Southeast Valley
Transit System Study

Transit Optimization Analysis
Assessment of Existing Conditions

Prepared for:

Maricopa Association of Governments
Valley Metro

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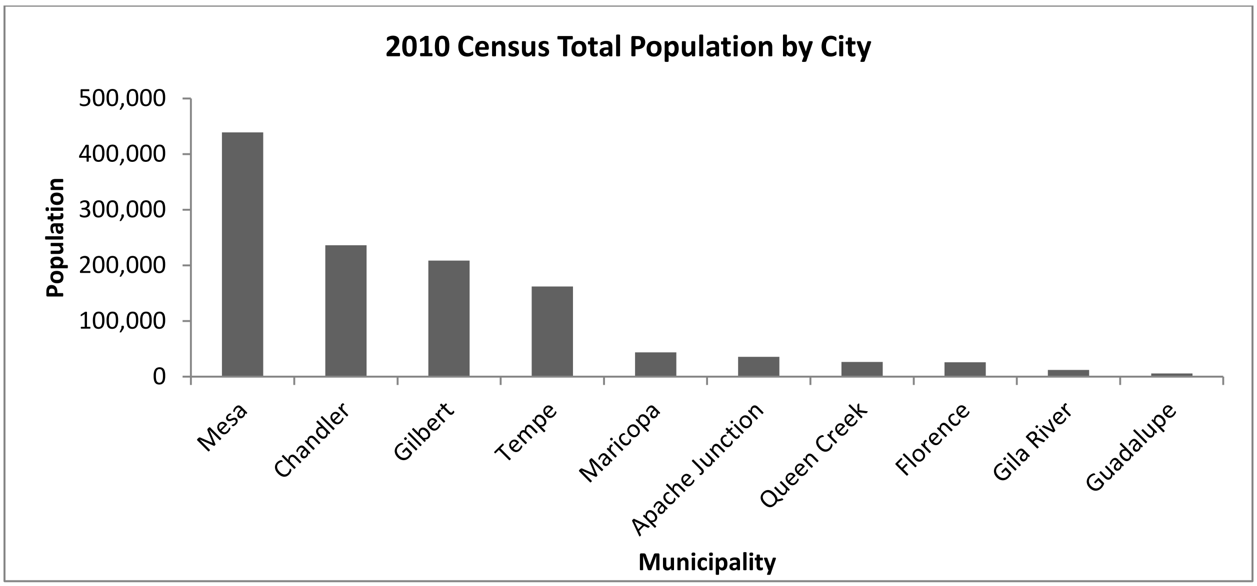
1.0 INTRODUCTION AND PURPOSE

The Southeast Valley is one of the fastest growing regions in the Phoenix metropolitan area. Comprised of six cities in Maricopa County, three cities in the neighboring Pinal County and nearby Native American communities, the Southeast Valley (SEV) is home to over one million people. This region experienced a 30 percent growth in population between 2000 and 2010. MAG and Central Arizona Governments (CAG) Socioeconomic Projections indicate that this high growth rate is expected to continue. With the future population and employment expected to expand, transit will need to play an even greater role in the mobility and transportation of people throughout the area.

The Transit Optimization Analysis (TOA) is a key component of the Southeast Valley Transit System Study whose purpose is to identify short, mid, and long-term recommendations that will advance the transit system. Using a data-driven approach to evaluate service effectiveness and operational efficiency, the TOA seeks to identify current transit successes and challenges. The TOA will provide recommendations for developing an integrated transit network that aims to maximize the use of agency resources to grow ridership and improve the overall quality of service.



1.1 DATA SOURCES

Multiple data sources were used to support the analysis and findings in this report.

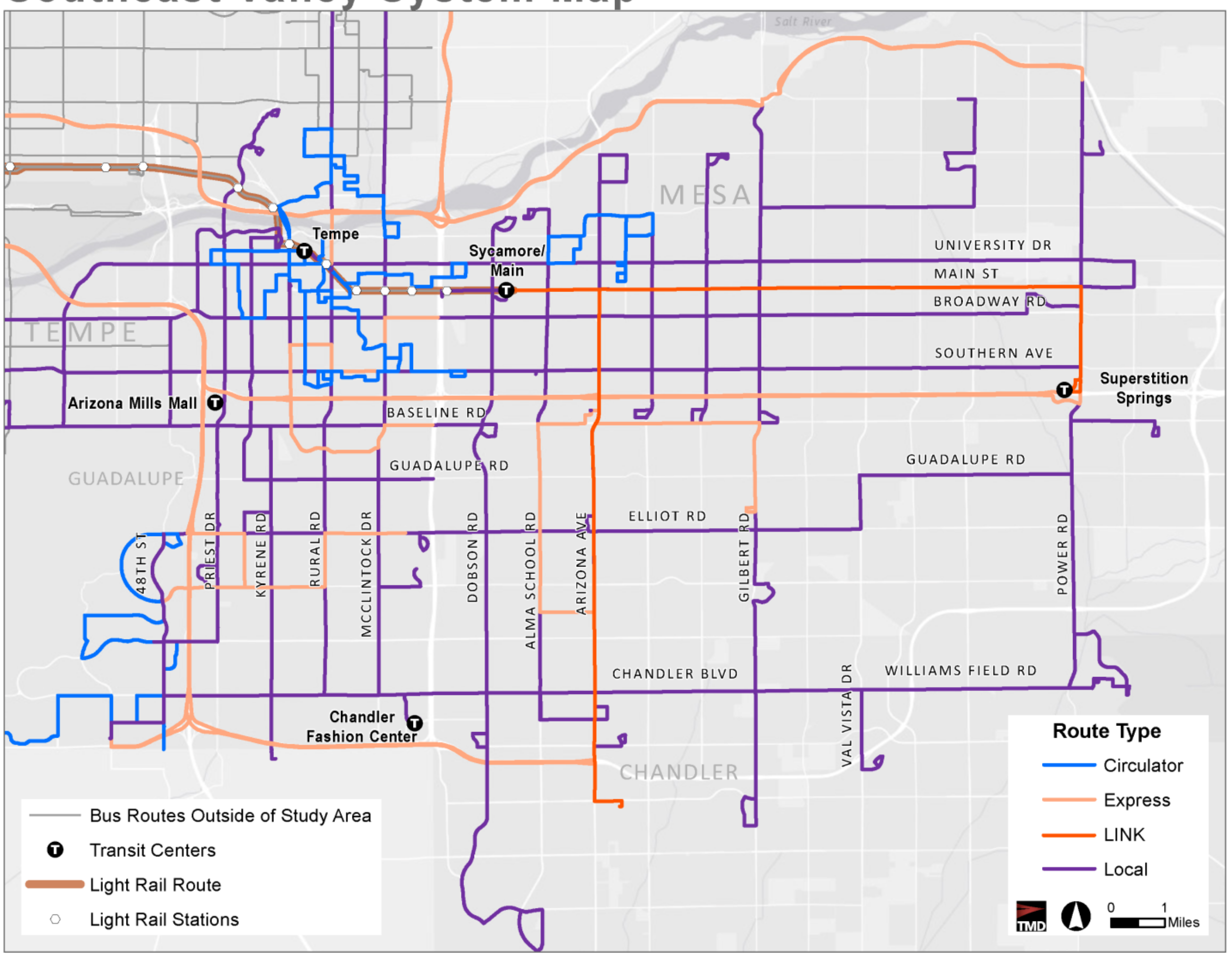
The analysis of ridership is based on the September and October 2013 farebox data as collected by Valley Metro. This sample period was chosen due to the significant impact of Arizona State University (ASU) on ridership in the Southeast Valley. Farebox data was chosen over automatic passenger counting data (APC) due to its much larger sample size and more complete sampling of trips than the APCs.

2.0 EXISTING CONDITIONS

2.1 SYSTEM OVERVIEW

Valley Metro, in coordination with Phoenix, operates a total network of 102 routes throughout the Phoenix region. Valley Metro operates 43 routes that serve the Southeast Valley. The TOA considers the Southeast Valley service area to include routes operating in the cities of Tempe, Mesa, Chandler, Gilbert, and Guadalupe. Southeast Valley services include 21 local routes, 2 LINKs, 10 circulators, 9 Express routes, 1 RAPID route, and Valley Metro Rail (LRT). Each service type plays a unique role within the larger transit network.

Southeast Valley System Map



Local routes provide the majority of service in the Southeast Valley and operate with frequencies of 30 minutes or better on weekdays. LINK routes provide bus rapid transit service with faster travel times and higher frequencies. Bus stops for LINK services are spaced every ½ mile as opposed to every ¼ mile for local routes. LINK stops also have upgraded amenities including real-time stop arrival information, enhanced shelters, and level boarding platforms (curb is level with bus height to make boarding easier). Circulator routes are short-distance collection and distribution routes that connect with civic and regional destinations. Circulator routes are free to ride and are only operated within their respective jurisdiction. Express routes are peak-only services that operate to the downtown Phoenix area in the AM peak and in the reverse direction in the PM peak. The single RAPID route operating in the Southeast Valley also provides peak-only service to Phoenix. The Valley Metro Rail route serves a total of 28 stations with 10 stations within or adjacent to the Southeast Valley.

