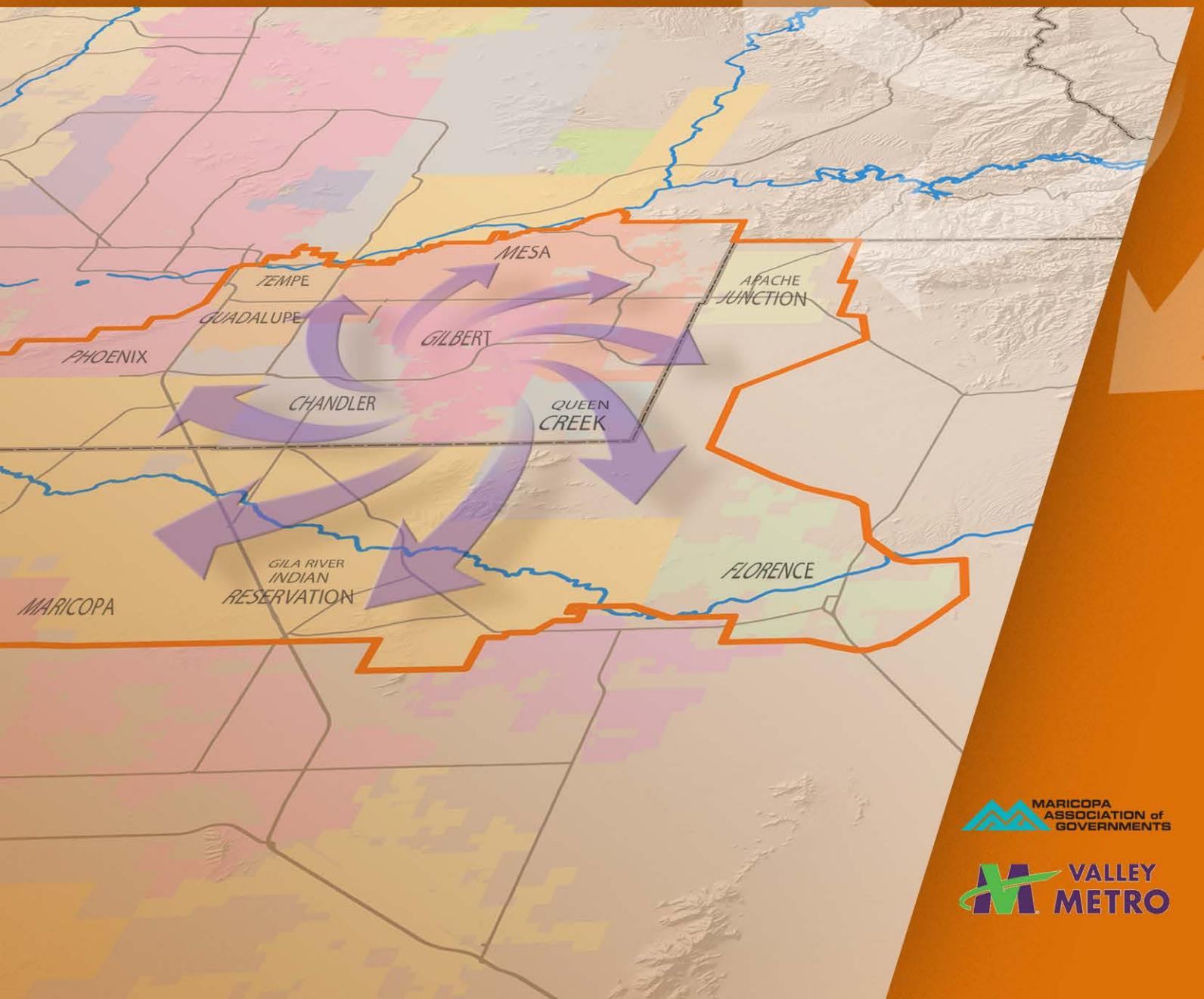
SOUTHEAST VALLEY
TRANSIT SYSTEM STUDY

JULY 2015

FINAL REPORT



MARICOPA ASSOCIATION of GOVERNMENTS

VALLEY METRO

SOUTHEAST VALLEY
TRANSIT SYSTEM STUDY

FINAL REPORT

Prepared for:

Maricopa Association of Governments
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URS

