

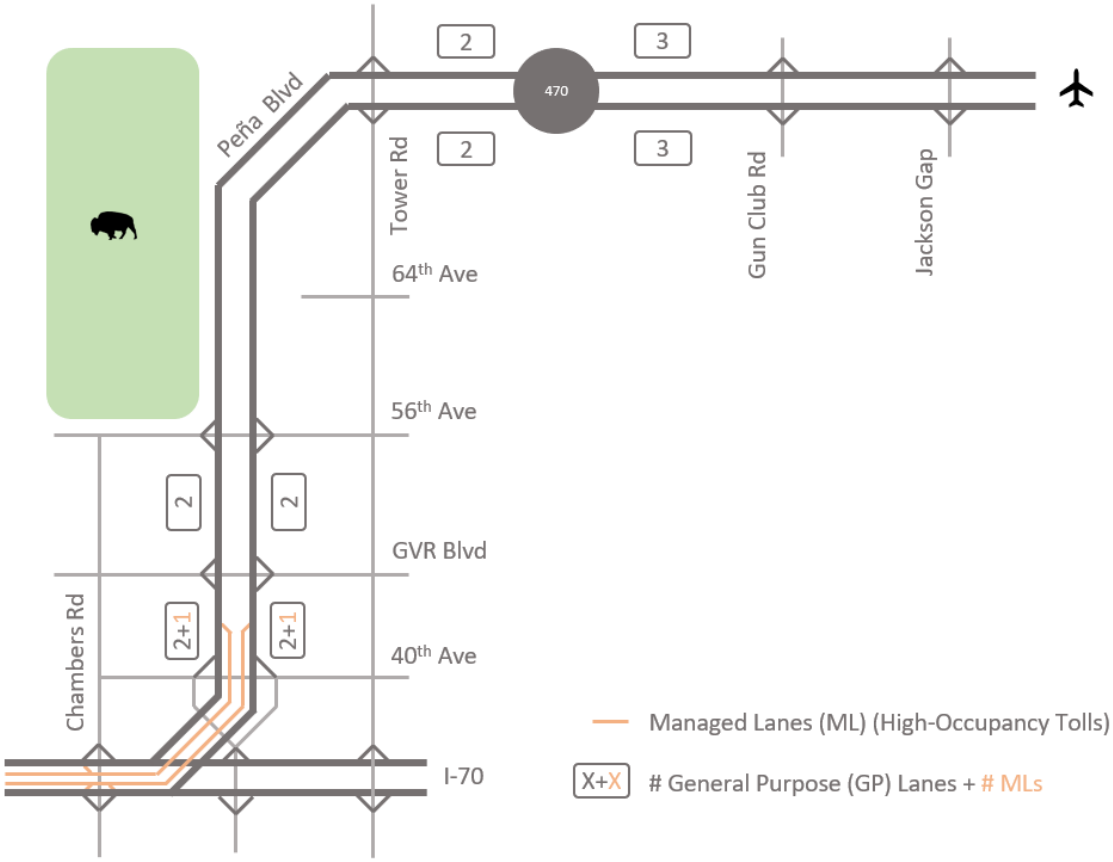
The rationale behind the concepts evaluated in this family is to understand potential impacts to Peña Boulevard, and the surrounding roadway network should no additional vehicle capacity be added to Peña Boulevard in the future. Three concepts were evaluated as part of this family:

- Alt 1: No Build
- Alt 12: Bus Only Lanes
- Alt 15: No Build Without Managed Lane Direct Connects to/from I-70

### 2.1.1. Alt 1: No Build

The No Build concept represents the baseline condition in 2050 should no action be taken to improve/change Peña Boulevard. It should be noted that the Denver Regional Council of Governments' (DRCOG) 2050 Regional Transportation Plan (RTP) includes plans to add one high-occupancy toll (HOT) lane direct connect to/from I-70 and Peña Boulevard in each direction, add one HOT lane to Peña Boulevard from I-70 to E-470 in each direction, and add one additional general-purpose (GP) lane in each direction to Peña Boulevard from E-470 to the DEN terminals. Because the purpose of this study is to evaluate potential improvements to Peña Boulevard, some of which may differ from what is currently included in the RTP, the planned HOT lanes on Peña Boulevard from I-70 to E-470 and these additional GP lanes east of E-470 are not included as part of the No Action concept. However, the HOT direct connect between I-70 and Peña Boulevard is included in the No Action concept as it may be constructed regardless of any other changes made to Peña Boulevard. Figure 2-1 shows a conceptual diagram of the No Build concept.

**Figure 2-1 – Conceptual Diagram of Alt 1: No Build**



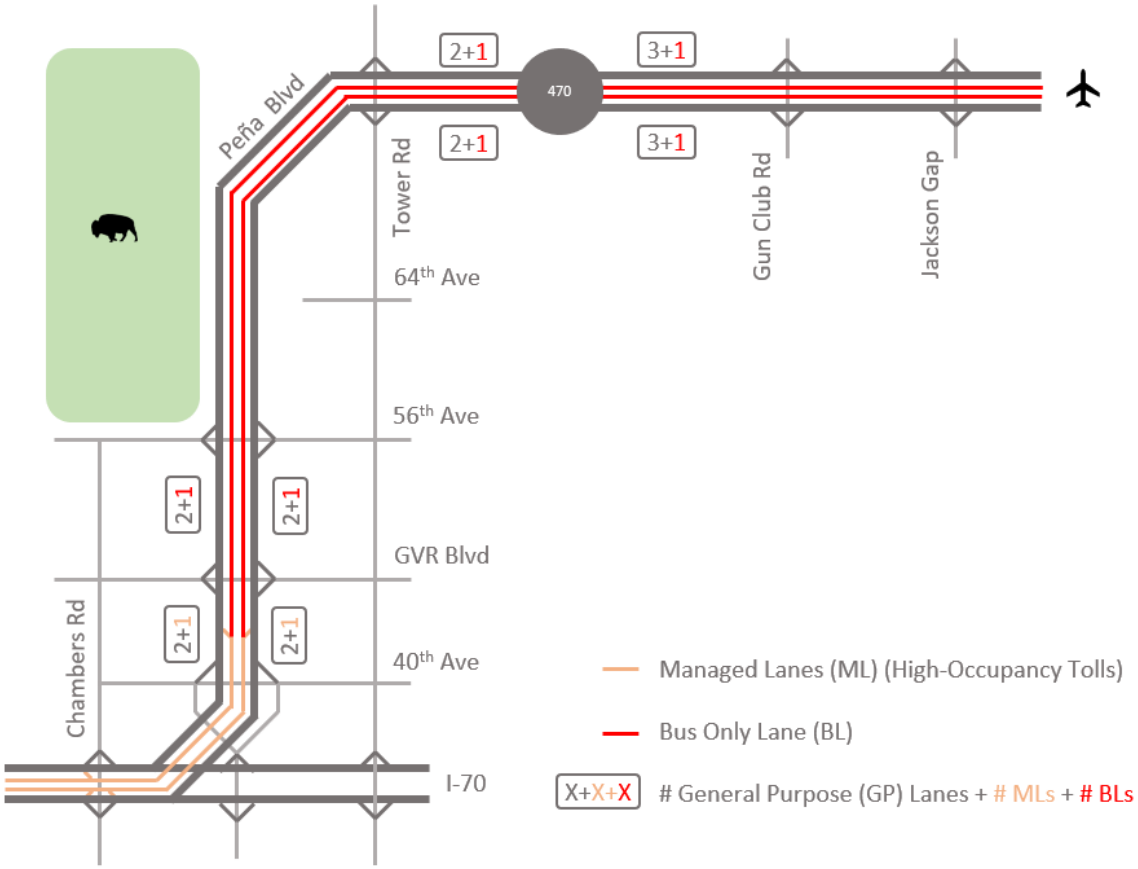

### 2.1.2. Alt 12: Bus Only Lanes

The Bus Only Lanes concept evaluates potential impacts of adding a dedicated bus only lane along Peña Boulevard. In this concept, the bus lane is imagined running along Peña Boulevard adjacent to the GP lanes. At the southern end of the corridor, the bus only lane would start/end between 40th Avenue and GVR Boulevard and

connect directly into an ML direct connect to/from I-70. At this location, inbound drivers (those going toward DEN) who used the ML direct connect from I-70 would be required to exit the lane, and only buses would be allowed to proceed further north in the bus only lane. Outbound drivers (those going away from DEN) would conversely be allowed to enter the ML direct connect at this location. At the northern end of the corridor, the bus only lanes are imagined extending all the way past Jackson Gap Street. Figure 2-2 shows a conceptual diagram for this alternative.

For the purposes of this evaluation, details, such as additional ingress/egress locations to/from the bus lanes and potentially new or modified transit routes to take advantage of the bus lanes, were not considered as these details would not measurably impact overall Peña Boulevard roadway operations within the analysis completed as part of this study.

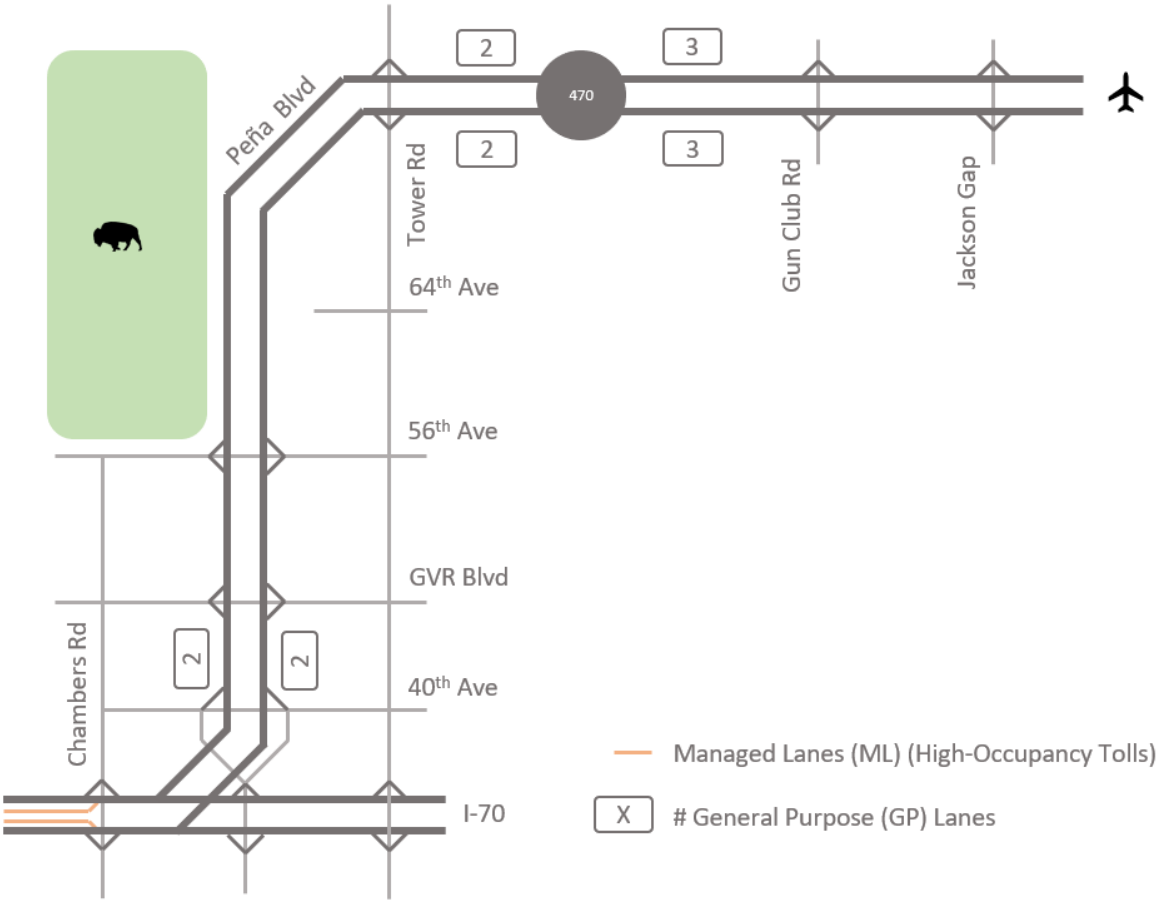
**Figure 2-2 – Conceptual Diagram of Alt 12: Bus Only Lanes**




## 2.1.3. Alt 15: No Build Without ML Direct Connects to/from I-70

This concept is the same as Alt 1, with the exception that this concept does not include a ML direct connect between I-70 and Peña Boulevard. Along Peña Boulevard, this concept matches the geometry of the existing conditions. Figure 2-3 shows a conceptual layout for this concept.

**Figure 2-3 – Conceptual Diagram of Alt 15: No Build Without ML Direct Connects to/from I-70**




## 2.2. Family B – For Comparison

The purpose of concepts in Family B is to provide comparative information for the purposes of more fully understanding travel demand along Peña Boulevard and adjacent local roadways. It is important to note that concepts within this family are not intended to be formal alternatives to be carried forward for further evaluation or implementation. Rather, these concepts were only evaluated to provide a point of comparison with other concepts which may be carried forward for further consideration. Within this family, only one concept, Alt 7: Four General-Purpose Lanes was evaluated.

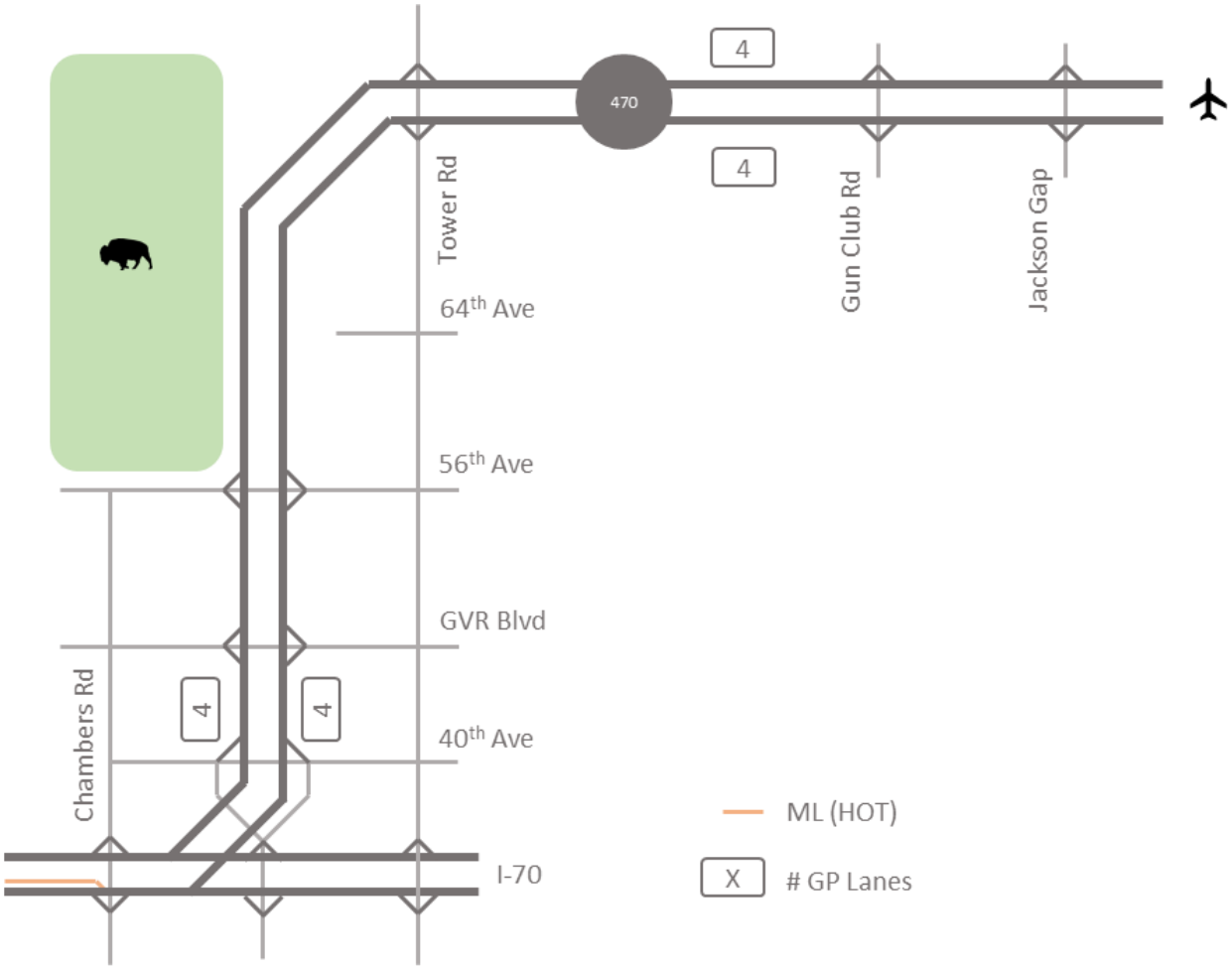
### 2.2.1. Alt 7: Four General-Purpose Lanes

This concept evaluates the effects of providing four GP lanes on Peña Boulevard in each direction from I-70 to Jackson Gap Street. Figure 2-4 shows a conceptual layout for this concept.

It is important to note that this concept was only evaluated to provide an understanding of the latent demand for Peña Boulevard. Latent demand is additional drivers who would choose to use Peña Boulevard if congestion were reduced. By evaluating a concept with four GP lanes on Peña Boulevard, an understanding of the potential latent demand along Peña Boulevard can be obtained. This information provides a point of comparison for use in

evaluating/understanding other concepts but is not intended to represent a formal alternative to be carried forward in the planning process or implemented.

**Figure 2-4 – Conceptual Diagram of Alt 7: Four GP Lanes**




## 2.3. Family C – Managed Lanes

The purpose of evaluating concepts within Family C is to understand potential impacts of constructing additional capacity along Peña Boulevard in the form of MLs. For the purposes of this study, ML terminology is used as a generic umbrella term to refer to any travel lane that is open to vehicular traffic, where operational strategies are proactively implemented and managed in response to changing conditions. Typical management strategies for such lanes are summarized in Table 2-2. These strategies can be mixed, matched, and applied in various ways to achieve goals and specific to a given corridor.

**Table 2-2 – Typical Managed Lane Strategies**

| Strategy | Description | Purpose/Benefits |
|---|---|---|
| Access Controlled | Lanes which are separated from other traffic (either via a physical barrier or painted markings) in which access into/out of the lane(s) is only provided at discreet locations. | Separates traffic traveling through an area from local traffic entering or existing the facility. By separating the two user groups, through traffic can avoid the turbulence/slowdowns created by merging and weaving vehicles and thus achieve a faster travel time. |
| Reversible | Lanes in which the direction of travel can be changed during different time periods. | Being able to change the direction of travel within a travel lane can help match directionally capacity to demand during different time periods, such as having extra capacity heading into a business district during the morning commuter rush and then reversing the capacity to accommodate the evening commuter rush out of the business district. Such lanes can allow for more optimized operations and thus reduce the number of overall lanes needed. |
| Restricted Vehicle Eligibility | Lanes in which only vehicles meeting a/the certain requirement(s) (occupancy, vehicle type, etc.) are allowed to travel in them. | Only having a sub-set of vehicles allowed to use a lane can help keep the demand for such a lane below its capacity and thus improving travel time for the users allowed to use it. These improved travel times can then be used as an incentive to encourage a specific type of travel behavior, such as carpooling or taking transit. |
| Pricing | Lanes in which drivers are charged a toll to use them. | Charging a toll, especially a toll where the price is dependent on congestion levels, can help manage travel demand and thus reduce congestion. |

Five concepts were evaluated as part of this family. These include:

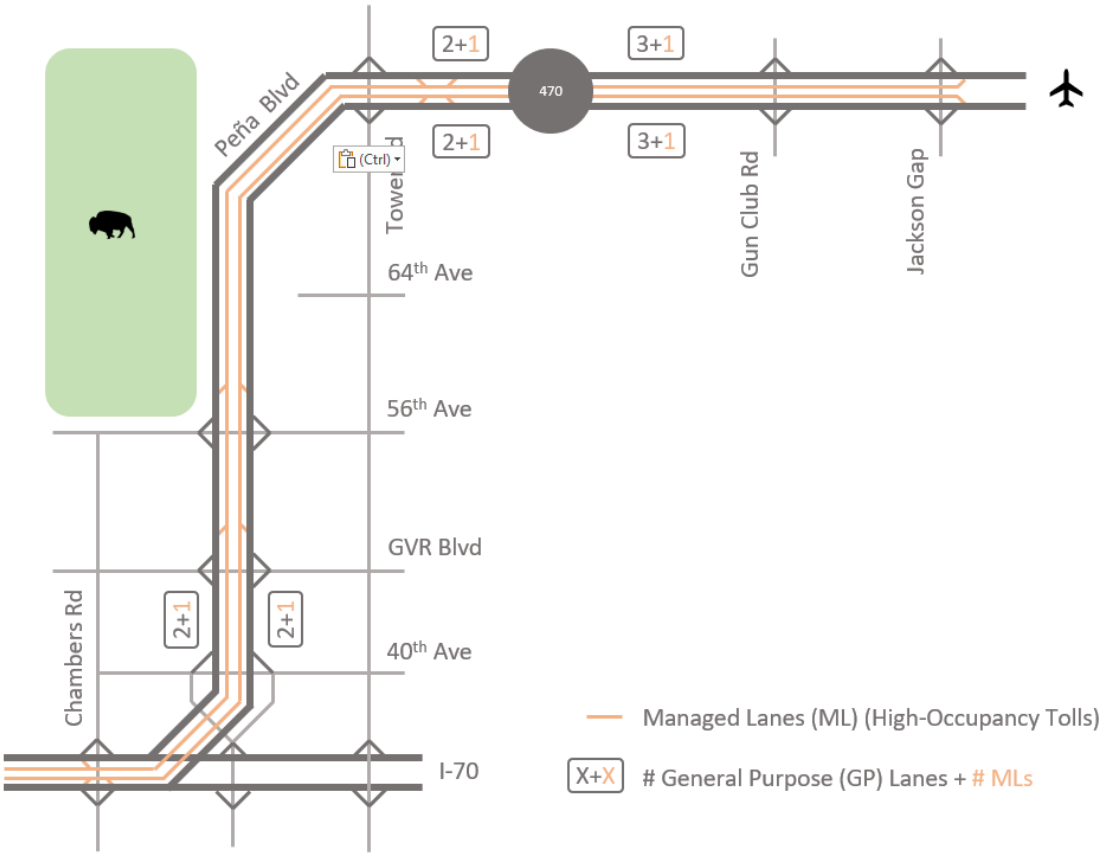
- Alt 2: HOT from I-70 to Jackson Gap Street
- Alt 3: HOV2+ from I-70 to E-470
- Alt 4: HOV3+ from I-70 to E-470
- Alt 13: HOV2+ from I-70 to Jackson Gap Street
- Alt 14: HOV3+ from I-70 to Jackson Gap Street

### 2.3.1. Alt 2: HOT from I-70 to Jackson Gap

This concept considers the potential impact of constructing one new HOT lane along Peña Boulevard from 40th Avenue to Jackson Gap Street in each direction. The HOT lanes would run along the inside of Peña Boulevard and adjacent to the existing GP lanes. For evaluation purposes, it was assumed that the HOT lanes would be free to use for any vehicle with three or more people (HOV3+), while vehicles with two or fewer people would be charged a toll to use the HOT lane. This HOT management approach is consistent with the existing management strategy for other HOT lanes in the Denver metropolitan area.

Access into and out of the HOT lanes (referred to as ingress and egress, respectively), within this concept, was deliberately set up to prioritize traffic in the HOT lanes heading to/from DEN, while discouraging use of the HOT lanes for trips going to local interchanges between I-70 and E-470. Therefore, in the inbound direction, only ingress locations are provided between GVR Boulevard and 56th Avenue and between 56th Avenue and Tower Road. Similarly, in the outbound direction, only egress locations are provided to these two interchanges. A full ingress and egress in both directions are provided between Tower Road and E-470. Figure 2-5 shows the conceptual layout for this concept.

**Figure 2-5 – Conceptual Diagram of Alt 2: HOT from I-70 to Jackson Gap Street**



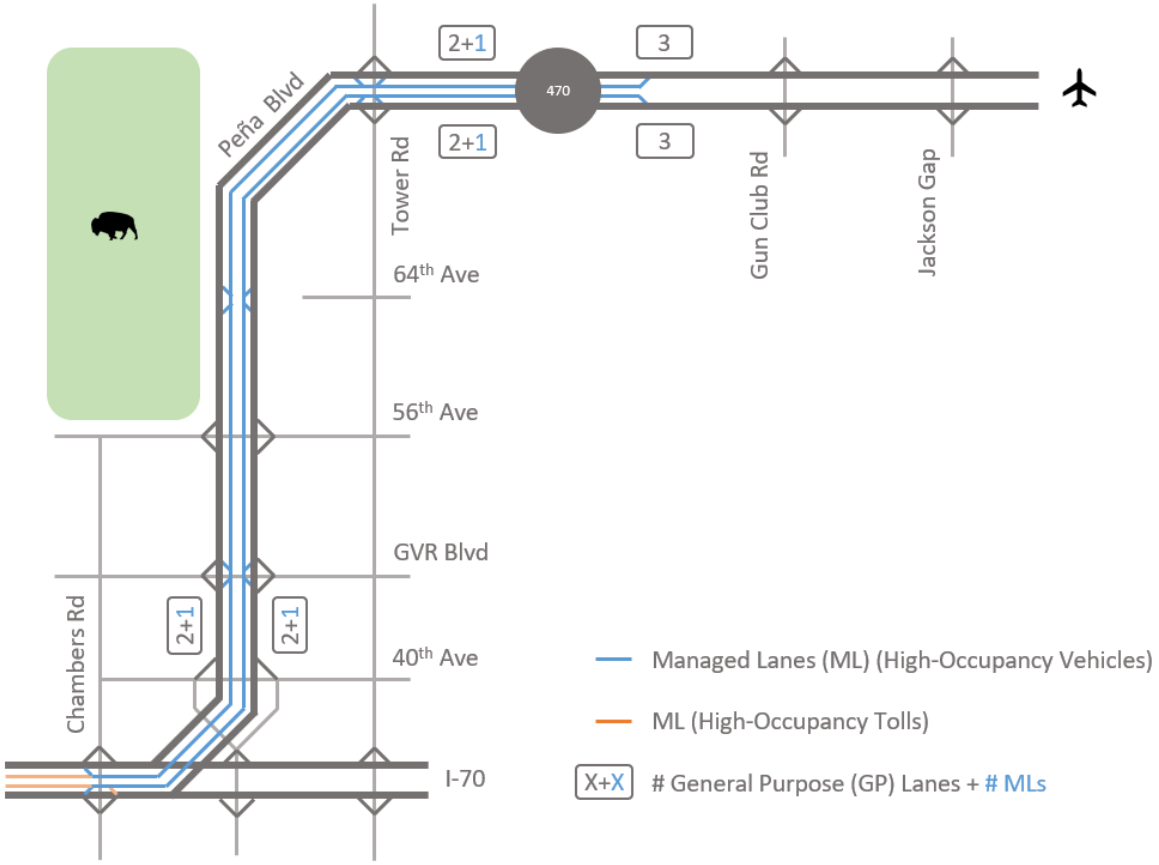
### 2.3.2. Alt 3: HOV2+ from I-70 to E-470 and Alt 4: HOV3+ from I-70 to E-470

From a geometric perspective, both Alt 3: HOV2+ from I-70 to E-470 and Alt 4: HOV3+ from I-70 to E-470 are the same. Each considers the impact of an additional lane on Peña Boulevard from 40th Avenue to just east of E-470 in each direction, which would run on the inside and adjacent to the existing GP lanes. The difference between these two concepts is that in Alt 3: HOV2+ from I-70 to E-470, this additional lane would require all vehicles traveling in the additional lane to have two or more people in the vehicle; whereas, Alt 4: HOV3+ from I-70 to E-470 would require a minimum of three or more people in the vehicle. Note that, in both concepts, the additional lane would be free to use and only open to vehicles meeting specific occupancy requirements. Unlike HOT lanes, there would be no option for other vehicles to pay a toll to use these lanes.

In both concepts, full access into and out of the HOV lanes is provided at GVR Boulevard, north of 56th Avenue, and at Tower Road. This access configuration is unique from other ML concepts and was set up to provide an understanding of the potential impact different ML access configurations have on ML utilization.

In these concepts, it was assumed that usage restrictions for the ML direct connect between I-70 and Peña Boulevard would match those MLs along Peña Boulevard. Therefore, HOVs would be allowed to use the direct connect, free of charge. Figure 2-6 shows the conceptual geometric layout for both concepts.

**Figure 2-6 – Conceptual Diagram of Alt 3: HOV2+ from I-70 to E-470 and Alt 4: HOV3+ from I-70 to E-470**



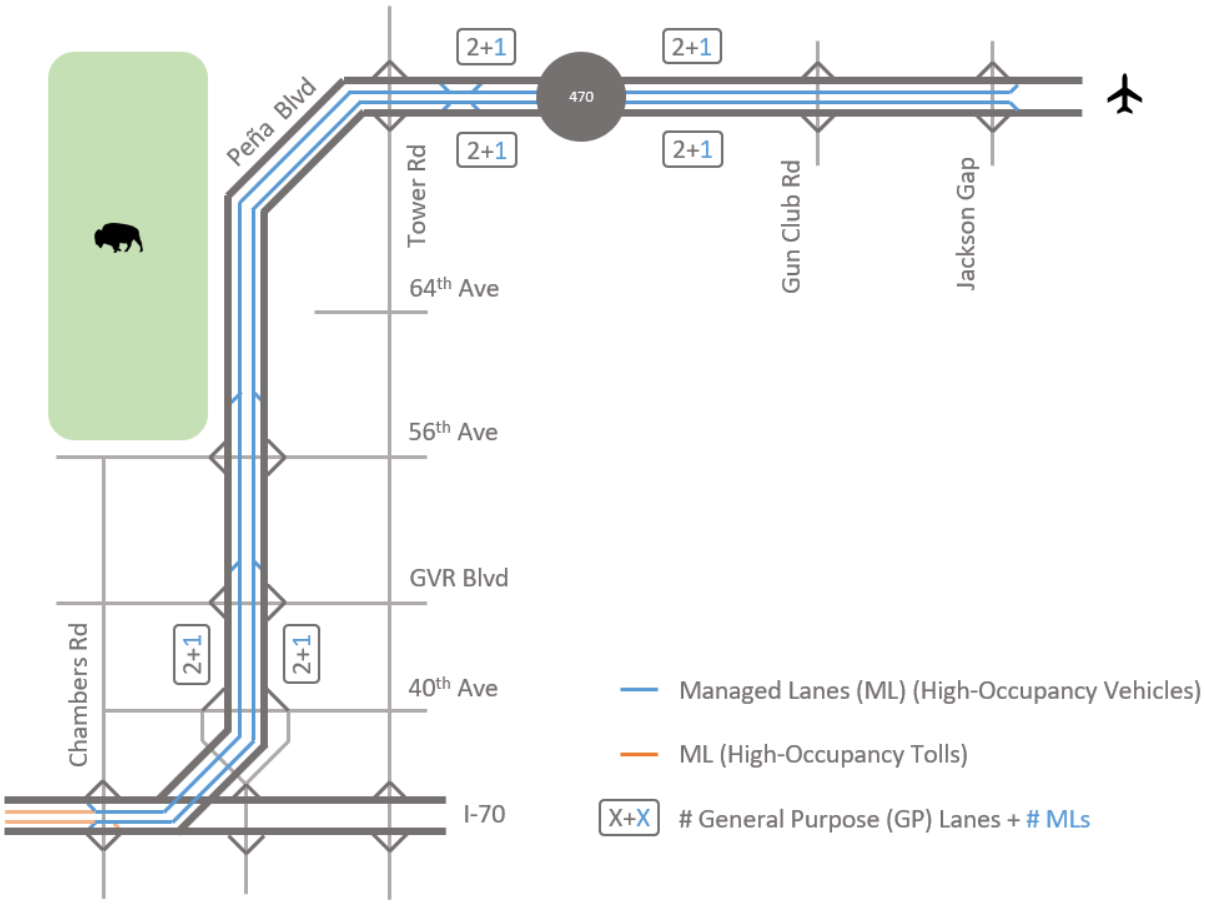
### 2.3.3. Alt 13: HOV2+ from I-70 to Jackson Gap Street and Alt 14: HOV3+ from I-70 to Jackson Gap Street

From a geometric perspective, both Alt 13: HOV2+ from I-70 to Jackson Gap Street and Alt 14: HOV3+ from I-70 to Jackson Gap Street are the same. Each considers the impact of an additional lane on Peña Boulevard from 40th Avenue to E-470 in each direction and converting an existing GP lane between E-470 and Jackson Gap Street into an HOV lane in each direction. These HOV lanes would run on the inside and adjacent to the existing GP lanes. The difference between these two concepts is that in Alt 13: HOV2+ from I-70 to Jackson Gap Street, the additional lane would require all vehicles to have two or more people in the vehicle; whereas, Alt 14: HOV3+ from I-70 to Jackson Gap Street would require a minimum of three or more people in the vehicle. Note that, in both concepts, the additional lane would be free to use and only open to vehicles meeting specific occupancy requirements. Unlike HOT lanes, there would be no option for other vehicles to pay a toll to use these lanes.

Access into and out of the HOV lanes within these concepts was deliberately set up to prioritize traffic in the HOV lanes heading to/from DEN, while discouraging use of the HOV lanes for trips going to local interchanges between I-70 and E-470. Therefore, in the inbound direction, only ingress locations are provided between GVR Boulevard and 56th Avenue and between 56th Avenue and Tower Road. Similarly, in the outbound direction, only egress locations are provided to these two interchanges. A full ingress and egress in both directions are provided between Tower Road and E-470.

In these concepts, it was assumed that usage restrictions for the ML direct connect between I-70 and Peña Boulevard would match those of MLs along Peña Boulevard. Therefore, HOVs would be allowed to use the direct connect, free of charge. Figure 2-7 shows conceptual geometric layouts for these concepts.

**Figure 2-7 – Conceptual Diagram of Alt 13: HOV2+ from I-70 to Jackson Gap Street and Alt 14: HOV3+ from I-70 to Jackson Gap Street**




## 2.4. Family D – Frontage Roads

The purpose of evaluating concepts within Family D is to understand potential impacts of implementing a frontage road adjacent to Peña Boulevard. For the purposes of this study, a frontage road is an at-grade, arterial roadway, which would run parallel to Peña Boulevard and have traditional intersections with cross streets, such as traffic signals at 40th Avenue, GVR Boulevard, 56th Avenue, and Tower Road. The purpose of a frontage road would accommodate traffic going to local interchanges, such as GVR Boulevard and 56th Avenue, without having to provide access from these roadways to Peña Boulevard itself. The intent of such configurations would prioritize capacity on Peña Boulevard for trips heading to/from DEN, while still accommodating the connectivity needs to local roadways.

Note that, at this early stage of the planning process, the specific layout of a frontage road has not been formally established. A frontage road may be bi-directional and run on one side of Peña Boulevard, or it could be a one-way couplet with mono-directional flow on each side of Peña Boulevard. For consistency within this study, all frontage road concepts were evaluated as bi-directional arterials located on one side of Peña Boulevard; however, details of which layout to implement, if any, will need to be further evaluated in future studies.