Service Area Routes			Weekday Span		Frequency			
Service Type	Route Number	Route Name	Start Time	End Time	Peak	Off-Peak	Sat.	Sun.
Local	30	University	4:00 AM	12:30 AM	30	30	30	30
	40	Apache/Main St	4:45 AM	11:00 PM	30	30	30	30
	45	Broadway	4:30 AM	12:30 AM	15	30	30	30
	48	48th Street/Rio Salado	5:00 AM	12:30 AM	30	30	30	30
	56	Priest Drive	4:45 AM	12:30 AM	15	30	30	30
	61	Southern	5:00 AM	12:30 AM	15	30	30	30
	62	Hardy/Guadalupe	5:00 AM	1:00 AM	30	30	30	30
	65	Mill/Kyrene	5:00 AM	1:00 AM	30	30	60	60
	66	Mill/Kyrene	4:45 AM	12:30 AM	30	30	60	60
	72	Scottsdale Rd/Rural	4:45 AM	12:30 AM	20	20	30	30
	77	Baseline	5:00 AM	12:30 AM	30	30	30	30
	81	Hayden/McClintock	4:45 AM	12:30 AM	15	30	60	60
	96	Dobson	4:30 AM	11:30 AM	15	30	30	30
	104	Alma School	5:15 AM	9:45 PM	30	30	60	
	108	Elliot Rd	5:15 AM	12:00 AM	30	30	60	60
	112	Country Club/Arizona Ave	5:00 AM	10:15 PM	30	30	60	60
	120	Mesa Dr	8:45 AM	9:00 PM	30	30	60	
	128	Stapley	5:45 AM	6:45 PM	30	30	60	
	136	Gilbert Rd	4:30 AM	7:30 PM	30	30	30	
	156	Chandler/Williams Field	4:45 AM	10:00 PM	30	30	30	30
	184	Power Rd	4:30 AM	10:00 PM	15	30	60	60
LINK	AZAV	LINK - Arizona Ave	4:45 AM	10:45 PM	25	25	60	60
	MAIN	LINK - Main St	4:00 AM	10:30 PM	15	25		
Circulator	ALEX	Phoenix Neighborhood	5:15 AM	5:45 PM	60	60	60	
	BUZZ	Mesa Downtown BUZZ	5:30 AM	7:30 PM	30	30	60	
	FLASH	Tempe – FLASH Forward	6:45 AM	1:00 AM	10	10		
	FLASH	Tempe – FLASH Back	6:45 AM	5:45 PM	10	10		
	FLASH	Tempe – FLASH McAllister	6:00 AM	10:00 PM	30	30		
	Mercury	Tempe - Orbit Mercury	6:00 AM	9:45 PM	10	10	15	30
	Venus	Tempe - Orbit Venus	6:00 AM	9:45 PM	15	15	15	30
	Earth	Tempe - Orbit Earth	5:45 AM	11:00 PM	15	15	15	30
	Mars	Tempe - Orbit Mars	6:00 AM	10:00 PM	15	15	15	30
	Jupiter	Tempe - Orbit Jupiter	6:00 AM	9:45 PM	15	15	15	30

	511	Tempe/Scottsdale	5:00 AM 4:15 PM	6:45 AM 5:30 PM	60			
	520	Tempe Express	6:00 AM 4:15 AM	7:00 AM 5:15 PM	60			
	521	Tempe Express	6:00 AM 4:15 PM	7:00 AM 5:15 PM	20			
	522	Tempe Express	6:00 AM 4:15 AM	7:00 AM 5:15 PM	20			
	531	Mesa/Gilbert Express	5:30 AM 3:30 PM	7:30 AM 5:15 PM	20-40			
	533	Mesa Express	5:00 AM 3:45 PM	7:00 AM 6:00 PM	15-30			
	535	Northeast Mesa/Downtown	5:45 AM 3:45 PM	7:15 AM 5:15 PM	15-30			
	541	Chandler Express	5:00 AM 3:45 PM	7:15 AM 5:15 PM	30			
	542	Chandler/Downtown Express	6:00 AM 3:30 PM	7:30 AM 5:15 PM	15-30			

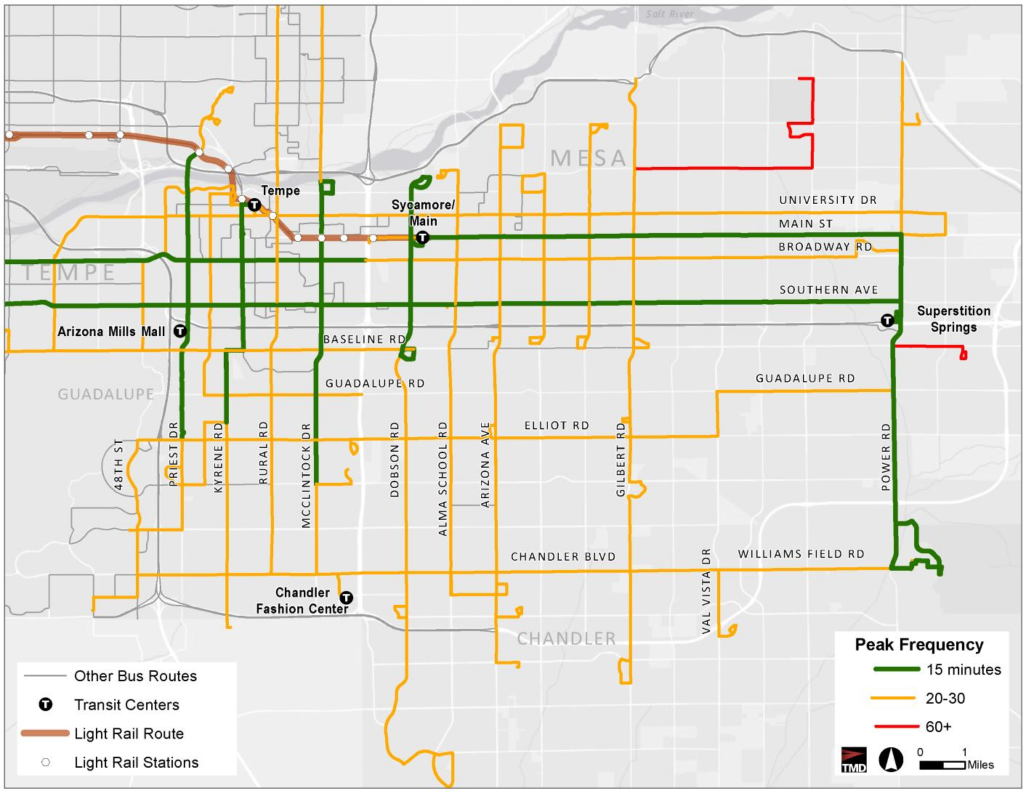
*Routes 3, 52, 251, and I-10E RAPID were not analyzed as part of the study area as only small portions of these routes fall within the Southeast Valley. Route 511 was eliminated in October 2014.

2.2 SERVICE LEVELS

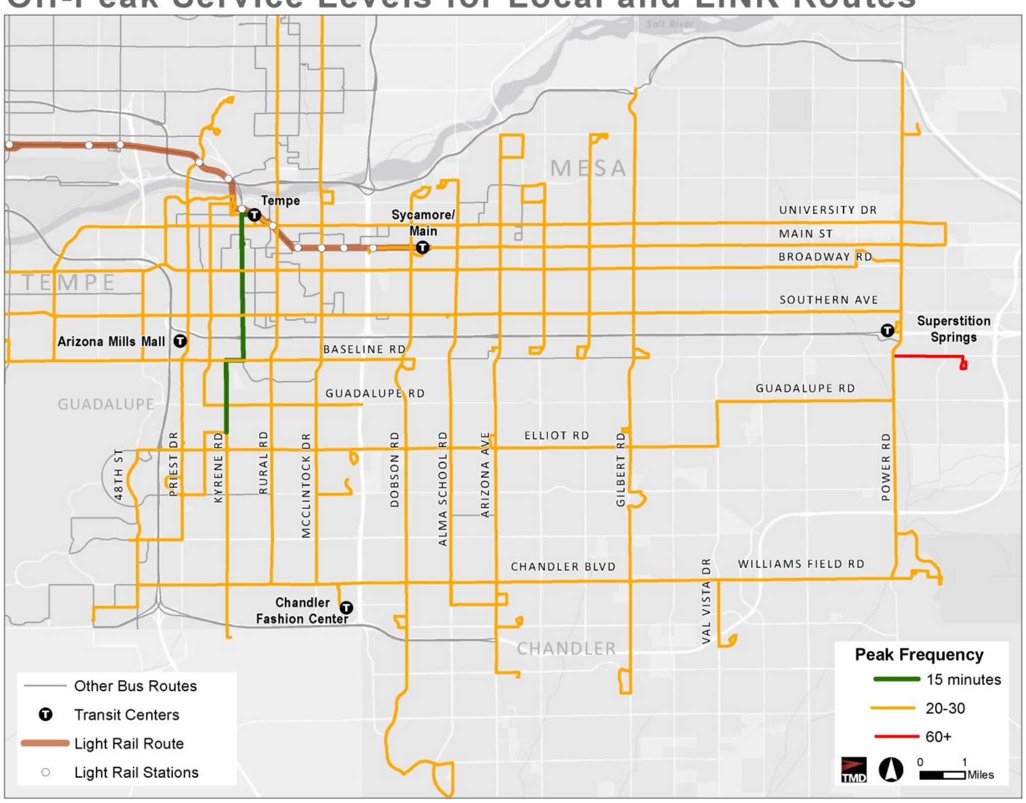
The majority of local routes operate every 30 minutes on weekdays with some 15-minute peak service. With the exception of a few route segments, no local route operates less frequently than every 30 minutes on weekdays. Weekend frequencies are either 30 or 60 minutes. The regular clockface headways of 15, 30, and 60 minutes facilitate transfer connections between routes at hubs and make the overall network easier to understand and remember. The irregular frequencies of routes, such as Route 72 (20 minutes) and LINK services (25 minutes), make transfers between routes less convenient for passengers.

