

## Transit Strategies – Transit Modes

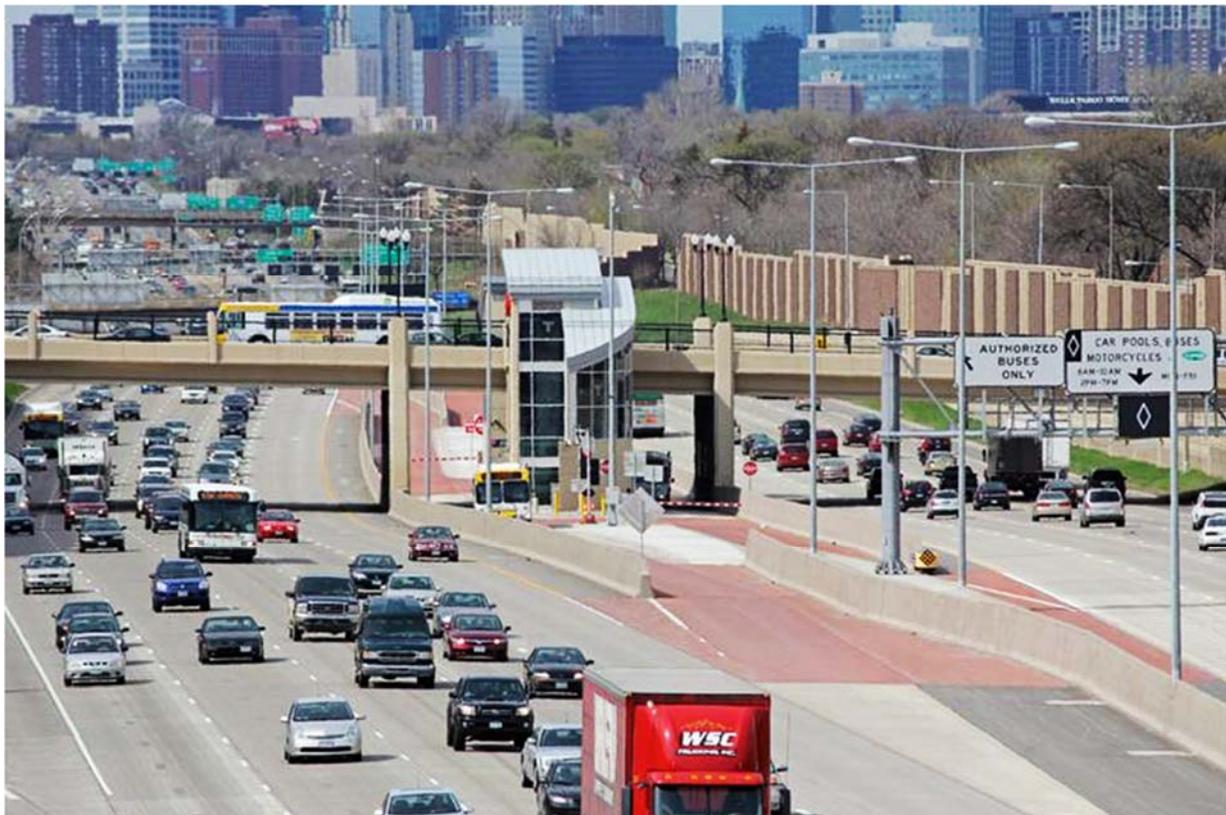
# Freeway Bus Rapid Transit

Most decisions about whether or not to use transit involve time and cost, and most transit services are slower than travel by private vehicle. However, when transit is faster or nearly as fast as travel by private vehicle (for example, many rail services), large numbers of travelers will choose to travel by transit instead of by car. Thus, one of the most effective ways to encourage transit use is to make transit faster by implementing transit priority strategies. Freeway bus routes are often slowed by congestion, and the development of transit priority around the routes and better circulation in and out of a station can make service faster and more convenient.