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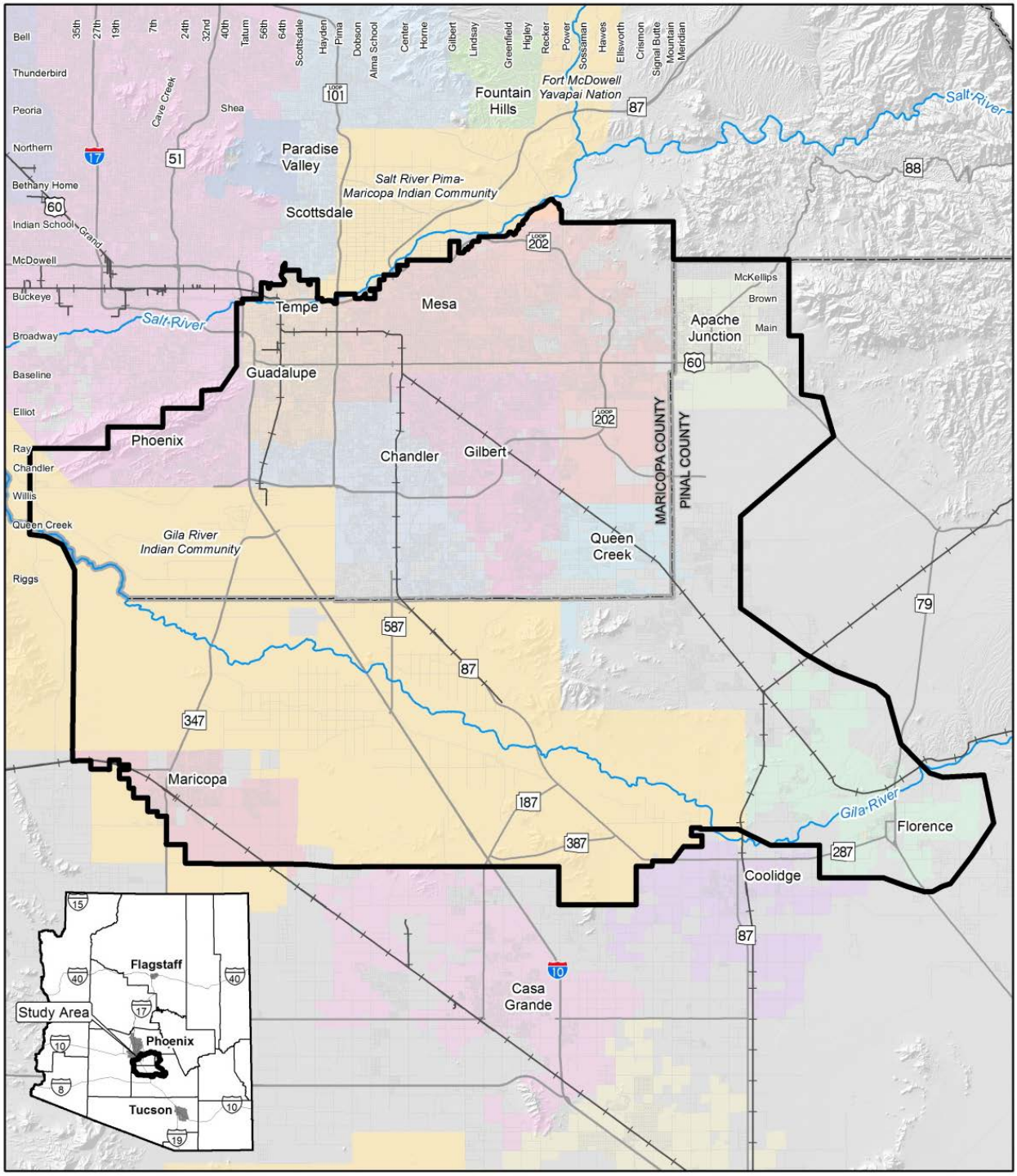
1.0 INTRODUCTION

The Southeast Valley Transit System Study (SEVTSS) analyzed transit services and ridership demand in transit-established and transit-aspiring communities within the southeast subarea of the Maricopa Association of Governments (MAG) region. The study addresses primarily local bus transit; rail high capacity transit is not part of the analysis. The study area encompasses the full extents of the City of Tempe, City of Mesa, Town of Guadalupe, City of Chandler, Town of Gilbert, City of Apache Junction, Town of Queen Creek, City of Maricopa, and Town of Florence as shown in **Figure 1**. In addition, the study area also includes portions of the City of Phoenix (Village of Ahwatukee), unincorporated Maricopa County, Pinal County, and the Gila River Indian Reservation. Beyond the jurisdictional extents of the study area, this study also included input from transit partners that operate within the study area such as the City of Coolidge. Through a data driven process, this study resulted in the identification of short-, mid-, and long- term recommendations that can be used to enhance and develop a performance-based transit system throughout the Southeast Valley. The recommended concepts may be implemented through other planning and programming processes such as the Short-Range Transit Plan (SRTP).

The goals and objectives that guided the development of the SEVTSS include:

- Develop an effective market-driven transit system for each planning horizon that provides connectivity within the Southeast Valley and to the rest of the region.
    - Objective: Connect major residential areas within Southeast Valley with major activity centers within and outside of Southeast Valley, and connect major activity centers within Southeast Valley with each other.
    - Objective: Provide a transit system that is well-integrated with other modes including pedestrian, bike and auto travel; and that provides connectivity to high capacity and other regional transit services.
    - Objective: Give high priority to transit-dependent and transit-oriented travel markets.
    - Objective: Provide a seamless transit system from the customer perspective (e.g., minimize or eliminate service inconsistencies due to jurisdictional boundaries) that has competitive travel time, reliability, comfort, and convenience.
    - Objective: Provide a transit system that is consistent and supportive of regional and community transportation visions, goals, plans, and service standards.
    - Objective: Provide a transit system that is adaptive to changing conditions in terms of land use, population, employment, activity centers, including an aging population.
- Develop an efficient performance-driven transit system that is affordable given the potential funding sources, and cost-effective.

Figure 1: Study Area



- Objective: Provide a transit system that meets or exceeds the necessary regional targets for transit productivity in order to ensure a financially sustainable transit system.
- Objective: Provide a transit system that applies the most appropriate transit service types to the various travel markets.
- Objective: Ensure the appropriate mix between service performance and service coverage.
- Objective: Promote an ongoing dialog between transit planners and land use and community planners to support the relationship between transit investments, land use, and development decisions.