While six local routes operate segments every 15-minutes during peak periods, only Route 61 operates a 15-minute frequency along its entire route alignment within the study area. The other five routes (45, 56, 81, 96, and 184) only operate 15-minute service on a select portion of the route (shortlines). In the off-peak all routes operate between 20-30 minute frequencies. Routes 65 and 66 operate every 30 minutes along the Mill Avenue corridor to provide a combined frequency of 15 minutes.

Peak Service Levels for Local and LINK Routes



Off-Peak Service Levels for Local and LINK Routes



Increase availability of 15-minute service - the minimum frequency required to attract spontaneous use riders and maximize the benefits of a grid network.

The presence of a strong 15-minute frequent network is necessary to attract choice riders to the system and maximize the benefits of a grid network. Frequencies of 15 minutes are the minimum threshold for spontaneous use, meaning that passenger wait time is minimized to the point where most riders do not plan their stop arrival using a schedule. High frequency service eliminates the need for passengers to plan their trips and transfers which ultimately attracts more riders who can use the overall network instead of just "their" route, specifically new lifestyle riders who choose to use transit and active modes as their primary means of mobility.

Additionally, high frequency service is crucial to the success of a grid network. In a grid network, passengers will likely have to transfer at least once in order to reach their destination, especially for discretionary travel. High service frequencies mitigate the inconvenience of having to transfer and allow passengers to more easily complete their trips using the overall network.

2.3 RIDERSHIP

Rail and bus services in the Southeast Valley carry over 82,000 riders on weekdays, 43,000 riders on Saturdays, and 27,000 riders on Sundays. Ridership is fairly evenly distributed throughout the day, with 49 percent of passengers riding during peak periods, and 35 percent riding during the midday. Services in the Southeast Valley have strong demand throughout the day, and most trips are taken for work and school commutes. Weekend ridership is around 50 percent of weekday ridership on Saturday and just under 30 percent on Sundays, indicative of lower lifestyle transit use with less discretionary travel.

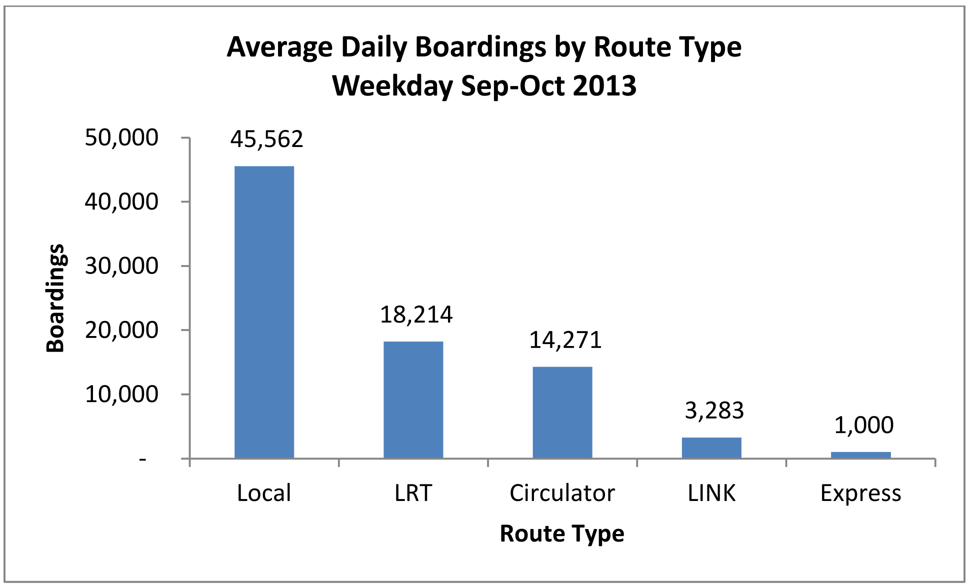
Ridership varies greatly by route, both between and within service types. Over half the daily weekday riders using the Southeast Valley service (55 percent) ride the local routes. Average ridership per route is 2,170 passengers, with route ridership ranging from 5,402 passengers on Route 61 to 709 passengers on Route 128. The top four routes by weekday ridership, Routes 61, 45, 72, and 30, account for 33 percent of Local bus boardings and 25 percent of all daily bus boardings in the Southeast Valley. Routes 61, 45, and 72 connect the Southeast Valley with Phoenix and Scottsdale and serve transit-dependent populations with higher concentrations of low-income persons and zero-vehicle households. The two LINK corridors, Arizona Avenue (served by ALNK and Route 112) and Main Street (MLNK and Route 40) account for 13 percent of total daily bus boardings. Together, these six corridors, account for 38 percent of all daily bus boardings, and 50 percent of Local and LINK bus boardings. Due to the high ridership on these routes, investing improvements in just these six corridors will generate significant gains in SEV network ridership.

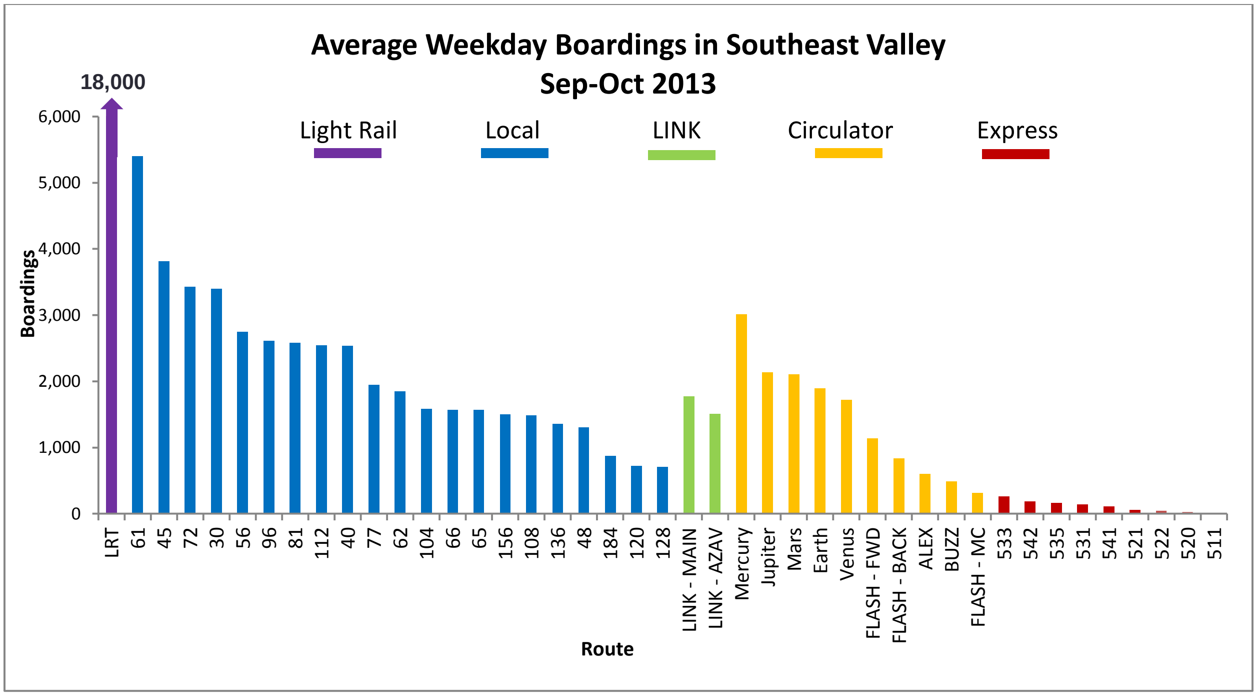
Invest in top six corridors to benefit 38 percent of all daily bus riders.

Light rail service accounts for almost one quarter (22 percent) of daily weekday ridership. The single rail line generates more ridership than the top four local bus routes combined. The light rail has a higher frequency than any bus route, operating every 12 minutes during the peak and midday periods, resulting in inconsistent transfer connections with the primary 15-minute and 30-minute bus service.

Circulator routes account for 17 percent of daily ridership and average 1,427 passengers per route each day. The five Orbit routes named after planets have high ridership because they provide connections between Arizona State University and surrounding residential and commercial destinations. The FLASH services likely have lower ridership because they primarily circulate around the campus, without connecting students to outside destinations. High ridership on these routes can also be attributed to the free rides for passengers.