Strategies to develop Freeway Bus Rapid Transit (BRT) include:

- 1. Operate service along major highways in a combination of regular traffic lanes, high-occupancy vehicle (HOV) lanes, or along the shoulders.**
- 2. Develop stations within highway rights-of-way and/or with efficient circulation to and from stops and stations that are located outside of the freeway right-of-way.**

*Bus Station in Freeway Median on I-35W in Minneapolis, MN*



## Freeway Bus Operations

In the 1970s, exclusive bus lanes were developed on freeways in Washington, DC, New Jersey, and California. However, most of these exclusive bus lanes were later converted to HOV lanes, and today,



nearly all significant freeway bus services operate in general traffic, High Occupancy Vehicle (HOV) or Managed (toll) lanes, and on shoulders.

Lane Type	Access	Cost to Implement	Revenue	Compatible Stop Design
General Traffic	All traffic	\$0	None	Possible to develop within interchanged or on shoulder
Freeway Shoulders	Bus only	\$	None	Within interchanged or on shoulder
Dedicated Bus Lanes	Bus only	\$\$\$	None	In median, on interchange ramp, or on shoulder
High-Occupancy Vehicle (HOV) Lanes	Bus, vehicles w/ 2+ (or 3+) passengers	-\$\$\$\$	None	Ideally in median If on interchange ramp, likely must merge across traffic
Managed (toll) Lanes	Bus, vehicles w/ 2+ (or 3+) passengers, toll-paying vehicles w/ fewer passengers	-\$\$\$\$	From tolls on low-occupancy vehicles	Ideally in median If on interchange ramp, likely must merge across traffic

## Service in General Traffic

With service in general traffic, no special considerations are provided for bus service, and bus service operates in the same manner and at the same speed as all other traffic. Most express bus services operate in general traffic. Though this type of operation is lower cost than other lane types, buses often get stuck in traffic during peak hours, leading to just as slow or slower travel times than car-commuting.

## Limited Access Lanes

Freeway BRT-type services primarily operate along highways and other high-speed roads. In the 1970s, exclusive bus lanes were developed on freeways in Washington, DC, New Jersey, and California in order to separate buses from congestion. However, most of those exclusive bus lanes were later converted to HOV lanes, and today, nearly all highway bus services operate in general traffic, High Occupancy Vehicle (HOV) or Managed (toll) lanes, and on shoulders.

One challenge for these services is that most HOV lanes are the leftmost lanes, which require buses to weave across all lanes of traffic to serve stops that are off the highway. To avoid this situation, transit stations are now being constructed in freeway medians where they can be easily accessed from HOV lanes.

## Dedicated Bus Lanes

As described above, most dedicated freeway bus lanes have been converted to HOV or Managed lanes. Today, and as described further below, most dedicated bus lanes are short segments that provide access and egress to stations and stops so that buses can avoid entering local traffic.



## Shoulder-Running Bus Service

Buses can be given a travel time advantage when they are allowed to use highway shoulders when traffic is congested. Bus on shoulder operations were first implemented in Minnesota more than 20 years ago. The state now has 300 miles of shoulders in use by buses today and cites a number of benefits to bus on shoulder operation, including shorter and more predictable and reliable transit travel times and increased ridership.

This approach is now being used in at least 14 states,<sup>1</sup> and more are considering it. Implementing bus on shoulder operations usually starts with policies put in place by state governments and departments of transportation that allow for buses to use shoulders. These policies have the following considerations:

- **Lane Width:** Buses are approximately 9.5 feet wide including mirrors, so operation in 9 or 10 feet shoulders may require overlapping into the rightmost lane. Implementing bus on shoulder policies on highways with wider shoulders, or widening existing shoulders to 12 feet or more, can allow for safer operation.
- **Speed:** Policies may outline speed limits or guidelines for bus on shoulder operation.
- **Operations:** Buses may be permitted on shoulders just during times of congestion, or any time. Stalled vehicles in emergency situations tend to have priority over bus operations.
- **Safety:** There are often perceived safety issues with shoulder operations, particularly with respect to the potential for conflict with stalled vehicles or vehicles entering or exiting the highway in front of the path of a shoulder-running bus. However, there has been only one injury-crash that has been attributed to shoulder-running buses in Minnesota since 1992 and measures can and should be taken to ensure maximum safety while operating.