2.0 STUDY PROCESS

This section describes the steps taken to develop recommended concepts for the short-, mid-, and long-term planning timeframes. **Figure 2** illustrates the major tasks that were undertaken as part of this study. The initial efforts refined the study approach (Task 1) and established the public outreach processes that would be used throughout the duration of the study (Task 3).

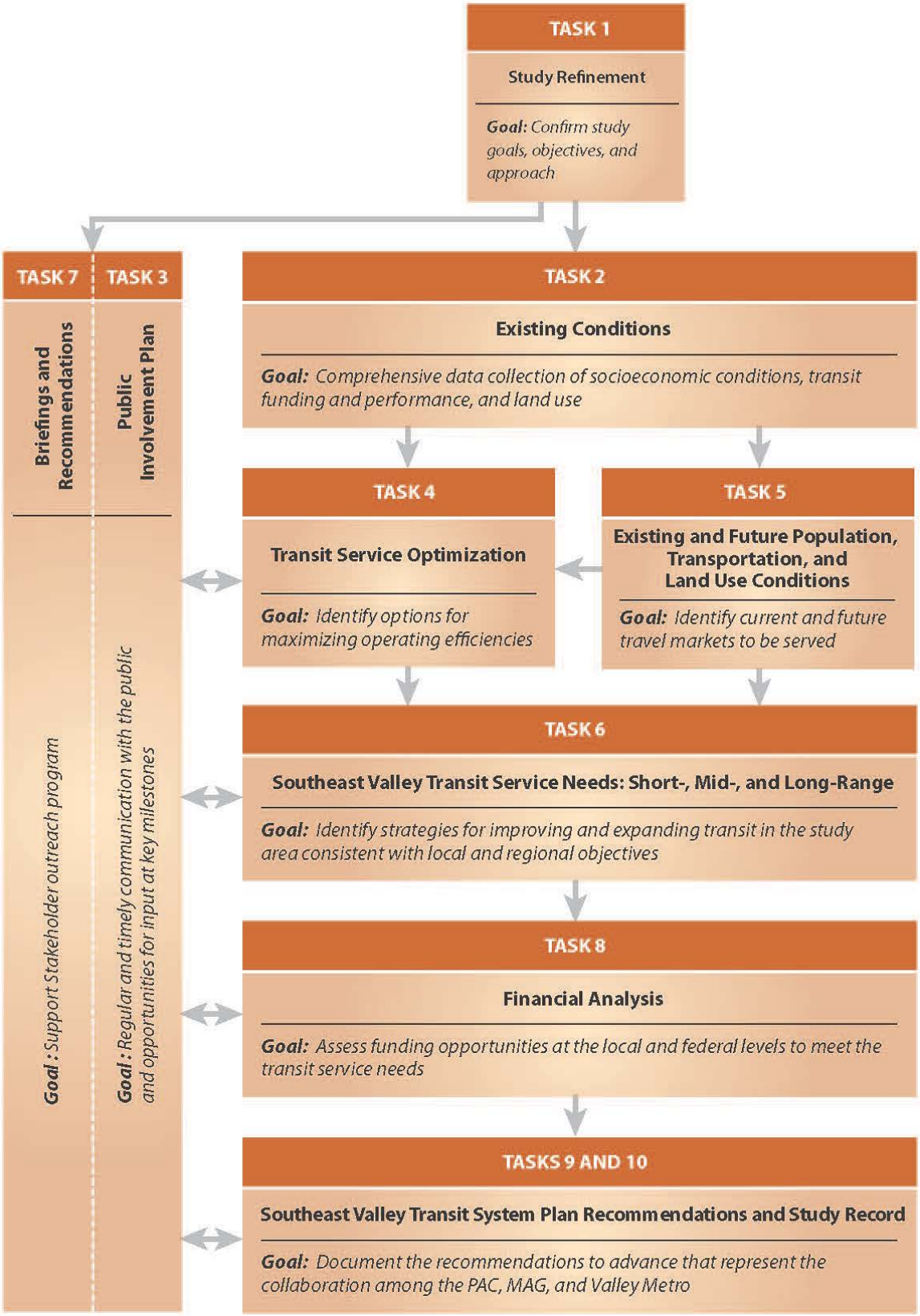
An analysis of the existing and future study area conditions addressed socioeconomics, land use, and existing transit services (Tasks 2 and 5) and laid the foundation for:

- Transit Optimization Analysis (Task 4), which identified recommendations to maximize operating efficiencies within the existing system based on an analysis of available boarding data and a HASTUS service design review; and
- Needs Assessment (Task 6) that explored longer term demographic and land use trends to identify future travel markets and service needs.

In addition, ongoing coordination with Project Advisory Committee (PAC), which included representation of all the jurisdictions within the study area, provided input on community objectives, preferences, and experiences. This study also was concurrent with Valley Metro's Transit Standards and Performance Measures process, which resulted in adopted standards that will be applied to future service planning.

The financial analysis (Task 8) inventoried the current funding structure for fixed route service in the Southeast Valley and established methods to estimate the financial requirements of the proposed recommendations. This *Working Paper* (Task 9) documents the final concepts for each planning timeframe that may be integrated into ongoing and future programming processes.