Three concepts were evaluated as part of this family. These include:

- Alt 5: Two-Lane Frontage Road with Limited Access at GVR Boulevard, 56th Ave, and Tower Road with HOT Lanes from I-70 to Jackson Gap Street
- Alt 8: Two-Lane Frontage Road with No Access at GVR Boulevard and 56th Avenue and no MLs
- Alt 8.01: Four-Lane Frontage Road with No Access at GVR Boulevard and 56th Avenue and no MLs

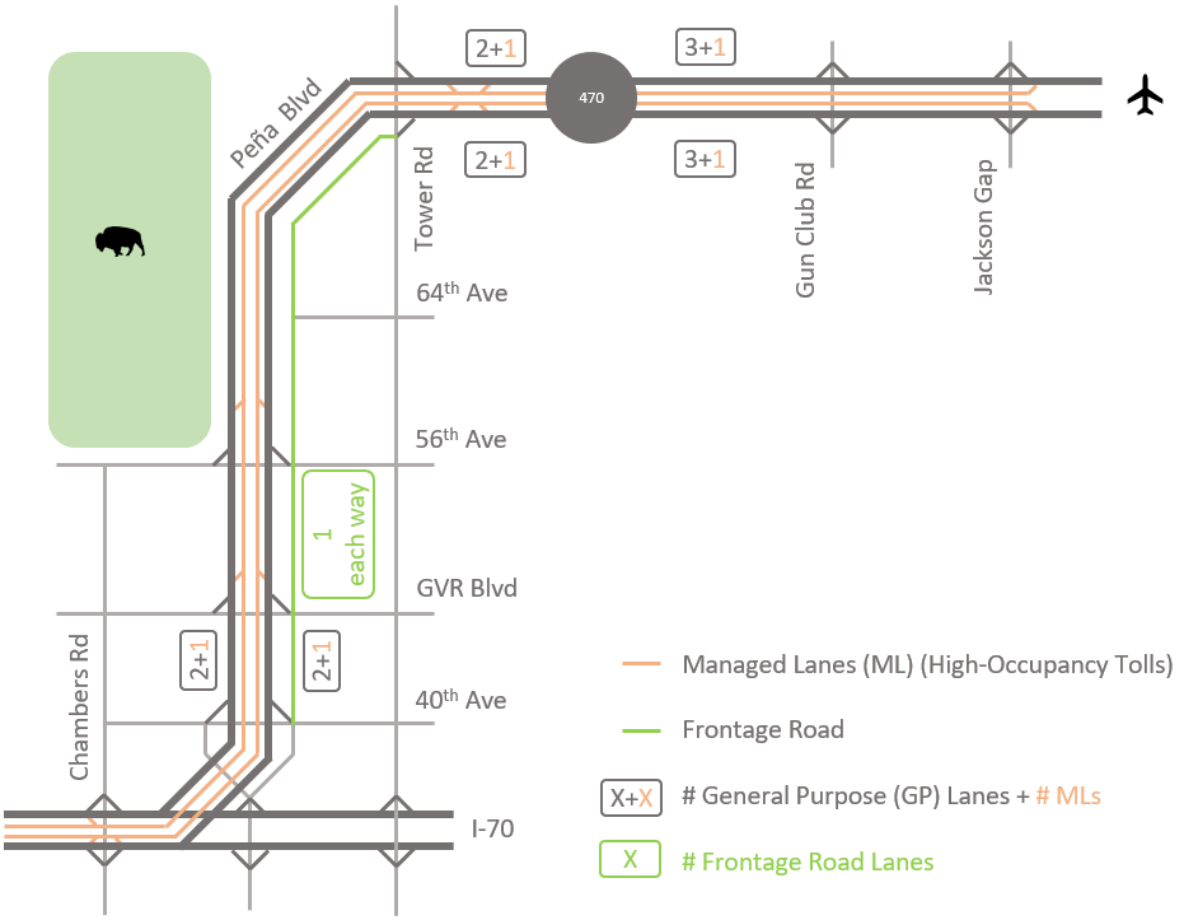
### 2.4.1. Alt 5: Two-Lane Frontage Road with Limited Access at GVR Boulevard, 56th Avenue, and Tower Road with HOT Lanes from I-70 to Jackson Gap Street

This concept considers the impacts of constructing a two-lane (one lane in each direction) frontage road adjacent to Peña Boulevard from 40th Avenue to Tower Road with a local intersection at 40th Avenue, GVR Boulevard, 56th Avenue, 64th Avenue, and Tower Road. Additionally, this concept would remove access to/from Peña Boulevard heading to/from I-70 at GVR Boulevard, 56th Avenue, and Tower Road. The intent of such access reductions is to prioritize traffic along Peña Boulevard heading to/from DEN, while encouraging local traffic to use the new frontage road.

This concept also includes one new HOT lane along Peña Boulevard from 40th Avenue to Jackson Gap Street in each direction. The HOT lanes would run along the inside of Peña Boulevard adjacent to the existing GP lanes. For evaluation purposes, it was assumed that the HOT lanes would be free to use for any vehicle with three or more people (HOV3+), while vehicles with two or fewer people would be charged a toll to use the HOT lane. This HOT management approach is consistent with the existing management strategy for other HOT lanes in the Denver metropolitan area.

Ingress and egress to/from the HOT lanes was deliberately set up to prioritize traffic in the HOT lanes heading to/from DEN. Therefore, in the inbound direction, only ingress locations are provided between GVR Boulevard and 56th Avenue and between 56th Avenue and Tower Road. Similarly, in the outbound direction, only egress locations are provided to these two interchanges. A full ingress and egress in both direction are provided between Tower Road and E-470. Figure 2-8 shows a conceptual layout for this concept.

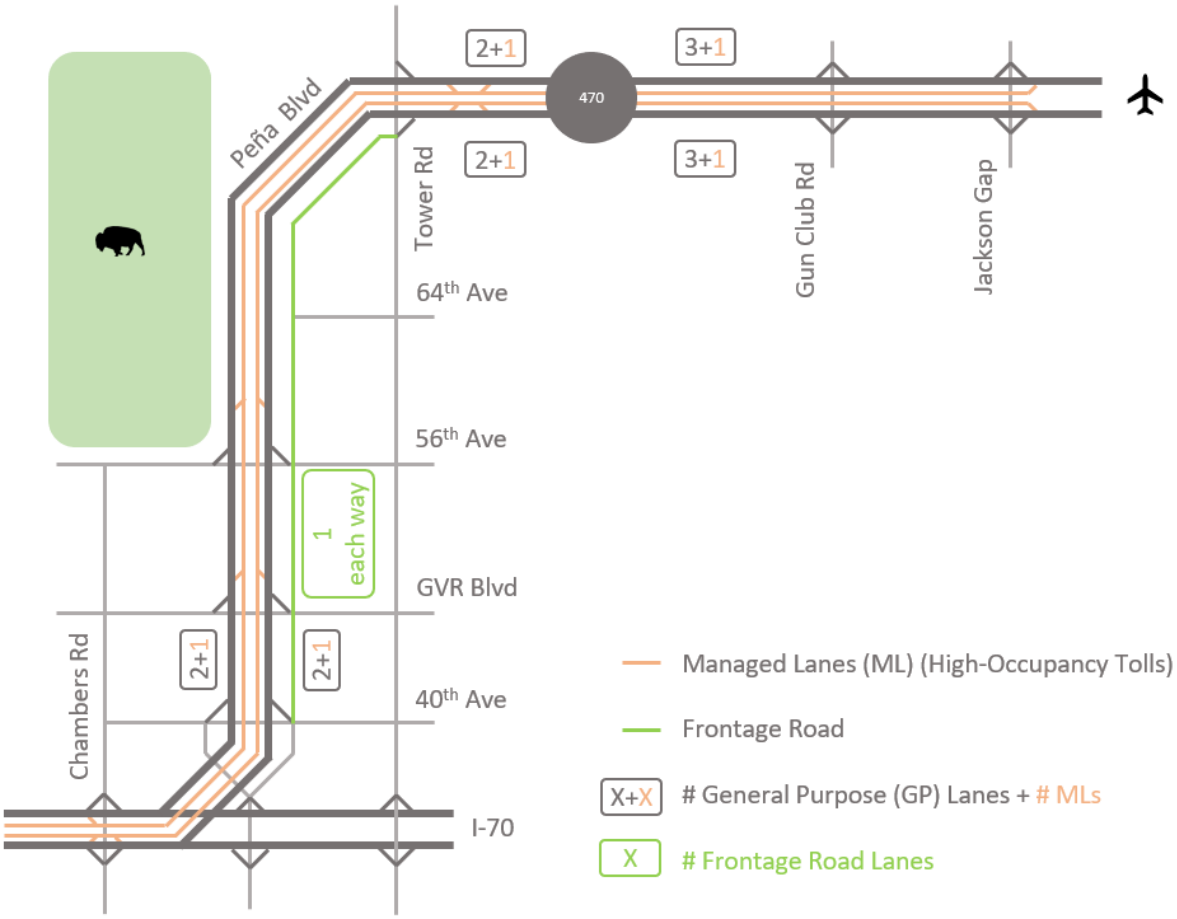
**Figure 2-8 – Conceptual Diagram of Alt 5: Two-Lane Frontage Road with Limited Access at GVR Boulevard, 56th Avenue, and Tower Road with HOT Lanes from I-70 to Jackson Gap Street**




### 2.4.2. Alt 8: Two-Lane Frontage Road with No Access at GVR Boulevard and 56th Avenue and No MLs

This concept considers the impacts of constructing a two-lane (one lane in each direction) frontage road adjacent to Peña Boulevard from 40th Avenue to Tower Road with local intersection at 40th Avenue, GVR Boulevard, 56th Avenue, 64th Avenue, and Tower Road. Additionally, this concept would remove all access to/from Peña Boulevard at GVR Boulevard and 56th Avenue. The intent of such access reductions is to prioritize traffic along Peña Boulevard heading to/from DEN, while encouraging local traffic to use the new frontage road. Figure 2-9 shows a conceptual layout for this concept.

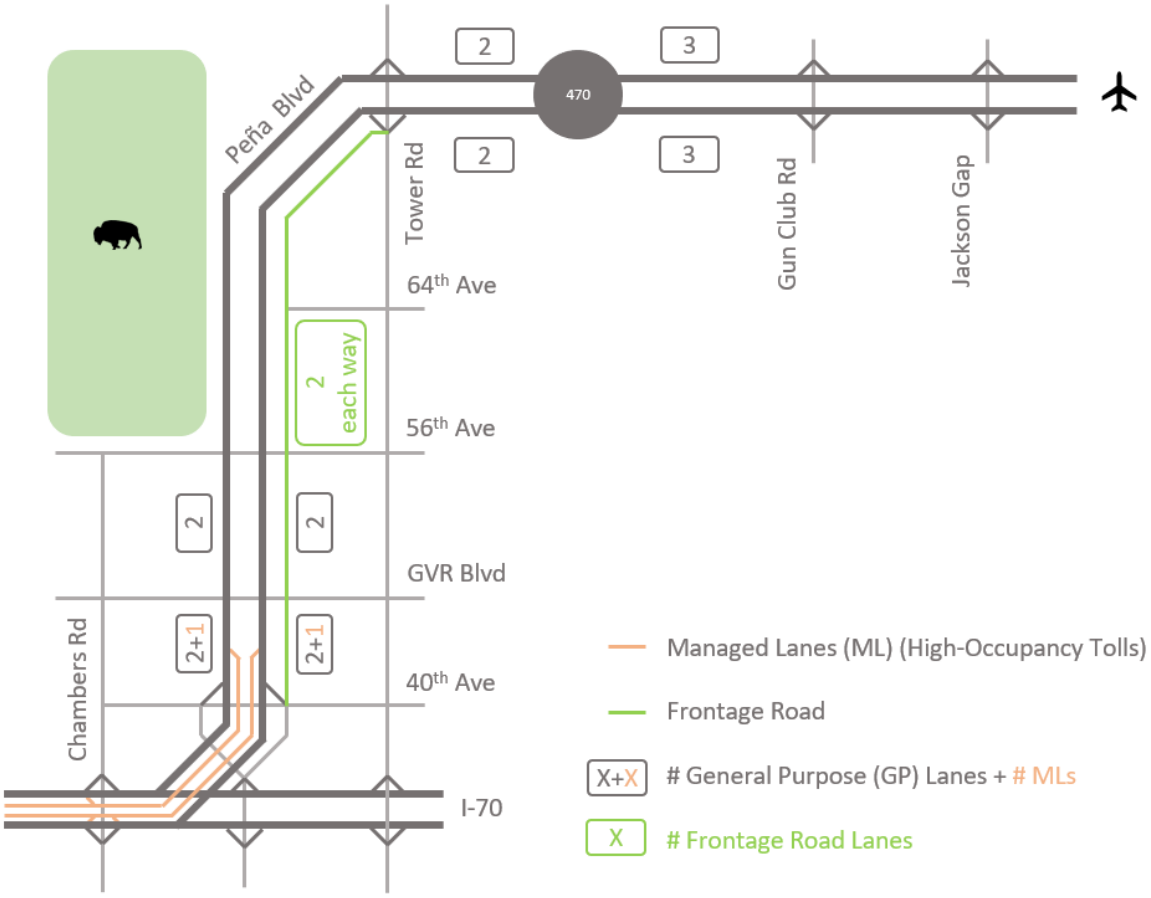
**Figure 2-9 – Alt 8: Two-Lane Frontage Road with No Access at GVR Boulevard and 56th Avenue and No MLs**




### 2.4.3. Alt 8.01: Four-Lane Frontage Road with No Access at GVR Boulevard and 56th Avenue and No MLs

This concept considers the impacts of constructing a four-lane (two lanes in each direction) frontage road adjacent to Peña Boulevard from 40th Avenue to Tower Road with local intersection at 40th Avenue, GVR Boulevard, 56th Avenue, 64th Avenue, and Tower Road. Additionally, this concept would remove all access to/from Peña Boulevard at GVR Boulevard and 56th Avenue. The intent of such access reductions is to prioritize traffic along Peña Boulevard heading to/from DEN, while encouraging local traffic to use the new frontage road. Figure 2-10 shows a conceptual layout for this concept.

**Figure 2-10 – Alt 8.01: Four-Lane Frontage Road with No Access at GVR Boulevard and 56th Avenue and No MLs**




## 2.5. Family E – CD Roads

The purpose of evaluating concepts within Family E is to understand potential impacts of implementing CD roads. For the purposes of this study, a CD road is a grade-separated, freeway-type facility, which would run adjacent to Peña Boulevard (either buffer- or barrier-separated). Freeway on-ramps and off-ramps would connect from local roadways to CD roads and CD roads would tie into GP lanes on Peña Boulevard at select locations. The purpose of CD roads would accommodate the weaving and merging turbulence created by traffic entering and exiting Peña Boulevard in a separate facility from through traffic on Peña Boulevard. The intent of such configurations allows through traffic, such as trips headed to/from DEN, to travel along Peña Boulevard with fewer impacts from local interchange congestion, while still accommodating local access.

Four concepts were evaluated as part of this family. These include:

- Alt 6: One-Lane CD Roads between 40th Avenue and 56th Avenue with HOT Lanes from I-70 to Jackson Gap Street
- Alt 9: One-Lane CD Roads between 40th Avenue and Tower Road with HOT Lanes from I-70 to Jackson Gap Street

- Alt 10: One-Lane CD Roads between 40th Avenue and Tower Road without MLs
- Alt 10.01: Two-Lane CD Roads between 40th Avenue and Tower Road without MLs

### 2.5.1. Alt 6: One-Lane CD Roads Between 40th Avenue and 56th Avenue with HOT Lanes from I-70 to Jackson Gap Street

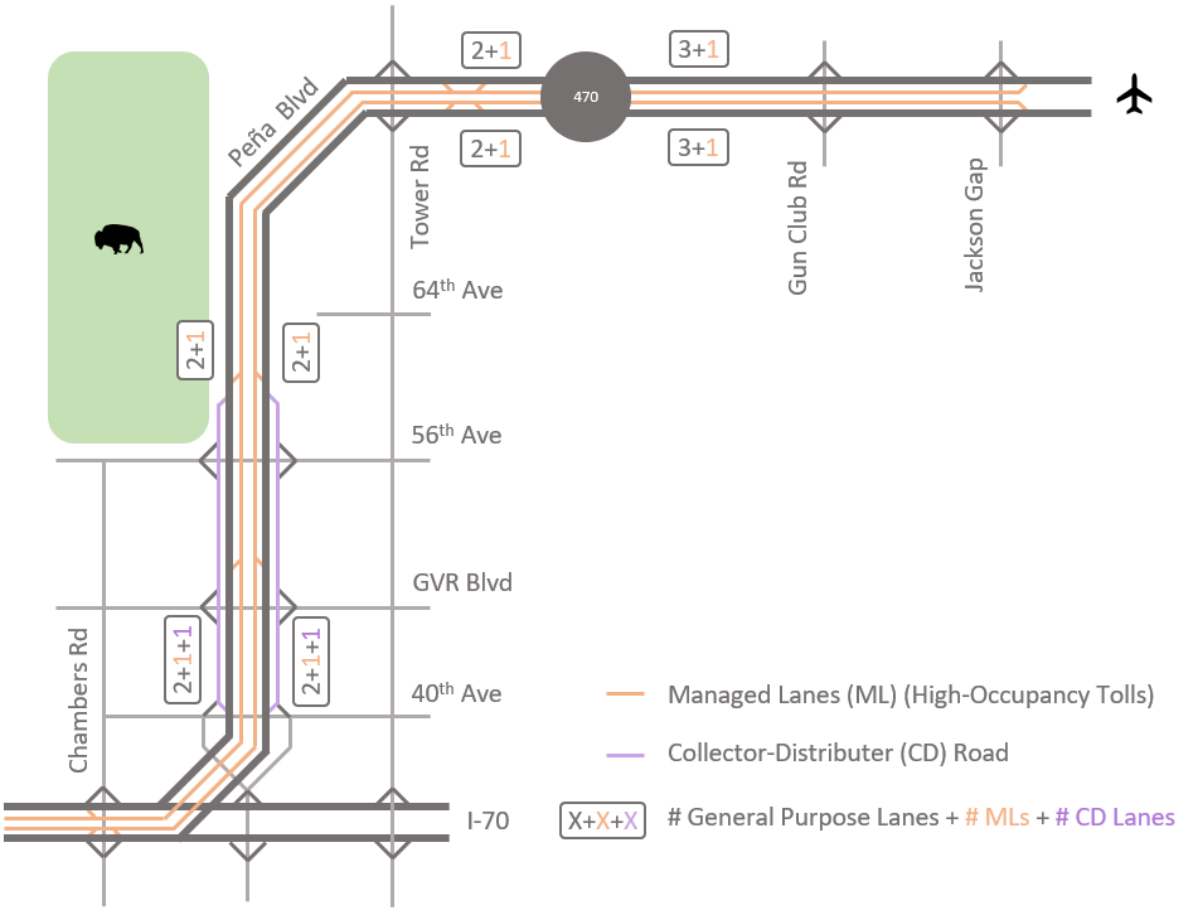
This concept considers the impacts of constructing one-lane CD roads in each direction between 40th Avenue and 56th Avenue as well as HOT lanes between I-70 and Jackson Gap Street. These CD roads would run on the outside of the existing GP lanes on Peña Boulevard and are conceptually envisioned to be constructed as either separate roadway facilities away from GP lanes or constructed adjacent to the existing GP lanes with a physical barrier separating different facilities.

The inbound CD road would diverge from the Peña Boulevard mainline near 40th Avenue and accommodate on-ramp traffic from 40th Avenue, off-ramp and on-ramp traffic to/from GVR Boulevard, and off-ramp and on-ramp traffic to/from 56th Avenue before connecting back into the GP lanes north of 56th Avenue. The outbound CD road would diverge from the Peña Boulevard mainline north of 56th Avenue and accommodate off-ramp and on-ramp traffic to/from 56th Avenue, off-ramp and on-ramp traffic to/from GVR Boulevard, and off-ramp traffic to 40th Avenue before connecting back into the Peña Boulevard GP lanes south of 40th Avenue.

This concept also includes one new HOT lane along Peña Boulevard from 40th Avenue to Jackson Gap Street in each direction. The HOT lanes would run along the inside of Peña Boulevard adjacent to the existing GP lanes. For evaluation purposes, it was assumed that the HOT lanes would be free to use for any vehicle with three or more people (HOV3+), while vehicles with two or fewer people would be charged a toll to use the HOT lane. This HOT management approach is consistent with the existing management strategy for other HOT lanes in the Denver metropolitan area.

An ingress and egress to/from the HOT lanes was deliberately set up to prioritize traffic in the HOT lanes heading to/from DEN. Therefore, in the inbound direction, only ingress locations are provided between GVR Boulevard and 56th Avenue and between 56th Avenue and Tower Road. Similarly, in the outbound direction, only egress locations are provided to these two interchanges. A full ingress and egress in both directions are provided between Tower Road and E-470. Figure 2-11 shows a conceptual layout for this concept.

**Figure 2-11 – Alt 6: One-Lane CD Roads Between 40th Avenue and 56th Avenue with HOT Lanes from I-70 to Jackson Gap Street**




## 2.5.2. Alt 9: One-Lane CD Roads Between 40th Avenue and Tower Road with HOT Lanes from I-70 to Jackson Gap Street

This concept considers the impacts of constructing one-lane CD roads in each direction between 40th Avenue and Tower Road as well as HOT lanes between I-70 and Jackson Gap Street. These CD roads would run on the outside of the existing GP lanes on Peña Boulevard and are conceptually envisioned to be constructed as either separate roadway facilities away from GP lanes or constructed adjacent to the existing GP lanes with a physical barrier separating the different facilities.

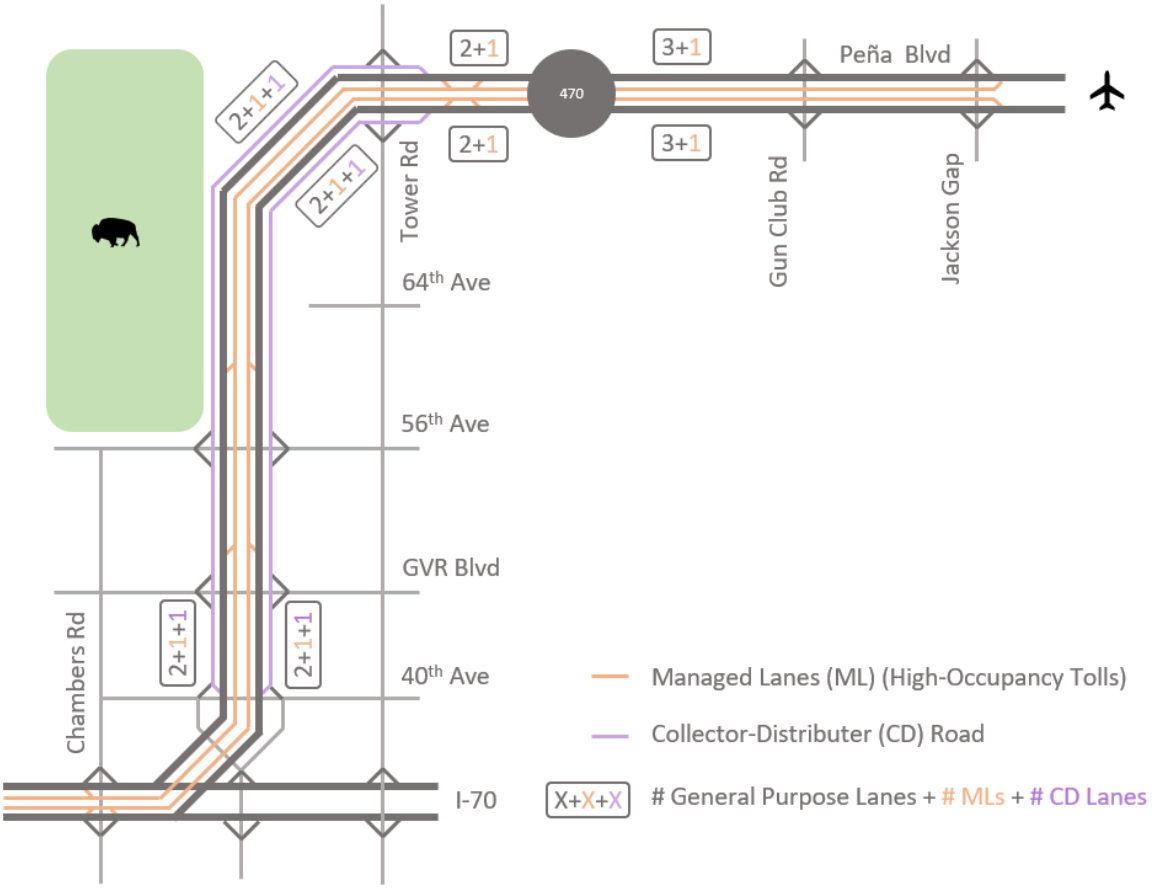
The inbound CD road would diverge from the Peña Boulevard mainline near 40th Avenue and accommodate on-ramp traffic from 40th Avenue, off-ramp and on-ramp traffic to/from GVR Boulevard, off-ramp and on-ramp traffic to/from 56th Avenue, and off-ramp and on-ramp traffic to/from Tower Road before connecting back into the GP lanes east of Tower Road. The outbound CD road would diverge from the Peña Boulevard mainline east of Tower Road and accommodate off-ramp and on-ramp traffic to/from Tower Road, off-ramp and on-ramp traffic to/from

56th Avenue, off-ramp and on-ramp traffic to/from GVR Boulevard, and off-ramp traffic to 40th Avenue before connecting back into the Peña Boulevard GP lanes south of 40th Avenue.

This concept also includes one new HOT lane along Peña Boulevard from 40th Avenue to Jackson Gap Street in each direction. The HOT lanes would run along the inside of Peña Boulevard adjacent to the existing GP lanes. For evaluation purposes, it was assumed that the HOT lanes would be free to use for any vehicle with three or more people (HOV3+), while vehicles with two or fewer people would be charged a toll to use the HOT lane. This HOT management approach is consistent with the existing management strategy for other HOT lanes in the Denver metropolitan area.

An ingress and egress to/from the HOT lanes was deliberately set up to prioritize traffic in the HOT lanes heading to/from DEN. Therefore, in the inbound direction, only ingress locations are provided between GVR Boulevard and 56th Avenue and between 56th Avenue and Tower Road. Similarly, in the outbound direction, only egress locations are provided to these two interchanges. A full ingress and egress in both directions are provided between Tower Road and E-470. Figure 2-12 shows a conceptual layout for this concept.

**Figure 2-12 – Alt 9: One-Lane CD Roads Between 40th Avenue and Tower Road with HOT Lanes from I-70 to Jackson Gap Street**

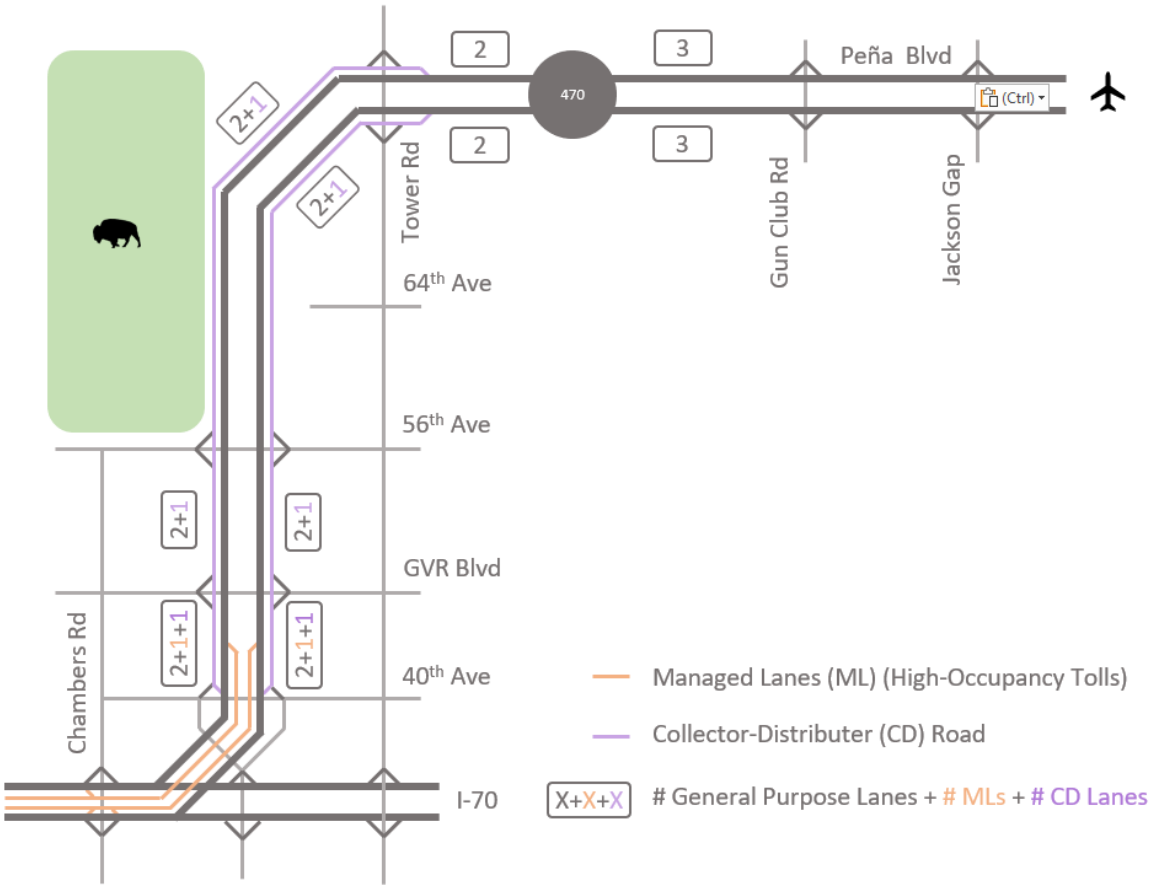


### 2.5.3. Alt 10: One-Lane CD Roads Between 40th Avenue and Tower Road without MLs

This concept considers the impacts of constructing one-lane CD roads in each direction between 40th Avenue and Tower Road without the implementation of an ML facility. The CD roads would run on the outside of the existing GP lanes along Peña Boulevard and are conceptually envisioned to be constructed as either separate roadway facilities away from GP lanes or constructed adjacent to the existing GP lanes with a physical barrier separating different facilities.

The inbound CD road would diverge from the Peña Boulevard mainline near 40th Avenue and accommodate on-ramp traffic from 40th Avenue, off-ramp and on-ramp traffic to/from GVR Boulevard, , off-ramp and on-ramp traffic to/from 56th Avenue, and off-ramp and on-ramp traffic to/from Tower Road before connecting back into the GP lanes east of Tower Road. The outbound CD road would diverge from the Peña Boulevard mainline east of Tower Road and accommodate off-ramp and on-ramp traffic to/from Tower Road, off-ramp and on-ramp traffic to/from 56th Avenue, off-ramp and on-ramp traffic to/from GVR Boulevard, and off-ramp traffic to 40th Avenue before connecting back into the Peña Boulevard GP lanes south of 40th Avenue. Figure 2-13 shows a conceptual layout for this concept.

**Figure 2-13 – Alt 10: One-Lane CD Roads Between 40th Avenue and Tower Road without MLs**

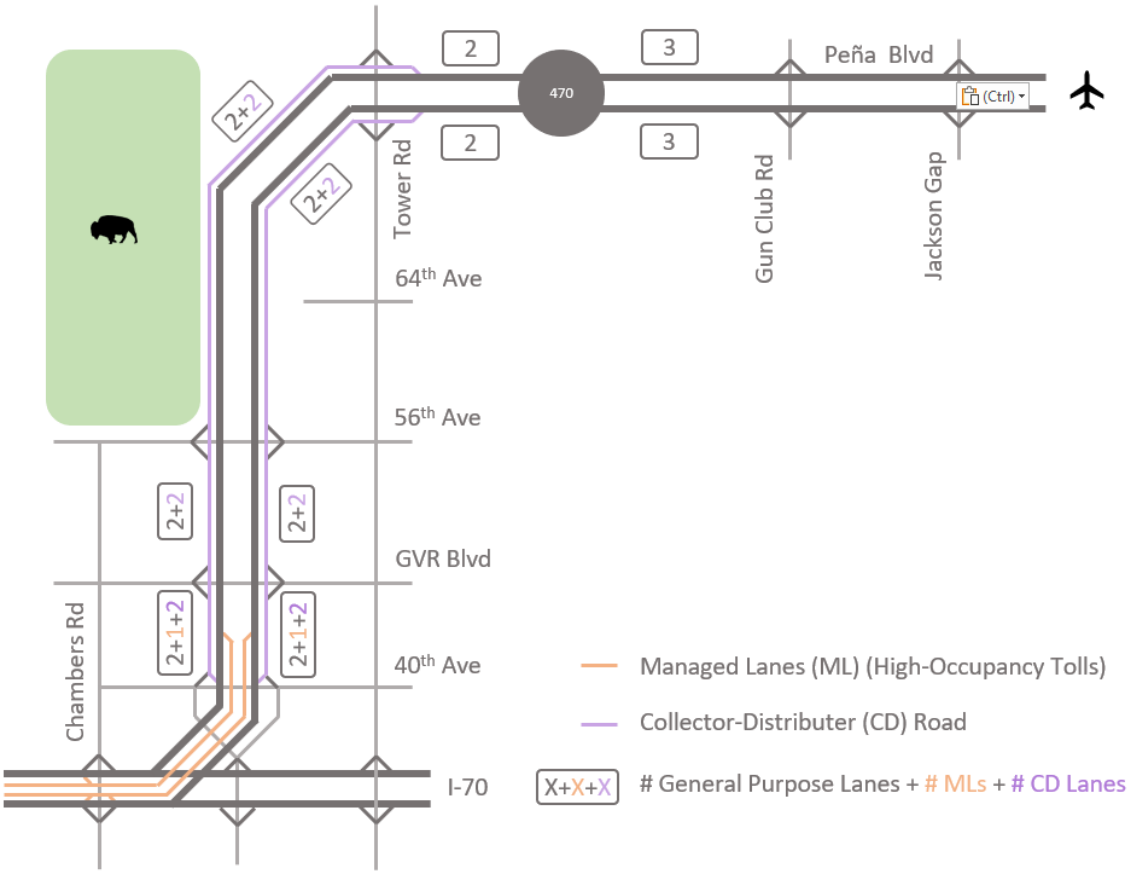


### 2.5.4. Alt 10.01: Two-Lane CD Roads Between 40th Avenue and Tower Road without MLs

This concept considers the impacts of constructing two-lane CD roads in each direction between 40th Avenue and Tower Road without implementing an ML facility. CD roads would run on the outside of the existing GP lanes on Peña Boulevard and are conceptually envisioned to be constructed as either separate roadway facilities away from GP lanes or constructed adjacent to the existing GP lanes with a physical barrier separating the different facilities.