## Circulation to Stops and Stations

One of the most time-consuming aspects of freeway bus service can be the time it takes to get off the freeway in order to serve local stops and then get back on again. To reduce these delays, many areas have developed stops and stations that are located directly along freeways, with most “retrofitted” into existing freeways. In general, there are three types of freeway stops and stations:

Stop Location	Interactions	Cost	Bus Travel Time	Passenger Access
Freeway Shoulder	Bus only or enter general traffic	\$\$\$\$	Medium	Most Walking
Interchange Ramp	Enter general traffic	\$\$\$	Slow	Moderate Walking
Freeway Median	Bus only	\$\$-\$\$\$	Fast	Some Walking

Of the three different types, those that use exclusive bus ramps and/or pullouts along the freeway are the most attractive because they deliver the fastest service. They also do not get stuck in traffic while picking up or dropping off passengers.

Stations and stops that are located along interchange ramps typically require buses to travel straight through from the off-ramp to the on-ramp. With this type of station, travel times are longer because buses are subject to intersection delays at the ends of the interchange ramps. These delays can be mitigated through the use of bus queue jump lanes. Stations and stops that are located along interchange ramps also typically involve longer walk distances because of the extra right-of-way width at interchanges.

<sup>1</sup> Including California, Colorado, Delaware, Florida, Georgia, Kansas, Illinois, Maryland, Minnesota, New Jersey, North Carolina, Ohio, Virginia, and Washington.



## Park and Rides

Many regional bus stops and stations also function as park-and-rides, since people are driving from suburban and rural areas to reach transit services to travel downtown. Building adequate facilities to connect transit to other modes such as driving can encourage more people to take transit. In addition to parking, agencies can put in place passenger drop-off/pick-up zones, bike facilities, and car-share to enable more multi-modal connections.

## Freeway Bus Service/BRT Examples

### Denver to Boulder, CO

*Flatiron Flyer service operates between Boulder and Denver and consists largely of Bus on Shoulder service with in-line stations.*

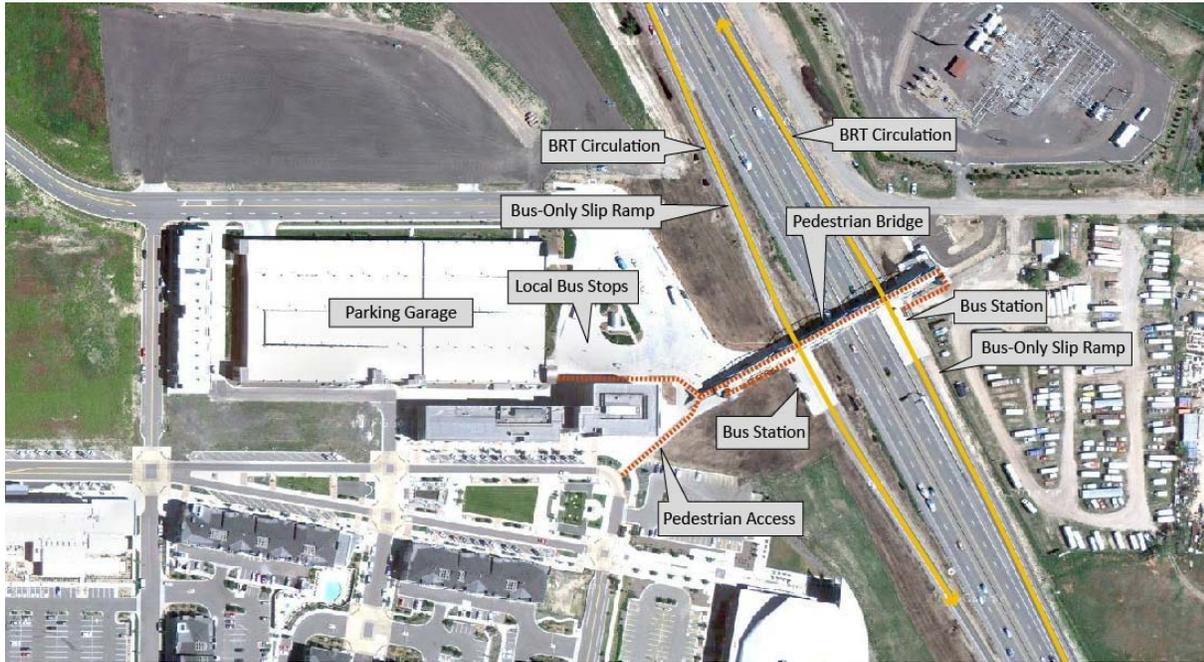
In early 2016, the Flatiron Flyer, 18 miles of an express bus service with some elements of BRT, opened between Denver and Boulder. The line has six stops, and is served by a combination of all-stop and express service. Most freeway stations also include park and ride lots and connections to local bus services.