Figure 2: Study Tasks



2.1 PLANNING TIMEFRAMES

Three timeframes were considered for this study: the Optimization of Existing Services (Short-term), Mid-term, and Long-term. These timeframes were defined in collaboration with the PAC. Each is described below.

2.1.1 Optimization of Existing Services

The Optimization of Existing Services timeframe focuses solely on the enhancement of transit services that are currently in operation within the Southeast Valley as of January 2015. Project concepts that were considered include increasing frequency of service, eliminating route deviations that reduce network efficiency, and modifying route structures that create overlap and duplication with other routes in the same area.

2.1.2 Mid-Term

The Mid-term planning timeframe will identify projects for implementation within the next 10 years and may require funding beyond what is currently programmed. The set of concepts for this timeframe includes:

- recommendations for the Optimization of Existing services timeframe that were determined to be of lower priority and/or require additional funding;
- projects that are part of the Regional Transportation Plan (RTP) program in Group 1 and Group 2, which are programmed to be implemented through the year 2026;
- recommendations to address emerging needs throughout the study area based on the Needs Assessment; and
- input from adopted local plans.

2.1.3 Long-Term

The Long-term planning timeframe will identify projects for implementation beyond the next 10 years and may require funding beyond what is currently programmed. The set of concepts for this timeframe includes:

- projects that are part of the RTP program in Group 3, which identifies projects to be implemented by 2035 and have allocated regional funding;
- recommendations to address the future transit needs of the Southeast Valley based on the Needs Assessment that was conducted; and
- input from adopted local plans.

2.2 COMMUNITY OUTREACH

Stakeholders in the Southeast Valley were encouraged to complete an on-line survey so that public opinions could be incorporated into the study recommendations.

2.2.1 Survey

Residents in the Southeast Valley were asked to complete an on-line survey to assess community transit likes, dislikes, needs and over all support. Over 1,100 individuals responded to the survey.

Although the survey was not a scientific analysis of community needs, feedback included:

- About 80% of the respondents did not work in the same community as they lived
- Personal vehicle was the primary transportation mode
- Majority of respondents did not use transit because it did not meet their needs
- Majority would support a tax or fare increase to support transit

2.2.2 Community Events/Presentations and Media

Participation in community and presentations within the Southeast Valley offered an opportunity to educate the public about the study and to encourage public comments for the final study.

- Participated in 23 events/presentations

In addition, a press release was issued in both English and Spanish. The Arizona Republic newspaper and several local media outlets published information about the study.

3.0 SUMMARY OF NEEDS ASSESSMENT

3.1 LOCAL TRANSIT NEEDS ASSESSMENT

The needs analysis focused on identifying local (local and key local) and enhanced local (such as LINK-style limited-stop) bus service needs within the Southeast Valley. Areas of need were defined as locations that deserve consideration for local or enhanced bus service based on land use, route connectivity, population and employment density, and other demographic characteristics. Three types of analyses were performed to determine areas of need, using the following data:

- Current and future population and employment density;
- Available demographic indicators of transit dependency (e.g., zero- or one-automobile households, lower income households); and
- Current and projected travel patterns.

A more detailed discussion of the Needs Assessment is provided in *Working Paper 6: Transit Needs within the Southeast Valley*, as well as the *Transit Optimization Analysis: Assessment of Existing Conditions*. The assessment concluded that near- and mid-term areas of need include filling in the grid within the existing service area. Based on the analysis of the above-referenced data, east-west roads in the southern portion of the study area such as Baseline Rd., Elliot Rd., Warner Rd., and Ray Rd., are candidates for further service expansion. Generally, population and employment are less dense east of Gilbert Rd. The census tracts in the study area with the highest concentrations of transit-dependent households are mostly within the existing service area. Apache Junction, Maricopa and Pinal County unincorporated areas, and eastern portions of Mesa on the Main St. and Broadway Rd. corridors are among the areas that show higher transit-dependent populations but do not currently have transit service. Another area that appears to merit additional transit service is downtown Chandler, which has a high concentration of transit-dependent households but limited transit service. While there appear to be significant households with transit-dependent characteristics within the GRIC, the large size of the census tracts causes densities to appear low. A more detailed analysis of the GRIC would need to be conducted to determine how densely concentrated these areas are and where they are located.

By the early 2030s, there appears to be a fairly strong match between planned transit services and the areas with densities projected to support fair to good transit effectiveness (i.e., areas where transit service seems likely to attract good ridership).

The analysis of travel patterns was based on output from the MAG travel demand model. Currently, the areas with the highest densities of trips that are satisfied within the study area are in the northwest part of the of the study area. The density of trips tends to reduce as one head south and southeast from Tempe. This is still projected to be the case by 2035. North Tempe is projected to grow the most in terms of density of trips but other study area districts in Chandler, Gilbert, and Mesa are also expected to have significant increases in internal trip density, especially in the vicinity of the Phoenix-Mesa Gateway Airport. This corroborates the findings of the analysis of population and employment density. Altogether, the analysis of travel patterns and density of trips attracted and produced within the study area does not suggest that there are additional areas of unmet need beyond what was identified through the population and employment analysis.