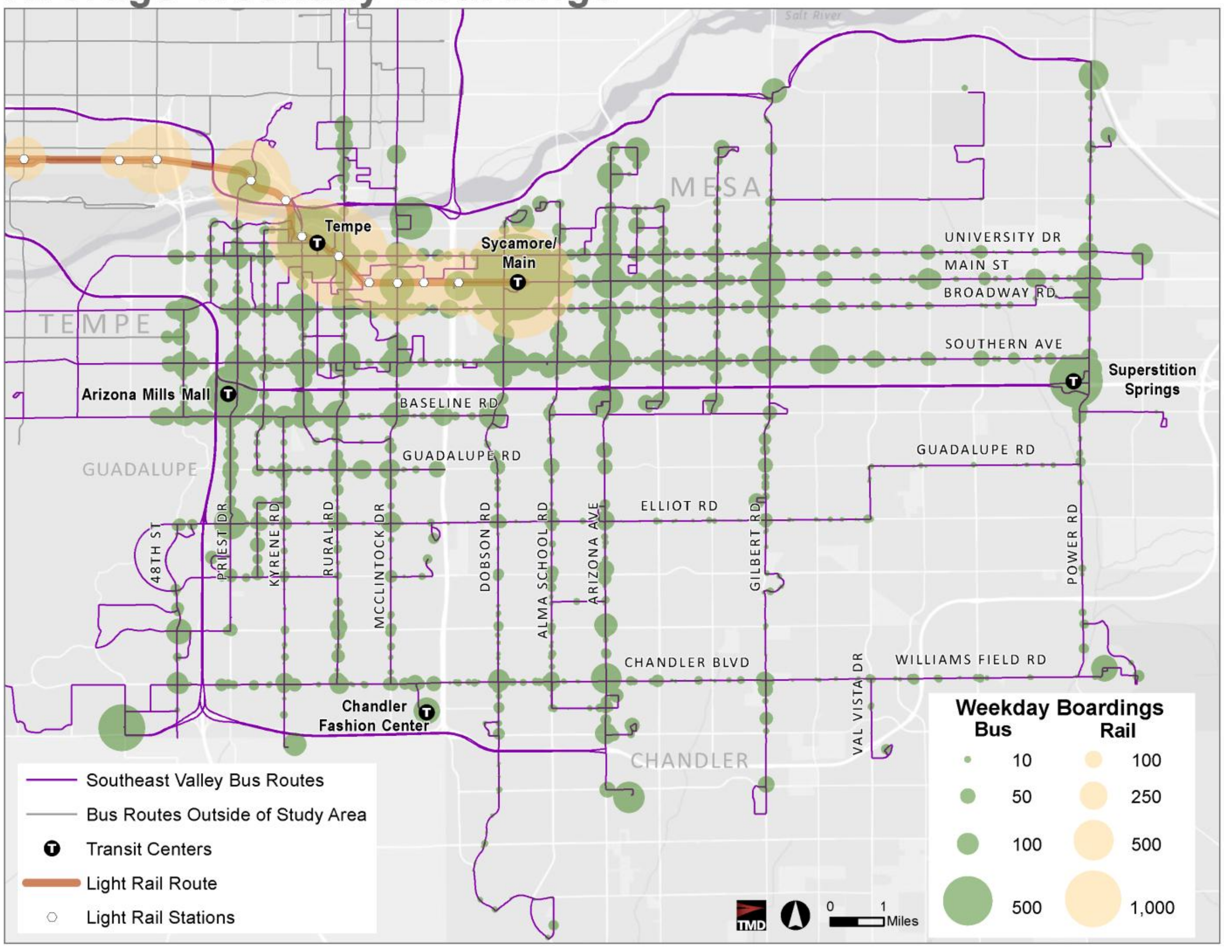
Express routes only account for 1.2 percent of daily ridership in the Southeast Valley. The nine Express routes that serve the Southeast Valley average only 119 boardings per day. Route 533 with the highest boardings of any Express route only averages 251 boardings per day.





Weekday ridership also varies greatly by geographic area. The stops with the greatest boarding activity are the major transfer hubs. Boarding activity is greater in the more developed and denser northwestern portion of the service area, and ridership activity drops significantly when moving east of Gilbert Road and south of Baseline Road. Higher boarding activity in the northwest can be attributed to higher service frequencies, higher surrounding population and employment densities, major activity centers, and the presence of a fully-developed grid route network.

Average Weekday Boardings



2.4 PRODUCTIVITY

Productivity is the measurement of the effectiveness of a route and is measured by dividing total passenger boardings by total revenue hours for each route.[1] It measures ridership generated per unit of service, making it possible to compare the performance of routes with greatly differing ridership and service levels. Productivity usually varies greatly across routes, service types, and geographic areas.

2.4.1 Productivity by Route and Service Type

On weekdays, the local, LINK, and circulator services average 32 passengers per revenue hour within the Southeast Valley. Three of the top four productive local routes serve Tempe, and two of these provide connections to light rail stations. High performing routes in the service area tend to serve multiple jurisdictions and connect to Tempe and Arizona State University.

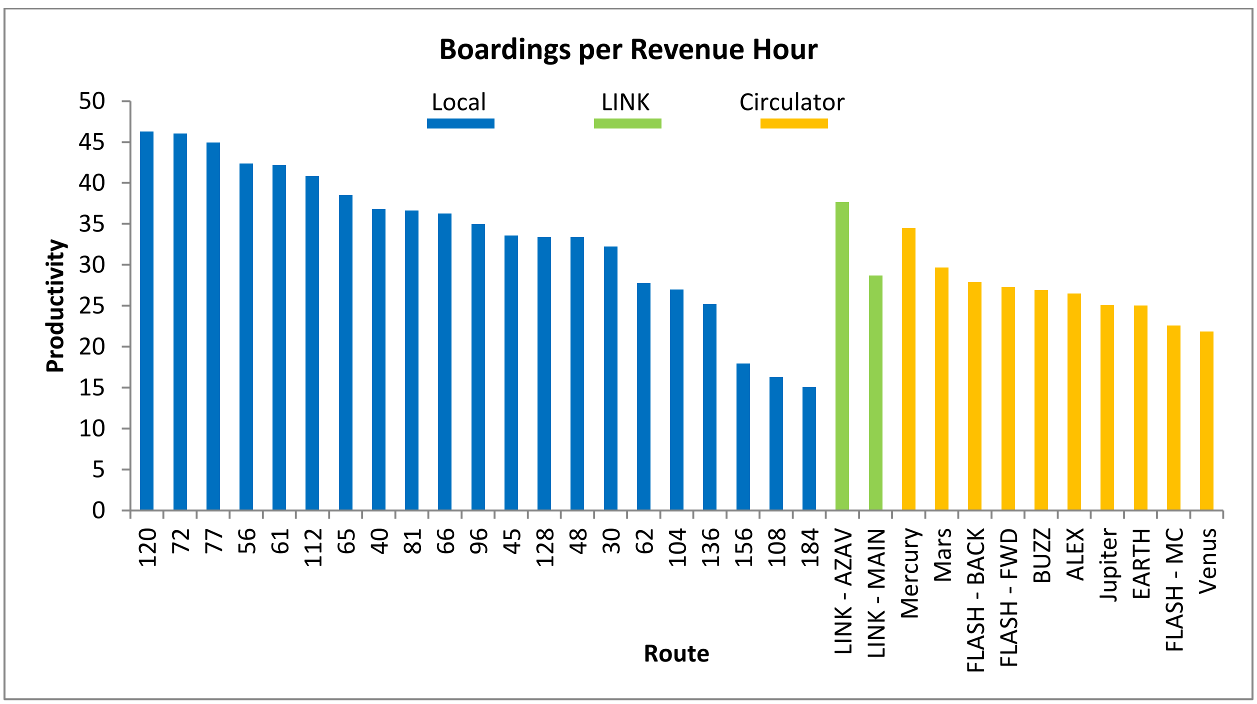
[1] Passenger boardings per revenue hour is the preferred productivity metric because it includes the impact of operating speed on service effectiveness. Operating speed directly affects labor cost which is 60-70 percent of total operating cost. Although the current service contracts pay based on a cost per revenue mile, operating speed and the resulting labor cost heavily impact this overall cost per revenue mile.

Routes 56, 61, and 72 rank in the top five in both ridership and productivity for local routes, making them prime candidates for further investment. Route 61 is able to maintain high productivity even with 15-minute service in the peak periods, reflecting the high ridership demand for this route. Route 120, which has the highest productivity, has the second lowest local ridership, which may be due to its very short route length and very efficient resource use.

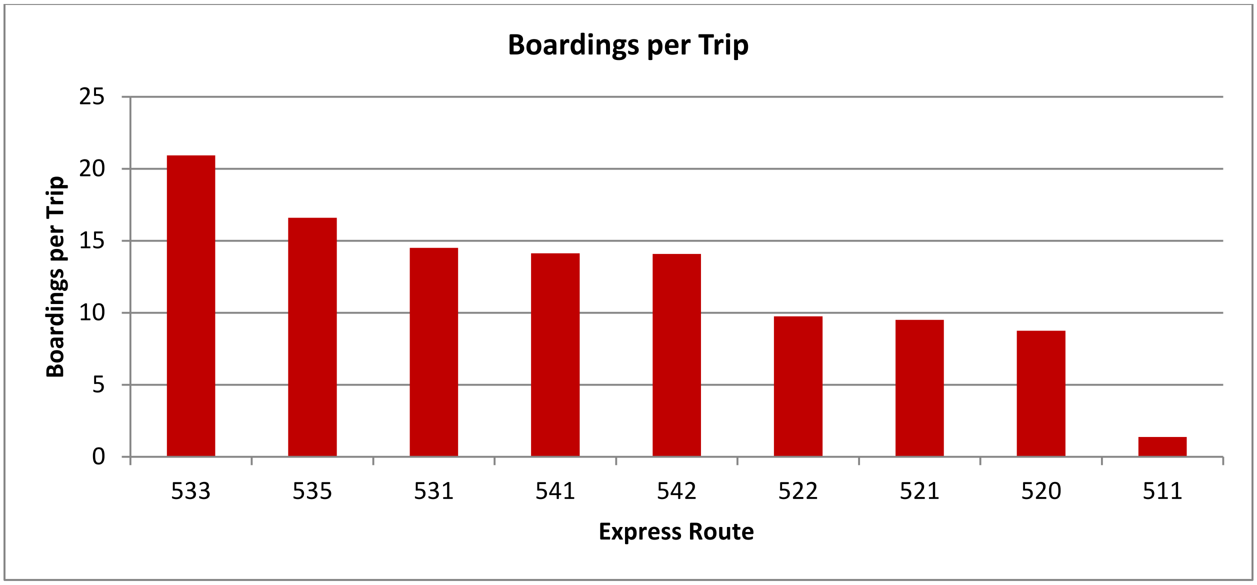
Routes 56, 61, and 72 rank in the top five in both ridership and productivity and are top candidates for investment.