The service uses the US 36 Express Lanes, which are high occupancy toll (HOT) lanes that allow for free passage for motorcycles and cars with three or more people and tolled passage for cars with one or two. The stop styles vary based on station, using both on shoulder and on interchange ramps types:

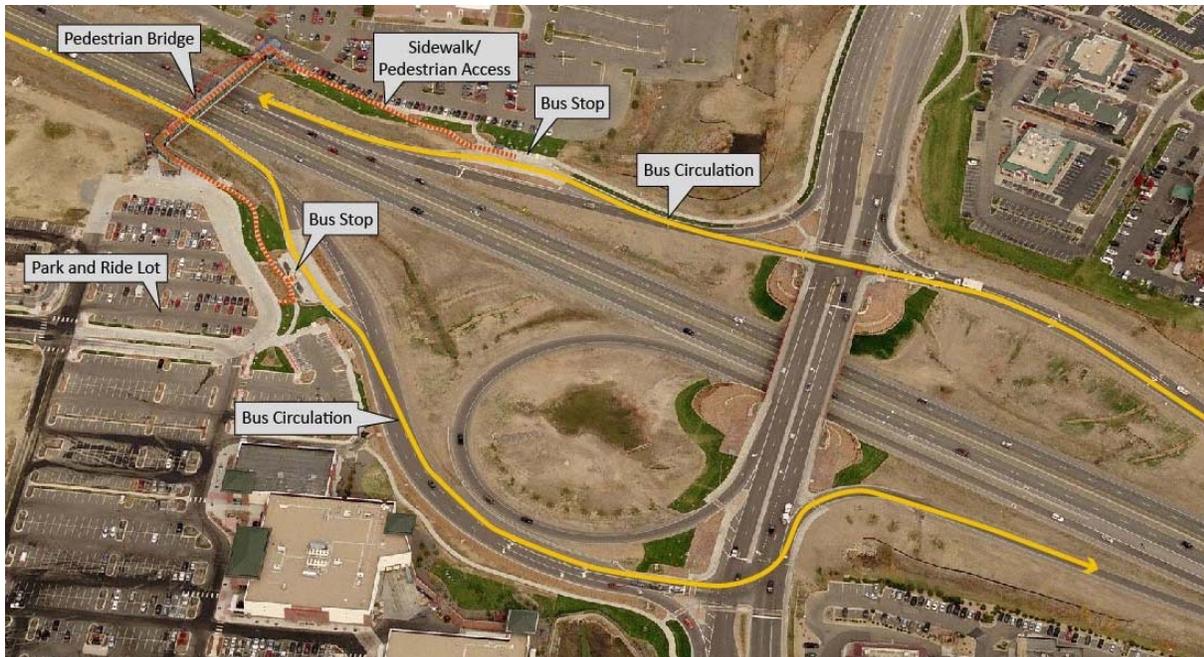
- Broomfield Station, with a 1,500 space parking garage, is located along exclusive bus slip ramps, and a pedestrian bridge that provides access across the freeway and to the parking garage.
- At the McCaslin Station, the bus stops have been developed on the southbound off-ramp and the northbound on-ramp. This configuration requires buses to exit the freeway and to travel through the traffic lights at the ends of the freeway ramps. This operation is slower than the exclusive slip ramps in Broomfield, but still fairly direct.