3.2 NEEDS IDENTIFIED IN OTHER PLANS AND STUDIES

Potential transit needs are also identified by stakeholder communities and jurisdictions in recent local plans and studies. Mesa's recently adopted plan identifies route expansion of existing east/west routes as a long term goal. The Power Rd. corridor is identified for further investment and the possibility of high capacity transit (HCT). Chandler and Gilbert's plans call for coordinated extension of existing routes into and between their jurisdictions or implementation of new services within the existing local transit coverage area. New services on Baseline Rd., Val Vista Drive, Ray Rd., McQueen Rd., and perhaps Queen Creek Rd. are

all identified. Potential long-term HCT investments on Williams Field Rd./Chandler Blvd. and Arizona Ave. are also identified.

The City of Tempe adopted an update to its transportation master plan in December 2014. This plan recommends Rural Rd. and Southern Ave. for enhanced bus services and transit service improvements on local routes 45, 48, 56, 61, 72, and 77. Longer term recommendations include new HCT on Rural Rd. and a streetcar system in the downtown area.

Outlying communities such as Queen Creek, Apache Junction, and Pinal County have evaluated the feasibility of implementing future transit service. Recent studies identify a need to connect Apache Junction to the existing grid along Broadway Rd. or Main St./Apache Trail and also recommend the development of internal transit circulation within the community. As identified in the Queen Creek Transit Study, current travel demand and patterns within Queen Creek are not yet supportive of fixed-route service so subsidized vanpool is suggested for the short-term. Due to the current rural nature of Pinal County, the Pinal County Transit Feasibility Study's focus is mainly placed on regional connectivity of the noncontiguous communities in Pinal County with each other and Maricopa County communities. Needs identified include Express transit services to serve commuter markets including the airport and downtown Phoenix from the City of Maricopa and feeding the grid network with Express services connecting San Tan Valley and Queen Creek to the Superstition Springs Transit Center. Regional routes are suggested for implementation between Florence, Coolidge, Eloy and City of Maricopa to a central hub in Casa Grande.

3.3 EXPRESS SERVICES

Express services are designed to serve commuter markets (i.e., work trips). Express services are peak commute period, peak commute direction oriented. Typically, the destination needs to be a regional center or sub-center with a high concentration of 8 AM to 5 PM employment. Important characteristics necessary to support Express include low availability or high cost of parking at the work place, and distance commuted. Express service typically also needs to serve residences far enough away from the employment center that savings are experienced by the rider in exchange for the inconvenience of using a bus instead of his/her personal auto. A challenge for effective Express service is that the more distance the service travels between its origin and destination, the more operating cost and subsidy per passenger needed to operate the service. Hence the further the distance the Express service travels, the more competitive it is for the customer but also the more cost is borne by the service provider.

A list of reasonable destination centers that may be able meet these criteria in the Phoenix metropolitan area includes:

- Downtown Phoenix (already supports Express service)
- Sky Harbor International Airport
- Downtown Tempe/ASU Main Campus

All three of these locations have parking costs in addition to being significant trip attractors. Currently, downtown Phoenix is the only of the three that currently supports Express services. Three Express services, one from Queen Creek, one from the City of Maricopa, and one from Scottsdale Airpark, previously served downtown Tempe but were canceled due to low demand or funding shortfalls.

Trip Reduction Program (TRP) data, origin-destination data available for residence and employer through the U.S. Census Bureau, and existing Express route ridership/ performance data were used to determine potential Express service needs. This analysis concluded that the areas with highest concentrations of downtown Phoenix commuters are already currently served by Express/RAPID service. Ahwatukee and the areas south of the US 60 in Tempe and Chandler have the most significant concentrations of downtown Phoenix-bound commuters, and also have the highest level of investment in Express services. Exceptions to this include Queen Creek and the City of Maricopa; however, Express services both previously served these communities but were canceled. Service in the City of Maricopa was canceled during the recession because the service was deemed unaffordable, while a pilot service in Queen Creek served downtown Tempe instead of downtown Phoenix and had poor ridership.