Routes 112 and LINK Arizona Avenue both carry close to 40 passengers per revenue hour (pph) along the same corridor. The above average productivity of both services indicates strong potential for this corridor moving forward especially with the LRT extension eliminating the need for two separate route patterns. Since the LRT will be extended to Arizona/Main, there will no longer be a need for the LINK AZAV to operate to the west on Main St. It could directly mirror Route 112, providing an opportunity for one enhanced service pattern on Arizona Avenue. On the other hand, LINK Main Street has below average productivity at 29 pph, low performance for a route that has undergone such significant investment.

The three routes with the lowest productivity all serve the far southeast portion of the study area where surrounding population and employment densities are low and the grid network is incomplete. However, these services perform above 15 passengers per revenue hour, indicating they still warrant all-day fixed-route service and are not good options for flex service replacement and will see productivity improve along with development densities over time.



Express services were evaluated on a trip basis instead of on a revenue hour basis due to the difference in service delivery strategy. Express services average 13 passengers per trip with origins in the Southeast Valley. Many express routes extend beyond the service area, so this metric is not an assessment of the route as a whole, but rather its performance within the Southeast Valley. Route 533 is the most productive express route with 21 boardings per trip.



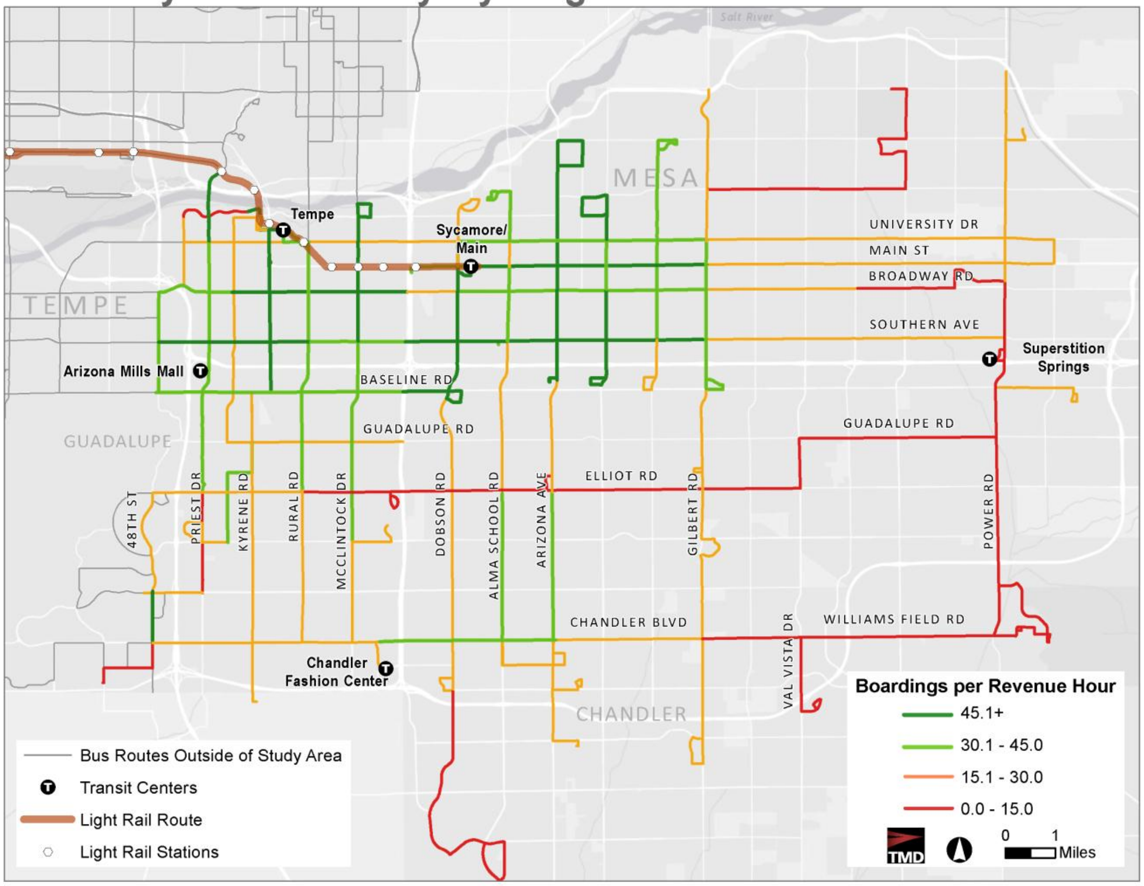
*Route 511 was discontinued in October 2014

2.4.2 Productivity by Geographic Area

> ***Service is generally more productive north of Baseline Rd and west of Gilbert Rd where service has higher frequencies and serves areas with higher surrounding densities.***

Routes in the Southeast Valley experience a significant difference in performance by geographic area. Productivity by route segment shows that routes that serve multiple markets may have high productivity in one area and low productivity in another area. Analyzing routes by segment finds that segments west of Gilbert Road and north of Baseline Road have above average productivity, and the highest productivities in the service area. This high productivity stems from the higher surrounding employment and population densities and the fact that the grid network is complete in this area. With a complete network of north/south and east/west routes in this area, passengers have relatively convenient transit access to anywhere in the region. The converse is true of route segments east of Gilbert Road and south of Baseline Road. These routes tend to have below average productivity, with many segments falling below 15 passengers per hour. The low densities increase the distances a bus must travel between destinations and decrease the number of people who have convenient access to any one route. The absence of a north/south route between Gilbert Rd and Power Rd also limits the accessibility of destinations in the eastern portion of the service area. This trend reinforces the impact that local land use and development patterns have on transit route and network area performance.

Weekday Productivity by Segment



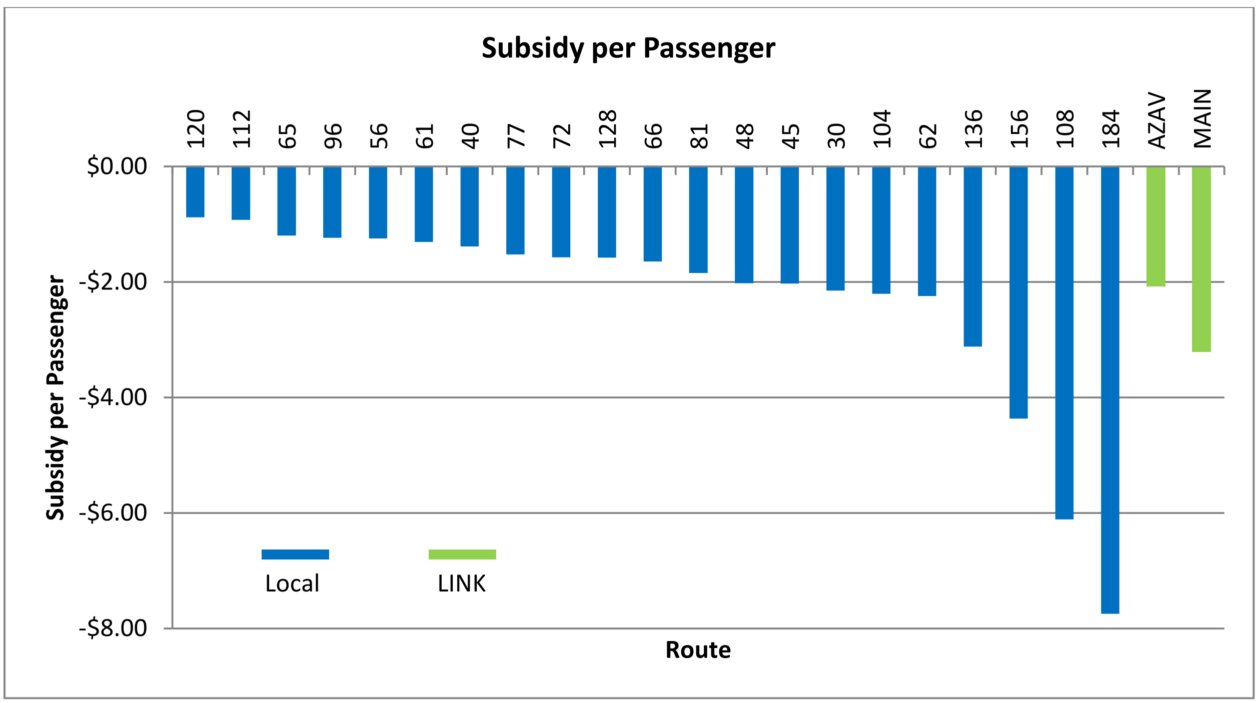
Routes 30, 40, 45, and 61 are examples of east-west routes that serve multiple transit markets and vary greatly in productivity throughout their alignment. An analysis performed on route segment productivity east and west of Gilbert Road found that route segments east of Gilbert Road experience more than 50 percent lower productivity than route segments west of Gilbert Road.

Route Number	Route Name	Productivity (pph)		Percent Difference
		West of Gilbert Rd	East of Gilbert Rd	
30	University	34.9	24.3	30%
40	Main St	52.6	19.4	63%
45	Broadway	41.9	14.8	65%
61	Southern	49.6	24.8	50%

2.5 FINANCIAL PERFORMANCE

Financial performance can be assessed using the metric of subsidy per passenger boarding which measures the net cost to operate a route on a “per boarding” basis. It is calculated using passenger revenue minus operating cost divided by the total number of passenger boardings. Financial performance is not always proportional to the service performance due to average fare differentials. Routes could have similar service productivity, but a lower subsidy per boarding if one of the routes has a higher average passenger fare than the other. This assessment only evaluated internal Southeast Valley Local and LINK routes as other services, i.e. circulators, do not collect fares.