The inbound CD road would diverge from the Peña Boulevard mainline near 40th Avenue and accommodate on-ramp traffic from 40th Avenue, off-ramp and on-ramp traffic to/from GVR Boulevard, off-ramp and on-ramp traffic to/from 56th Avenue, and off-ramp and on-ramp traffic to/from Tower Road before connecting back into the GP lanes east of Tower Road. The outbound CD road would diverge from the Peña Boulevard mainline east of Tower Road and accommodate off-ramp and on-ramp traffic to/from Tower Road, off-ramp and on-ramp traffic to/from 56th Avenue, off-ramp and on-ramp traffic to/from GVR Boulevard, and off-ramp traffic to 40th Avenue before connecting back into the Peña Boulevard GP lanes south of 40th Avenue. Figure 2-14 shows a conceptual layout for this concept.

**Figure 2-14 – Alt 10.01: Two-Lane CD Roads Between 40th Avenue and Tower Road without MLs**



## 2.6. Family F – New Interchange at 64th Avenue

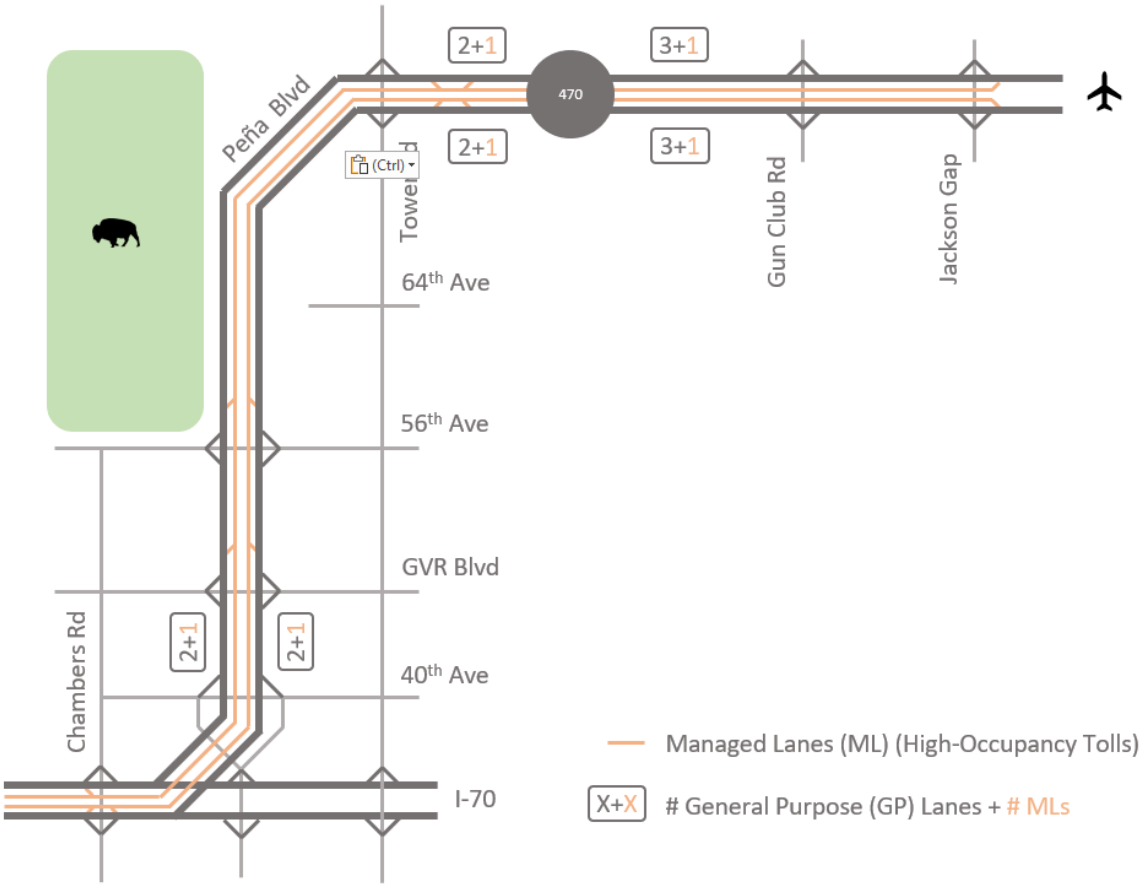
The purpose of concepts in Family F is to provide comparative information for the purposes of more fully understanding how travel patterns and congestion may be affected if an additional interchange along Peña Boulevard were constructed at 64th Avenue. This new interchange was previously considered prior to this study; however, due to geometric considerations associated with the proximity of construction near the RTD A-Line, the cost and feasibility make its implementation challenging. Additionally, the Federal Aviation Administration (FAA) has determined that new interchanges along Peña Boulevard are undesirable. Therefore, it is important to note that concepts within this family are not intended to be formal alternatives to be carried forward for further evaluation or implementation. Rather, these concepts were only evaluated to provide a point of comparison with other concepts. Within this family, only a single concept, Alt 11: HOT Lanes from I-70 to Jackson Gap Street with a New Interchange at 64th Avenue was evaluated.

### 2.6.1. Alt 11: HOT Lanes from I-70 to Jackson Gap Street with a New Interchange at 64th Avenue

This concept evaluates the effects of providing an additional interchange along Peña Boulevard at 64th Avenue. For evaluation purposes, it was assumed that this concept also includes one new HOT lane along Peña Boulevard from 40th Avenue to Jackson Gap Street in each direction. The HOT lanes would run along the inside of Peña Boulevard adjacent to the existing GP lanes. For evaluation purposes, it was assumed that the HOT lanes would be free to use for any vehicle with three or more people (HOV3+), while vehicles with two or fewer people would be charged a toll to use the HOT lane. This HOT management approach is consistent with the existing management strategy for other HOT lanes in the Denver metropolitan area.

An ingress and egress to/from the HOT lanes was deliberately set up to prioritize traffic in the HOT lanes heading to/from DEN. Therefore, in the inbound direction, only ingress locations are provided between GVR Boulevard and 56th Avenue and between 56th Avenue and Tower Road. Similarly, in the outbound direction, only egress locations are provided to these two interchanges. A full ingress and egress in both directions are provided between Tower Road and E-470. Figure 2-15 shows a conceptual layout for this concept.

**Figure 2-15 – Alt 11: HOT Lanes from I-70 to Jackson Gap Street with a New Interchange at 64th Avenue**



# 3. Evaluation Methodology

All concepts were evaluated using DRCOG's regional TDM. Details about the TDM, including information about refinements made to the model to make it applicable to this project, are provided in the *Peña Boulevard Transportation and Mobility Master Plan Existing Traffic Conditions and Needs Technical Report*.

Several measures of effectiveness (MOEs) were considered to evaluate the concepts. These included:

- Demand volumes (along Peña Boulevard, at on-ramps and off-ramps, and on nearby local roadways)
- Person trips and changes to vehicle occupancy on Peña Boulevard
- Travel times along Peña Boulevard
- Vehicle miles traveled (VMT) within the study area
- Vehicle hours traveled (VHT) within the study area

## 3.1. HOT Tolling Strategy

Within DRCOG's TDM, usage of tolled facilities, such as HOT lanes, is controlled by a combination of drivers' value of time and toll rates. Drivers' value of time is set regionally for the entire DRCOG model and was not modified for this study. However, the toll rate for individual HOT facilities can be set at varying costs per mile traveled. When implemented in the field, toll rates for HOT facilities are tailored to the specific corridor and are set in a manner in which the toll rate is the following: (1) low enough to ensure usage of the tolled facility, (2) high enough to managed demand and ensure a minimum speed/level of service within the tolled facility, and (3) generally equal to or above the cost of transit.

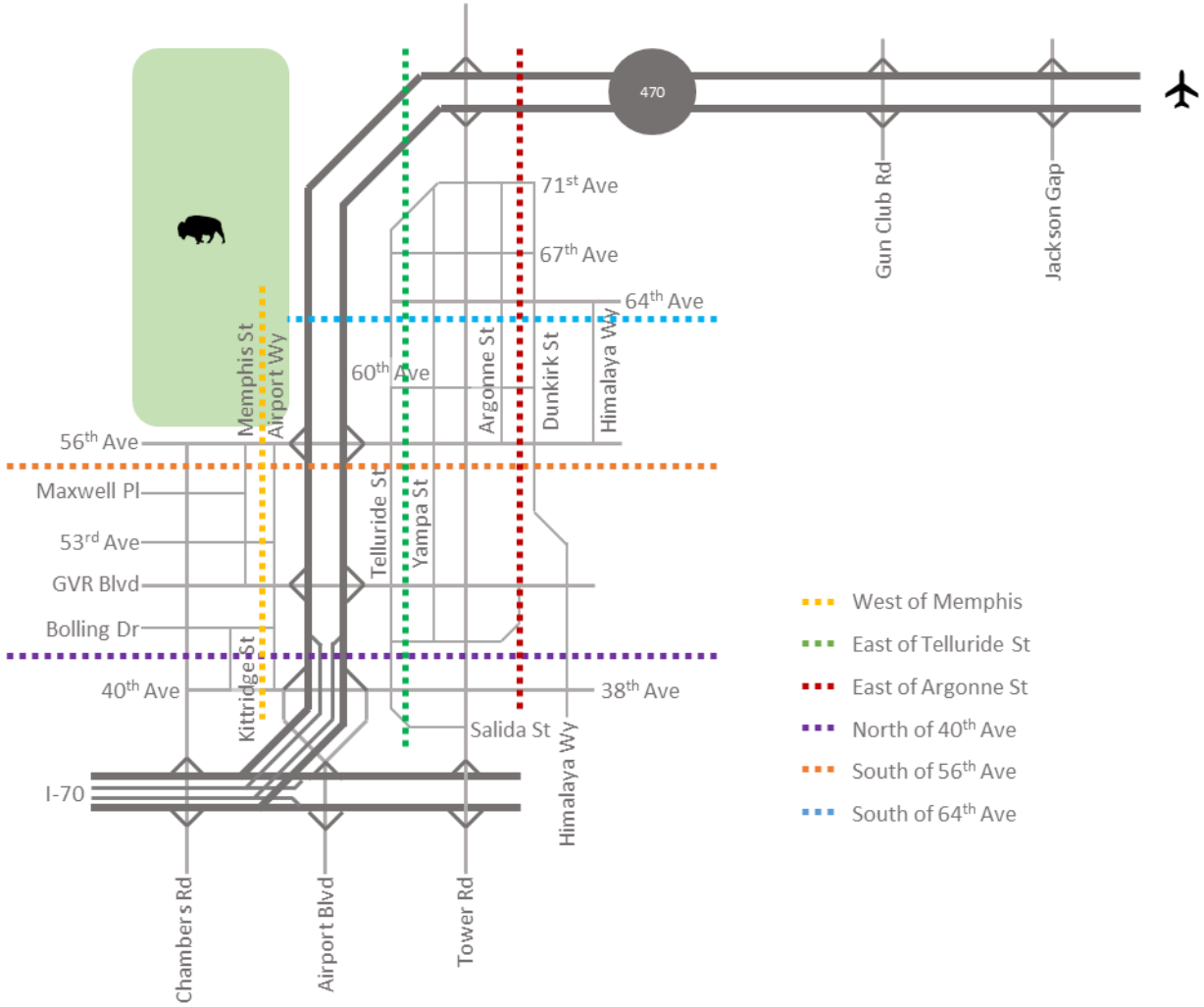
To provide the best comparison between various concepts considered in this study, a single, uniform toll rate was established for all HOT facilities. This rate eases the comparison between results of different concepts; however, it may also result in sub-optimal utilization rates for HOT facilities. At this level of the study, such sub-optimal utilization was not considered to likely have a major impact on overall results; however, an additional detailed analysis of toll rates will be needed in future studies should concepts, including HOT facilities, proceed.

## 3.2. Screenlines for Local Roadway Volumes

Due to the anticipated congestion on the roadway network in 2050, it is expected that traffic will detour to alternative routes to avoid congestion on certain facilities, such as Peña Boulevard. To understand how congestion on Peña Boulevard in different concepts may influence vehicle demand on nearby local roadways, a screenline analysis was completed. This type of analysis creates a series of imaginary lines across the study area and reports all volumes crossing that line along each facility. The results provide an understanding of where traffic may be diverting, given different roadway configurations and capacities.

To provide a consistent analysis between all concepts, volumes across a standard set of six screenlines were examined. Figure 3-1 shows the location, extents, and names for each of these screenlines. The results of the analysis are provided in Chapter 4 of this report.

**Figure 3-1 – Location of Screenlines**



# 4. Evaluation Results

The following sections discuss the results of the concept evaluation. For organizational purposes, the discussion is grouped by MOEs.

## 4.1. Demand Volumes

This MOE considered the vehicle demand within the roadway network. Evaluation of this criteria included an examination of vehicle demand along Peña Boulevard, at on-ramp and off-ramps to/from Peña Boulevard, and along nearby local roadways.

Note that the TDM provides demand volumes for facilities, which, due to congestion, may differ from serviced volumes. Because of this, the consideration of this MOE was based on daily demand volumes from the TDM, which minimizes the potential difference between demand and serviced volumes that typically diverge the most during congested peak travel periods.

### 4.1.1. Family A – Volume Results

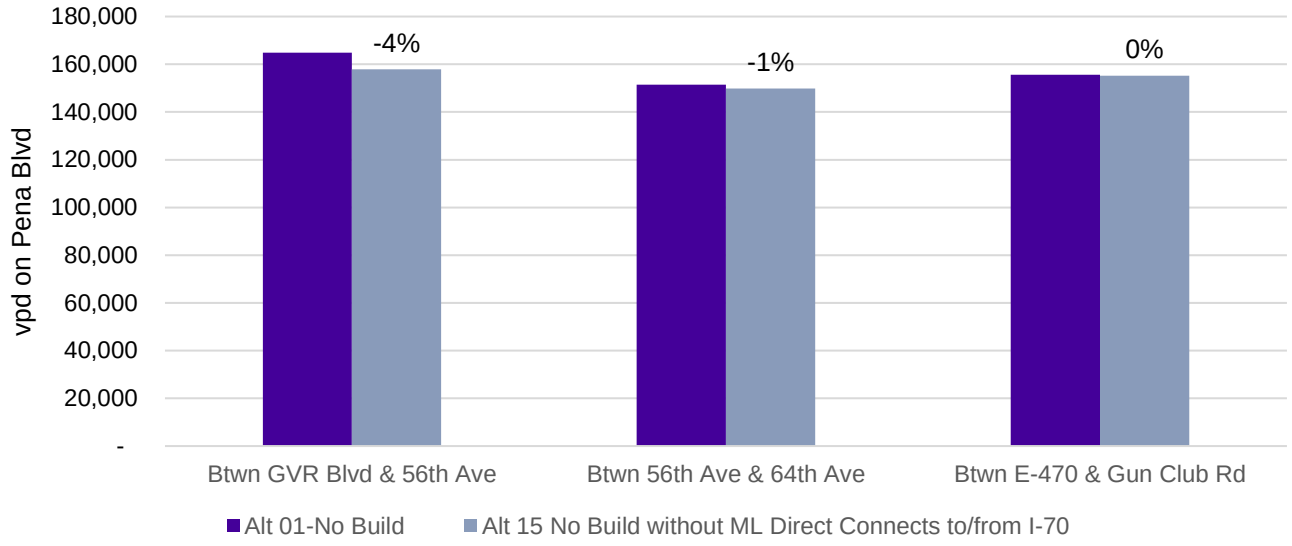
The primary difference between concepts within Family A is the provision of ML direct connects between I-70 and Peña Boulevard with Alt 1: No Build, including the direct connect ramps and Alt 15: No Build Without Direct Connects to/from I-70, not including direct connect ramps.

Note that although Alt 12: Bus Only Lanes could increase transit ridership and reduce vehicle volumes by shifting vehicle trips to transit, the impact of such mode shift is unknown at this time and would depend highly on complementary, network-wide changes to transit service in response to new infrastructure. Such changes and scenarios are not captured within the TDM analysis used for this study. Therefore, the vehicle analysis for Alt 12: Bus Only Lanes is the same as Alt 1: No Build. To simplify reporting, only results for Alt 1: No Build and Alt 15: No Build Without Direct Connects to/from I-70 are shown and discussed. However, all results and a discussion from Alt 1: No Build would be applicable or the same for Alt 12: Bus Only Lanes.

#### 4.1.1.1. Family A – Volumes on Peña Boulevard

The volume results show that without direct connect ramps between I-70 and Peña Boulevard there is an approximate 4 percent reduction in traffic along Peña Boulevard between GRV Boulevard and 56$^{th}$ Avenue. This reduction lessens moving away from I-70, with approximately a 1 percent volume reduction north of 56$^{th}$ Avenue and no meaningful changes to volumes east of E-470. Figure 4-1 shows the volumes along Peña Boulevard for each concept.

**Figure 4-1 – Family A – 2050 Daily Vehicle Demand on Peña Boulevard**

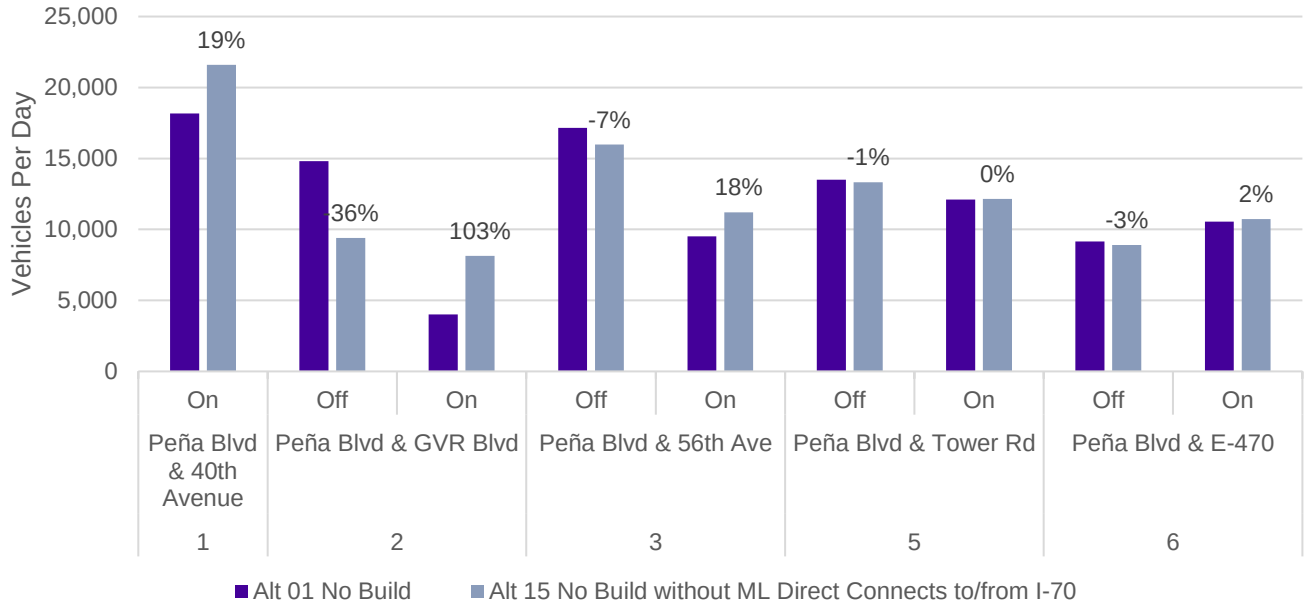



Note: Percentages shown reflect the percent difference in volumes as compared to the No Build concept.

#### 4.1.1.2. Family A – Interchange Volumes

The provision of an ML direct connect between I-70 and Peña Boulevard primarily affects volumes at the 40th Avenue, GVR Boulevard, and 56th Avenue interchanges. In the inbound direction, the direct connect results in approximately 19 percent fewer vehicles entering Peña Boulevard from 40th Avenue. Additionally, the inbound direct connect results in more vehicles exiting Peña Boulevard at GVR Boulevard and 56th Avenue. Without the inbound direct connect, vehicle demand shifts to have more people enter Peña Boulevard at 40th Avenue and GVR Boulevard. This pattern is caused because the interchange between I-70 and Peña Boulevard is expected to be over capacity in 2050. Without the additional capacity provided by the inbound direct connect, vehicles would choose to access Peña Boulevard via the local roadway network at 40th Avenue and GVR Boulevard rather than the I-70 interchange. Figure 4-2 shows inbound demand volumes at each interchange.

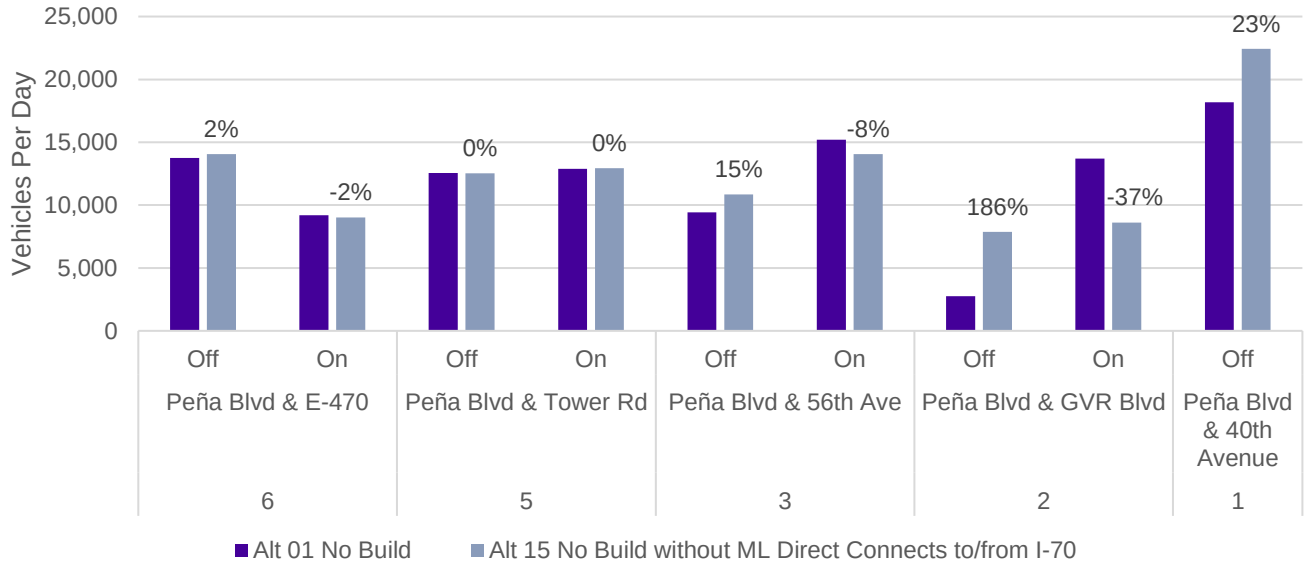
**Figure 4-2 – Family A – 2050 Inbound Daily Interchange Vehicle Demand Volumes**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

A similar but reversed pattern is observed in the outbound direction. In this direction, without the direct connect more vehicles exit Peña Boulevard to GVR Boulevard and 40th Avenue to avoid congestion at the I-70 and Peña Boulevard interchange. With the direct connect, more people enter Peña Boulevard at GVR Boulevard to take advantage of the additional capacity through the interchange. Figure 4-3 shows outbound demand volumes at each interchange.

**Figure 4-3 – Family A – 2050 Outbound Daily Interchange Vehicle Demand Volumes**



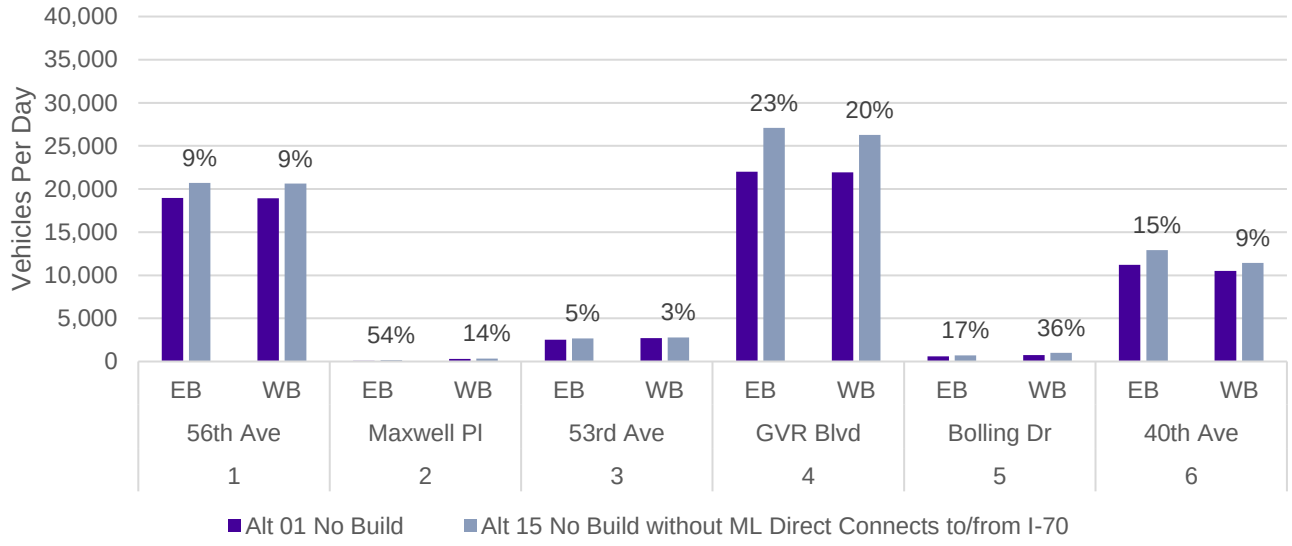

Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

#### 4.1.1.3. Family A – Local Roadway Volumes

For east/west traffic across the study area, the provision of a direct connect might have the largest impact on the arterial street network west of Peña Boulevard. In this area, results of the analysis show that without the direct connect, there is an increase in vehicle demand along all major east/west routes, including 56th Avenue, GVR Boulevard, and 40th Avenue. This is a result of the reduced capacity through the Peña Boulevard and I-70 interchange without the direct connect, which results in traffic avoiding the interchange by using east/west local roads instead of I-70.

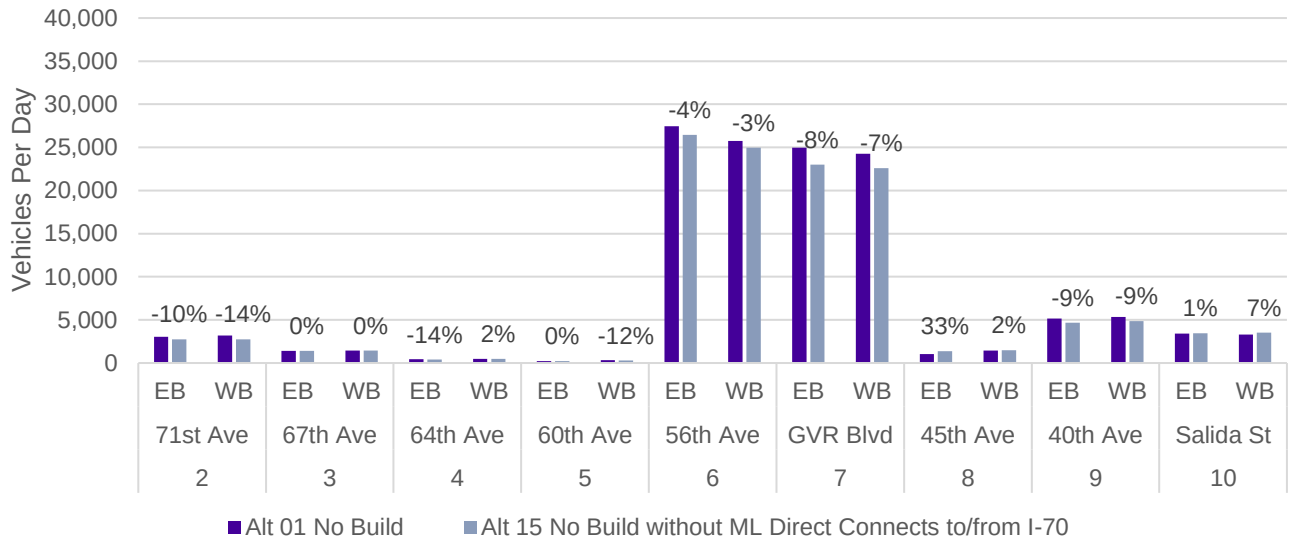
East of Peña Boulevard, volumes on east/west facilities are expected to be similar or slightly less in Alt 15: No Build Without the Direct Connect as compared to Alt 1: No Build. This reduction in east/west demand volumes east of Peña Boulevard is because of capacity constraints west of Peña Boulevard. With more Peña Boulevard traffic diverting to local roadways west of Peña Boulevard, there is less capacity available to accommodate through traffic on local roadways that would otherwise continue east of Peña Boulevard. Figure 4-4, Figure 4-5, and Figure 4-6 show volumes on east/west local roadway facilities for concepts in Family A.

**Figure 4-4 – Family A – 2050 East/West Daily Vehicle Demand Crossing the West of Memphis Street Screenline**



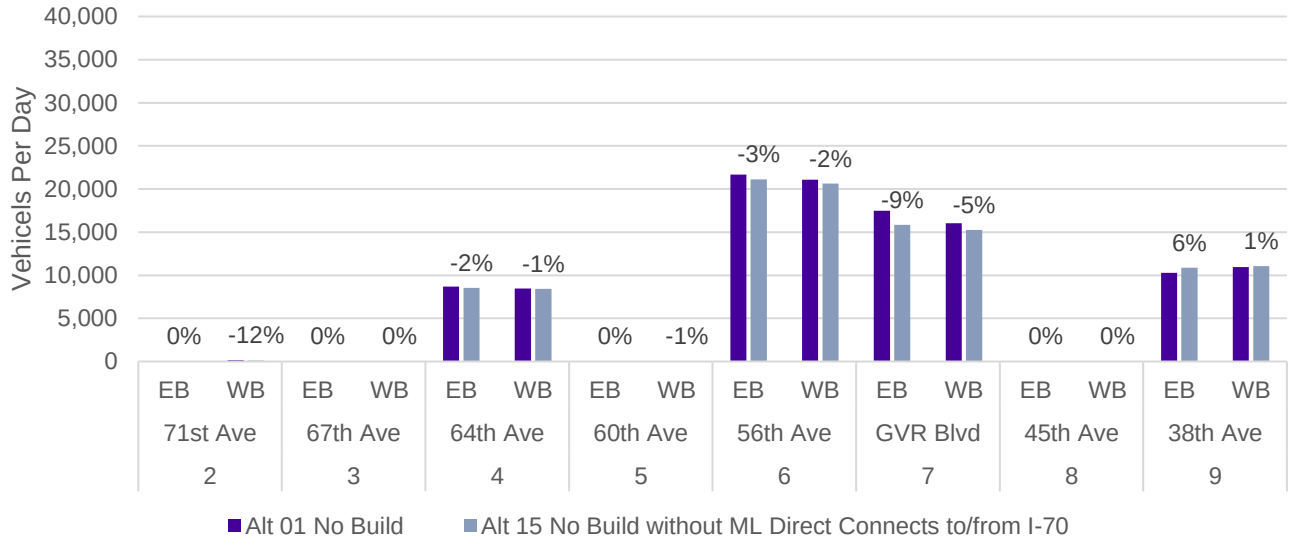

Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

**Figure 4-5 – Family A – 2050 East/West Daily Vehicle Demand Crossing the East of Telluride Street Screenline**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

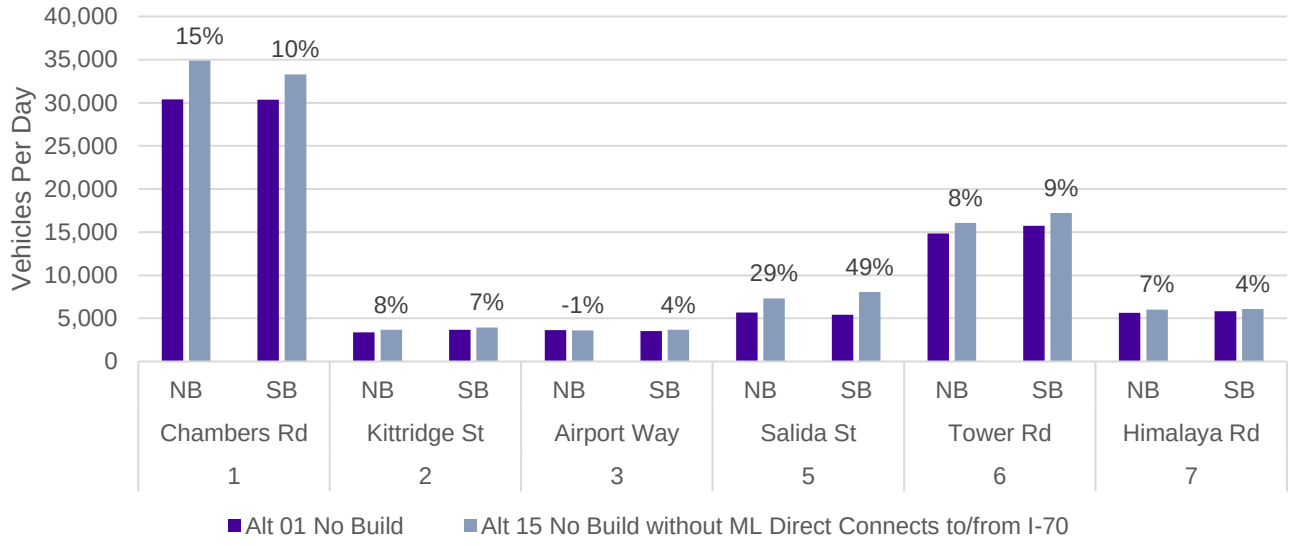
**Figure 4-6 – Family A – 2050 East/West Daily Vehicle Demand Crossing the East of Argonne Street Screenline**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

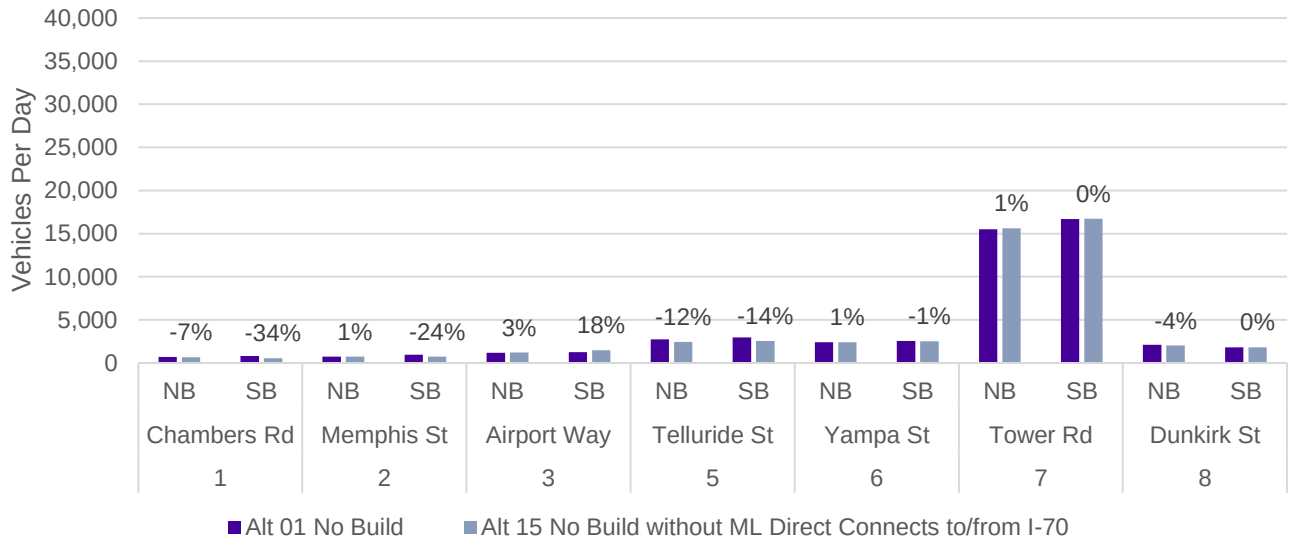
For north/south traffic across the study area, the provision of a direct connect is expected to have the largest impact south of GVR Boulevard. The results show that without the direct connect, there will be additional north/south traffic on most facilities between approximately I-70 and GVR Boulevard. The largest increases in traffic are expected on Chambers Road, Salida Street, and Tower Road. Further to the north, near 56th Avenue and 64th Avenue, there are not expected to be any large changes in north/south traffic patterns, with the results showing a modest decrease in volumes across most north/south facilities. Figure 4-7, Figure 4-8, and Figure 4-9 show volumes on north/south local roadway facilities for concepts in Family A.