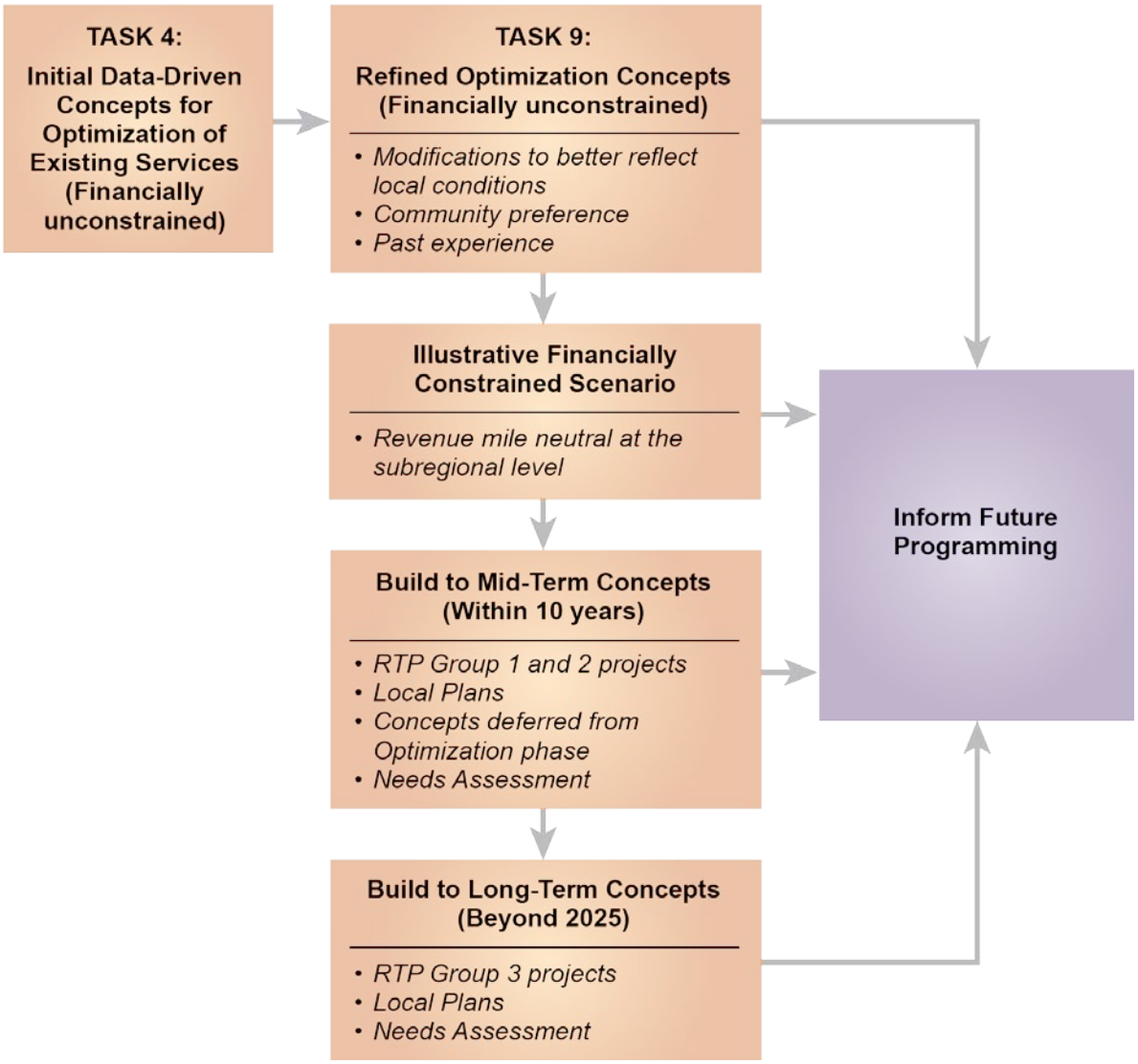
Solely based on comparison to characteristics of downtown Phoenix, both Phoenix Sky Harbor airport and Tempe/ASU are unlikely at this time to support effective Express service. The amount of employment in both locations is significantly smaller than downtown Phoenix. Phoenix Sky Harbor airport and downtown Tempe attract 34% and 38% as many peak home-based work, trips as downtown Phoenix, respectively. By 2035 both are projected to still only attract around 50% as many peak home-based work trips as downtown Phoenix does today. This results in lower densities of home-based work trips on the origin end to downtown Tempe/ASU and Phoenix Sky Harbor airport which means less potential ridership per catchment area. Furthermore, since downtown Tempe/ASU and Phoenix Sky Harbor are both closer to study area transportation analysis zones (TAZs) than downtown Phoenix, the TAZs of the study area that are sufficiently far enough away from the destinations to experience substantial time saving/cost saving benefits to the user are much fewer-especially for downtown.

In addition, much of the employment at Phoenix Sky Harbor and downtown Tempe/ASU may not appropriate to serve with Express. “Nine to five” office/professional services make up a relatively small composition of the airport’s employment mix. Employees are arriving and egressing from the airport throughout the 24-hour day. Similarly, downtown Tempe has a temporal split for its employment. Some employment has typical daytime shifts but a substantial portion of its employment is entertainment/service-related so many employees work in the evenings/nights. The dispersed temporal nature of work shifts at these locations makes serving them with Express less practical, however, serving them with local and HCT transit investments is very practical. Both downtown Tempe and the airport are well connected with local and HCT services.

4.0 RECOMMENDATIONS AND CONCEPT DEVELOPMENT

The overall planning concepts and recommendations identified for the Southeast Valley were defined based on the results of the needs analysis, the Transit Optimization Analysis (TOA), and stakeholder input. The process through which the recommendations were developed is shown in Figure 3.

Figure 3: Recommendations Development



As recommendations were developed, several overarching best practices were identified, including:

- Design routes with high level of network synergy, by completing the grid network to enhance connectivity and maximizing the effectiveness of the grid by developing a frequent 15-minute network that fosters spontaneous use.
- Coordinate transit service expansion priorities with land use planning and development services.
    - Consider characteristics of the physical environment (such as neighborhood walls, pedestrian amenities, etc.) that influence the ease of accessing transit.
    - Integrate transit service considerations when planning new social service developments to ensure they are built on existing transit corridors to avoid making costly bus deviations.
    - Ensure federal Americans with Disabilities Act (ADA) compliance on facilities (e.g., bus stops) with service expansion or new service.
- Reevaluate Express ridership every 5 years to assess changes in population, employment, and land use that would affect ridership.
- Plan for facilities (new or expansion) in the context of the overall plan for services in this expanding region, to consider that the purpose and level of use might change as the system matures and evolves.