Average weekday subsidy per passenger is $2.00 on local routes and $2.69 on LINK routes. The majority of routes have subsidies between $1.00 and $2.00 which is an indication of strong overall service performance. Three routes have subsidies over $4.00, twice the average, and these routes are also the three least productive routes. As development densities of the southeast part of the study area increase, the productivity of these routes will improve over time.



3.0 KEY ISSUES DISCUSSION

3.1 LINK SERVICE

Valley Metro operates two LINK services that act as light rail extensions and provide limited-stop enhanced service from the Sycamore/Main terminal LRT station. The routes perform well, but their potential is limited by the fact that they share their corridors with local bus service without a strong enough market to support two transit services on one corridor. The

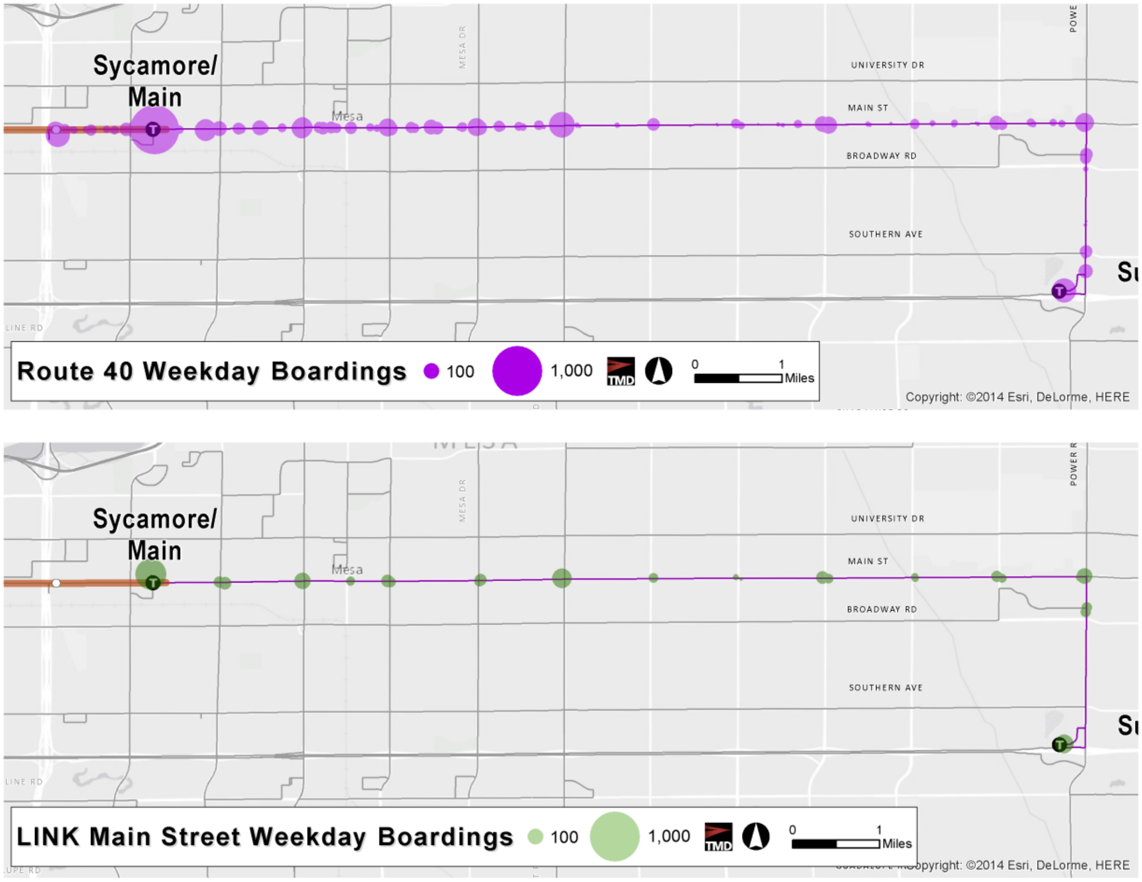
Arizona Avenue LINK (AZAV) operates on Arizona Avenue with Local Route 112 while the Main Street LINK (MAIN) operates on Main Street with Local Route 40. The table below shows that throughout the day, the local routes consistently have stronger performance than the LINK services. AZAV and Route 112 have similar productivities with Route 112 performing a little stronger, but MAIN and Route 40 vary considerably in their respective productivities.

Corridor	Service	Passengers per Revenue Hour		
		AM Peak	Midday	PM Peak
Main St	LINK	30.3	28.3	33.9
	40	37.1	41.7	41.4
Arizona Ave	LINK	36.7	35.0	43.1
	112	41.6	41.5	43.1

Ridership on the two local routes (5,082) is one and a half times the ridership on the LINK routes (3,283). As shown in the following maps, for the stops that the local and LINK services have in common, the boardings on the LINK routes are fewer than the boardings on the local routes, especially along Main Street.

Arizona Avenue Corridor

Main Street Corridor



In most cases, higher frequencies are associated with higher ridership. MAIN operates at twice the frequency of Route 40 during peak periods, but has fewer boardings: 931 compared to Route 40's 1,142. This trend is not surprising given the fact that the route alignments are nearly identical and a significant number of Route 40 boardings occur at shared stops – the frequencies are such that customers are simply catching the next bus.

LINK frequencies are not competitive with local bus alternatives.

The best practice experience is that the keys to attracting ridership on BRT-style services comparable to the LINK are high frequencies (10 minutes or better) and significantly faster travel times (20 percent savings). At and above these thresholds, the passenger benefits of riding the BRT service are enough to offset the negative of having to walk further to access service or let a local bus pass. LINK services meet the thresholds for travel time savings, but not for the 10 minute frequencies. Frequencies of 25 minutes on LINK are not enough to be competitive with the 30 minute frequencies of local routes. Passengers at shared stops get on whichever bus arrives first.

Additionally, the frequencies are not well-matched with the LRT service which operates every 12 minutes. The difference in frequencies limits the ability to make consistent time transfers between LINK routes and LRT service, an essential feature of rail extension service.

Corridor	Service	Frequencies (minutes)		
		AM Peak	Midday	PM Peak
Main St	LINK	15	25	15
	40	30	30	30
Arizona Ave	LINK	25	25	25
	112	30	30	30

LINK does provide competitively faster corridor travel times for passengers. The half-mile stop spacing means that buses stop at fewer locations, reducing dwell time and overall travel time. AZAV provides up to a 30 percent time savings over local service on Route 112, while MAIN provides up to a 37 percent time savings over local service on Route 40.

Additionally, Valley Metro does not capture the cost-effectiveness of LINK service because of the operating contract unit cost structure. Because Valley Metro operating contractor costs accrue by revenue mile and not revenue hour, LINK service ends up being more costly to operate than local bus service.[2] Because LINK service also generates fewer passengers per revenue hour, the service looks much more costly to operate than local bus service.

LINK potential is limited because market conditions are not strong enough to support two distinct transit services on LINK corridors. Consolidation of LINK and local service into one enhanced service would more effectively serve the corridors.

Bus Rapid Transit has many incarnations ranging from full BRT to Rapid overlay of regular local service. Valley Metro has chosen the latter approach on Arizona Avenue and Main Street. It is suggested that an alternative BRT "flavor" be considered that reinvents transit on these two corridors around one "enhanced" service that is a composite of both BRT and local transit – one where a single route operates with a 10-minute frequency with full transit priority, but with a station spacing that is balanced between BRT (½ mile) and local (¼ mile).

2 Normal transit operating costs accrue based on both miles (maintenance, fuel, tires, etc.) and hours (labor and benefits). The hourly costs usually comprise 60-70% of overall operating costs with the mileage portion much smaller at around 20%. With Valley Metro's one-variable contract pricing based on mileage costs, the LINK is assigned a disproportionately higher operating cost.