**Figure 4-7 – Family A – 2050 North/South Daily Vehicle Demand Crossing the North of 40th Avenue Screenline**



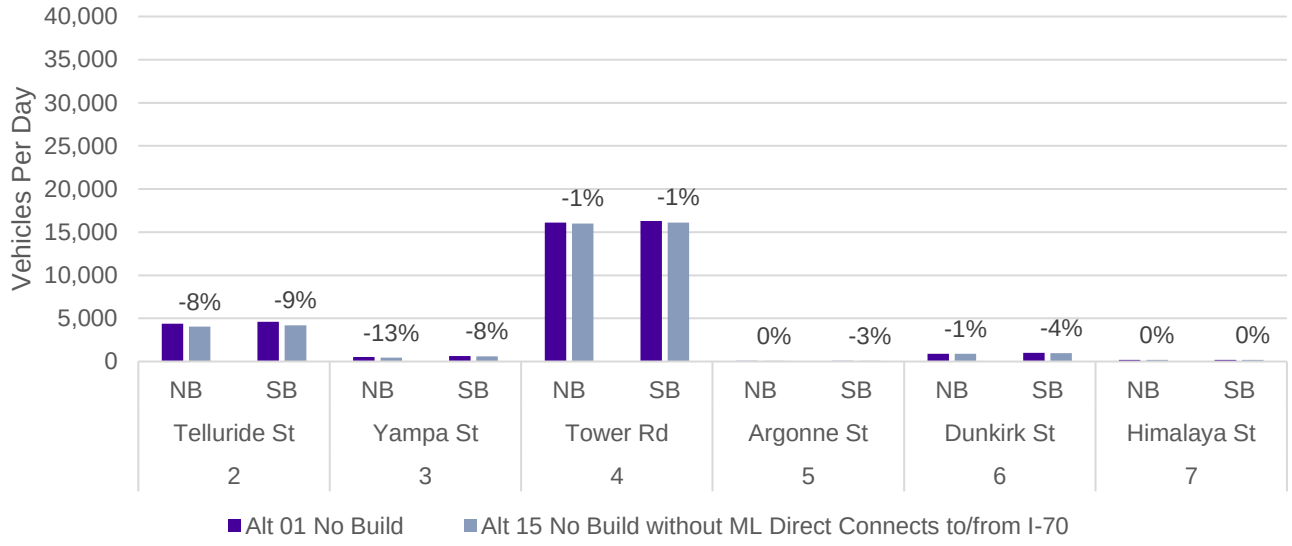

Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

**Figure 4-8 – Family A – 2050 North/South Daily Vehicle Demand Crossing the South of 56th Avenue Screenline**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

**Figure 4-9 – Family A – 2050 North/South Daily Vehicle Demand Crossing the South of 64th Avenue Screenline**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

## 4.1.2. Family B – Volume Results

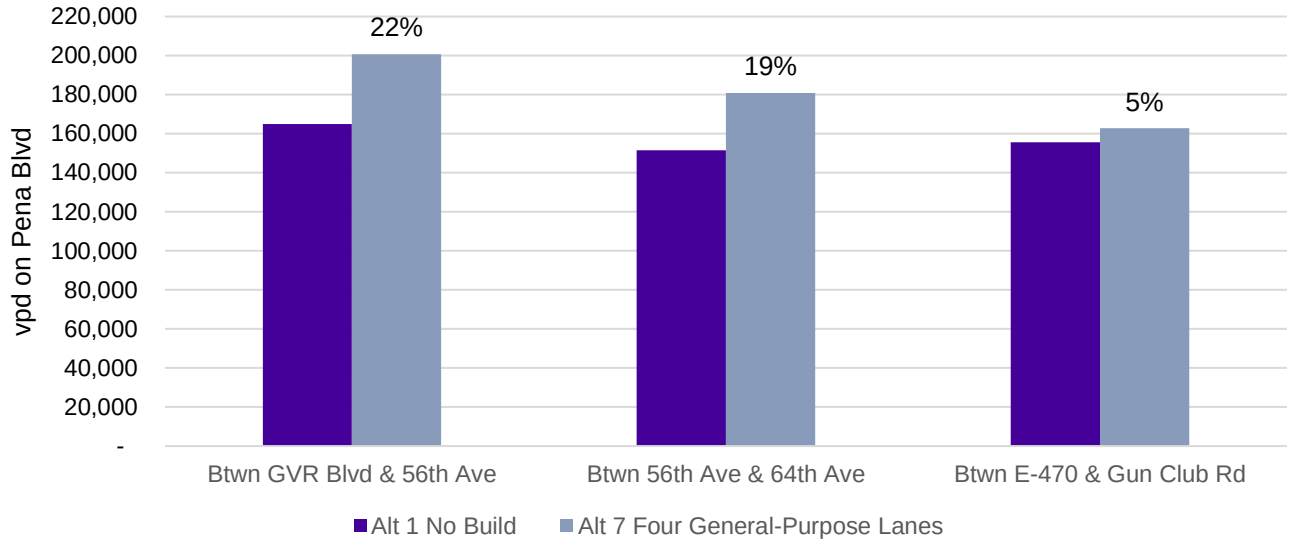
The primary purpose of Family B was to understand the traffic volume that would use Peña Boulevard if congestion was not a major factor. This is commonly referred to as the unconstrained demand, as it is the full demand to use a facility if it is not constrained by congestion.

### 4.1.2.1. Family B – Volumes on Peña Boulevard

The results show that this unconstrained demand for Peña Boulevard (Alt 7: Four GP Lanes) is between approximately 5 percent and 22 percent more than the demand in Alt 1: No Build, with the most additional demand near I-70 and the least additional demand east of E-470 (see Figure 4-10).

These results reflect two key findings. Firstly, the results indicate that future congestion along Peña Boulevard will result in people either changing their travel behavior or avoiding travel altogether. Secondly, the results show that the change in vehicle demand to/from DEN (assumed to be the traffic east of E-470) is relatively small as compared to the change in vehicle demand to non-airport destinations. This change indicates that vehicle demand to/from DEN is less elastic than demand to/from other destinations. This is likely because people traveling to/from DEN need to make the trip regardless of congestion on Peña Boulevard, such as to commute to work for a start time of a set shift or to catch a flight; whereas, other trips in the area, such as commuting, shopping, or leisure trips, may be more easily shifted or eliminated in response to congestion.

**Figure 4-10 – Family B – 2050 Daily Vehicle Demand on Peña Boulevard**

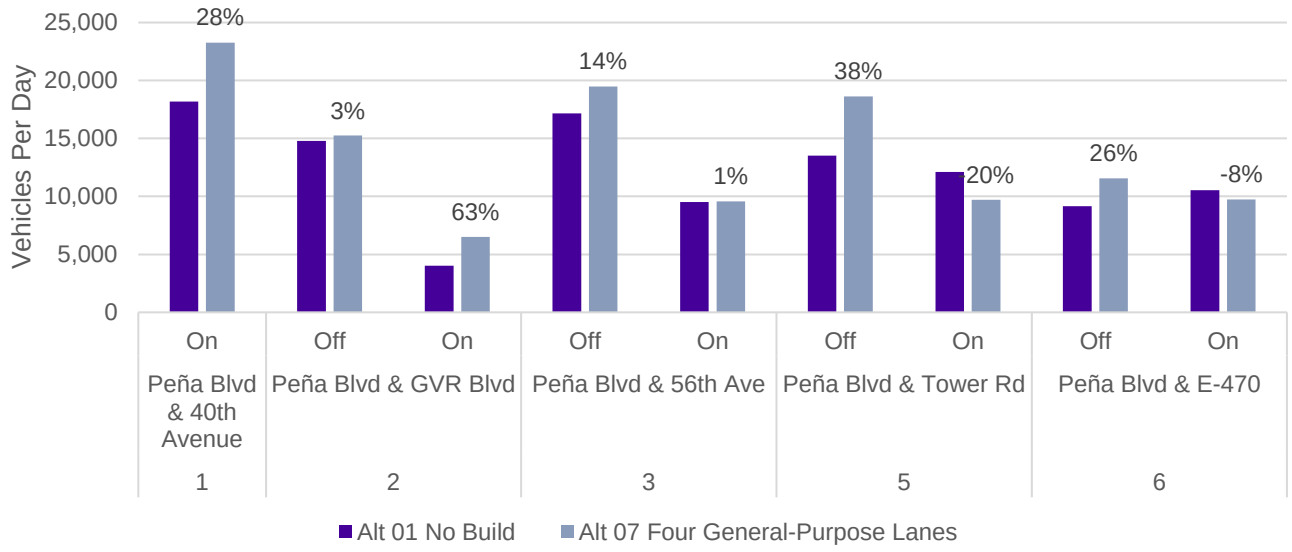



Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept.

#### 4.1.2.2. Family B – Interchange Volumes

Adding GP lanes to Peña Boulevard in the inbound direction results in more vehicles entering Peña Boulevard at 40th Avenue and GVR Boulevard and additional vehicles exiting at 56th Avenue, Tower Road, and E-470 (Figure 4-11). Note that, the Alt 7: Four GP Lanes concept was evaluated without the provision of an ML direct connect between I-70 and Peña Boulevard. The lack of an ML direct connect is likely representing at least a portion of the additional on-ramp traffic at 40th Avenue and GVR Boulevard. If additional capacity was provided at the I-70 and Peña Boulevard interchange, some drivers may choose to remain on Peña Boulevard. An additional discussion about isolated effects of more capacity at the I-70 and Peña Boulevard interchange is provided in Section 4.1.1 of this report.

**Figure 4-11 – Family B – 2050 Inbound Daily Interchange Vehicle Demand Volumes**

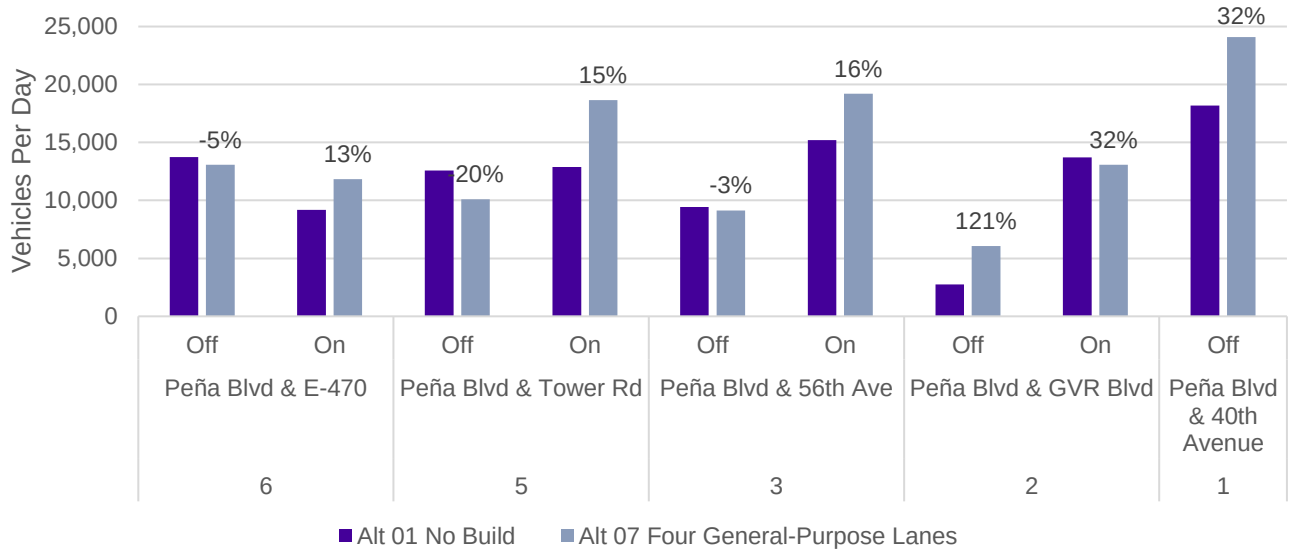



Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

Adding additional GP lanes in the outbound direction results in more traffic coming on to Peña Boulevard at E-470, Tower Road, and 56th Avenue and additional traffic exiting Peña Boulevard at GVR Boulevard and 40th Avenue. When there are additional GP lanes on Peña Boulevard, this pattern is also strengthened by fewer trips exiting to E-470, Tower Road, and 56th Avenue. These results indicate that additional GP lanes would both attract more trips to Peña Boulevard that would not otherwise use it due to congestion, and it would encourage more traffic to remain on Peña Boulevard for a longer duration rather than exiting to use parallel local roadway facilities. Figure 4-12 shows outbound volumes at interchanges along Peña Boulevard.

Note that, the Alt 7: Four GP Lanes concept was evaluated without the provision of an ML direct connect between I-70 and Peña Boulevard. The lack of an ML direct connect is likely accounting for at least a portion of the additional off-ramp traffic at GVR Boulevard and 40th Avenue. If additional capacity was provided at the I-70 and Peña Boulevard interchange, some drivers may choose to remain on Peña Boulevard. An additional discussion about isolated effects of additional capacity at the I-70 and Peña Boulevard interchange is provided in Section 4.1.1 of this report.

**Figure 4-12 – Family A – 2050 Outbound Daily Interchange Vehicle Demand Volumes**

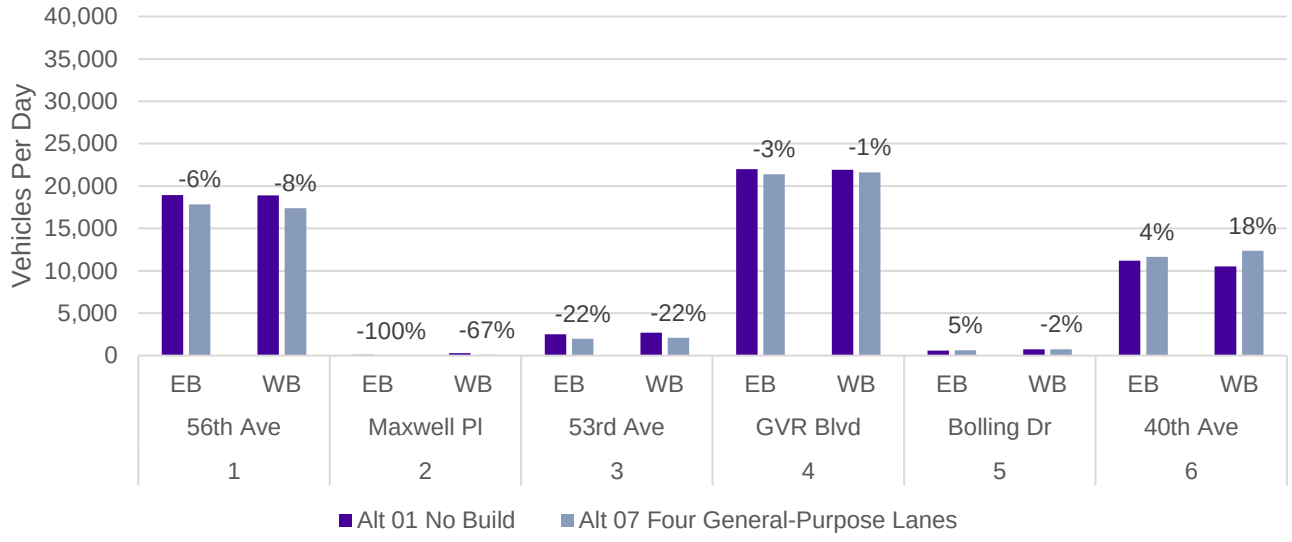



Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

#### 4.1.2.3. Family B – Local Roadway Volumes

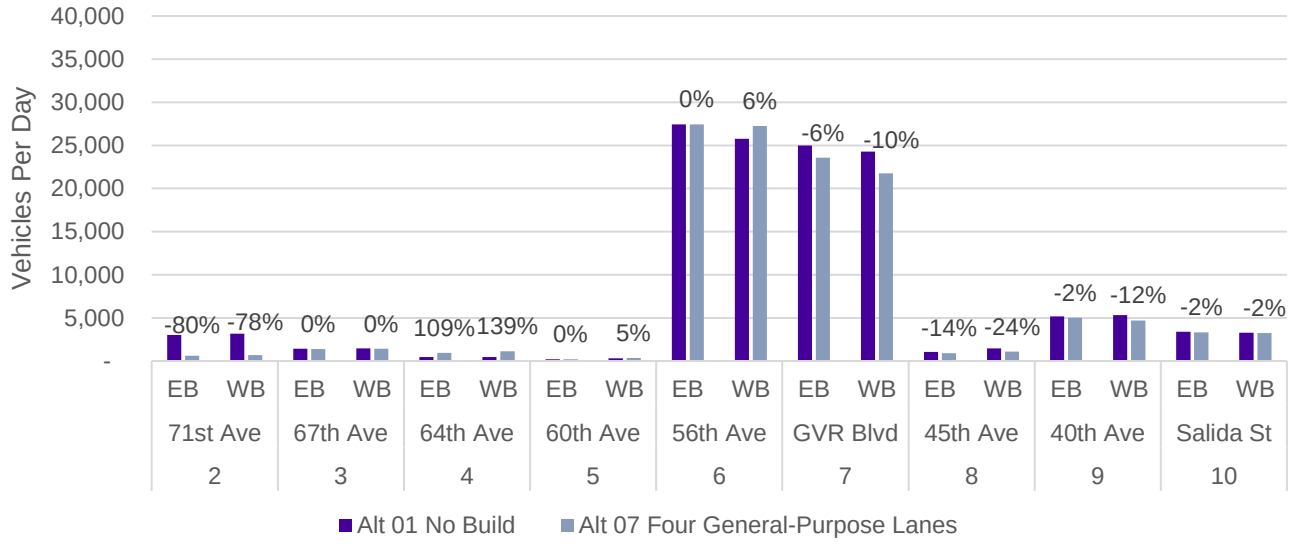
For east/west traffic across the study area, additional GP lanes on Peña Boulevard is expected to generally result in a modest decrease in traffic on local east/west roadways. The largest decreases are anticipated to occur east of Peña Boulevard. The exception to this trend is along 40th Avenue west of Peña Boulevard, which is expected to have an increase in traffic of 4 percent and 18 percent in both eastbound and westbound directions, respectively. This increase in traffic is because Alt 7: Four GP Lanes were evaluated by assuming no additional capacity is provided at the I-70 and Peña Boulevard interchange (i.e. no ML direct connect). Because of this configuration, traffic is diverting to 40th Avenue to avoid congestion at the interchange. Figure 4-13, Figure 4-14, and Figure 4-15 show east/west volumes across the study area.

**Figure 4-13 – Family B – 2050 East/West Daily Vehicle Demand Crossing the West of Memphis Street Screenline**



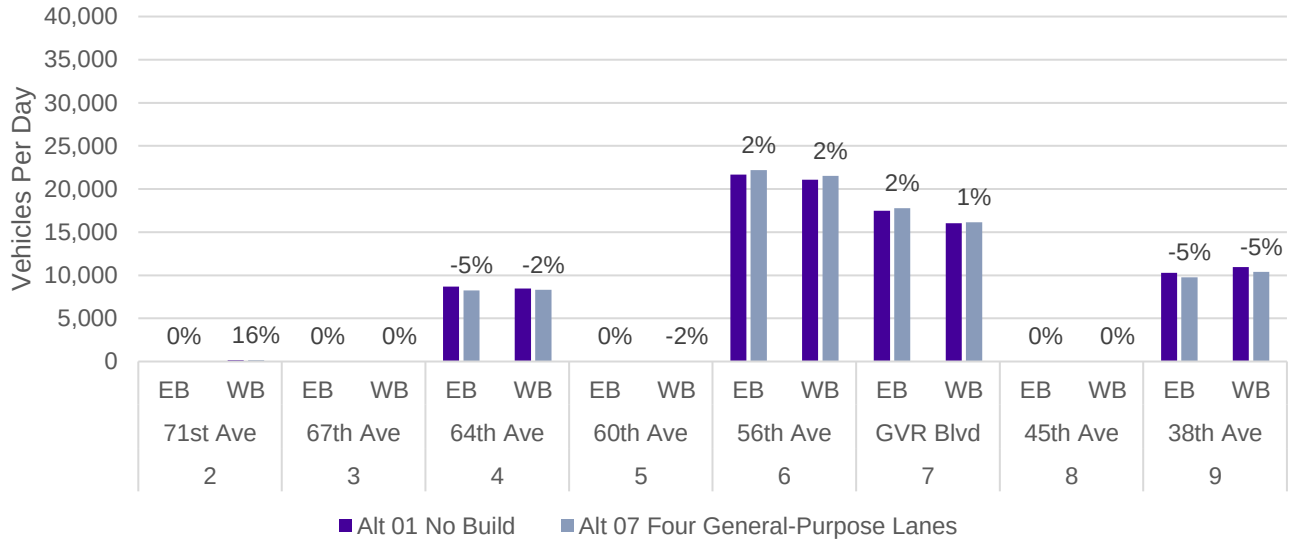

Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

**Figure 4-14 – Family B – 2050 East/West Daily Vehicle Demand Crossing the East of Telluride Street Screenline**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

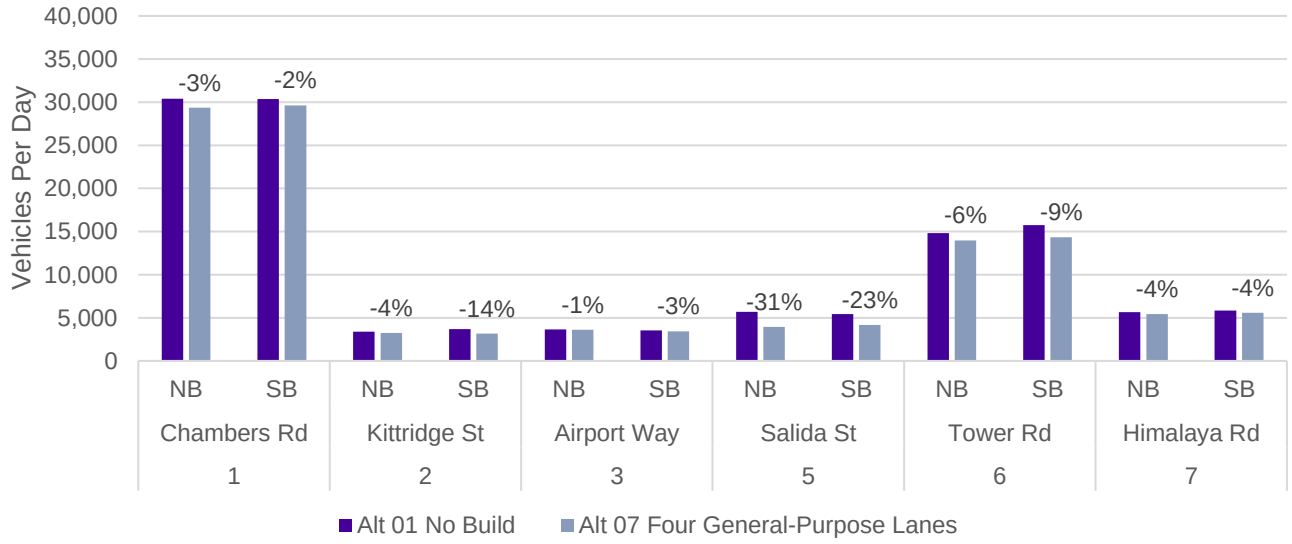
**Figure 4-15 – Family B – 2050 East/West Daily Vehicle Demand Crossing the East of Argonne Street Screenline**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

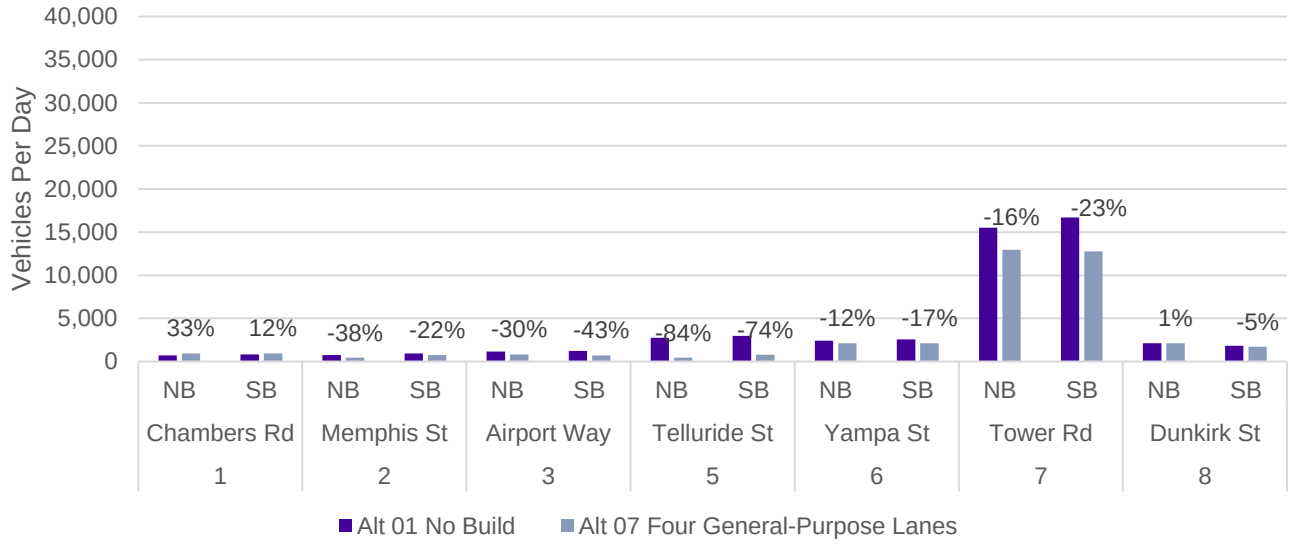
For north/south traffic across the study area, additional GP lanes on Peña Boulevard are expected to result in a decrease in traffic on local north/south roadways. The largest volume decreases are expected along Chambers Road, Salida Street/Telluride Street, and Tower Road. More traffic choosing to use the additional capacity on Peña Boulevard rather than traveling along local roadways causes this reduction. Figure 4-16, Figure 4-17, and Figure 4-18 show north/south volumes on local roadways within the study area.

**Figure 4-16 – Family B – 2050 North/South Daily Vehicle Demand Crossing the North of 40th Avenue Screenline**



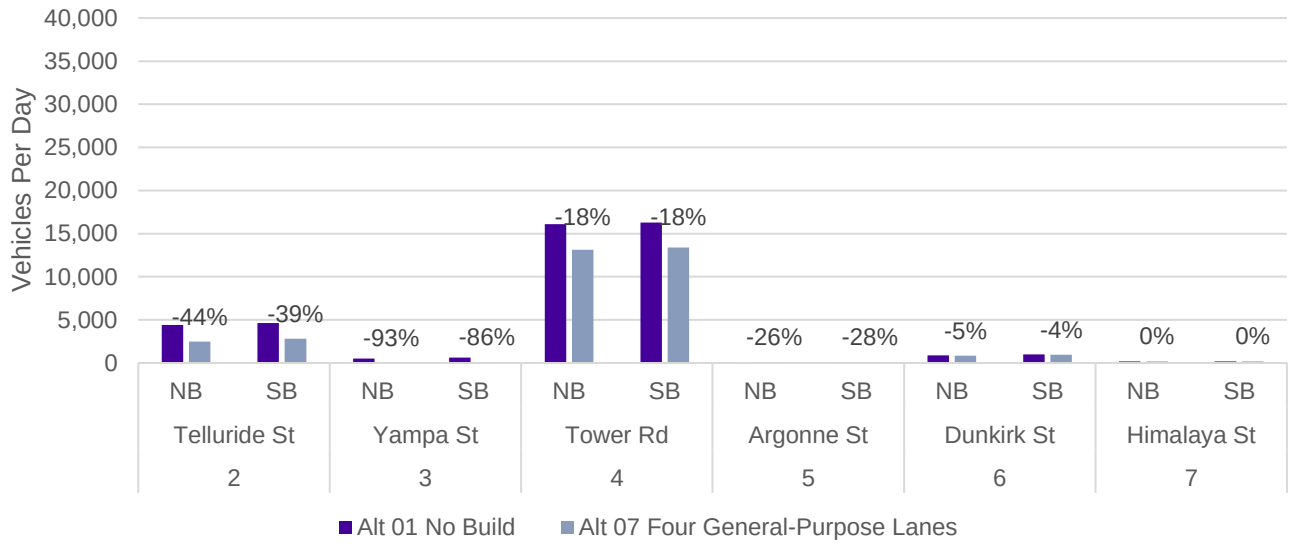

Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

**Figure 4-17 – Family B – 2050 North/South Daily Vehicle Demand Crossing the South of 56th Avenue Screenline**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

**Figure 4-18 – Family B – 2050 North/South Daily Vehicle Demand Crossing the South of 64th Avenue Screenline**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

### 4.1.3. Family C – Volume Results

The concepts within Family C evaluated the effects of providing an ML facility along Peña Boulevard. Within this family, slight variations in configurations have been evaluated to provide an understanding of the following things:

- Impact of different ML ingress/egress locations and configurations
- Impact of different ML management strategies (i.e., HOT, HOV2+, and HOV3+)
- Impact of different ML extents (I-70 to E-470 and I-70 to Jackson Gap Street)
- Impact of constructing an additional lane to be used as an ML east of E-470 versus the impact of converting an existing GP lane into an ML east of E-470

#### 4.1.3.1. Family C – Volumes on Peña Boulevard

The results of the traffic analysis show that the addition of any ML facility, regardless of extents, management strategy, or configuration will increase volumes along Peña Boulevard. The largest increase in volumes is expected in the southern portion of the corridor closest to I-70, with smaller increases further to the north. The provision of an HOT or HOV2+ lane is expected to result in the greatest increase in volumes along Peña Boulevard. Similar increases in traffic volumes are not observed with an HOV3+ ML because there are not enough HOV3+ vehicles on Peña Boulevard to fully utilize the additional capacity provided.

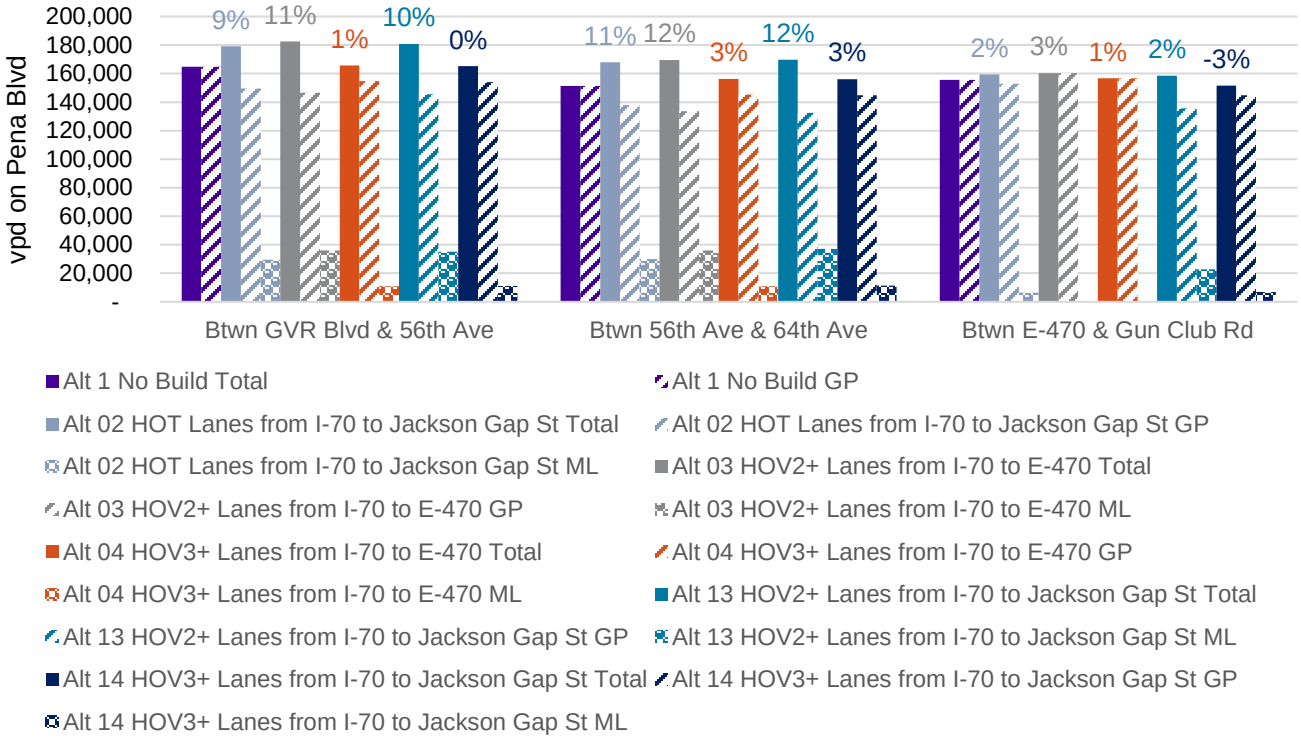
Comparing the total Peña Boulevard demand volumes in Alt 03: HOV2+ from I-70 to E-470 and in Alt 04: HOV3+ from I-70 to E-470 and to demand volumes in Alt 13: HOV2+ from I-70 to Jackson Gap Street and Alt 14: HOV3+ from I-70 to Jackson Gap Street show there is little difference resulting from different ML extents (I-70 to E-470 versus I-70 to Jackson Gap Street). This is because east of E-470 is less congested along Peña Boulevard. Therefore, vehicles receive fewer travel time savings when utilizing an ML facility as compared to a GP facility resulting in the presence of an ML facility having a little impact on drivers' route choice.