4.1 OPTIMIZATION OF EXISTING SERVICES

The TOA enlisted a data-driven approach that evaluated service effectiveness and operational efficiency based on boardings data and a service design review. The purpose of this analysis was to assess strategies for aligning investment with the level of demand, specifically to develop concepts to:

- Focus transit investment to maximize the effectiveness of Valley Metro resources.
- Position the network to meet the growing demand for service.
- Improve the customer experience.

The findings of this analysis formed the basis of the recommended concepts for the Optimization of Existing Services timeframe. The original, financially unconstrained concepts are documented in Appendix A. These concepts were then refined in collaboration with the PAC members to account for community goals and objectives, and specific local conditions and experiences.

The concepts for Optimization are intended to be implementable in the near-term. The concepts presented below are a menu of options that provide a mix of efficiencies that "save" revenue miles, as well as recommendations for the beneficial investment of

additional revenue miles where it would benefit the most productive parts of the system. To financially constrain the scenario, these would need to be balanced. Although the implementation of specific recommendations would occur through the programming and SRTP processes, an illustrative financially constrained scenario was developed to provide a sense for the trade-offs that may be required in the near term (see Appendix A).

The Optimization of Existing Services planning timeframe includes concepts to enhance transit services that are currently in operation within the Southeast Valley. Key elements of the concepts include:

- Consolidate the resources invested in the Arizona Ave. and Main St. corridors to provide a robust, high frequency service.
- Explore alternative service types to more efficiently serve some deviations or lower-productivity route segments.
- Obtain a minimum of 30-minute frequency service.
- As possible, improve frequencies on high ridership routes.

4.1.1 Detailed Recommendations

Table 1 summarizes and Figure 4 illustrates the recommendations for the Optimization of Existing Services planning timeframe for the Southeast Valley.

Table 1: Optimization of Existing Services Recommendations

Route	Recommendation	Source/Rationale
AZ Ave. LINK and Route 112	• Combine the resources of AZ Ave. LINK and Route 112 into one high-frequency service south of LRT. • This route will operate more frequently and would utilize existing stops to serve as a frequent north/south connection to rail. Service would terminate at the Chandler PnR on Germann Rd. on the south and have a tighter northern turnaround to reduce route mileage.	• Optimization Analysis • PAC Input
Main St. LINK and Route 40	• Combine the resources of Main St. LINK and Route 40 into one high frequency service east of LRT. • This route will continue to function as a rail extension east of the last train station to Superstition Springs Transit Center (Sycamore/Main in the near-term and Centennial/Main St. and Gilbert Rd. when rail is extended). It will operate more frequently and would utilize existing stops.	• Optimization Analysis • PAC Input

Route	Recommendation	Source/Rationale
AZ Ave LINK /Route 112 and Main St LINK/Route 40 corridors	• The goal for LRT feeder service is that it is an enhanced local service embodying certain BRT best practice toolbox elements. This means investing in farside stops, transit signal priority, and appropriate stop spacing. A target stop spacing of 1/4 to 1/3 mile requires a review of current local and LINK stops where none closer than 1/4 mile are retained and of those with virtually no ridership are eliminated (pushing the average spacing slightly above 1/4 mile). Most existing local service with an average stop spacing of 1/4 mile has stops even closer together, causing the bus to stop far too frequently, thus impacting its overall speed and travel time. Recommend discontinuing any nearside/farside stop pairs, underused stops, and stops closer together than 1/4 mile.	• Optimization Analysis
Route 40 Apache/Main St.	• If LINK and local service are combined, this route would operate as a LRT local underlay collector-distributor service, maintaining the current 30-minute service between Price Rd. and the eastern end of the light rail line. • In this area, LRT stations are spaced roughly one mile apart, and the updated Route 40 (east of the rail end-of-line) will provide local service for those who cannot or do not wish to walk to rail.	• Optimization Analysis • PAC Input
Route 30 University	• This route serves as a local alternative to rail and serves a largely sustainable corridor. Service is proposed to operate every 30 minutes with 15 minute short trips between 52nd St. and Gilbert Rd., with only these short line trips serving the new train station at Gilbert Rd. once it opens. Continue deviation to Sycamore TC. • Maintain 30 minute frequency east of Gilbert Rd. on long line trips. • Improve to 30 minute frequency on weekends.	• Optimization Analysis • PAC Input • Needs Assessment
Route 45 Broadway	• Eliminate duplicative service to Superstition Springs TC on Power Rd. – the route will terminate around the Banner Baywood Medical Center at Power Rd. • Improve to 30 minute frequency on weekends along entire route.	• Optimization Analysis • PAC Input • Needs Assessment
Route 48 48th St./ Rio Salado	• Maintain 30 minute frequency all day • Extend to Tempe Marketplace (Note: this is already under consideration in the SRTP and October 2015 Service Change process.)	• Optimization Analysis • PAC Input
Route 56 Priest Dr.	• Improve to 15 minute frequency all weekday. • The segment north of Washington LRT should be discontinued with service to the Zoo and Desert Botanical Garden covered by a community shuttle connecting rail with these two destinations. Also, Route 3 – Van Buren should also terminate at the Washington LRT station instead of at the Zoo. Explore alternative service to make this connection (see mid-term), which requires coordination with the City of Scottsdale.	• Optimization Analysis • PAC Input
Route 61 Southern	No change	