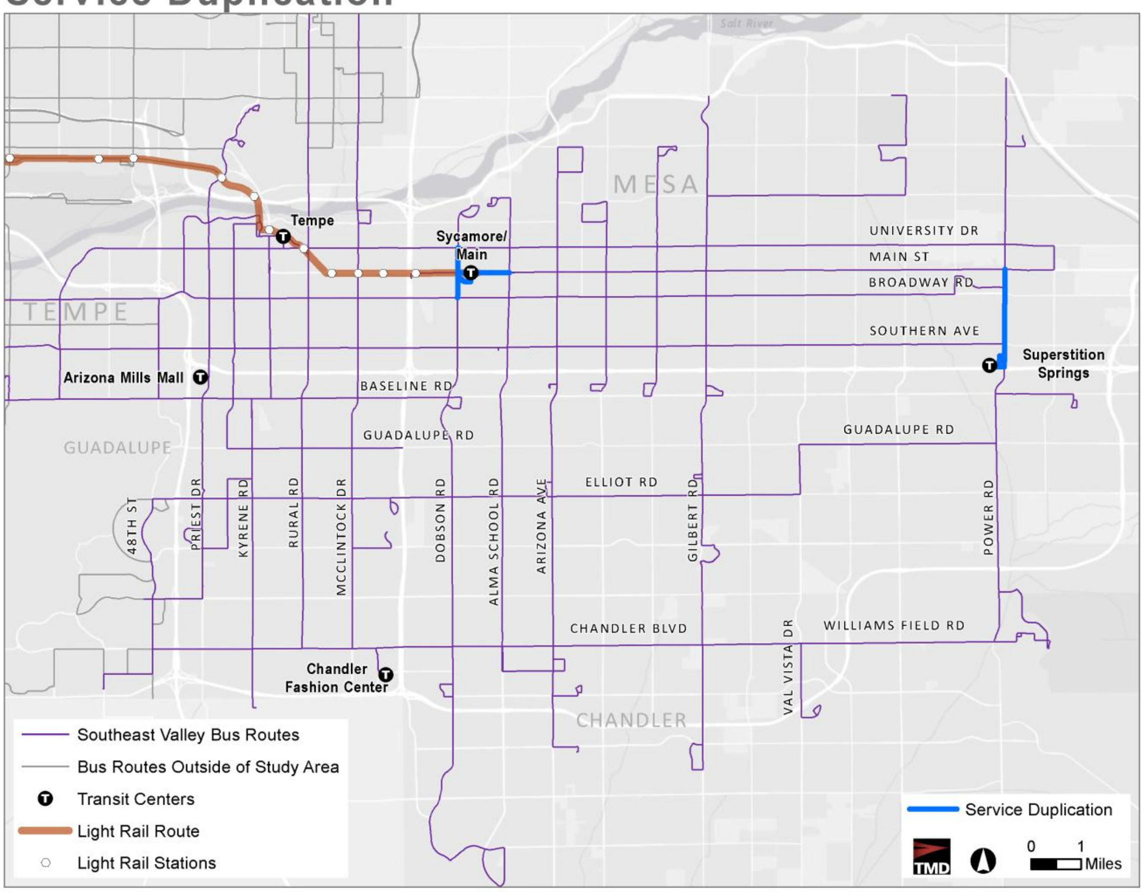
3.2 SERVICE DUPLICATION

There are a few places in the network, specifically near the Sycamore/Main LRT station and Superstition Springs, where there is considerable overlap between route alignments. These two locations are major destinations and logical anchor points for routes serving these areas. However, the convergence of many routes into a single transfer hub is more characteristic of a hub-and-spoke network than a grid network. In a complete grid network, the vast majority of locations are accessible by using only two routes. High frequency service makes transfers between routes easier, reducing the number of routes that need to serve any one location.

> ***Minimize route duplication where possible.***

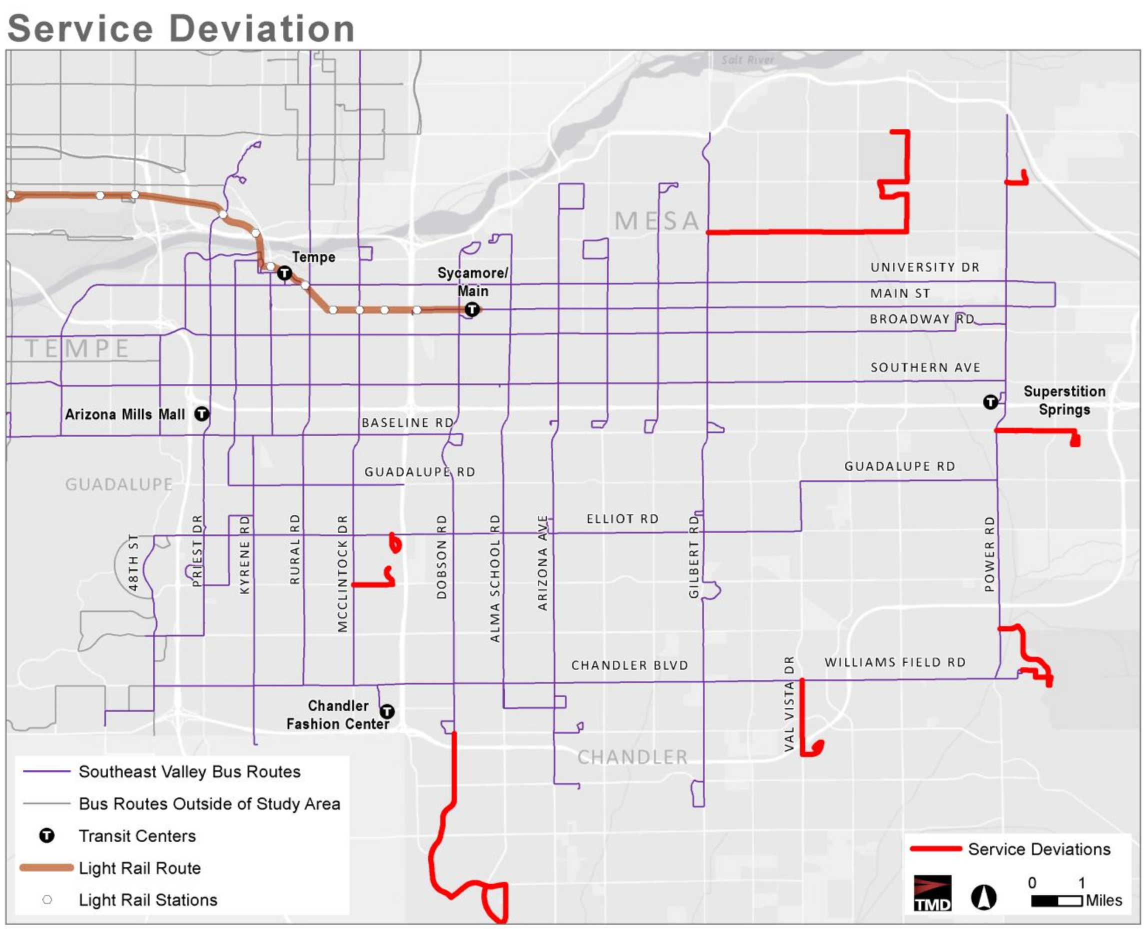
Service duplication also results in higher costs for Valley Metro. Because Valley Metro costs accrue on a per revenue mile basis, any extension of an alignment to serve a transit hub incurs additional operating costs. Minimizing the amount of service duplication on corridors will help reduce operating costs for Valley Metro or allow savings to be invested in service improvements elsewhere in the system.

Service Duplication



3.3 SERVICE DEVIATION

Overall, routes serving the Southeast Valley are linear and direct, forming a strong grid-like route structure. However, there are some route deviations that impact service performance. Routes deviate to serve activity centers such as hospitals, schools, or sports complexes or to serve transit network hubs such as the Sycamore/Main and Superstition Springs Transit Centers. There are two types of service deviations – those that occur at the end of the route, and those that occur in the middle of the route. Deviations at the ends of routes simply have a cost impact – they incur operating costs by adding mileage to the routes. Deviations in the middle of routes have the additional impact of negatively affecting through-riding passengers. Travel times for through-passengers are increased by serving deviations, and if a deviation is too time-consuming, it discourages passengers from riding. Consequently, on-corridor development should be emphasized and transit mobility impacts addressed during the location decision process for major activity centers.



The Route 156 deviation to serve Mercy Gilbert Hospital is an example of an unproductive deviation that significantly impacts through-riders. The Mercy Gilbert Hospital deviation is an 11-minute, 3.9 mile round-trip deviation that is served on every Route 156 trip (64 trips). On an average weekday, it picks up 39 passengers and takes 11.1 revenue hours, resulting in an effective productivity of just 3.5 passengers per revenue hour. The remainder of the route has 1,460 boardings for a productivity of 20.1 passengers per revenue hour. The time it takes to make the deviation discourages through-riders from using the service, costing the route potential ridership.

The table below compares the productivity of route deviations with the productivity of the rest of the route. In some cases, the deviations have high productivity and are justified for service. On deviations where the productivity is less than 10 passengers per revenue hour, the ridership gained along the deviation is not enough to offset the cost of providing service, and the deviation should be discontinued.

Route	Deviation	Boardings on Deviation	Productivity of Deviation	Boardings on Route	Productivity of Route
81	ASU Research Park	44	28.4	2,579	36.6
96	Fulton Ranch	100	14.3	2,614	35.0
108	ASU Research Park	26	15.9	1,488	16.3
108	Sunland Village East	7	12.9	1,488	16.3
136	Boeing	26	9.5	1,360	25.2
156	Mercy Gilbert Hospital	39	3.5	1,499	17.9
184	Red Mountain Mesa Community College	51	18.6	878	15.1
184	Phoenix-Mesa Gateway Airport	35	8.2	878	15.1

Attention should also be paid to whether or not the operation of a deviation requires adding a bus to a route. If serving a deviation requires an extra vehicle, it should be considered for discontinuation, as the productivity impact is even worse than noted above.[3] For example, the Boeing deviation on Route 136 adds 32 minutes of running time round trip over the main alignment, requiring the use of five vehicles instead of four to maintain 30-minute frequency. Other deviations that require an additional vehicle are the Route 96 extension to Fulton Ranch and Route 108 deviation to Sunland Village East. Adding vehicles to a route incurs significant operating costs and prevents resources from being used in service improvements where they could benefit more riders.

Eliminate route deviations that add resources to route operations or significantly impact through-riders.

[3] If the deviation adds a bus, then the ridership productivity should not be calculated on just the running time impact, but the entire hours for the additional bus. This would result in an even lower productivity than shown in the table.

4.0 TRANSIT OPTIMIZATION FRAMEWORK

The success of transit in the Southeast Valley hinges on decisions regarding two key factors: the presence of limited resources and the desired role for transit in the service area.

Because resources are limited, Valley Metro and its partners should strive to maximize the efficiency and effectiveness of the resources it puts on the street to get the best value for its investment. Making service more efficient allows Valley Metro to provide the same service with fewer resources, reducing cost and saving vehicles to be invested elsewhere in the system. Service is effective where each resource attracts as many riders as possible, most likely to be found in areas with higher population/job densities and concentrations of key destinations.