This same comparison also indicates that converting an existing GP lane to an ML east of E-470 (Alt 13: HOV 2+ from I-70 to Jackson Gap Street and Alt 14: HOV3+ from I-70 to Jackson Gap Street) does not have a large impact on Peña Boulevard traffic volumes. It should be noted, however, that the TDM analysis only shows the impact to Peña Boulevard would not be sufficiently large enough to change drivers' behaviors with their route choice. Converting an existing GP lane to an ML may still impact traffic congestion at a local scale.

Comparing the Peña Boulevard ML demand volumes between GVR Boulevard and 56$^{th}$ Avenue in Alt 03: HOV2+ from I-70 to E-470 and in Alt 04: HOV3+ from I-70 to E-470 and to ML demand volumes in Alt 13: HOV2+ from I-70 to Jackson Gap Street and in Alt 14: HOV3+ from I-70 to Jackson Gap Street show that altering the ML ingress/egress configuration to prefer traffic heading to/from DEN does not have a large impact on ML volumes/utilization. This change shows that there is sufficient ML demand between I-70 and E-470 to result in similar utilization rates regardless of ingress/egress configuration.

Figure 4-19 shows the results of demand volume along Peña Boulevard for concepts in Family C.

**Figure 4-19 – Family C – 2050 Daily Vehicle Demand on Peña Boulevard**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept.

#### 4.1.3.2. Family C – Interchange Volumes

Figure 4-20 and Figure 4-21 show the results of interchange volumes for concepts in Family C in inbound and outbound directions, respectively. At a high level, adding any additional capacity through the construction of ML facilities results in additional inbound traffic entering Peña Boulevard at 40th Avenue, GVR Boulevard, and 56th Avenue and exiting Peña Boulevard at Tower Road and E-470. A similar but reversed pattern is observed outbound, with additional traffic entering at E-470 and Tower Road and exiting to 56th Avenue, GVR Boulevard, and 40th Avenue.

Additionally, having ML facilities continue north of I-70/Peña Boulevard direct connects cause a 30 percent to 35 percent reduction in inbound traffic exiting to GVR Boulevard as compared to the Alt 1: No Build concept. This reduction is because extending ML facilities to the north avoids creating a bottleneck where direct connect traffic must merge with GP traffic between 40th Avenue and GVR Boulevard. A similar but reversed pattern is observed in the outbound direction in which there is an approximately 30 percent to 35 percent reduction in on-ramp traffic at GVR Boulevard.

At an individual concept level, variations in ML management and layout also result in differences to interchange volumes. Examining the impacts of HOT, HOV2+, and HOV3+ ML strategies show that inbound ramp volumes reflect a similar pattern as overall Peña Boulevard volumes with HOV3+ configurations showing the smallest

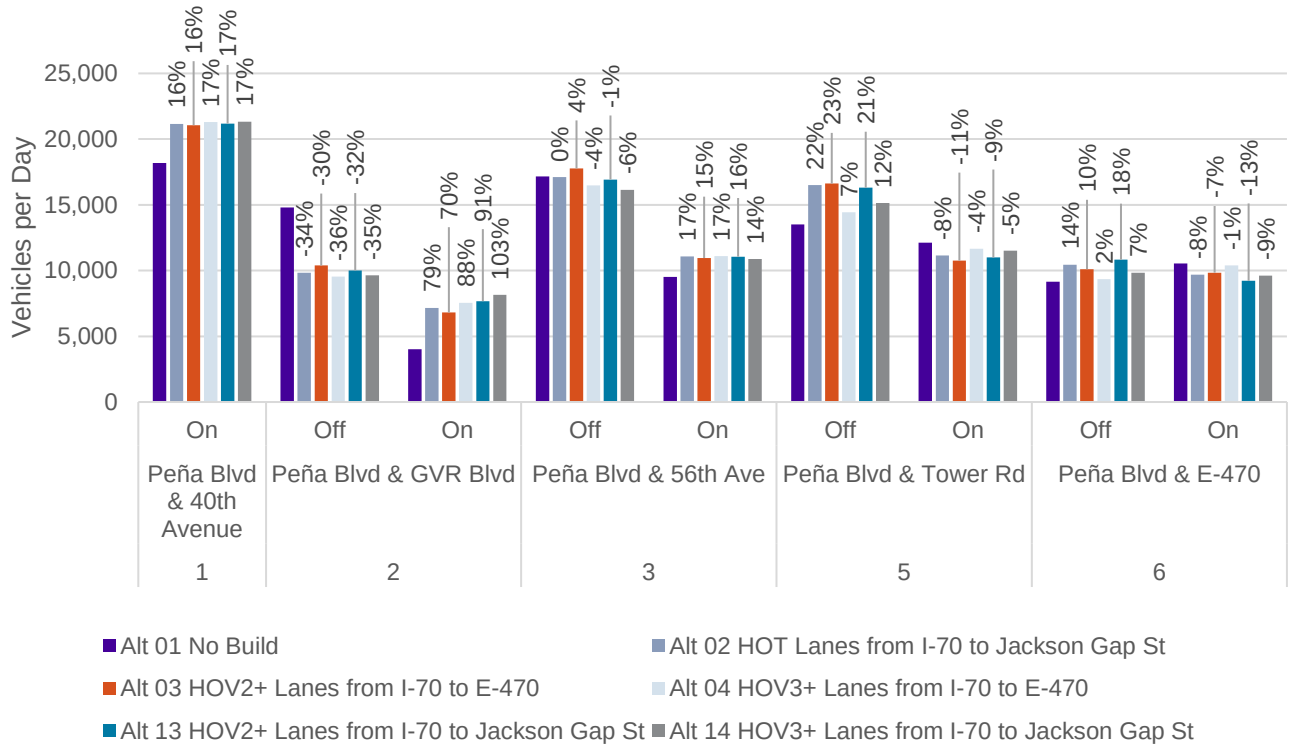
changes in both mainline and interchange volumes, as compared to Alt 01: No Build. The HOT and HOV2+ alternatives show similar interchange volumes.

The impact of different ML ingress/egress placements and configurations can be observed by comparing volumes in Alt 3: HOV2+ from I-70 to E-470 and in Alt 4: HOV3+ from I-70 to E-470 and to volumes in Alt 13: HOV2+ from I-70 to Jackson Gap Street and in Alt 14: HOV3+ from I-70 to Jackson Gap Street. This comparison indicates that providing additional egress options near GVR Boulevard and between 56th Avenue and Tower Road (Alt 3: HOV2+ from I-70 to E-470 and Alt 4: HOV3+ from I-70 to E-470) results in approximately 2 percent of additional off-ramp traffic to 56th Avenue and Tower Road, as some additional vehicles will utilize the ML facility to access these off-ramps. Without providing these additional egress locations (Alt 13: HOV2+ from I-70 to Jackson Gap Street and Alt 14: HOV3+ from I-70 to Jackson Gap Street), approximately 5 percent to 8 percent additional traffic exits Peña Boulevard to E-470.

Changing the extents of MLs to go between I-70 and E-470 (Alt 3: HOV2+ from I-70 to E-470 and Alt 4: HOV3+ from I-70 to E-470) or between I-70 and Jackson Gap Street (Alt 2: HOT from I-70 to Jackson Gap Street, Alt 13: HOV2+ from I-70 to Jackson Gap Street, and Alt 14: HOV3+ from I-70 to Jackson Gap Street) does not have a meaningful impact on inbound interchange volumes.

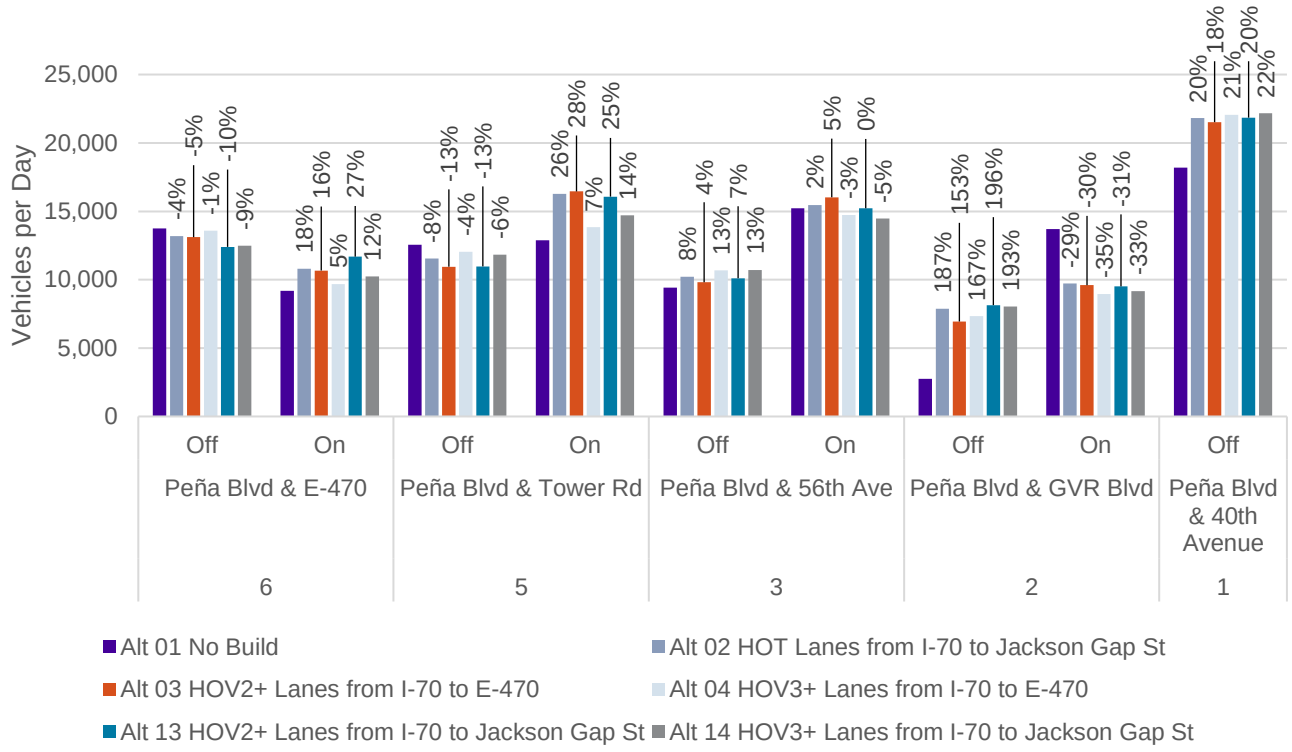
Similar patterns and results are observed in the outbound direction, which are shown in Figure 4-21.

**Figure 4-20 – Family C – 2050 Inbound Daily Interchange Vehicle Demand Volumes**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

**Figure 4-21 – Family C – 2050 Outbound Daily Interchange Vehicle Demand Volumes**

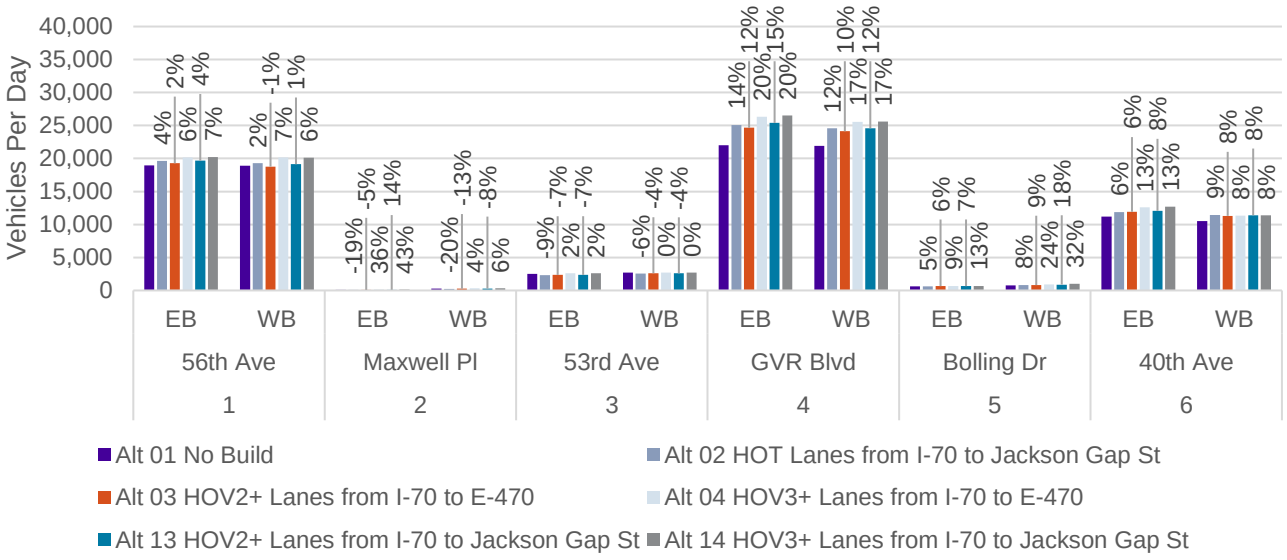



Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

#### 4.1.3.3. Family C – Local Roadway Volumes

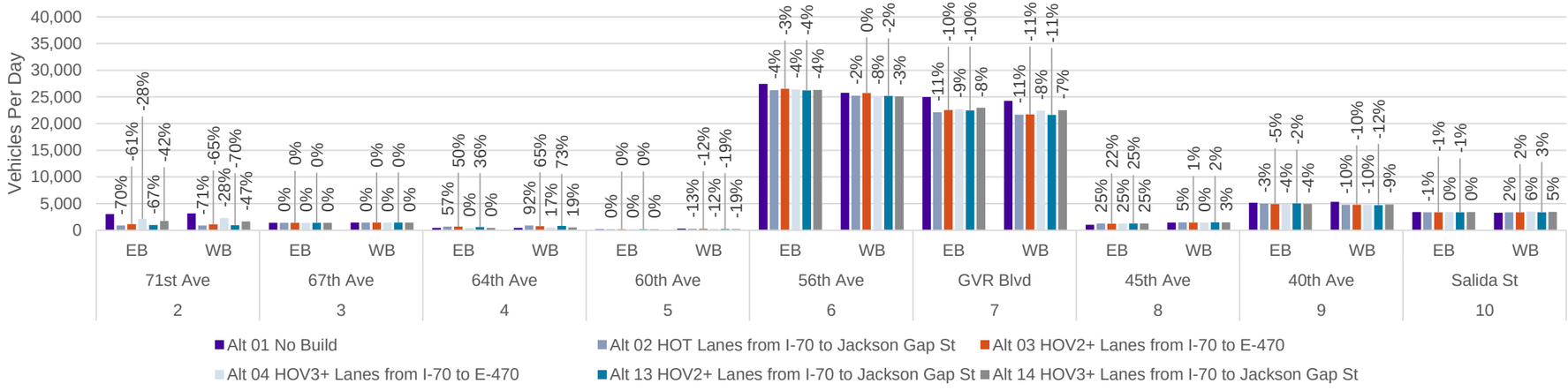
In general, the results for east/west local roadway show volumes on local roadways increase west of Peña Boulevard and decrease or remain similar to Alt 1: No Build just east of Peña Boulevard. This variation in volume changes corresponds to different ML management strategies with HOV 3+ concepts by showing a high-volume increase west of Peña Boulevard, and HOT and HOV2+ showing a lower increase in volumes. This pattern reflects the comparatively low utilization rate of the HOV3+ facility as compared to HOT and HOV2+ facilities. Having a low utilization rate on the direct connect between I-70 and Peña Boulevard results in more congestion through the interchange, and therefore more vehicles diverting onto the local roadway network. Figure 4-22, Figure 4-23, and Figure 4-24 show the results of east/west screenline volumes for concepts in Family C.

**Figure 4-22 – Family C – 2050 East/West Daily Vehicle Demand Crossing the West of Memphis Street Screenline**



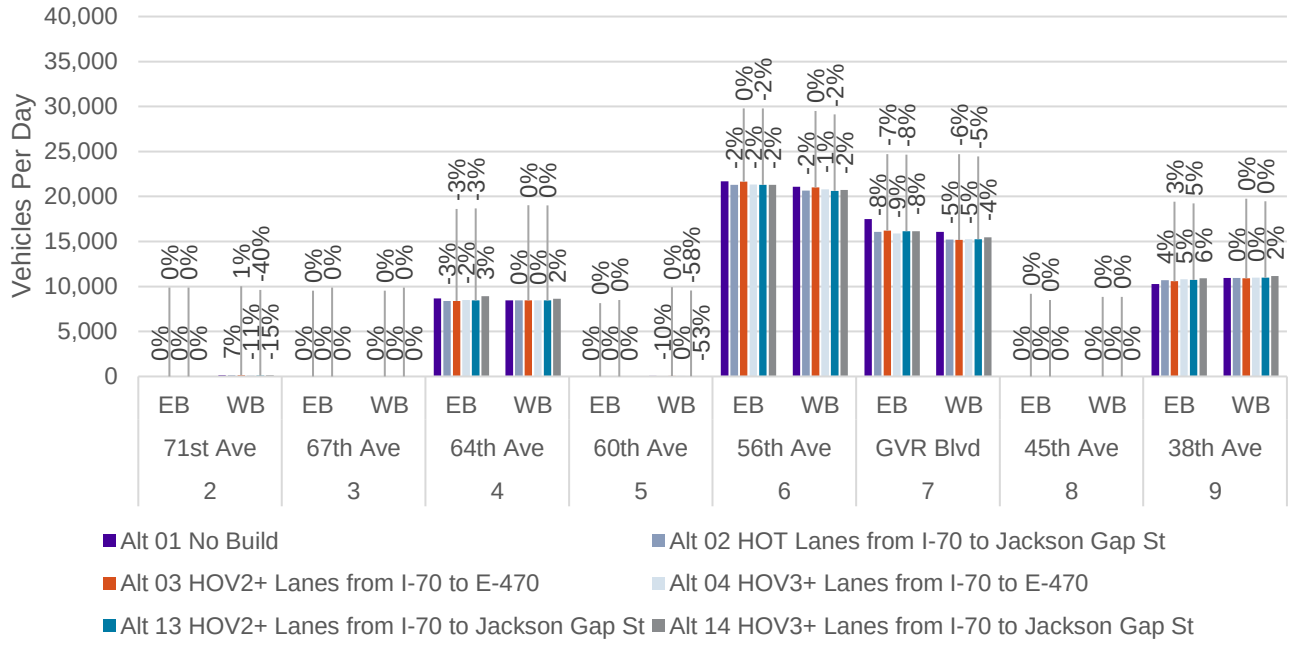

Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

**Figure 4-23 – Family C – 2050 East/West Daily Vehicle Demand Crossing the East of Telluride Street Screenline**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

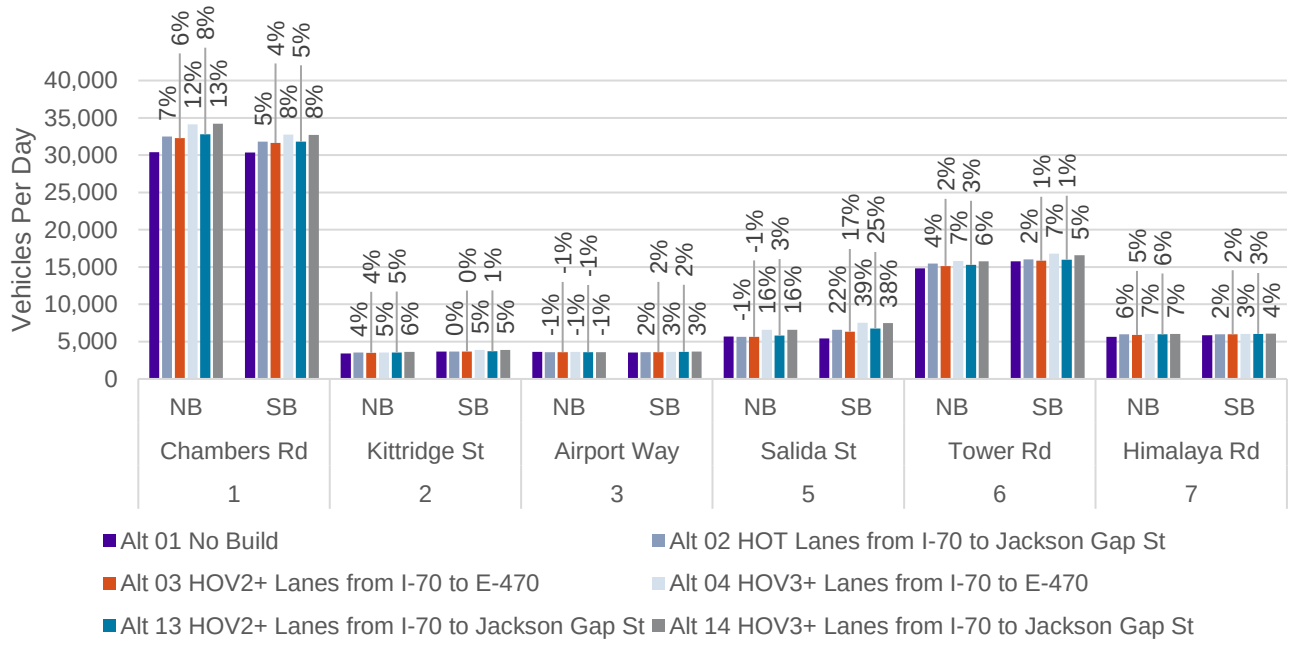
**Figure 4-24 – Family C – 2050 East/West Daily Vehicle Demand Crossing the East of Argonne Street Screenline**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

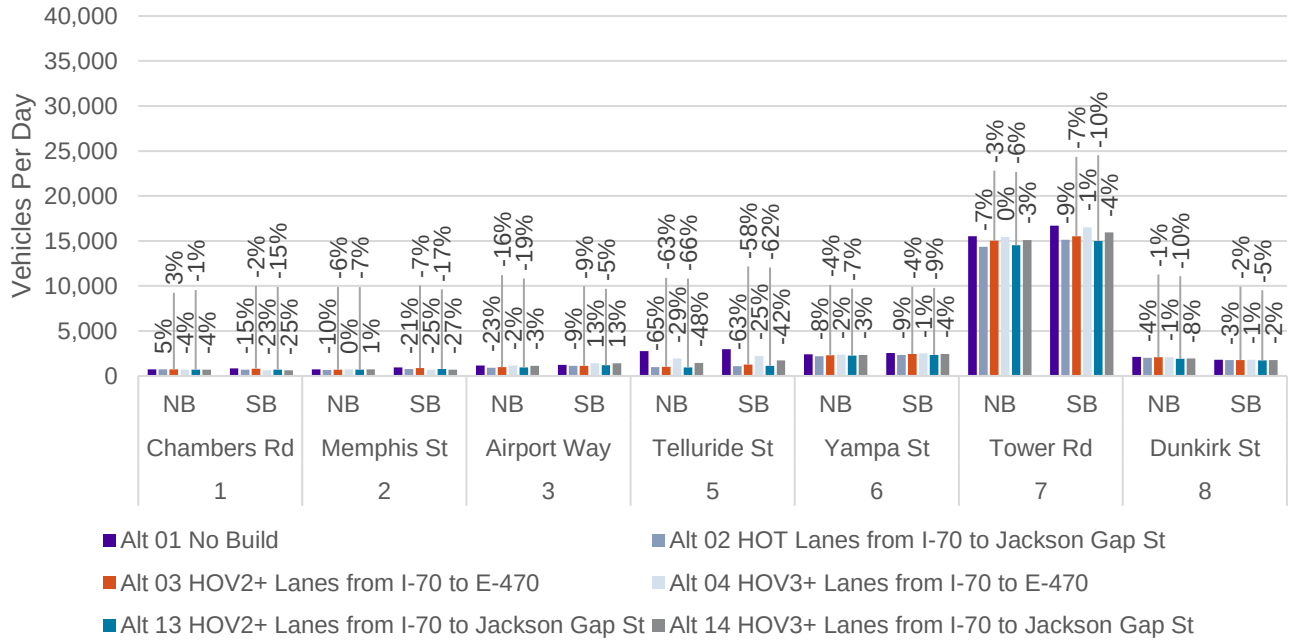
North/south local roadway volume results show that near 40th Avenue, local north/south roadway volumes are expected to increase because of the addition of MLs on Peña Boulevard. However, further to the north near the 56th Avenue and 64th Avenue north/south local roadway, volumes generally decrease with the additions of MLs on Peña Boulevard. The increase in north/south local roadway volumes near 40th Avenue aligns with the results of east/west local roadway volumes and indicates that vehicles are diverting from Peña Boulevard to local roadway facilities to avoid congestion on I-70. However, moving to the north, more vehicles choose to travel along Peña Boulevard with the addition of MLs because of the increased capacity along the freeway. Figure 4-25, Figure 4-26, and Figure 4-27 show the results of the north/south local roadway volumes for Family C concepts.

**Figure 4-25 – Family C – 2050 North/South Daily Vehicle Demand Crossing the North of 40th Avenue Screenline**



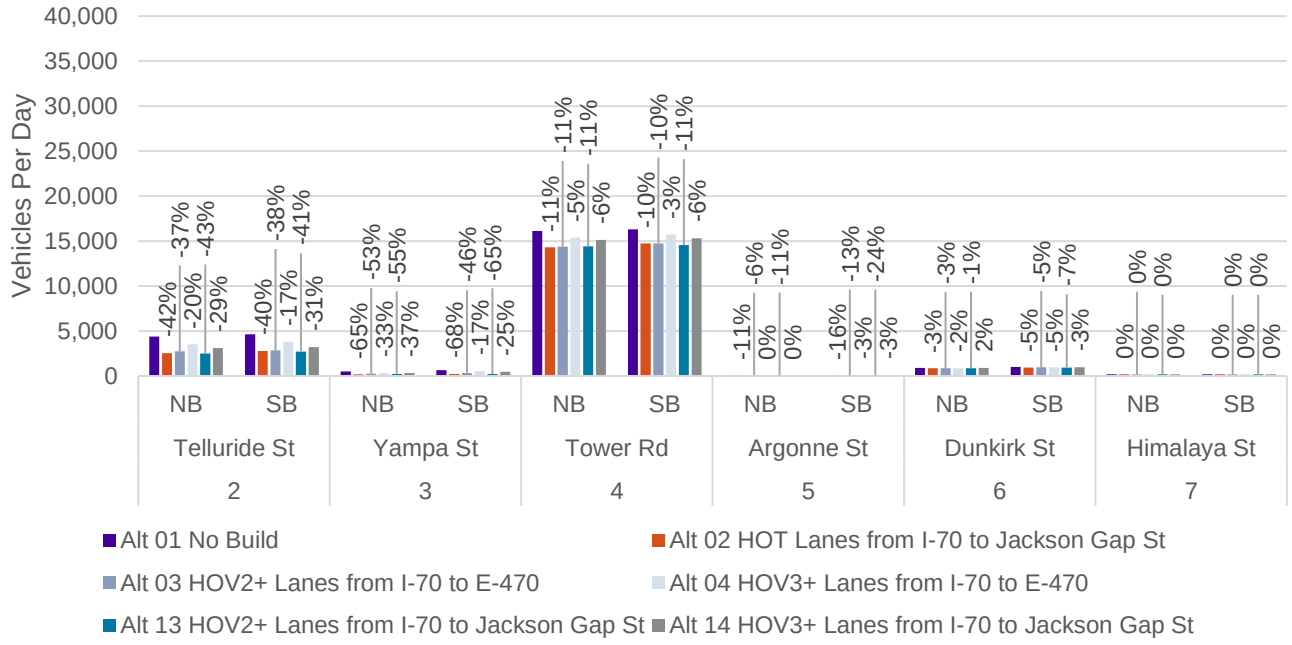

Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

**Figure 4-26 – Family C – 2050 North/South Daily Vehicle Demand Crossing the South of 56th Avenue Screenline**



Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

**Figure 4-27 – Family C – 2050 North/South Daily Vehicle Demand Crossing the South of 64th Avenue Screenline**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

## 4.1.4. Family D – Volume Results

The concepts within Family D evaluated the effects of providing a frontage road facility parallel to Peña Boulevard. Within this family, slight variations in configurations have been evaluated to provide an understanding of the following things:

- Impact of a different access configuration to/from Peña Boulevard
- Impact of a different number of lanes on the frontage road facility

### 4.1.4.1. Family D – Volumes on Peña Boulevard

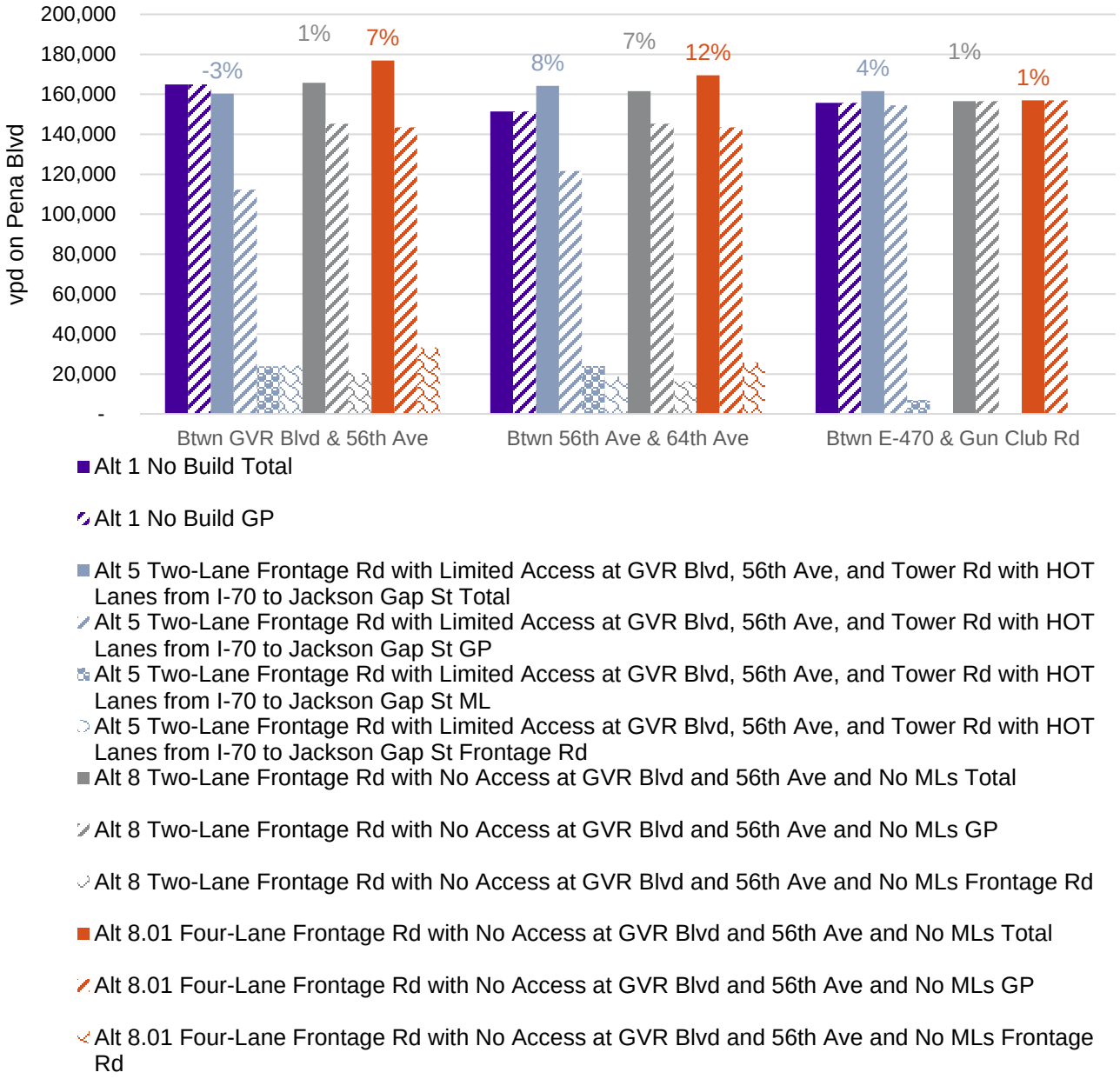
Volume results show that reducing access to/from Peña Boulevard and local roadways will reduce volumes on Peña Boulevard. The largest reduction in volumes is observed in Alt 5: Two-Lane Frontage Road with Limited Access at GVR Boulevard, 56th Avenue, and Tower Road with HOT Lanes from I-70 to Jackson Gap Street in which access to/from Peña Boulevard is only provided to/from the north. This reduction is even greater in Alt 8: Two-Lane Frontage Road with No Access at GVR Boulevard and 56th Avenue and no MLs and Alt 8.01: Four-Lane Frontage Road with No Access at GVR Boulevard and 56th Avenue and no MLs in which all access is eliminated at

GVR Boulevard and 56th Avenue. This reduction shows that even though some drivers utilize GVR Boulevard and 56th Avenue to access Peña Boulevard, a large amount of traffic is also generated from Tower Road.

The ML volume results in Alt 5: Two-Lane Frontage Road with Limited Access at GVR Boulevard, 56th Avenue, and Tower Road with HOT Lanes from I-70 to Jackson Gap Street also show that there is sufficient demand to fill an HOT lane even if there is no local access provided. This is similar to the results observed in Family C and affirm that there is sufficient HOT demand between I-70 and E-470/DEN to fill an HOT lane.

Volume results for the frontage road show that there is greater demand for a four-lane frontage road (two lanes in each direction), with the four-lane frontage road in Alt 8.01 carrying approximately 33,500 vehicles per day (vpd), or about 40 percent to 50 percent more traffic, as compared to 20,500 vpd to 24,000 vpd carried in two-lane frontage roads in Alt 8 and Alt 5, respectively. Figure 4-28 shows demand volumes on Peña Boulevard for concepts in Family D.

**Figure 4-28 – Family D – 2050 Daily Vehicle Demand Volumes on Peña Boulevard**



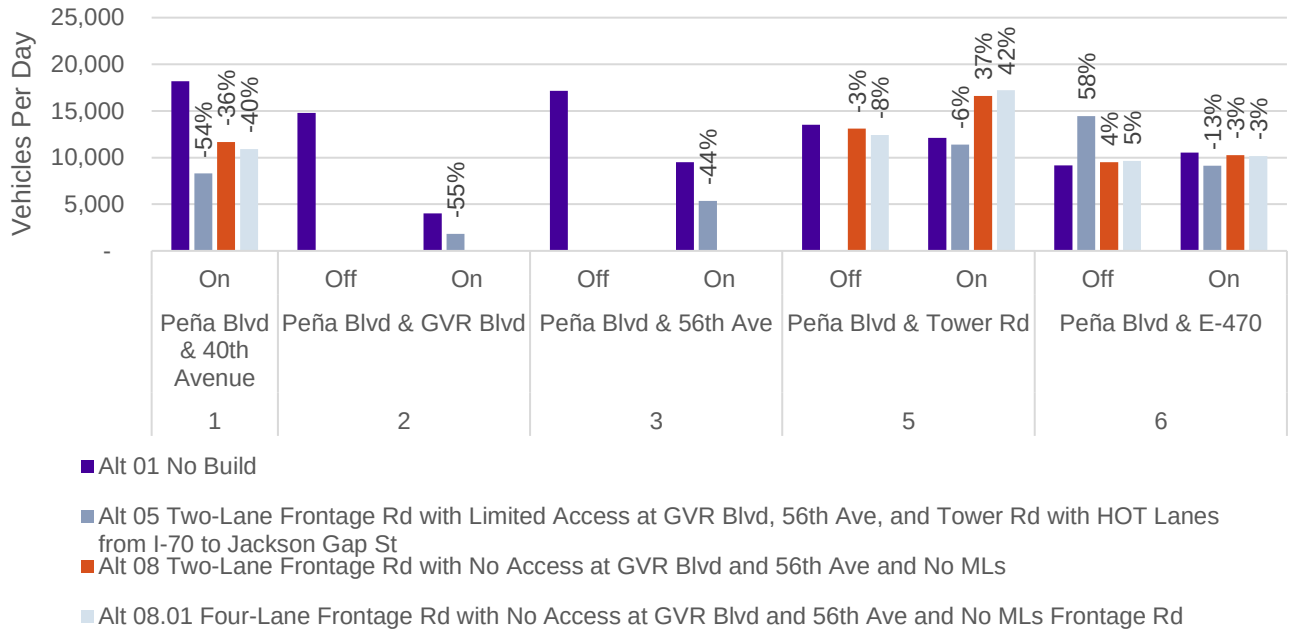

Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept.