As in Broomfield, this station has a pedestrian bridge that provides access across the freeway and to the park-and-ride lot. RTD is also planning to develop bus queue jump lanes along the interchange ramps to reduce intersection delays.

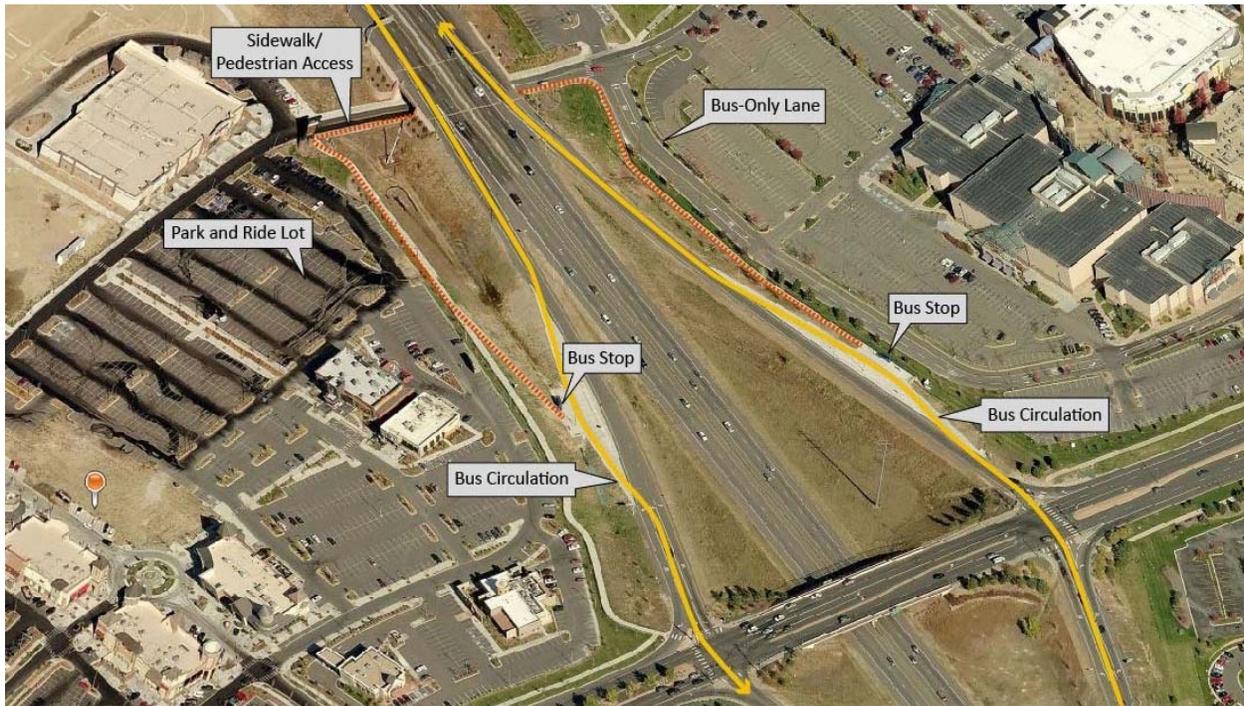
*US 36 Freeway Bus Station with Exclusive Slip Ramps: Broomfield Station*