Defining a role for transit in the Southeast Valley will direct investment decisions throughout the area for years to come, primarily the decision of whether to invest in productive service or broad coverage. Providing coverage gives more people basic access to the network, but resources are spread across more routes, resulting in lower service frequencies and much less attractive transit mobility. Productive service requires investment in key corridors to increase frequency and enhance the passenger experience but can limit the number of people who have access to service. First, there is a balance between providing basic mobility coverage for those dependent on transit for their transportation needs and the optimization of resource allocation to create a more efficient and effective network. Second, the local communities need to be involved in proactive transit oriented *linear corridor* development to promote land use decisions that would minimize need to balance these competing demands on public transit mobility.

Conditions in the Southeast Valley are ideal for investment in high service frequencies to create a robust grid network, but this investment may come at the cost of service coverage and relies heavily on route transfers to make the network successful. Investing heavily in a true grid network will require getting passengers comfortable with the idea of having to often make transfers to complete their journeys. It will require rethinking transit investment from a commuter, supply side focus to one oriented around lifestyle transit – live, work, play – that is the backbone of sustainable community development. This will require an ongoing partnership of transit with local communities.

4.1 SERVICE PERFORMANCE

Analysis of the service performance of existing services indicates that market conditions, primarily population and employment densities, rather than transit network design are having the greatest impact on service performance. On the whole, performance is good given the variance in surrounding densities and development around corridors. Overall, route productivity within the sub-area exceeds 15 passengers per revenue hour, suggesting there is limited value for non-fixed transit options such as flex routes or call-in-ride zones.

Support development of high-density, walkable neighborhoods and urban centers to create continuous, linear transit-oriented corridor development that will provide a ridership base for future transit service in the Southeast Valley.

Productivity is strongly tied to population and employment densities. Performance is stronger in areas with higher surrounding densities and a complete grid network. Lower performance in the Southeast Valley is the result of both low densities, and a dispersed transit network. This area is subjected to a negative feedback loop where low ridership results in a lack in service investment, which further perpetuates low ridership. Transit will only be productive in this area when there is both a complete grid network and higher levels of employment and residential densities. Furthermore, the presence of Complete Streets and permeable neighborhoods in higher density areas facilitate greater access to transit. The decision of which should come first – the phasing of new routes and frequency improvements to create a more robust route network or the urban development of less dense areas – is a key decision that will frame the foundation of the service investments moving forward.

Southeast Valley communities, MAG, and Valley Metro have a unique opportunity to play a role shaping the development of these emerging areas. They can advocate concentrated linear development along future transit corridors to create neighborhoods that are less automobile-centric, more sustainable, and more oriented on transit and active mode mobility.

The TOA findings and recommendations are in line with the Sustainable Transportation and Land Use Integration Study (ST-LUIS) prepared by MAG. The ST-LUIS calls for the development of high-density, walkable areas to create transit-oriented communities that will support high-capacity transit services. The ST-LUIS identifies density thresholds for different tiers of transit services and areas where transit will be most likely to succeed. It should be referred to when considering where and how to develop the Southeast Valley's transit grid.

4.2 NETWORK DESIGN

A grid network design is appropriate for service in the Southeast Valley. The portions of the Southeast Valley with a complete grid network have the highest productivity in the service area, providing insight into the potential success for a complete grid network throughout the entire service area as it fully develops.

Design a grid-based network with minimal out-of-direction deviations and service frequencies of 15 minutes or better.

Grids represent the optimal balance of effectiveness and efficiency of resources for the prevailing road network and development patterns. Each route serves a unique role in the network and route deviations and duplication are minimized. Route duplication to serve transit hubs is inefficient and ineffective and should be oriented only to the periphery of the service area where service is infrequent. Investment in infrastructure in these peripheral transit hubs should be limited, given that the periphery of development is constantly changing. Transfer hubs where necessary should be located along major spines or at major intersections to minimize out-of-direction costs and passenger impacts. Deviations should be reconsidered based on the value added to the network. With a grid network structure, demand should orient to the linear corridors, not to outlying destinations. Alternative mobility options such as last-mile service or new pedestrian enhancements can help serve off-corridor destinations. Private and public development should include public mobility (transit, biking, walking) in the location decision process with mitigation costs, including TDM strategies, addressed at that time.

Grid effectiveness is maximized when customers can use the network spontaneously, which requires service frequencies of 15 minutes or better. Because transfers are an integral part of traveling throughout a grid network, fast and convenient transfers are crucial to attracting and maintaining ridership. Major transit corridors within the grid should have fast, 10-minute or better service and targeted for linear transit-oriented development. Examples of such corridors are Main Street, Arizona Avenue, Southern Avenue, and Rural Road.

The development of a frequent grid network should follow a phased approach that responds to development intensification and expansion while adhering to minimum density thresholds for frequent transit. The ST-LUIS identifies areas with 30 or more people/acre as being supportive of high-frequency, high-quality transit service (LINK).

4.3 SYSTEM DESIGN

While performance metrics detail how a route compares to performance thresholds and the rest of the system, service design decisions provide insight into why a route performs the way it does. Transit agencies cannot control the external factors that influence ridership, but agencies can make service design decisions that positively influence a customer choice to use transit.

- **Frequency** – Potential riders consider service frequency more than any other factor when deciding whether to use transit. Routes with spontaneous-use frequencies (service every 15 minutes or better) benefit passengers by reducing their out-of-vehicle wait times. At these service levels, passengers typically do not need to consult schedules nor time their arrival at bus stops and can travel spontaneously. Higher bus frequencies also provide a better connection to more frequent rail services which maximizes network benefits by facilitating the transfer experience.

  Appropriate service frequencies are closely tied to surrounding population and employment densities, and while 15-minute or better service is ideal for passengers, it may not be warranted in all situations or at that time.

  Increase frequency of top-performing routes to at least 15 minutes to attract discretionary riders.

- **Service Span** – Service span is the hours and days of operation of a route. It affects ridership by limiting when passengers can travel and often affects both ends of a trip even though half of the trip occurs during regular service hours. Greater service span provides more travel flexibility and improves the customer experience, but excessive time span coverage like geographic coverage can be excessively unproductive. Most routes in the Southeast Valley operate between 4:00 AM and 1:00 AM.

Increase service span and days of operating as warranted by demand to provide riders with all-day all-week trip options.

The presence of an all-week network is also crucial to the success of the system in attracting lifestyle users – the live, work, play market. Services that operate only six days a week or have limited daily service spans require those needing to travel on the seventh day to find an alternative travel option, which they may continue to use on days when transit service is available.

Focus on delay reduction beginning with the higher ridership major corridor spines and continuing with all routes in the frequent network.

- **Service Speed** – Faster operating speeds benefit both the customer and the transit agency by reducing in-vehicle travel times for passengers and resource requirements for the agency. Out-of-direction travel (deviations), excessive stop dwell time (stops too closely spaced or long delays at stops), unsynchronized travel signal delay, and traffic congestion all contribute to slower service speeds and should be avoided or mitigated where possible through application of the transit priority toolbox.

  In the case of Valley Metro, increased service speeds do not necessarily have the same cost benefits as in other agencies. Because Valley Metro costs accrue on a per mile basis, higher service speeds allow vehicles to travel further in the course of an hour, increasing operating costs higher than the actual impact.

- **Alignment** – The alignment refers to the operating path of the transit route. Alignment design should balance customer access (walk distances) with service directness (fast travel). Direct service normally results in higher ridership (deviations deter upstream customer use) and lower operating costs (shorter round trip travel times often require fewer resources).

  Route alignments should be linear with minimal out-of-direction deviations.

  Out-of-direction deviations should be minimized wherever possible. They add time and mileage to service operations and make travel less convenient for through passengers.

Space routes 1/2 mile to 1 mile apart where supported by demand.

- **Route Spacing** – Routes should be spaced to maximize effective network access. Services placed too close together or too far apart are issues in network cost effectiveness (unproductive competition) and synergy. Typical route spacing in an area like the Southeast Valley is no closer than ½ mile and no farther apart than one mile where the necessary densities and service frequencies are present. These distances are heavily influenced by quality of the pedestrian infrastructure and service being provided. Consumer research has found that customers will walk further for better bus transit service, increasing the appropriate spacing between frequent routes.

- **Network Role** – While the design of individual routes is important, how they come together into an efficient and effective network is critical to attracting use of transit for all kinds of trip-making by a broad cross-section of the community (transit lifestyle design). Each route should serve a unique role in the network, and this feature is automatically integrated in a true grid network. Routes that act as rail extensions or rail feeders should have frequencies that match with rail service to provide convenient transfers between services.

Design an integrated network where each route has a unique role and reduce unproductive alignment duplication where feasible.

- **Approachability** – The approachability of a system refers to how easy it is for a passenger to navigate and understand a system. Systems that are approachable make customers comfortable with using public transit and reduce uncertainty. Excess complexity can negatively affect both route and more importantly network attractiveness.

Make the network easy for riders to understand by minimizing service complexity and using easy-to-remember, consistent service frequencies.

The Valley Metro service is very approachable, with few complicated scheduling measures such as short/long lines, tripper services, and out-of-direction deviations. The predominant use of regular frequencies (15, 30, 60 minutes) makes schedules easy for passengers to remember, enhancing their experience.

4.4 NEXT STEPS

The framework of the TOA outlines specific design principles for transit service. They focus on creating a high-frequency grid-like route network that will attract discretionary riders and encourage existing riders to use transit for more trip purposes. These service design principles will be applied on a network and an individual route basis to inform the development of service recommendations.