#### 4.1.4.2. Family D – Interchange Volumes

Interchange volume results show that altering access to/from Peña Boulevard will impact traffic patterns. Reducing access at local interchanges to only provide access to Peña Boulevard to/from the north (Alt 5) results in an approximate 40 percent to 50 percent decrease in on-ramp and off-ramp traffic to local interchanges and an

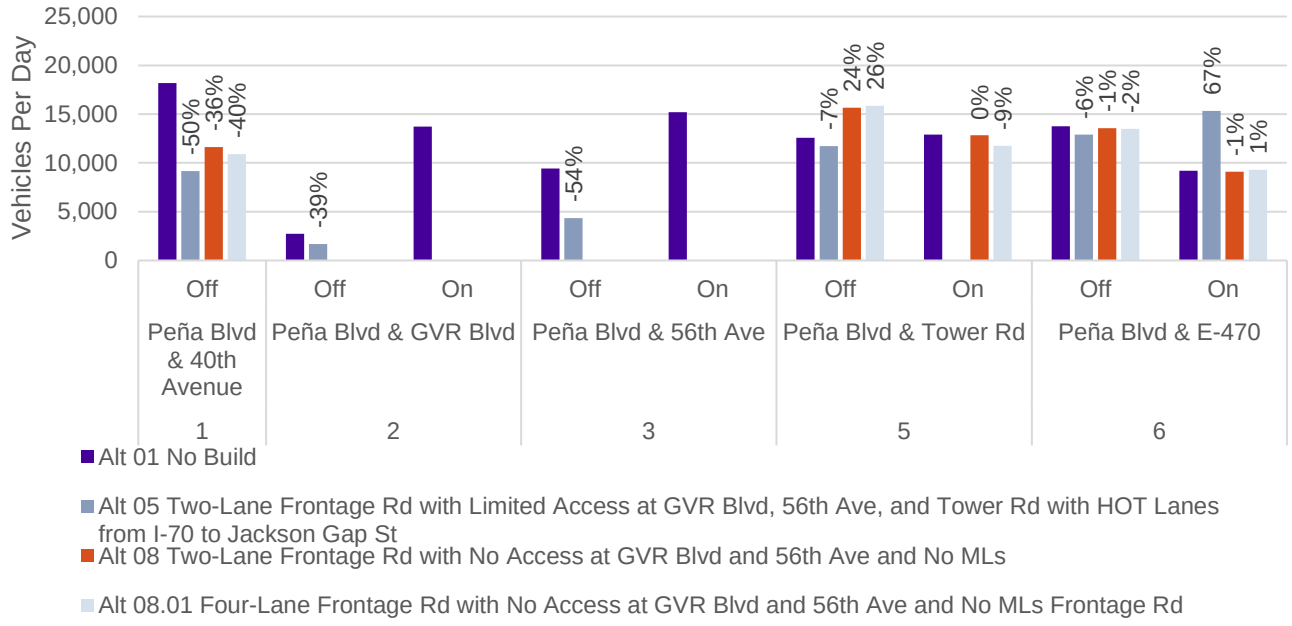
approximate 60 percent to 65 percent increase in traffic to E-470. This result indicates that although some trips are shifted to the frontage road or other non-Peña Boulevard facilities, some of the resulting capacity on Peña Boulevard is filled with either shifted trips or new trips to E-470. A similar effect is observed in Alt 8 and Alt 8.01; however, in these cases, trips are shifted to Tower Road (which in these concepts have a full interchange unlike Alt 5). Figure 4-29 and Figure 4-30 show the interchange volume results for concepts in Family D of inbound and outbound directions, respectively.

**Figure 4-29 – Family D – 2050 Inbound Daily Interchange Vehicle Demand Volumes**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

**Figure 4-30 – Family D – 2050 Outbound Daily Interchange Vehicle Demand Volumes**

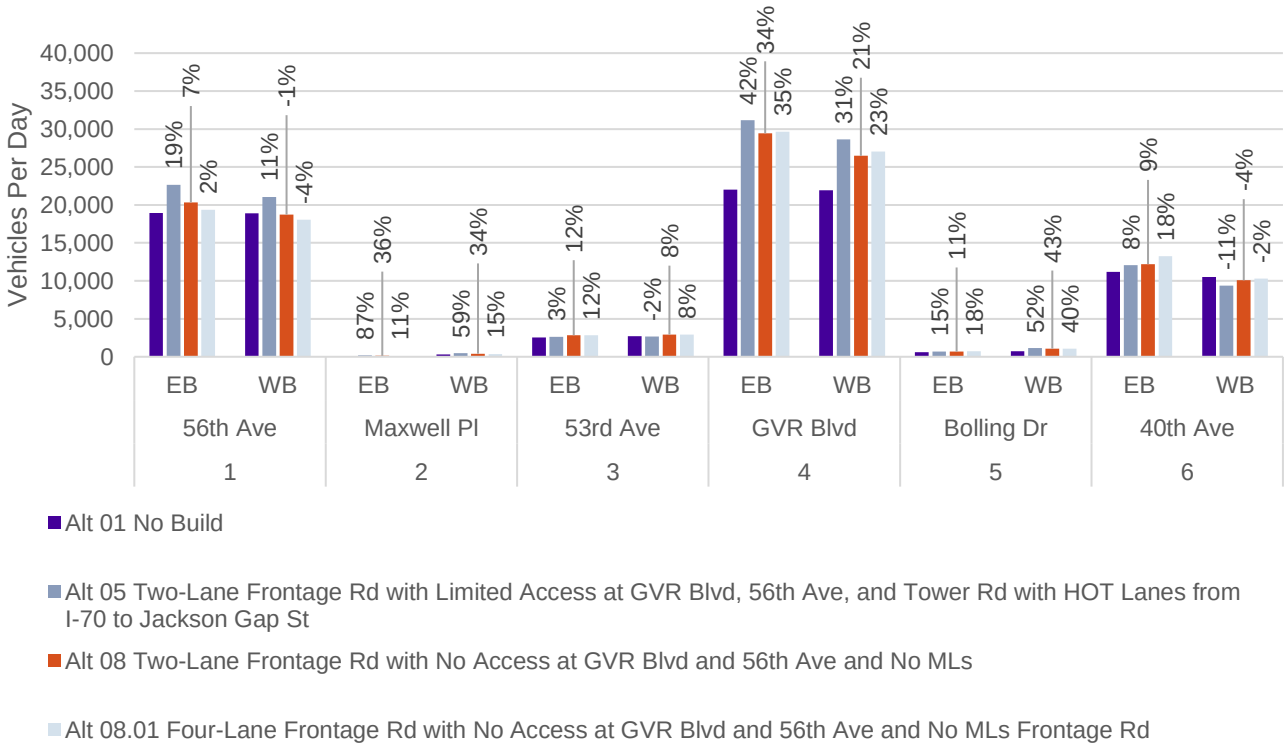



Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

#### 4.1.4.3. Family D – Local Roadway Volumes

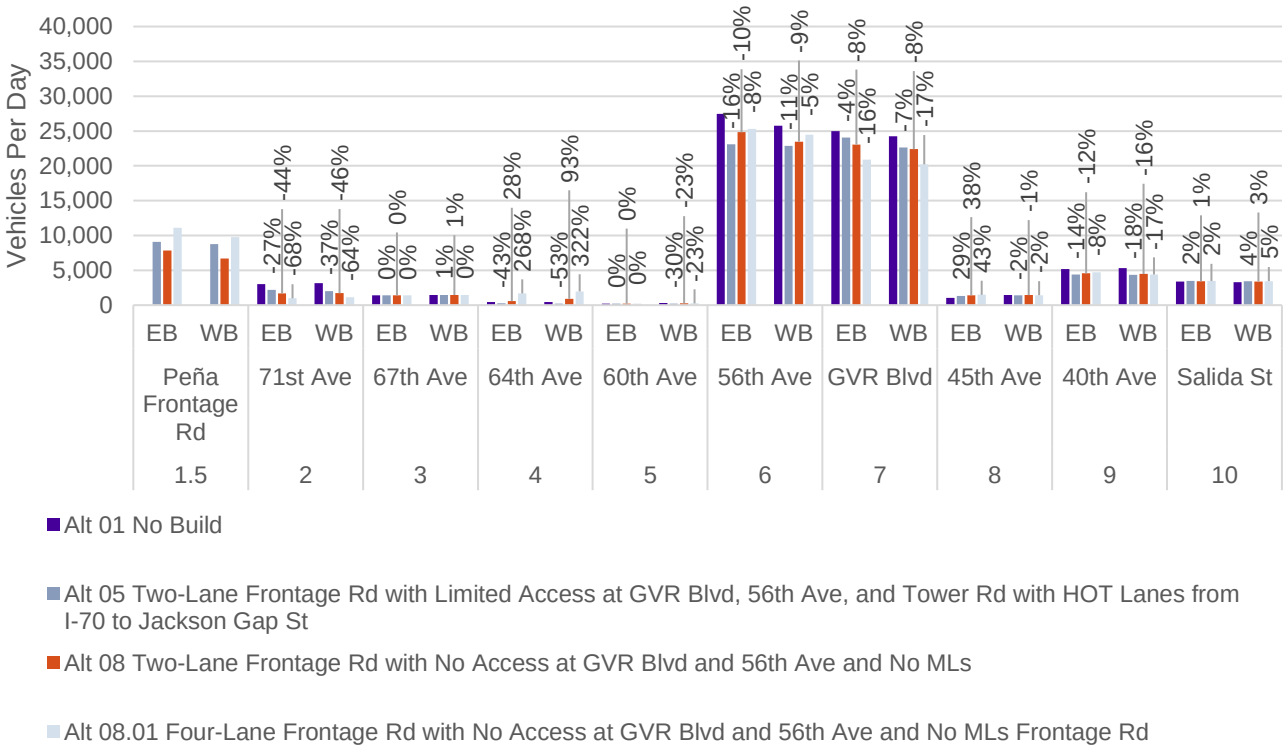
On east/west local roadways, adding a frontage road to Peña Boulevard generally results in an increase in east/west traffic west of Peña Boulevard and a decrease in east/west traffic east of Peña Boulevard as compared to Alt 1: No Build. West of Peña Boulevard, east/west local roadway volumes are expected to increase between approximately 20 percent and 40 percent in frontage road options as compared to Alt 1: No Build. This increase is the greatest in Alt 5 because of the partial ramp configuration providing access to Peña Boulevard from GVR Boulevard. Figure 4-31, Figure 4-32, and Figure 4-33 show daily demand volumes of east/west local roadway facilities for concepts in Family D.

**Figure 4-31 – Family D – 2050 East/West Daily Vehicle Demand Crossing the West of Memphis Street Screenline**



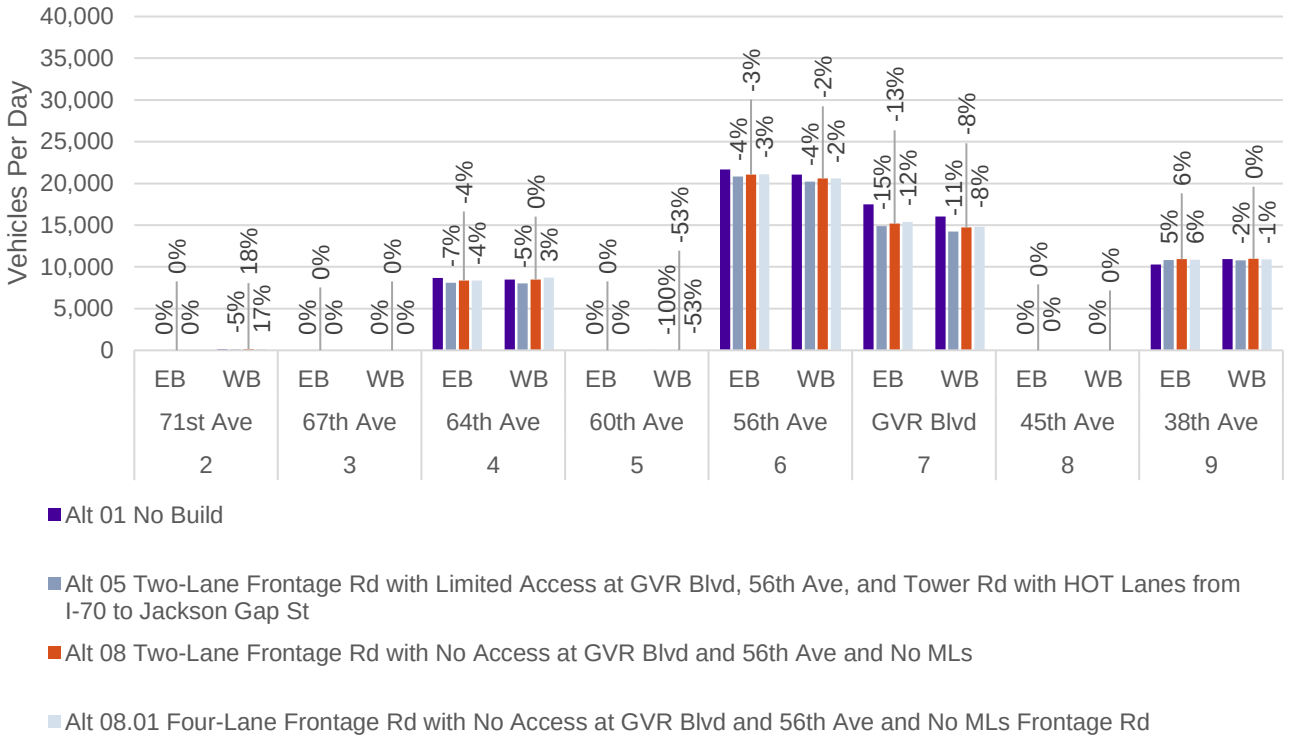

Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

**Figure 4-32 – Family D – 2050 East/West Daily Vehicle Demand Crossing the East of Telluride Street Screenline**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

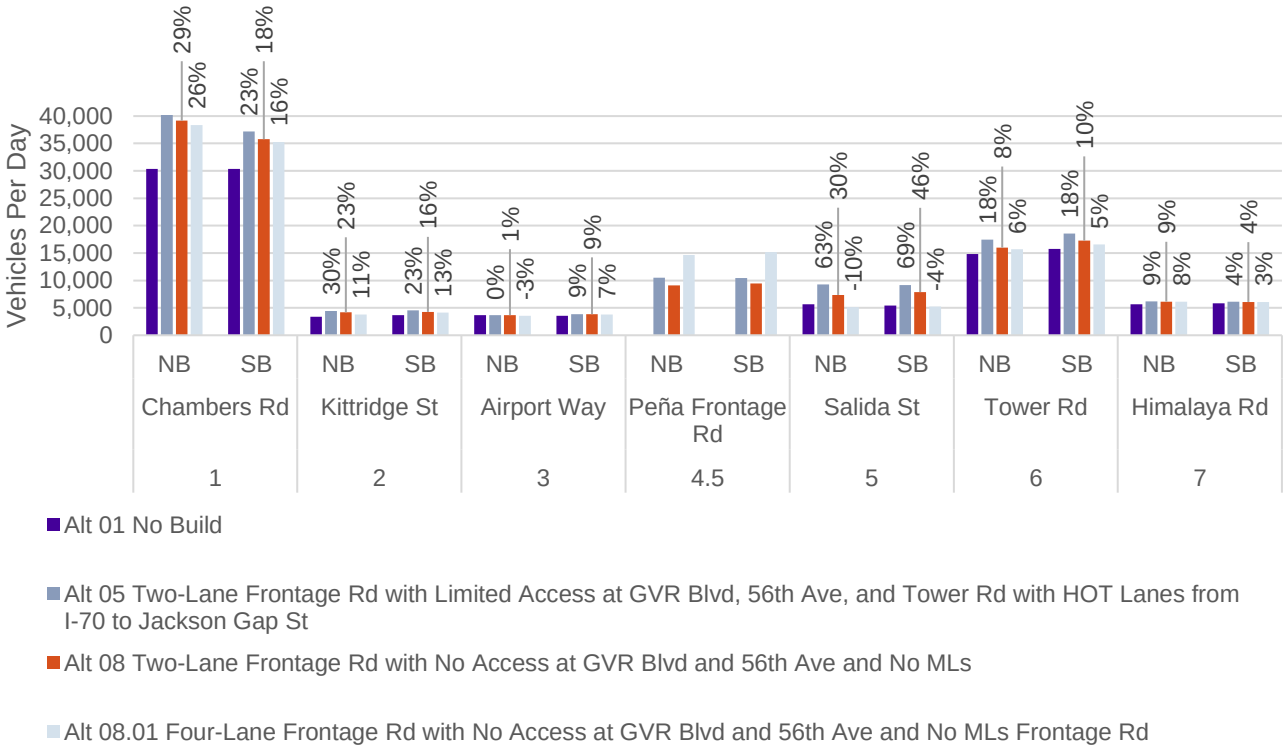
**Figure 4-33 – Family D – 2050 East/West Daily Vehicle Demand Crossing the East of Argonne Street Screenline**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

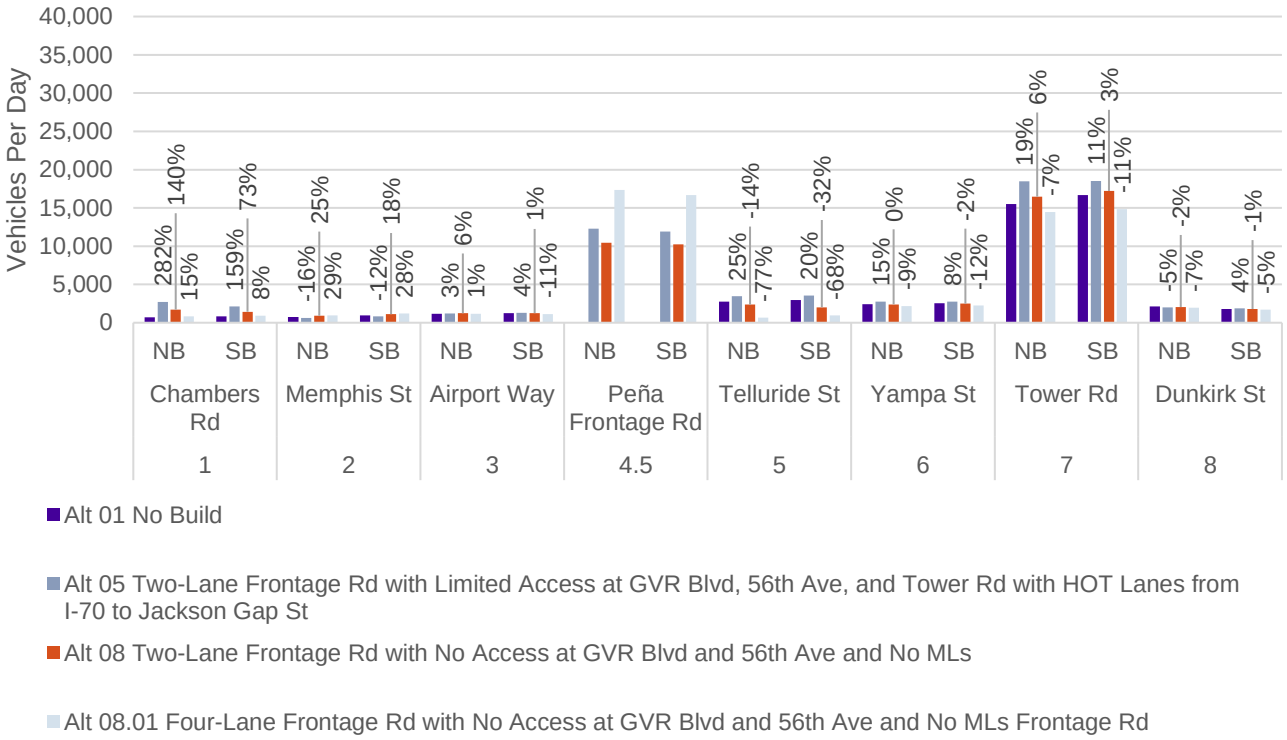
Along north/south local roadways, frontage road concepts are predicted to generally result in increased traffic. The largest increase in north/south local roadway traffic is expected in the southern portion of the study area (near 40th Avenue), with volumes on Chambers Road, Salida Street, and Tower Road generally showing an increase. The largest increase in north/south local roadway volumes is expected in Alt 5, with the smallest increase in traffic expected in Alt 8.01. Figure 4-34, Figure 4-35, and Figure 4-36 show daily demand volumes of north/south local roadway facilities for concepts in Family D.

**Figure 4-34 – Family D – 2050 North/South Daily Vehicle Demand Crossing the North of 40th Avenue Screenline**



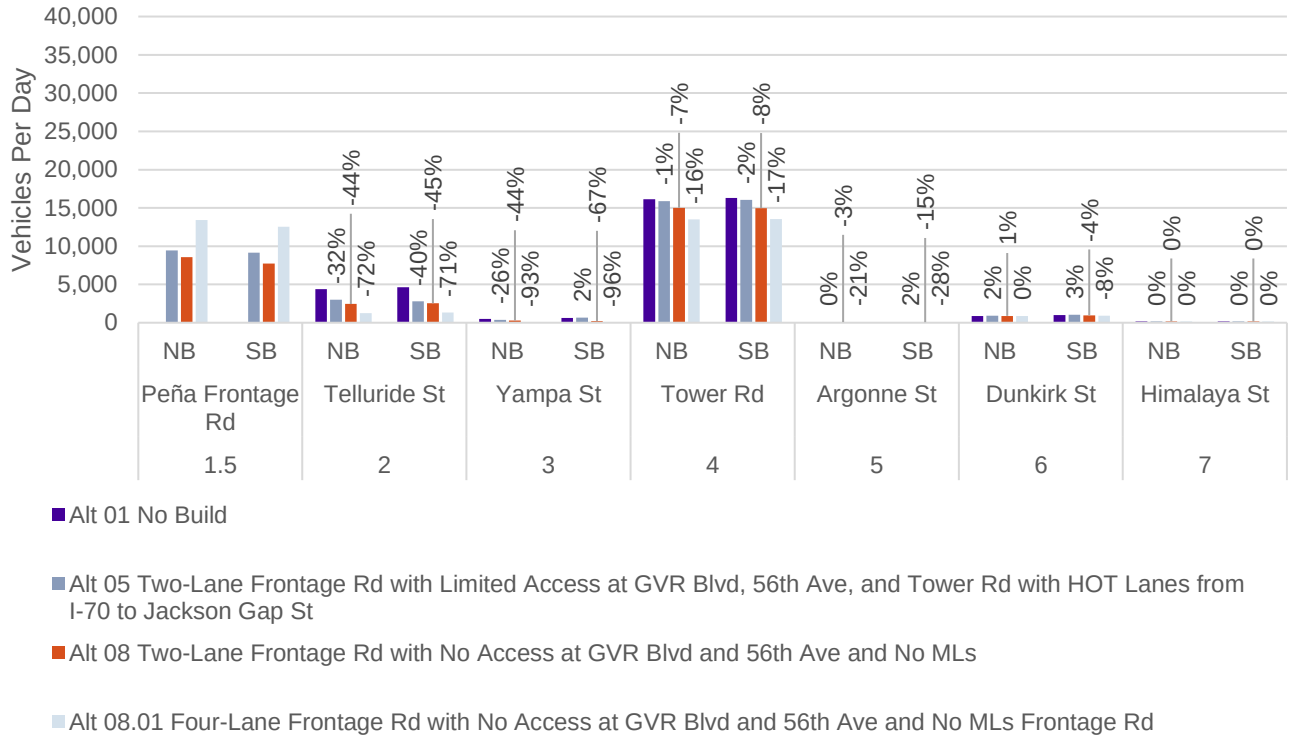

Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

**Figure 4-35 – Family D – 2050 North/South Daily Vehicle Demand Crossing the South of 56th Avenue Screenline**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

**Figure 4-36 – Family D – 2050 North/South Daily Vehicle Demand Crossing the South of 64th Avenue Screenline**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

## 4.1.5. Family E – Volume Results

The concepts within Family E evaluated the effects of providing CD roads along Peña Boulevard. Within this family, slight variations in configurations have been evaluated to provide an understanding of the following things:

- Impact of different extents of CD road facilities
- Impact of HOT lanes combined with CD road facilities
- Impact of a different number of lanes within CD road facilities

### 4.1.5.1. Family E – Volumes on Peña Boulevard

Adding CD roads to Peña Boulevard is expected to increase volumes along Peña Boulevard between 3 percent and 20 percent as compared to Alt 1: No Build. The largest increase in volumes is expected in the southern portion of the corridor, with the smallest changes in volumes in the northern portion of the corridor.

Within different CD road configurations evaluated, having a two-lane CD road in each direction between I-70 and Tower Road (Alt 10.01) results in the largest increase in traffic on Peña Boulevard whereas providing a single lane

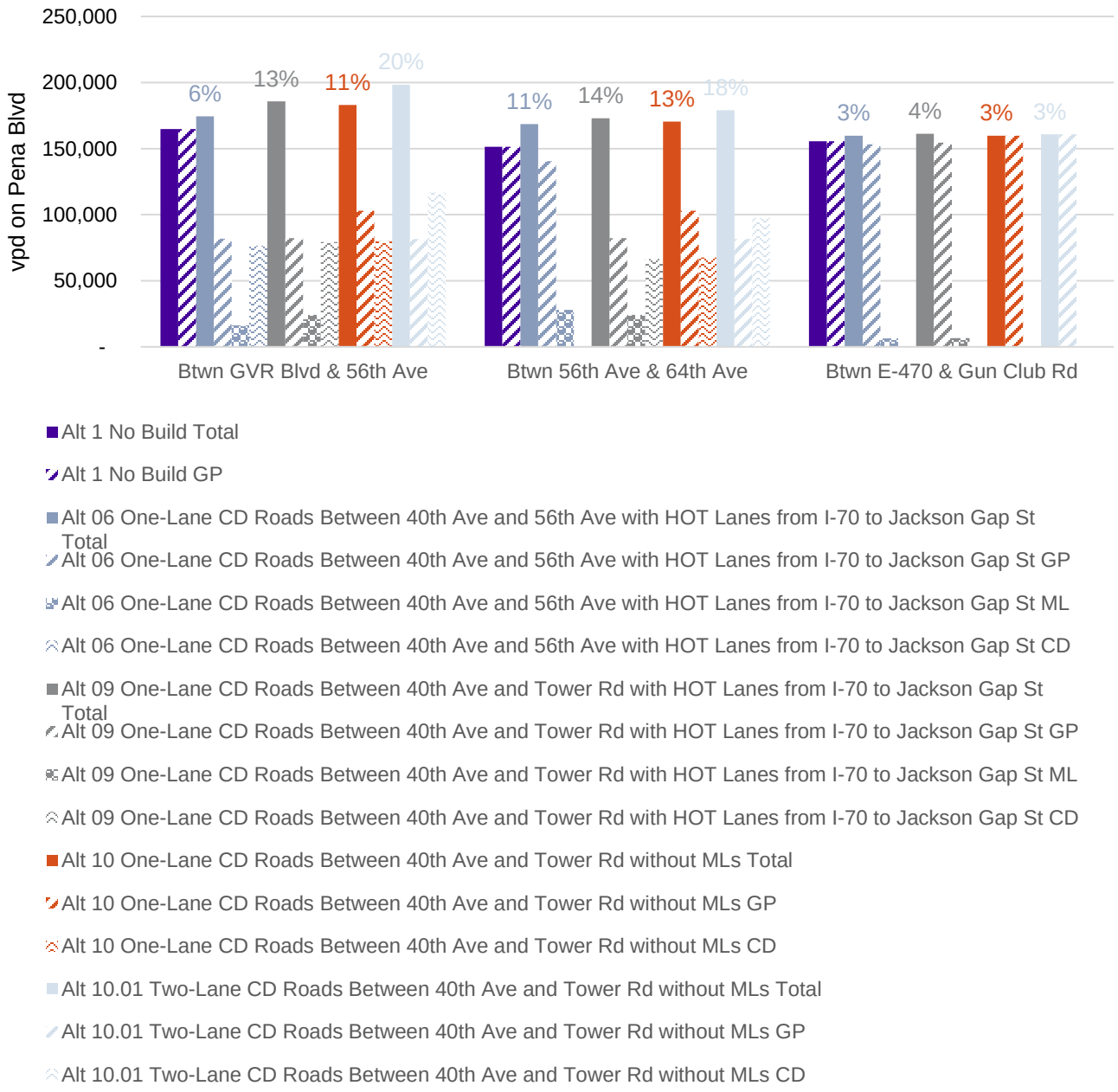
CD road from I-70 to 56th Avenue (Alt 6) results in the smallest increase in volumes on Peña Boulevard. This change is because the demand to utilize a CD road facility exceeds the capacity of a single lane, particularly in the southern portion of the corridor.

The effect of an ML facility paired with a CD road facility (Alt 10) is expected to result in a small (approximately 1 percent) difference in overall volumes on Peña Boulevard as compared to a concept without an ML facility (Alt 9).

Due to a high demand to utilize Peña Boulevard, the TDM modeling results indicate that some drivers will choose to utilize CD roads as an alternative to the GP lanes (i.e., using CD roads to bypass congestion in GP lanes with no intent of exiting Peña Boulevard), with volumes between two parallel facilities being similar.

Figure 4-37 shows demand volumes for Peña Boulevard in different CD road concepts in Family E.

**Figure 4-37 – Family E – 2050 Daily Vehicle Demand on Peña Boulevard**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept.

#### 4.1.5.2. Family E – Interchange Volumes

In general, inbound interchange volume results show that providing a CD road facility increases on-ramp traffic at 40th Avenue and GVR Boulevard and increases off-ramp traffic to Tower Road and E-470. The greatest increase in

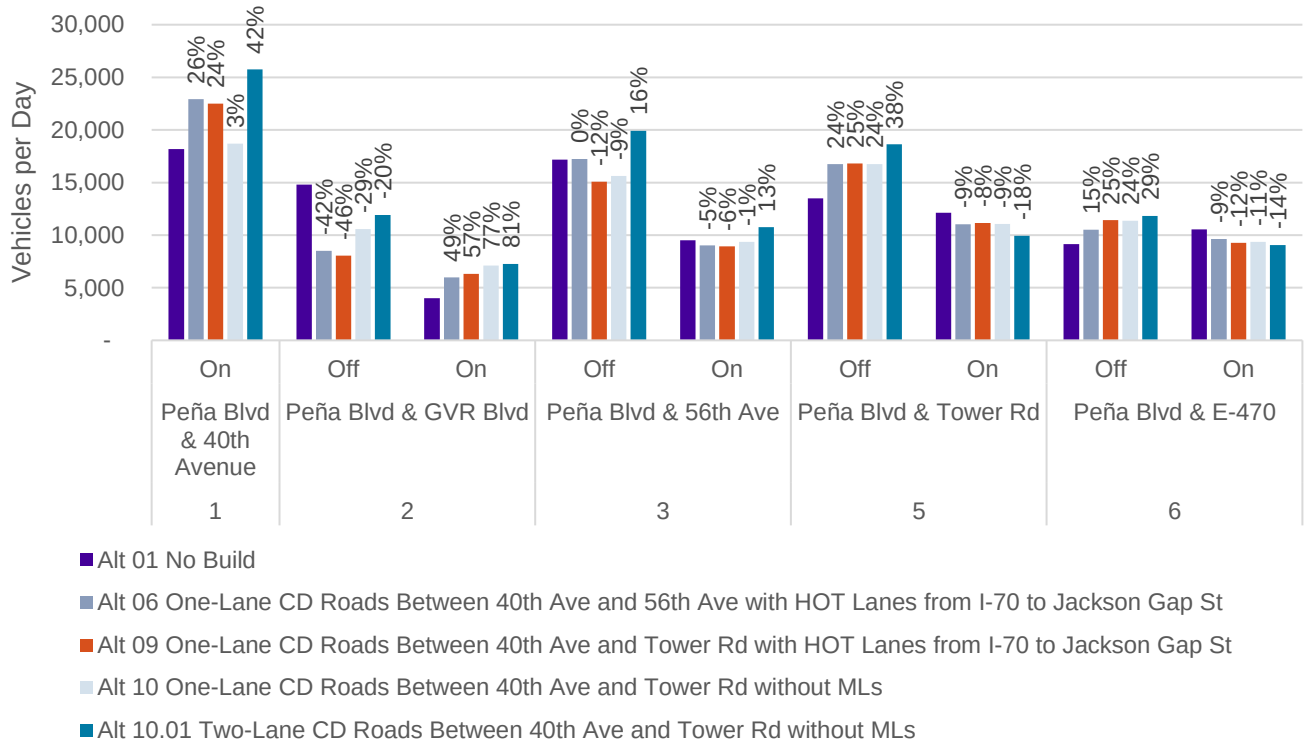
volumes is expected in Alt 10.01 because the two-lane CD road facility in this concept provides more capacity as compared to the single-lane CD road facilities in Alt 6, Alt 9, and Alt 10.

Alt 10 shows a unique inbound interchange volume pattern at 40th Avenue and GVR Boulevard as compared to other CD road concepts. This pattern is because Alt 10 does not have an ML along Peña Boulevard. The lack of an ML results in less capacity on Peña Boulevard as compared to Alt 6 and Alt 9. Because of this reduced capacity, fewer vehicles enter Peña Boulevard at 40th Avenue. Although Alt 10.01 also does not include an ML facility on Peña Boulevard, this same pattern is not observed because the additional lane on the CD road facility provides additional capacity to Peña Boulevard.

Comparing the results for Alt 6 and Alt 9 show that extending the inbound CD road from 56th Avenue to Tower Road results in approximately 8 percent more on-ramp traffic from GVR Boulevard and approximately 12 percent less off-ramp traffic to 56th Avenue.

Figure 4-38 shows the demand volume results of inbound interchanges for concepts in Family E.