*US 36 Freeway Bus Station Along Interchange Ramps: McCaslin Station*



US 36 Freeway Bus Station Along Interchange Ramps: Church Ranch Station



- A third example is Church Ranch, where stops are also located along the interchange ramps, along the southbound off-ramp and the northbound on-ramp of a diamond interchange. Buses operate straight through the interchange to re-enter the freeway. However, access across the freeway is via a sidewalk along a local street under the freeway rather than a pedestrian bridge: an approach that is less expensive but, as shown in the image below, significantly increases the walking distance. As at McCaslin, RTD is planning to develop bus queue jump lanes along the interchange ramps to reduce intersection delays.

## Los Angeles, CA

*LA's Silver Line Freeway BRT service operates in HOV lanes and serves five stations located in the freeway median.*

The Silver Line started as two express bus routes, one on I-10 and another on I-110, which were rebranded and combined into a continuous route. It provides freeway service from San Pedro to Downtown Los Angeles, where local service is provided, before re-entering the freeway to El Monte.

*I-110 Freeway Median Bus Station: Manchester Road, Los Angeles, CA*



The I-110 and I-10 freeways have Express Lanes, which are two HOT lanes in each direction that are separate from and located in between general traffic. The Silver Line, other express buses, carpools, and toll-paying solo drivers use these lanes. On the I-110, these express lanes are also called the “Harbor Transitway.”

The stops for the Silver Line are mostly in the median, plus local stops downtown. The Harbor Transitway has five stations located in the median, and buses access these stations via bus-only slip ramps from and to the HOT lanes. Pedestrian access to the stations is from the local streets below the freeway overpass, and in some cases, also via pedestrian bridges.

## Minneapolis/Saint Paul, MN

*Metro Transit has been running bus on shoulder service for over 20 years.*

Metro Transit in Minneapolis pioneered bus on shoulder service. Many of its original shoulder-running operations were originally along freeways with 10-foot shoulders, which are barely wider than a bus. In these areas, buses are only permitted to operate in the right-hand shoulder of highways when main-lane traffic speeds fall below 35 mph and are not permitted to operate more than 15 mph faster than the general traffic lanes. To better facilitate bus operations on highway shoulders, Metro Transit and the Minnesota Department of Transportation are widening highway shoulders throughout the Twin Cities area (to 12 feet where possible).

Bus on shoulder operations make service faster and, perhaps more importantly, provide reliable service. Bus services that used to frequently run late now usually run on schedule. In Minnesota’s 20-plus year experience with this type of service, bus on shoulder operations have had a better safety record than other types of bus service.

*Bus on Shoulder Service in Minneapolis, MN*



**Research Triangle, NC**

*North Carolina's Research Triangle has 60 miles of bus on shoulder operations.*

In North Carolina's Research Triangle, bus on shoulder operations are permitted on approximately 60 miles of highway that includes most of I-40 in Durham, Wake, and Johnston counties, and connecting highways. Buses are allowed to travel on these shoulders only when other lanes are travelling less than 35 MPH, and buses can travel up to 35 MPH as long as the bus stays within 15 MPH of general purpose travel speeds.

*Bus on Shoulder in North Carolina*



Additionally, only authorized buses with trained drivers are permitted to drive on the shoulders. For safety considerations, cars and other vehicles using the shoulder in the case of an emergency takes precedence over bus on shoulder travel.

## Seattle, WA

*Sound Transit has developed a large park and ride that is connected to freeway bus service that operates in I-5 HOV lanes.*

Sound Transit, which provides commuter service in the Seattle area, recently opened Mountlake Terrace Freeway Station in the median of I-5. Along this section of I-5, commuter bus service operates in left-hand HOV lanes and accesses the station via exclusive bus slip lanes from and to the HOV lanes. This station also includes 890 parking spaces, most of which are in a garage, and a pedestrian bridge across the eastern side of the freeway to connect all of the elements. The station was built in an area where there was a sufficiently wide median, which (unlike the I-35W station in Minneapolis) had sufficient room for outside platforms.