**Figure 4-38 – Family E – 2050 Inbound Daily Interchange Vehicle Demand Volume**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

In the outbound direction, the addition of CD roads along Peña Boulevard are generally expected to increase on-ramp traffic at E-470 and Tower Road and increase off-ramp traffic to GVR Boulevard and 40th Avenue. The largest

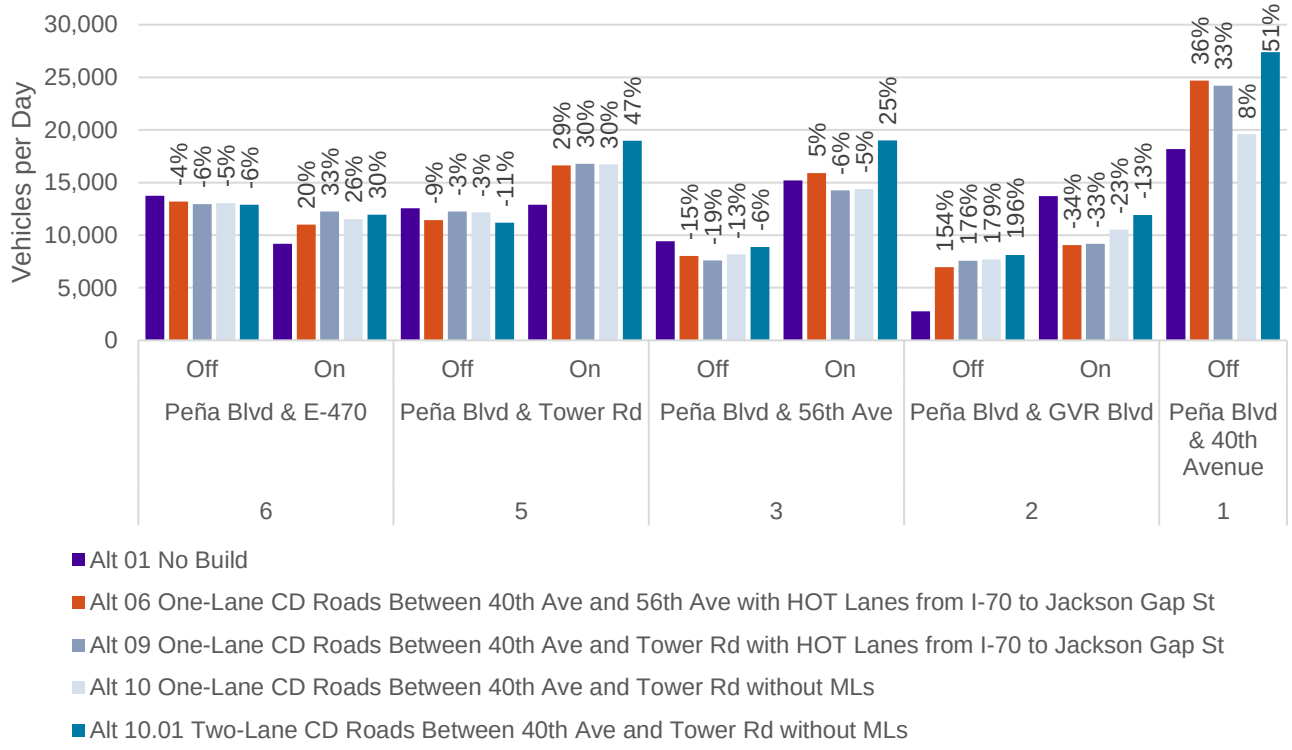
increase is observed in Alt 10.01 because the two-lane CD layout provides the most additional capacity along Peña Boulevard.

Alt 10 shows a unique outbound interchange volume pattern at 40th Avenue as compared to other CD road concepts. This pattern is because Alt 10 does not have an ML along Peña Boulevard. The lack of an ML results in less capacity on Peña Boulevard as compared to Alt 6 and Alt 9. Because of this reduced capacity, fewer vehicles exit Peña Boulevard at 40th Avenue. Although Alt 10.01 also does not include an ML facility on Peña Boulevard, this same pattern is not observed because the additional lane on the CD road facility provides additional capacity to Peña Boulevard.

Comparing the results for Alt 6 and Alt 9 show that extending the outbound CD road from Tower Road to 56th Avenue results in additional traffic from E-470 and Tower Road (13 percent and 1 percent, respectively) and an additional 22 percent off-ramp traffic to GVR Boulevard.

Figure 4-39 shows the demand volume results of outbound interchanges for concepts in Family E.

**Figure 4-39 – Family E – 2050 Outbound Daily Interchange Vehicle Demand Volumes**

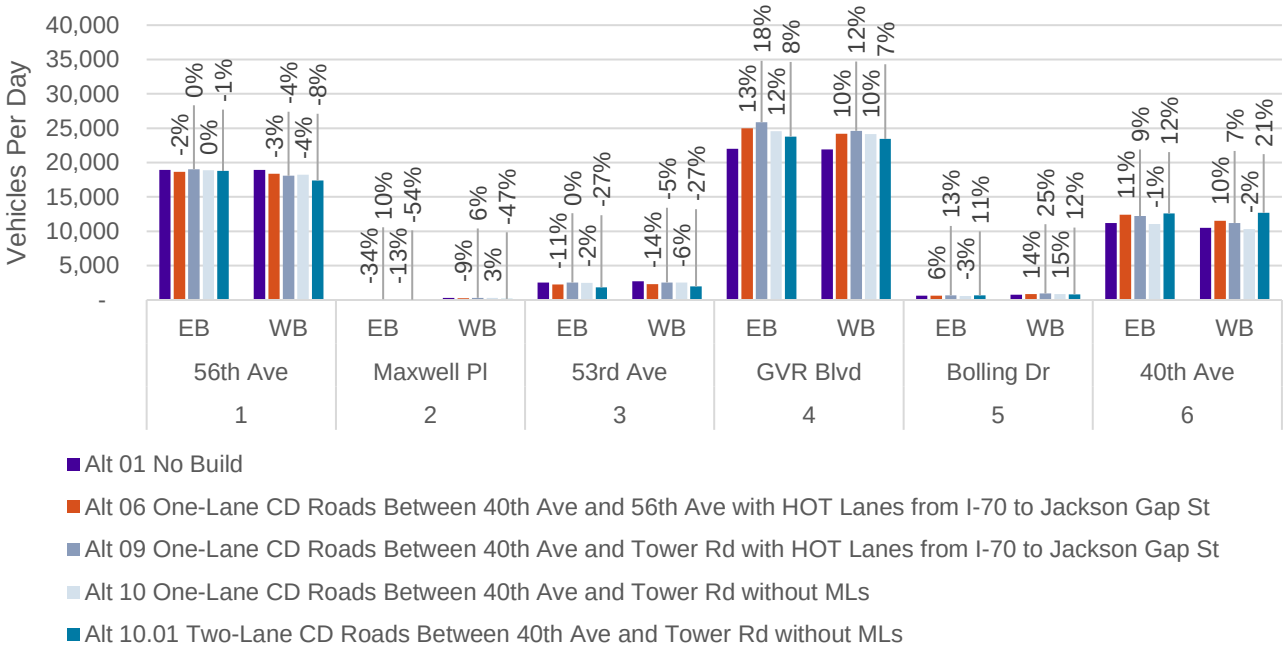



Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

#### 4.1.5.3. Family E – Local Roadway Volumes

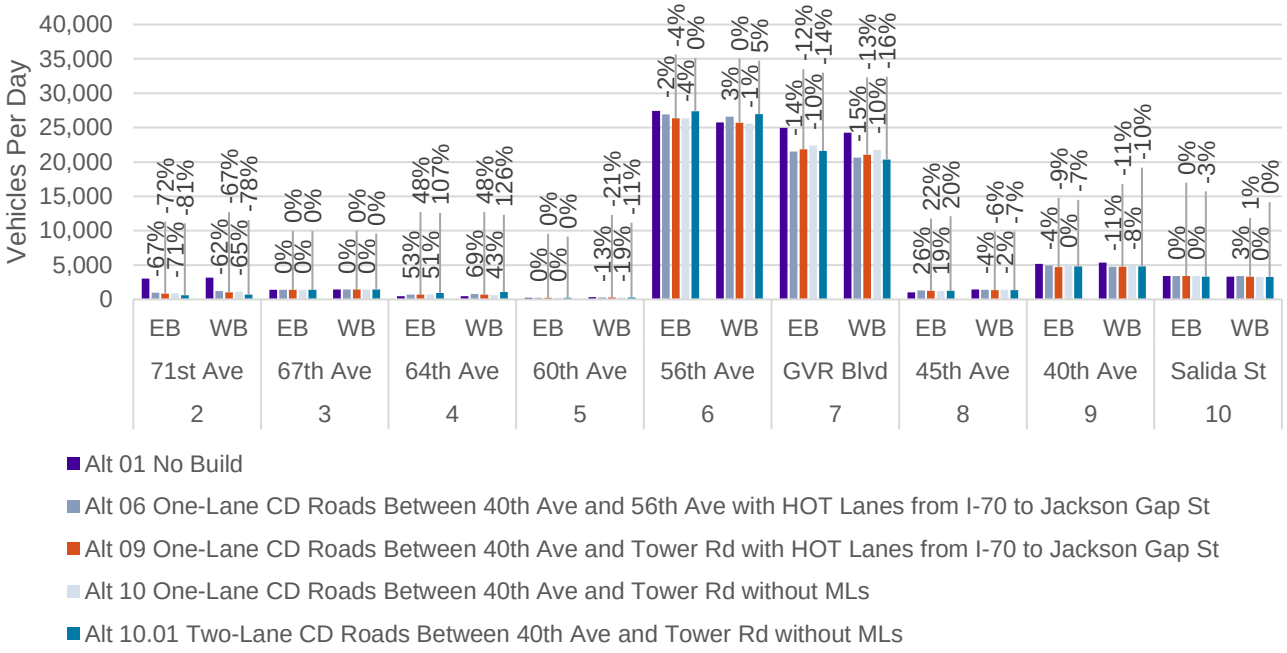
Along east/west local roadways, the largest change in volumes resulting from CD road facilities along Peña Boulevard are expected to be along GVR Boulevard. West of Peña Boulevard, volumes on GVR Boulevard are expected increase in all CD road concepts, while volumes along GVR Boulevard east of Peña Boulevard are expected to decrease in all CD road concepts. The extents of CD roads or the presence of an ML facility does not have a large impact on east/west local roadway volumes. Figure 4-40, Figure 4-41, and Figure 4-42 show demand volumes of east/west local roadway facilities for concepts in Family E.

**Figure 4-40 – Family E – 2050 East/West Daily Vehicle Demand Crossing the West of Memphis Street Screenline**



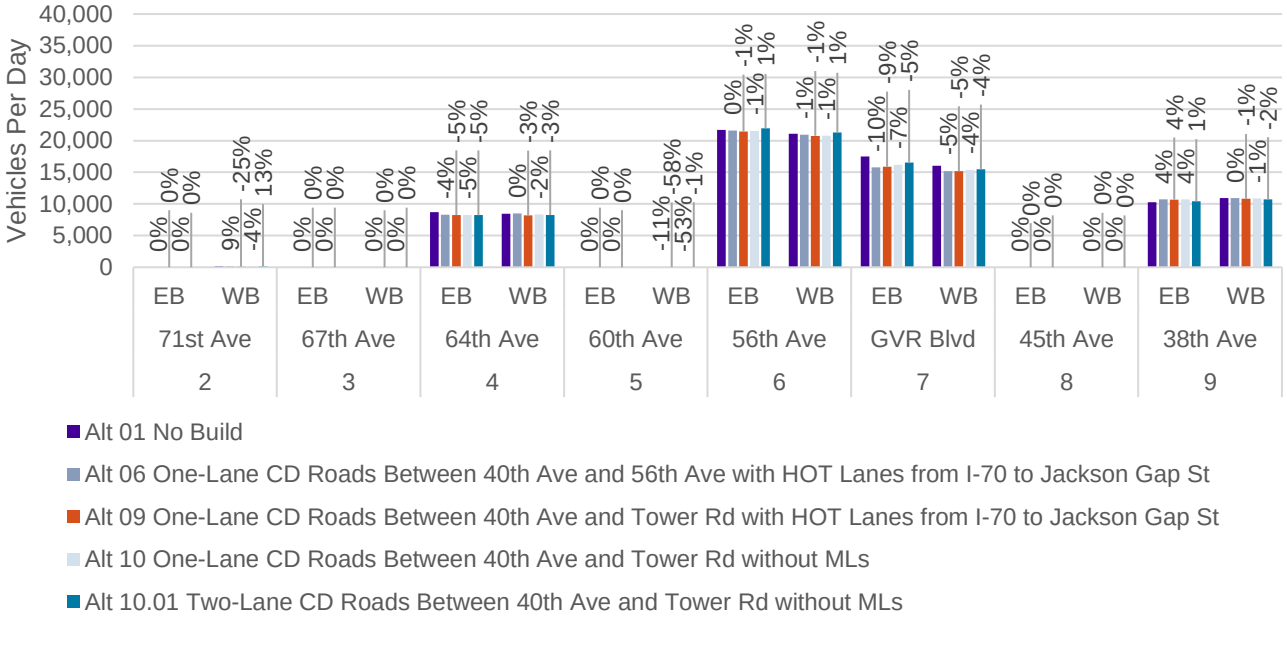

Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

**Figure 4-41 – Family E – 2050 East/West Daily Vehicle Demand Crossing the East of Telluride Street Screenline**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

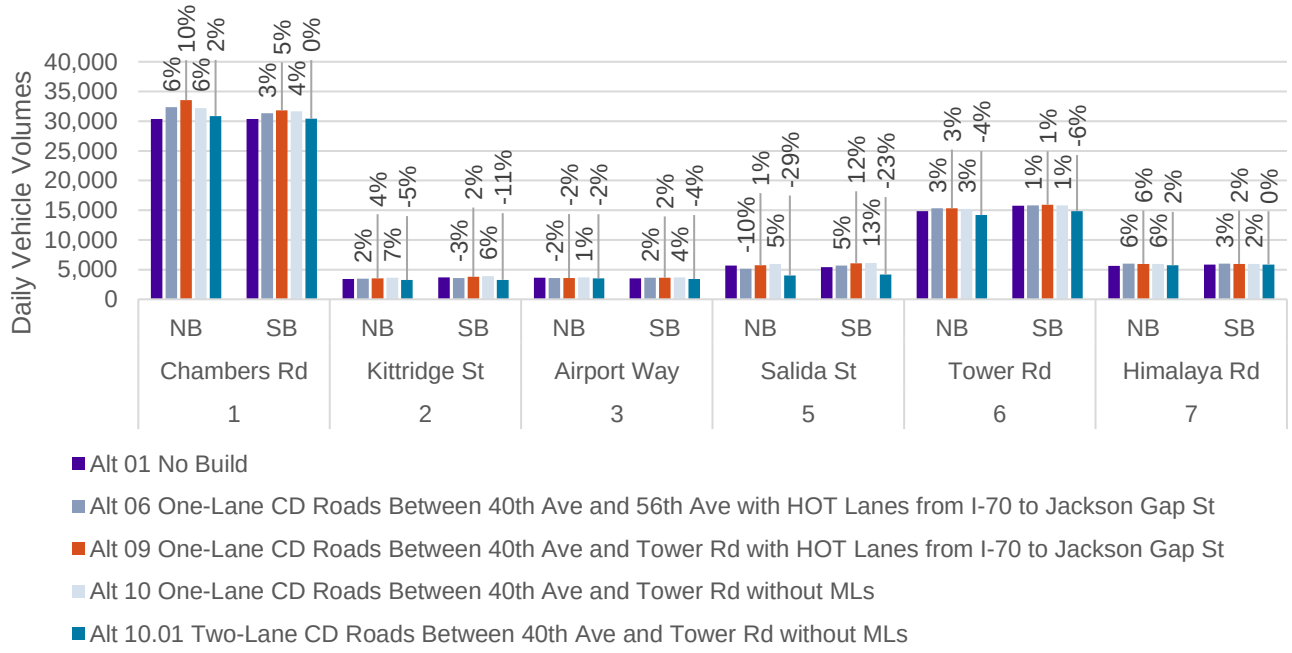
**Figure 4-42 – Family E – 2050 East/West Daily Vehicle Demand Crossing the East of Argonne Street Screenline**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

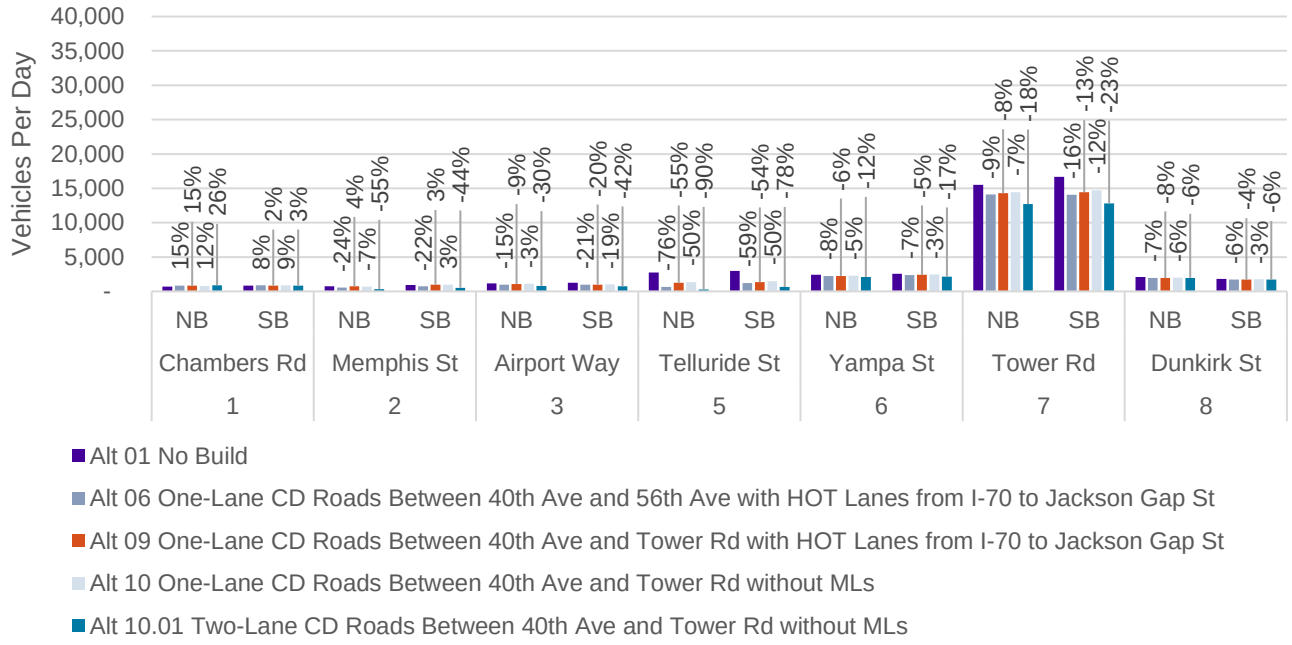
Along local north/south roadways, adding CD roads along Peña Boulevard is expected to generally result in north/south demand volumes to remain similar or decrease as compared to Alt 1: No Build. The largest reductions are expected along Tower Road and north of 56th Avenue, with the two-lane CD road configuration in Alt 10.01 resulting in the greatest traffic reduction on north/south roadways. Figure 4-43, Figure 4-44, and Figure 4-45 show daily demand volumes of north/south local roadway facilities for concepts in Family E.

**Figure 4-43 – Family E – 2050 North/South Daily Vehicle Demand Crossing the North of 40th Avenue Screenline**



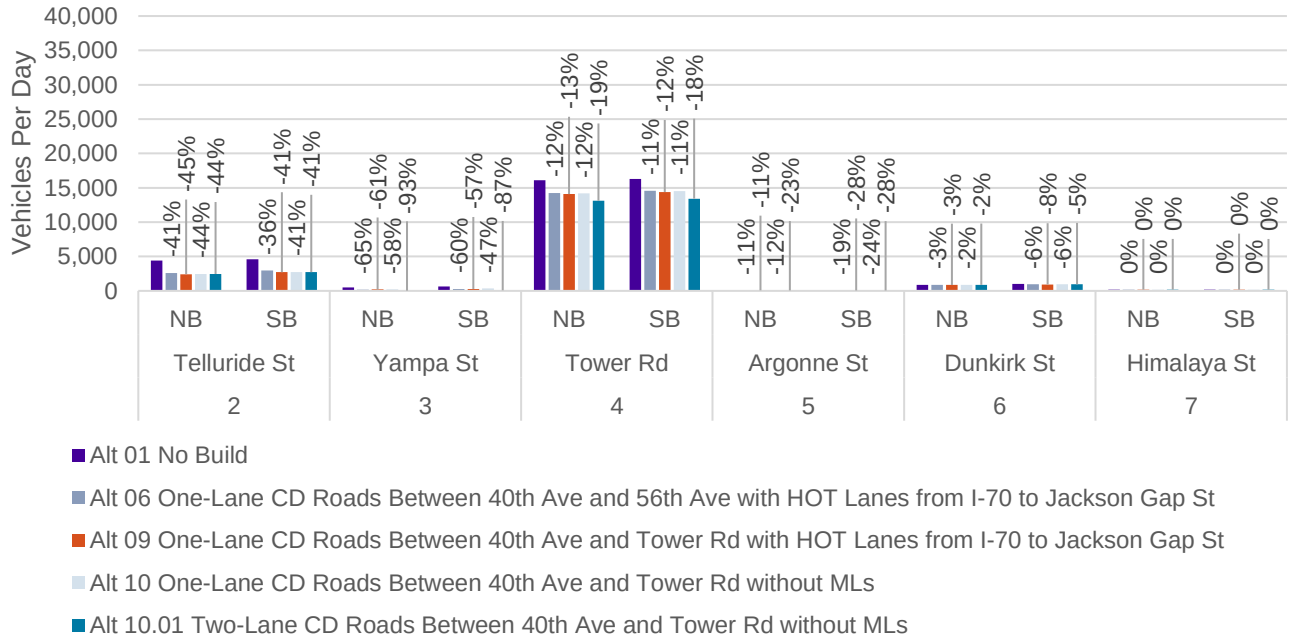

Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

**Figure 4-44 – Family E – 2050 North/South Daily Vehicle Demand Crossing the South of 56th Avenue Screenline**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

**Figure 4-45 – Family E – 2050 North/South Daily Vehicle Demand Crossing the South of 64th Avenue Screenline**



Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

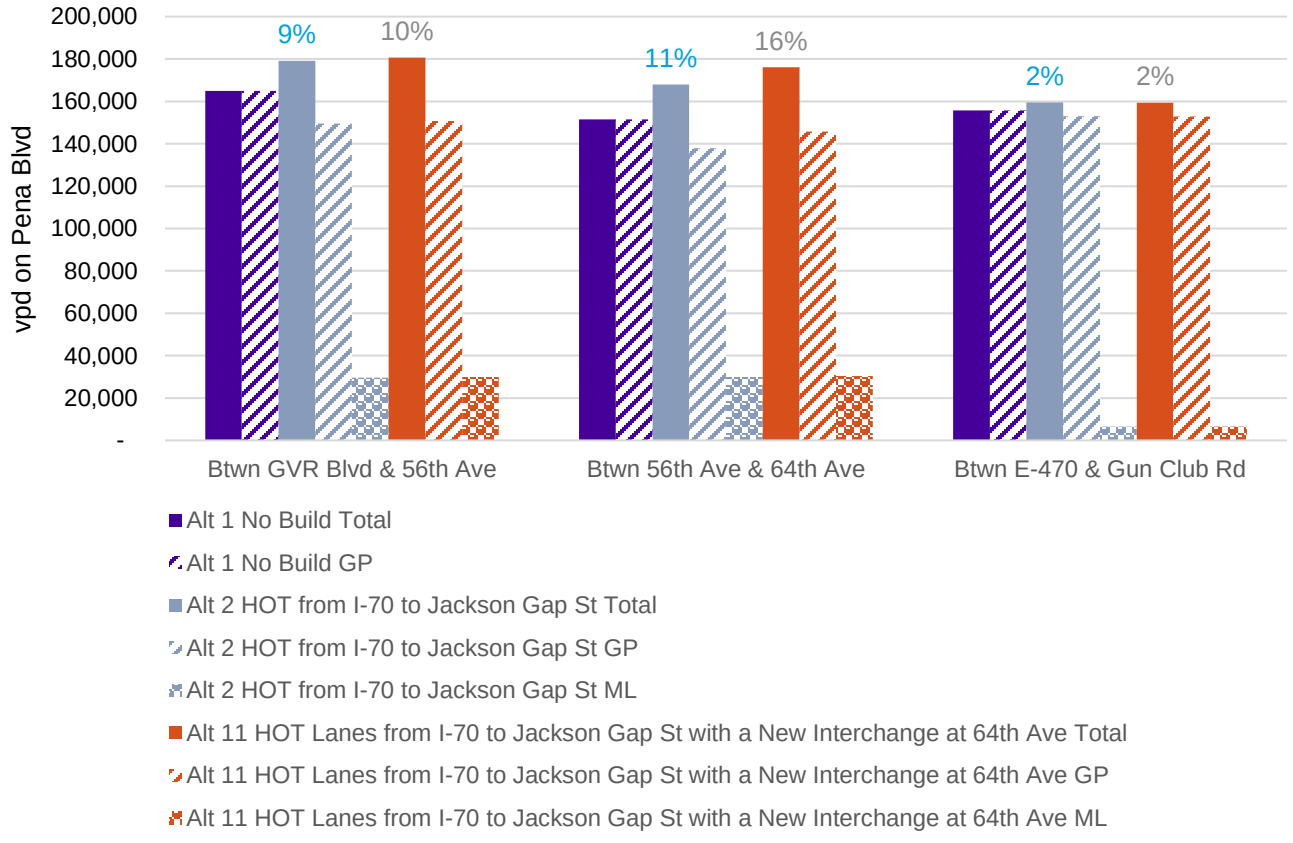
### 4.1.6. Family F – Volume Results

The single concept evaluated in Family F proposed to add a new interchange along Peña Boulevard at 64th Avenue. For evaluation purposes, this concept was assumed to also include an HOT facility on Peña Boulevard from I-70 to Jackson Gap Street. To isolate the impacts of the new interchange, results for Alt 11, which includes the new interchange at 64th Avenue, are compared to both Alt 1: No Build and Alt 2: HOT from I-70 to Jackson Gap Street.

#### 4.1.6.1. Family F – Volumes on Peña Boulevard

Providing a new interchange at 64th Avenue is expected to primarily impact volumes on Peña Boulevard between 56th Avenue and 64th Avenue. Within this segment, a new interchange as 64th Avenue (Alt 11) is expected to result in an approximate 5 percent increase in demand volumes as compared to a similar concept without an interchange at 64th Avenue (Alt 2). Figure 4-46 shows demand volumes for Peña Boulevard.

**Figure 4-46 – Family F – 2050 Daily Vehicle Demand on Peña Boulevard**

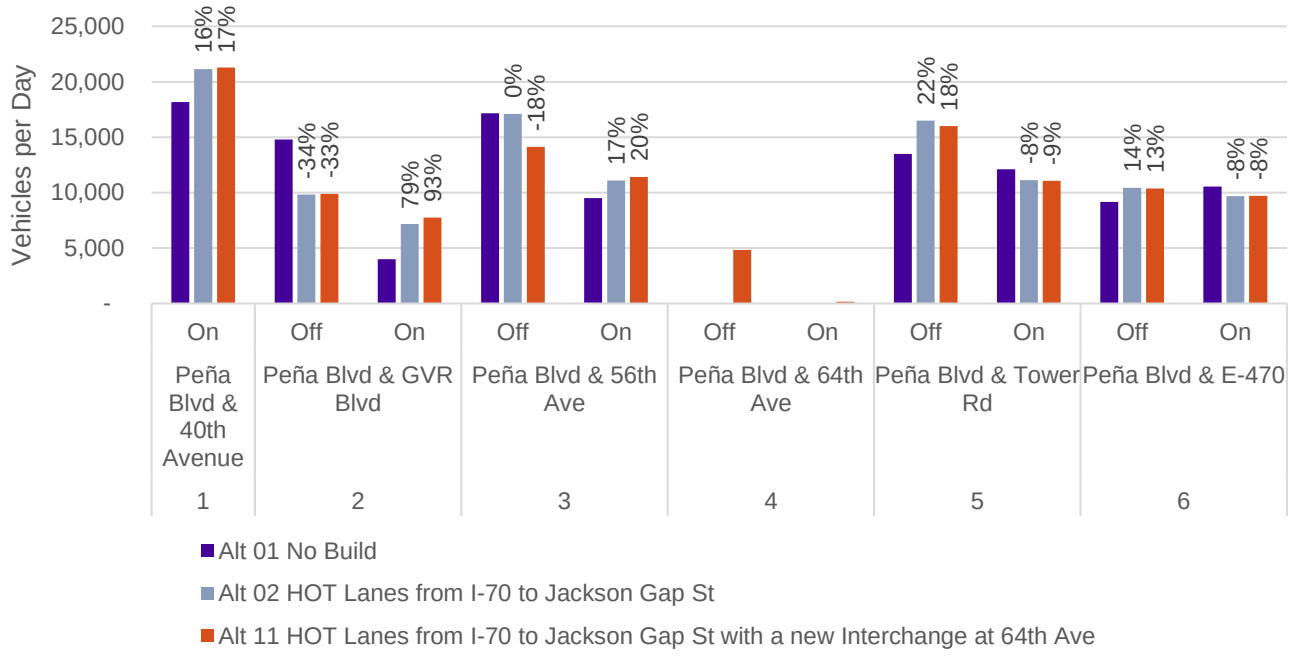



Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept.

#### 4.1.6.2. Family F – Interchange Volumes

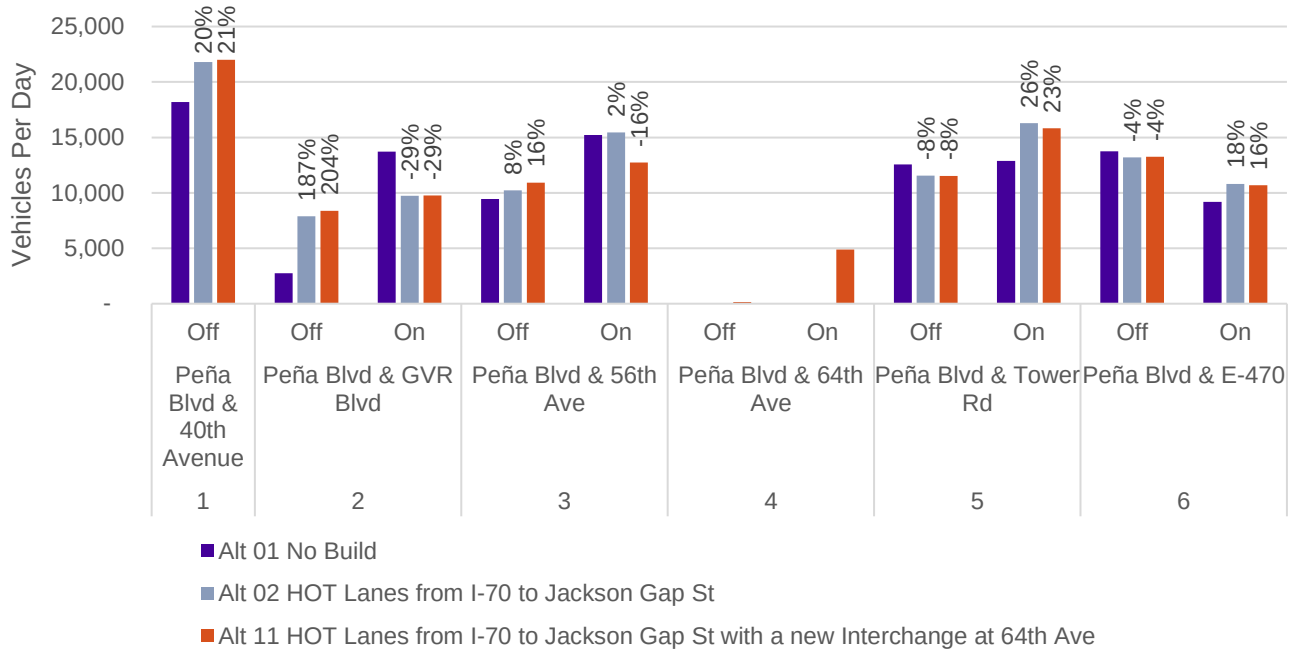
A new interchange on Peña Boulevard at 64th Avenue (Alt 11) is expected to primarily serve trips heading to/from I-70. Additionally, a large portion of the trips using 64th Avenue are expected to be trips shifting from the 56th Avenue interchange, with the volume result showing that a new 64th Ave interchange reduces inbound off-ramp volume at 56th Avenue by approximately 18 percent and reduces outbound on-ramp volumes at 56th Avenue by approximately 16 percent. A new interchange at 64th Avenue is not expected to have a large effect at another interchange other than 56th Avenue. Figure 4-47 and Figure 4-48 show inbound and outbound interchange volumes, respectively, for concepts in this family.