*Freeway Bus Station in Median: Mountlake Terrace, WA*



*Mountlake Terrace Bus Operations*





## KEY CONSIDERATIONS

As described above, there are a number of ways to provide freeway transit service. Key considerations include:

- **Bus on shoulder freeway service is a very low-cost way to provide faster and more reliable service** along freeways and has proven to be a very safe option
- **Bus service can be given priority through the use of HOV lanes or shoulder operations.** With HOV use, buses typically must be able to access stations from the center of the freeway. With shoulder running service, buses need to access stations or stops located beyond the shoulders of the freeway.
- **The most effective station designs serve passengers within the freeway right-of-way.** This type of operation is important because it greatly reduces transit travel times (compared to services that must exit the freeway and travel locally to off-freeway stations and stops), and thus makes transit much more attractive.
- **Of the different types of freeway stations and stops, those that use exclusive bus ramps and/or pullouts along the freeway are the most attractive** because they are the fastest (for example, the US 36 Broomfield Station, Minneapolis' I-35W Station, Seattle's Mountlake Terrace Station, and the Los Angeles and Marin County stations).
- **Stations and stops that are located along interchange ramps typically require buses to travel straight through from the off-ramp to the on-ramp.** With this type of station, travel times are longer because buses are subject to intersection delays at the ends of the interchange ramps. These delays can be mitigated through the use of bus queue jump lanes. Stations and stops that are located along interchange ramps also typically involve longer walk distances because of the extra right-of-way width at interchanges.
- **Most new freeway bus stations include large park-and-ride facilities, some of which are also major transit centers** (for example, the US 36 Broomfield Station and Seattle's Mountlake Terrace Station). However, freeway bus stops can also be developed to serve only local neighborhoods and local transit connections.

## Freeway Transit in Fort Worth

Trinity Metro currently operates seven express bus routes; five of which are freeway services:

### **I-30 West**

- 61X Normandale Xpress

### **I-35W North**

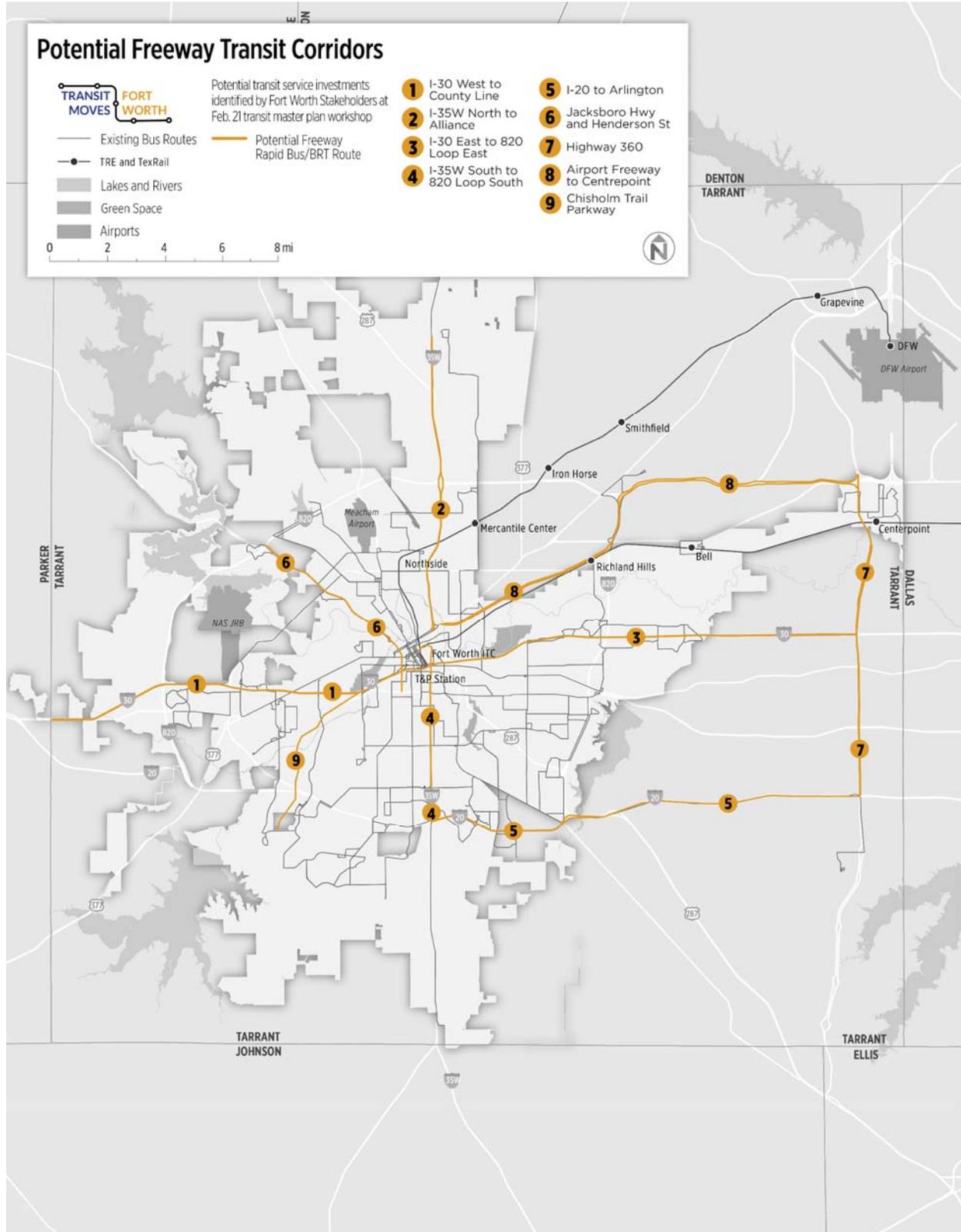
- 63X North Park & Ride Xpress
- 64X North Texas Xpress

### **I-35 W South**

- 65X South Park & Ride Xpress
- 66X Candleridge/Altamesa Xpress

In addition, new express services could also be developed to serve the city's outward growth. The map below shows existing and potential freeway transit corridors that could be improved and or developed. Putting elements of Rapid Bus and BRT into each of these corridors, paired with a branded rapid bus service, can get more riders to use the system. These routes could use a combination of the lane types (bus on shoulder, HOV/HOT lanes, and general traffic) depending on what can be retrofitted to the current freeway configuration.

Potential Freeway Transit Corridors in Fort Worth





On I-35W to the north of downtown Fort Worth, express buses operate via the managed lanes, and in conjunction with the managed lanes, there may be opportunities to develop in-line stations. On freeways without managed lanes, express buses operate in mixed traffic. Where this is the case, bus on shoulder operations could make existing and new express services faster, more reliable, and more competitive with automobile travel. At this time, bus on shoulder operations are not legal in Texas, and a vote of the state legislature would be required to authorize it.

Furthermore, as future freeway improvements are made, or as separate improvements, it could be possible to develop new, more conveniently located park-and-ride facilities within freeway rights-of-way or with more efficient connections. With more effective circulation between stations and freeways, express services could stop at multiple stations, which would enable the provision of more service with fewer routes.

New park-and-ride lots could also be constructed through partnerships with local developers. For example, Walsh Ranch, which will be located near the intersection of I-20 and I-30, will be one of the largest new residential communities in North Texas, and there will almost certainly be demand for express service between there and downtown Fort Worth. Similarly, demand is growing in the Alliance area as Hillwood continues its development there.