**Figure 4-47 – Family F – 2050 Inbound Daily Interchange Vehicle Demand Volume**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

**Figure 4-48 – Family F – 2050 Outbound Daily Interchange Vehicle Demand Volumes**

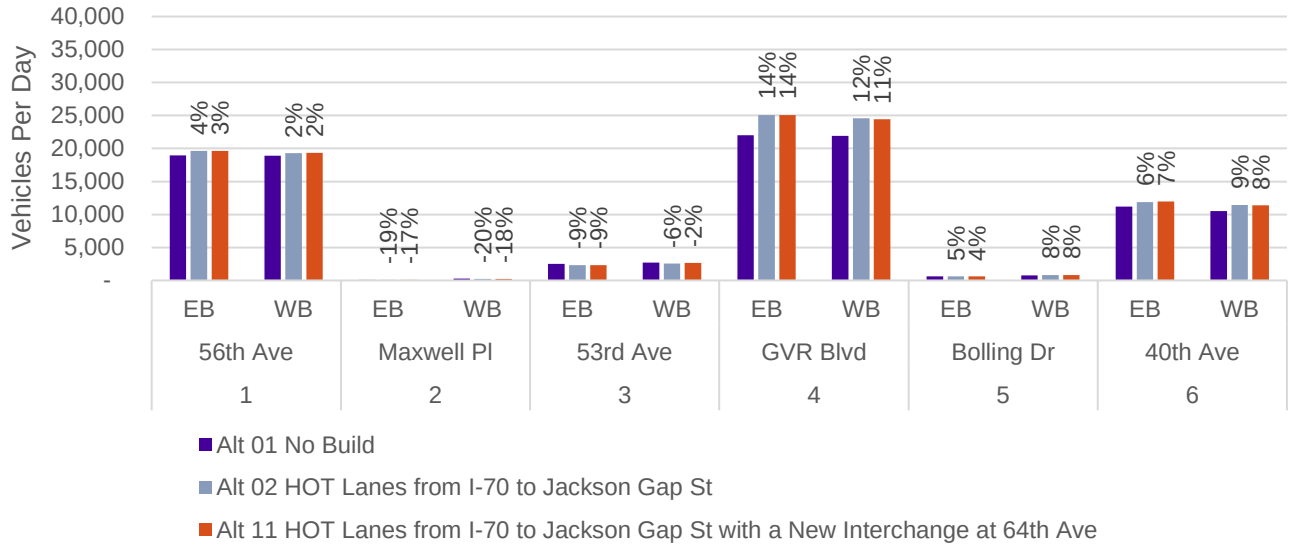



Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

#### 4.1.6.3. Family F – Local Roadway Volumes

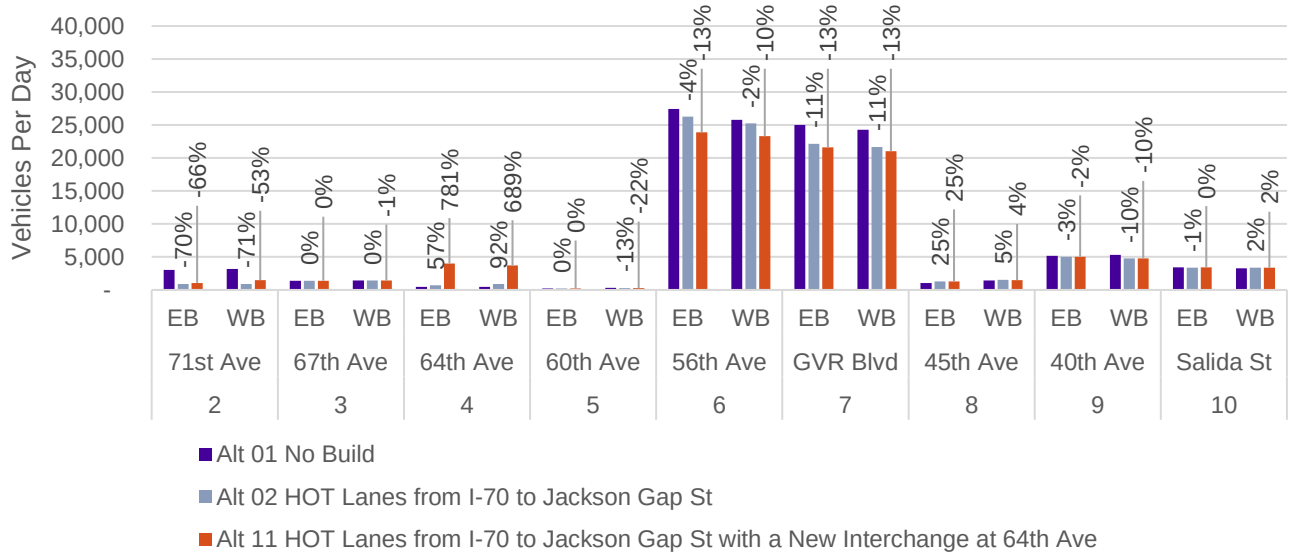
Adding a new interchange at 64th Avenue (Alt 11) is expected to only have localized impacts to east/west local roadway traffic volumes. These impacts are expected to occur on 64th Avenue, west of Tower Road, and on 56th Avenue between Tower Road and Peña Boulevard. Due to the new interchange at 64th Avenue, an increase in traffic along 64th Avenue is expected as drivers reroute to utilize the new interchange. In turn, this is expected to lower volumes along 56th Avenue as people utilize the 64th Avenue interchange instead of the 56th Avenue interchange. Figure 4-49, Figure 4-50, and Figure 4-51 show east/west demand volumes of local roadways for concepts in Family F.

**Figure 4-49 – Family F - 2050 East/West Daily Vehicle Demand Crossing the West of Memphis Street Screenline**



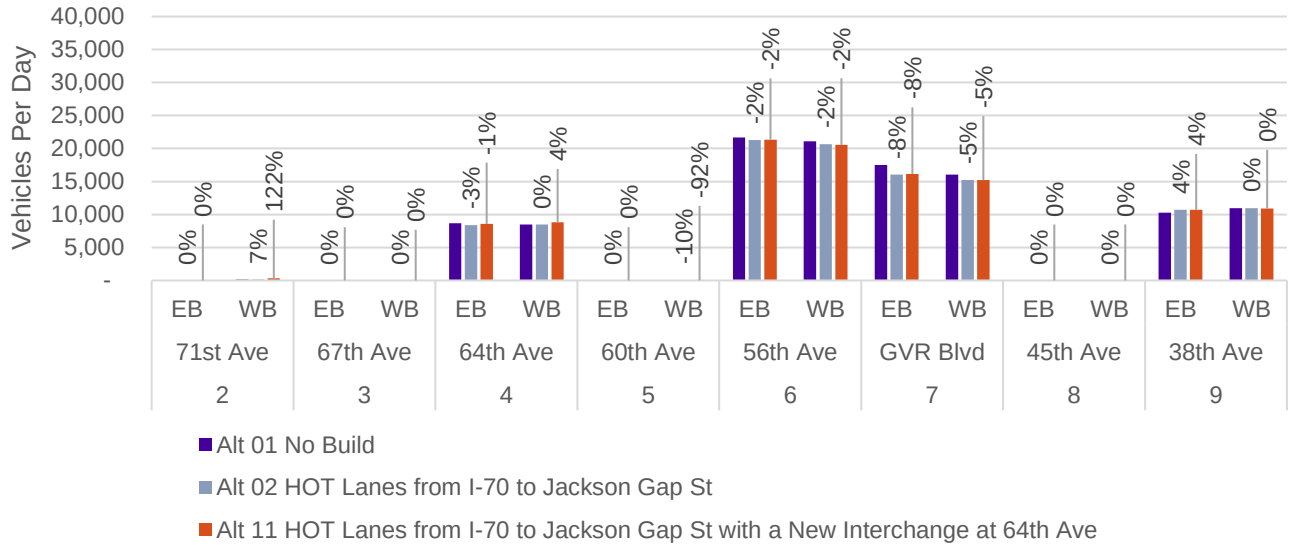

Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

**Figure 4-50 – Family F – 2050 East/West Daily Vehicle Demand Crossing the East of Telluride Street Screenline**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

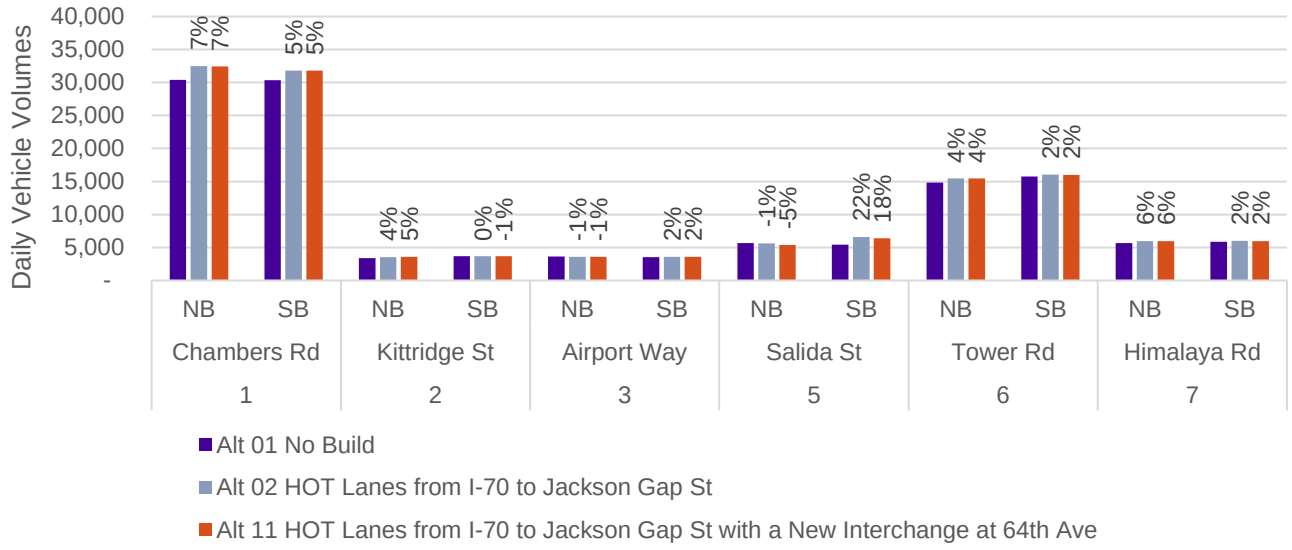
**Figure 4-51 – Family F – 2050 East/West Daily Vehicle Demand Crossing the East of Argonne Street Screenline**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

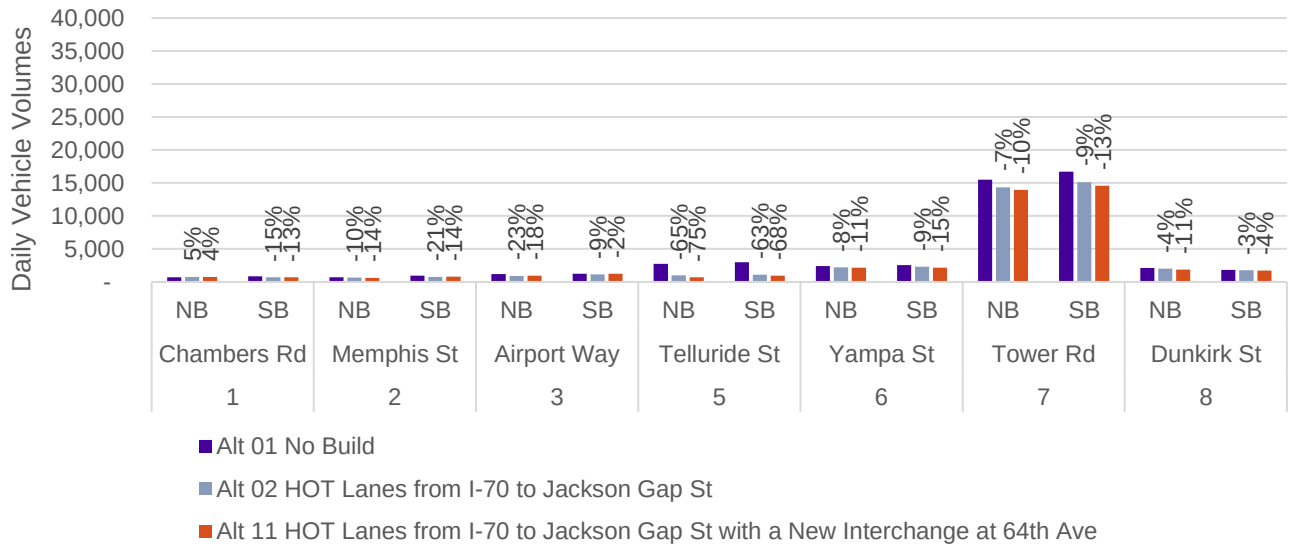
Adding a new interchange at 64th Avenue (Alt 11) is expected to only have localized impacts to north/south local roadway traffic volumes. These impacts are expected to occur primarily along Tower Road and Telluride Street. In both cases, adding a new interchange at 64th Avenue is expected to reduce volumes along both Tower Road and Telluride Street. This is the result of drivers exiting Peña Boulevard at the new 64th Avenue interchange rather than exiting at the 56th Avenue interchange and then using Tower Road or Telluride Street to access locations to the north. Figure 4-52, Figure 4-53, and Figure 4-54 show daily demand volumes of north/south local roadway facilities for concepts in Family F.

**Figure 4-52 – Family F – 2050 North/South Daily Vehicle Demand Crossing the North of 40th Avenue Screenline**



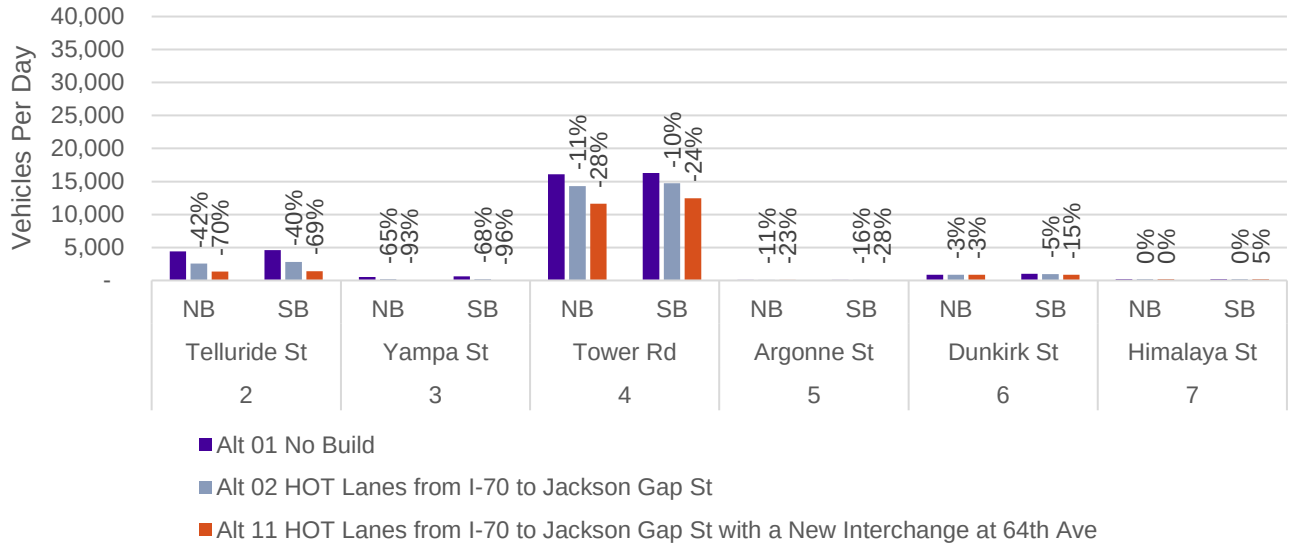

Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

**Figure 4-53 – Family F – 2050 North/South Daily Vehicle Demand Crossing the South of 56th Avenue Screenline**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

**Figure 4-54 – Family F – 2050 North/South Daily Vehicle Demand Crossing the South of 64th Avenue Screenline**




Note: Percentages shown reflect the percent difference in volumes as compared to the Alt 1: No Build concept. Additionally, numbers across the x-axis are for label sorting purposes only.

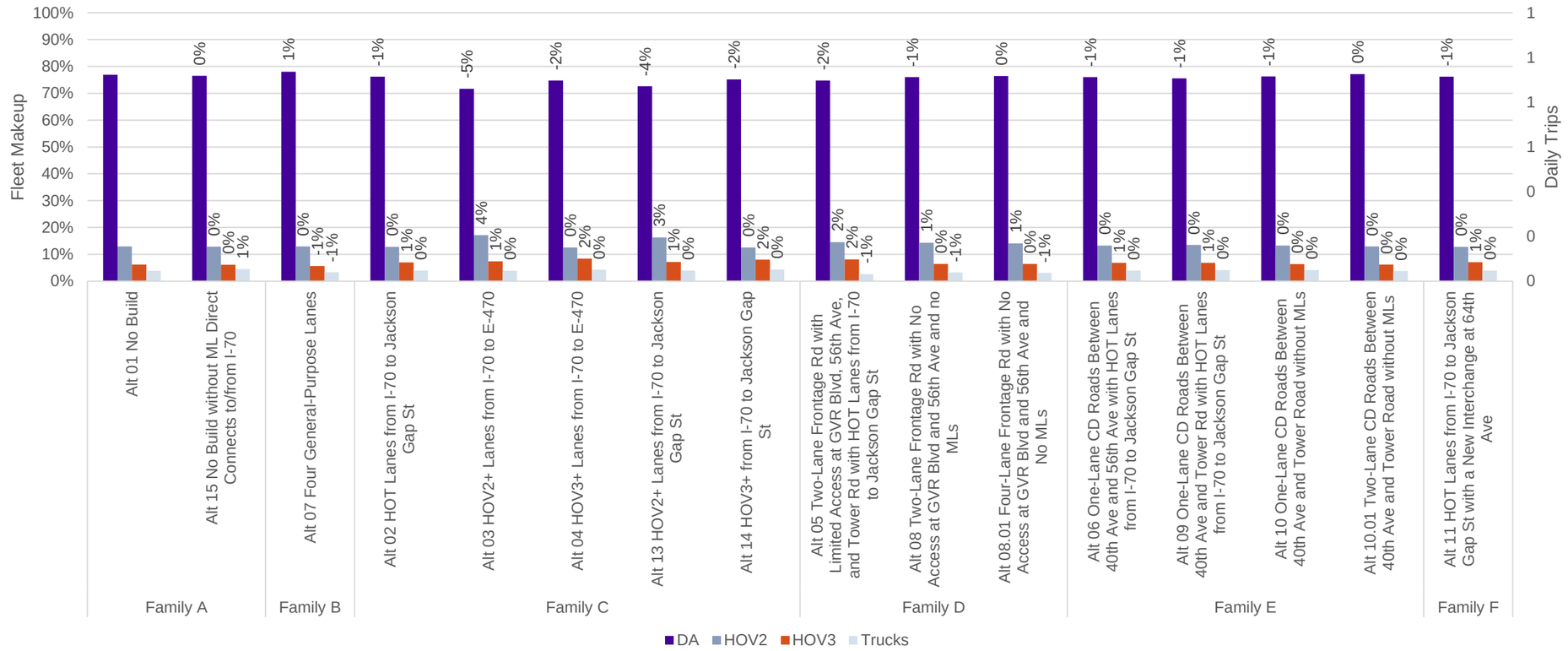
## 4.2. Vehicle Occupancy and Person Trips

This MOE considered a concept's impact to overall vehicle occupancy rates and person trips. For the purposes of this analysis, person trips were derived from vehicle trips within the TDM by assuming drive alone (DA) vehicles had one person, HOV2+ had two people, HOV3+ had three people, and trucks had one person. Note that, the person trip analysis does not include transit trips.

Because vehicle occupancy rates vary across the Peña Boulevard corridor, this MOE was examined at two locations, including along Peña Boulevard between 40th Avenue and GVR Boulevard (in the southern portion of the study area), as well as along Peña Boulevard between Tower Road ramps (in the northern portion of the study area). The results for these two locations are shown in Figure 4-55 and Figure 4-56, respectively. Note that the results include all vehicles traveling along the Peña Boulevard corridor including those in the general-purpose lanes, managed lanes, CD roads, and frontage road where these facilities are present within any given concept.

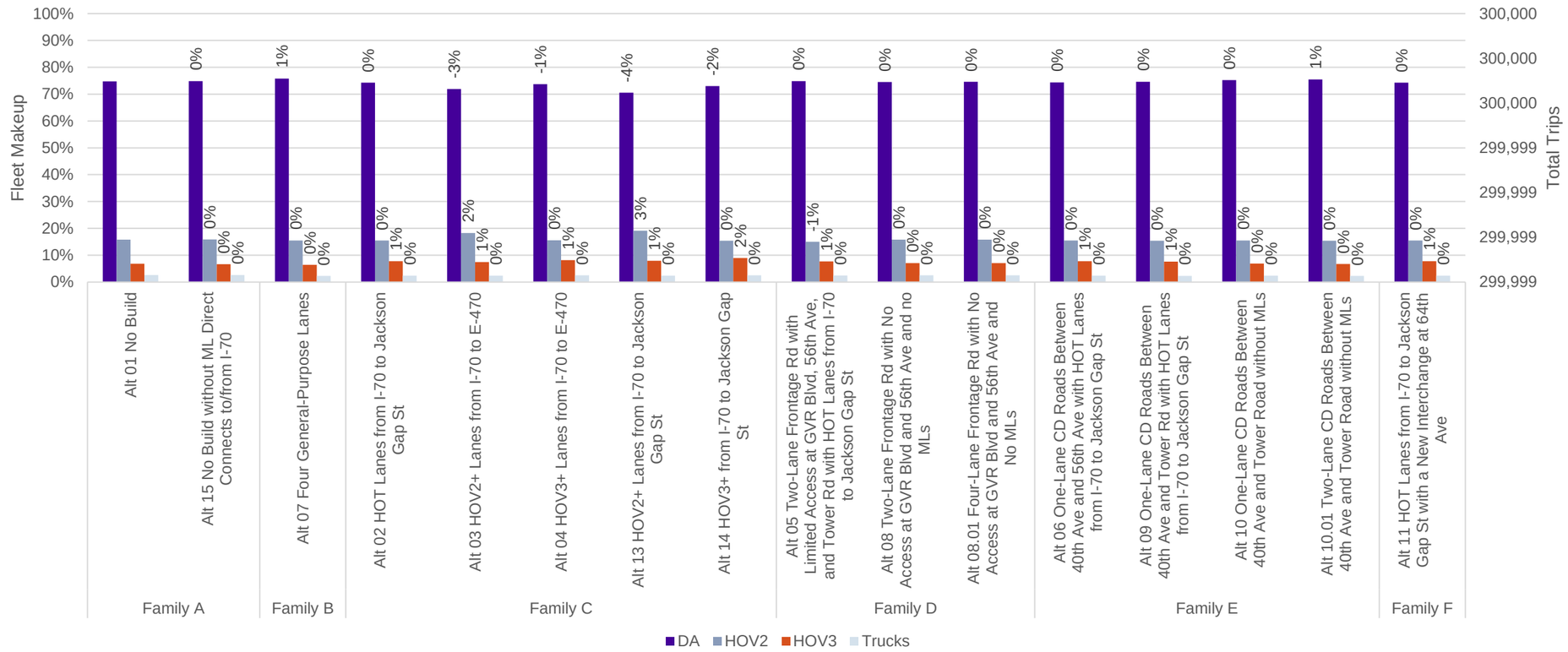
The results show the concepts with a managed lane facility have the largest impact to vehicle occupancy. Within these concepts, HOV2+ configurations (Alt 3 and Alt 13) result in the greatest increase in HOV vehicle trips and conversely the greatest decrease in DA trips. The largest impacts to vehicle occupancy are observed in the southern portion of the corridor near 40th Avenue. The impact of ML facilities on vehicle occupancy diminishes moving north.

**Figure 4-55 – 2050 Vehicle Occupancy and Person Trips Along the Peña Boulevard Corridor Between 40th Avenue and GVR Boulevard**




Note: Percentages shown reflect the percent difference as compared to the Alt 1: No Build concept.

**Figure 4-56 – 2050 Vehicle Occupancy and Person Trips Along the Peña Boulevard Corridor Between the Tower Road On-Ramps and Off-Ramps**




Note: Percentages shown reflect the percent difference as compared to the Alt 1: No Build concept.

## 4.3. Travel Times on Peña Boulevard

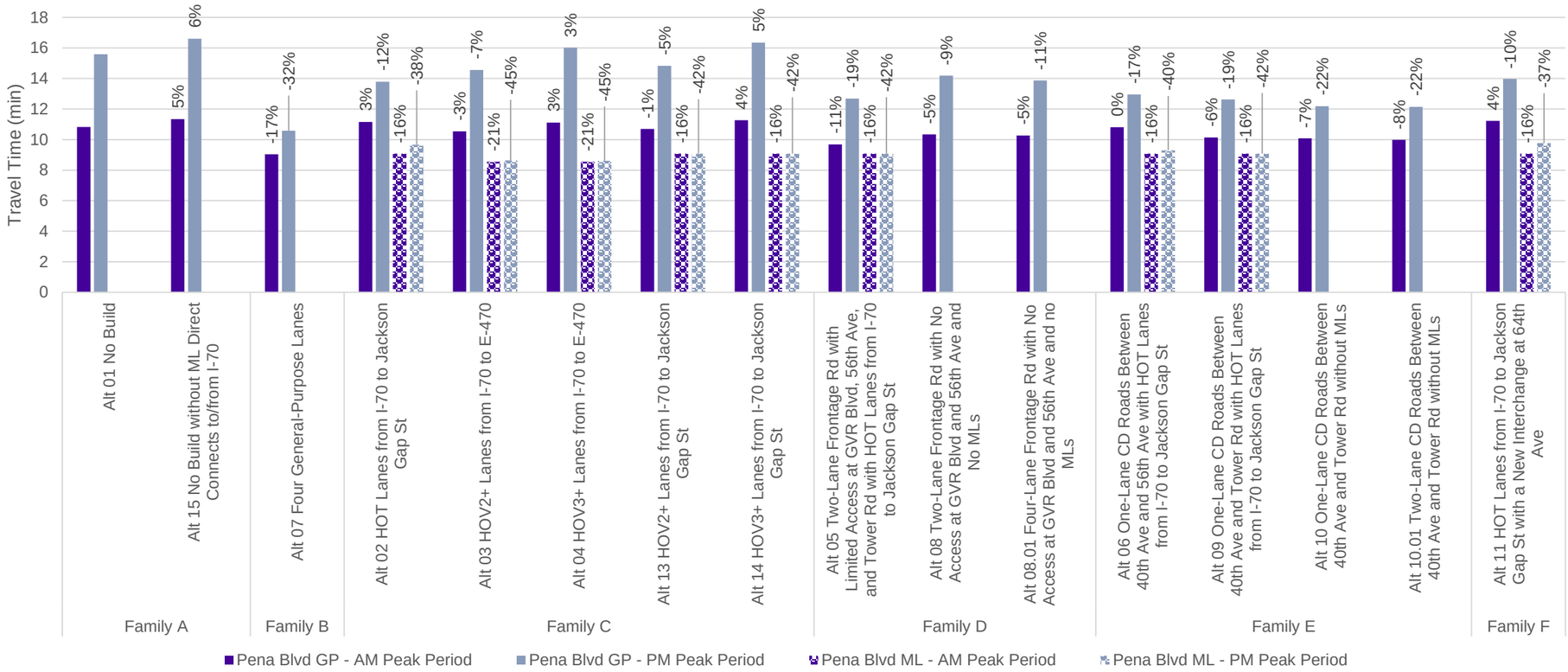
This MOE considered AM and PM peak period travel times along Peña Boulevard to travel from I-70 to Jackson Gap Street. It should be noted that travel time results were obtained from the TDM and should be interpreted as a comparative result between concepts, rather than a measure of actual travel times expected in-field. Additional design details and microsimulation modeling will be required to determine precise expected travel times along the corridor.

Inbound travel time results for all concepts are shown in Figure 4-57. The results show the following:

- Not constructing a direct connect between I-70 and Peña Boulevard (Alt 15) results in a 5 percent and 6 percent increase in inbound travel times during the AM and PM peak periods, respectively.
- Constructing four GP lanes would result in the largest travel time reductions as compared to all concepts considered.
- HOT facilities provide the most travel time saving to GP traffic as compared to geometrically similar HOV2+ and HOV3+ facilities.
- Having HOV facilities extend from I-70 to E-470 (Alt 3 and Alt 4) versus I-70 to Jackson Gap Street (Alt 13 and Alt 14) does not result in a large difference in inbound travel times.
- Having CD roads extend from I-70 to Tower Road (Alt 9) versus I-70 to 56$^{th}$ Avenue (Alt 6) results in a 6 percent and 2 percent inbound travel times savings to AM and PM peak periods, respectively.
- Providing an additional interchange at 64$^{th}$ Avenue (Alt 11) increases inbound AM and PM travel times by approximately 1 percent and 2 percent, respectively as compared to a similar configuration without a new interchange (Alt 2).

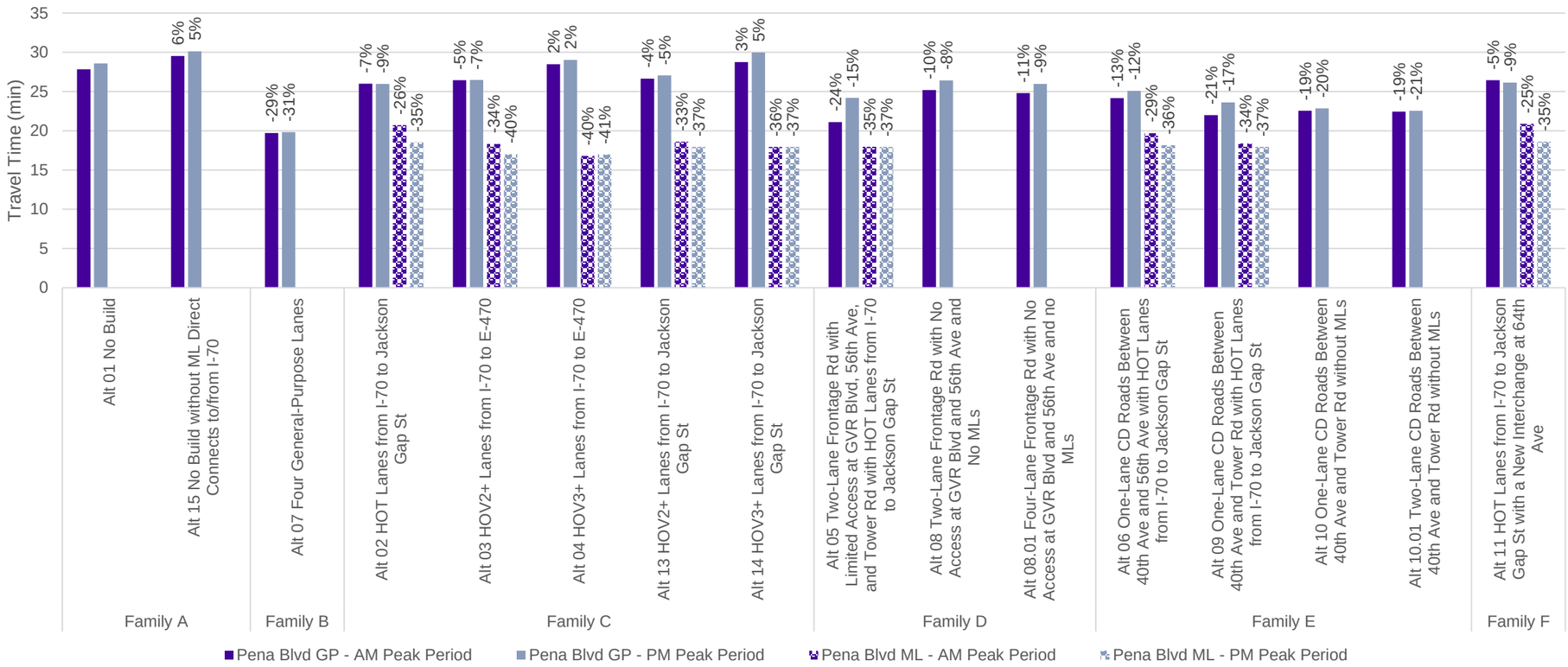
Outbound travel time results for all concepts are shown in Figure 4-58. The results show similar patterns to the inbound travel time results.

**Figure 4-57 – 2050 Inbound Travel Times on Peña Boulevard (I-70 to Jackson Gap Street)**




Note: Percentages shown reflect the percent difference as compared to the Alt 1: No Build concept.

**Figure 4-58 – 2050 Outbound Travel Times on Peña Boulevard (Jackson Gap Street to I-70)**

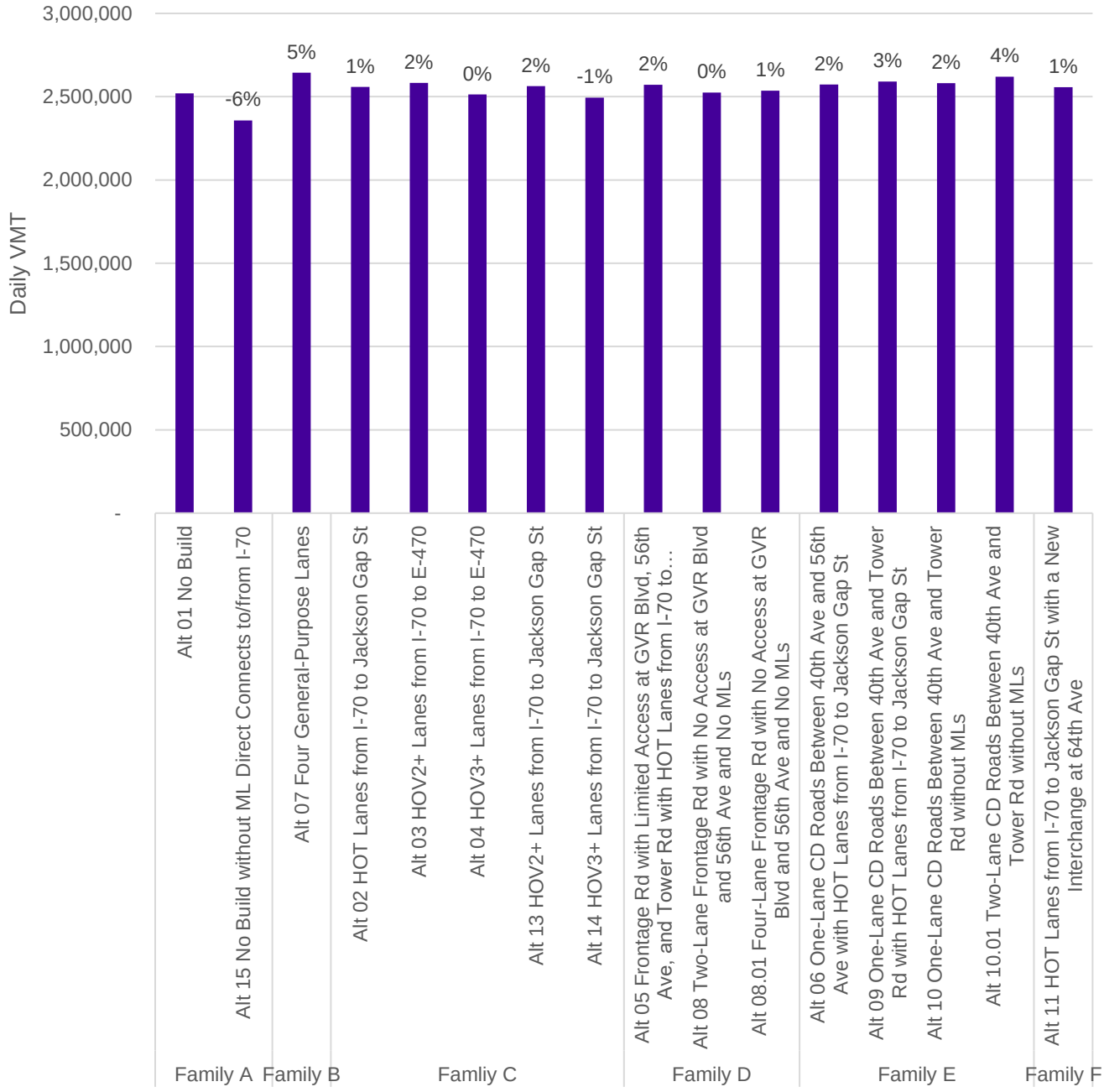



Note: Percentages shown reflect the percent difference as compared to the Alt 1: No Build concept.

## 4.4. Vehicle Miles Traveled

This MOE considered daily VMT within the traffic analysis area. The results of this MOE include VMT on all roadway links within the traffic analysis area. Figure 4-59 shows the VMT results for all concepts.

**Figure 4-59 – 2050 Traffic Analysis Area Daily VMT**




Note: percentages shown reflect the percent difference as compared to the Alt 1: No Build concept.

## 4.5. Vehicle Hours Traveled

This MOE considered daily VHT within the traffic analysis area. The results of this MOE include VHT on all roadway links within the traffic analysis area. Figure 4-60 shows the VHT results for all concepts.

**Figure 4-60 – 2050 Traffic Analysis Area Daily VHT**