Route	Recommendation	Source/Rationale
Route 62 Hardy/Guadalupe	• Maintain 30 minute frequency all day. • Eliminate segment between Tempe TC and Tempe Marketplace, in coordination with Route 48 extension to Tempe Marketplace.	• Optimization Analysis • PAC Input
Routes 65/66 Mill/Kyrene	• No change	
Route 72 Scottsdale/Rural	No change	
Route 77 Baseline	• Improve to 15 minute frequency all day to Dobson (current extent of service).	• Optimization Analysis • PAC Input • Needs Assessment
Route 81 Hayden/McClintock	This route should keep its original alignment and operations and operate 15-minute frequency between Tempe Marketplace and ASU Research Park with the short line serving ASU Research Park via Elliot Rd. like the deviation off Route 108 instead of entering the park off of Warner Rd. to reduce mileage. (Note: concept to analyze Research Park deviations is included as part of the mid-term.) The long line will continue to provide 30-minute south of Elliot Rd. • Maintain 30 minute frequency south of Elliot Rd. on current alignment. • Improve to 30 minute frequency on weekends.	• Optimization Analysis • PAC Input
Route 96 Dobson	• Route 96 – Dobson Rd. should operate with a short line/long line structure with service every 15 minutes from Mesa Riverview to Elliot Rd. with the long line providing 30-minute service further south. • The segment south of Fairview St. requires an extra bus for operation and does not generate enough ridership to warrant 30-minute service; a potentially optimal terminus for fixed route service is at Fairview St. just south of Chandler Regional Hospital. Evaluate alternative service types (such as circulator or community shuttle, or flex service) to continue to serve this area. • Maintain 30 minute frequency on weekends for long line trips.	• Optimization Analysis • PAC Input • Needs Assessment

Route	Recommendation	Source/Rationale
Route 104 Alma School	This route should operate 15-minute service from Mesa Riverview to Elliot Rd. with a short line/long line structure. The 30-minute long line should have its southern terminus at the southwest corner of Chandler Blvd & Alma School Rd. • Improve to 30 minute frequency on weekends for long line trips. • Discontinue deviation to the Sycamore/Main St. TC once the rail station opens at Alma School Rd.(under consideration in the SRTP).	• Optimization Analysis • PAC Input
Route 108 Elliot	• Maintain 30 minute frequency all day from Priest to Power Rd. on current alignment. • Explore other service types for Sunland Village. • Eliminate duplicative service to Superstition Springs TC. • Improve to 30 minute frequency on weekends to Power Rd.	• Optimization Analysis • PAC Input
Route 120 Mesa Dr.	• Improve to 15 minute service when the LRT opens at Mesa Dr. • Improve to 30 minute frequency on weekends.	• Optimization Analysis
Route 128 Stapley	• Improve to 15 minute service when the rail station opens at Gilbert Rd. • Improve to 30 minute frequency on weekends.	• Optimization Analysis
Route 136 Gilbert Rd.	The most productive segments between Town of Gilbert PNR (at Oak St. and Page Ave.) and University Dr. warrant 15-minute service. Consequently, it is proposed that this route operate as two 30-minute services, one from McDowell Rd. to Elliot Rd. and one from the Gilbert LRT Station at Main St. to Ryan Rd. These two services will overlap for 15-minute service between Elliot Rd. and Main St. • The boarding analysis suggests that the Boeing deviation may be served more conveniently and cost-effectively by alternative service types, such as an expanded vanpool program. Coordination with Boeing is recommended as needed to improve service in this area. • Note: The Civic Center area was also identified as an inefficient deviation; however the Town of Gilbert has identified land use changes that may be occurring and continued evaluation of the best fit in this area is noted as a mid-term concept. • Improve to 30 minute frequency on weekends.	• Optimization Analysis • PAC Input
Route 156 Chandler Blvd./ Williams Field Rd.	No change	

Route	Recommendation	Source/Rationale
Route 184 Power Rd.	• Modify route to operate at 30-minutes all day along the entire alignment (it is currently 15 minute peak and 30 minute off-peak). The Red Mountain Mesa Community College deviation should be restructured so the route does not double-back on itself on McKellips Rd. to save time and mileage by using both entrances. The southern alignment should be restructured to eliminate one-way service on Sossaman Rd. The current one-way terminus loop adds considerable mileage to the route while generating few passengers. The proposed alignment traveling south on Power Rd. is to enter the ASU Polytechnic campus via Williams Field Rd, merge onto Innovation Way, continue on Innovation Way heading north then east , turn left onto E Texas Ave, and terminate at the Phoenix-Mesa Gateway Airport terminal. The route should reverse this alignment for the northbound trips. • As possible, have layover between routes happen at the Airport rather than a parking lot.	• Optimization Analysis • PAC Input • Needs Assessment
Express Route 531 Mesa/Gilbert Express	• Consolidate local stops; ideally the route should only stop at the Gilbert and West Mesa PNRs to increase the speed of the service and improve its attractiveness to commuters. (Note: this is already under consideration in the SRTP and October 2015 Service Change process.)	• Optimization Analysis • PAC Input
Express Route 541 Chandler Express	• As possible increase the frequency of trips between West Mesa PnR and downtown Phoenix, which is the segment of the route that attracts the most riders.	• Optimization Analysis • PAC Input

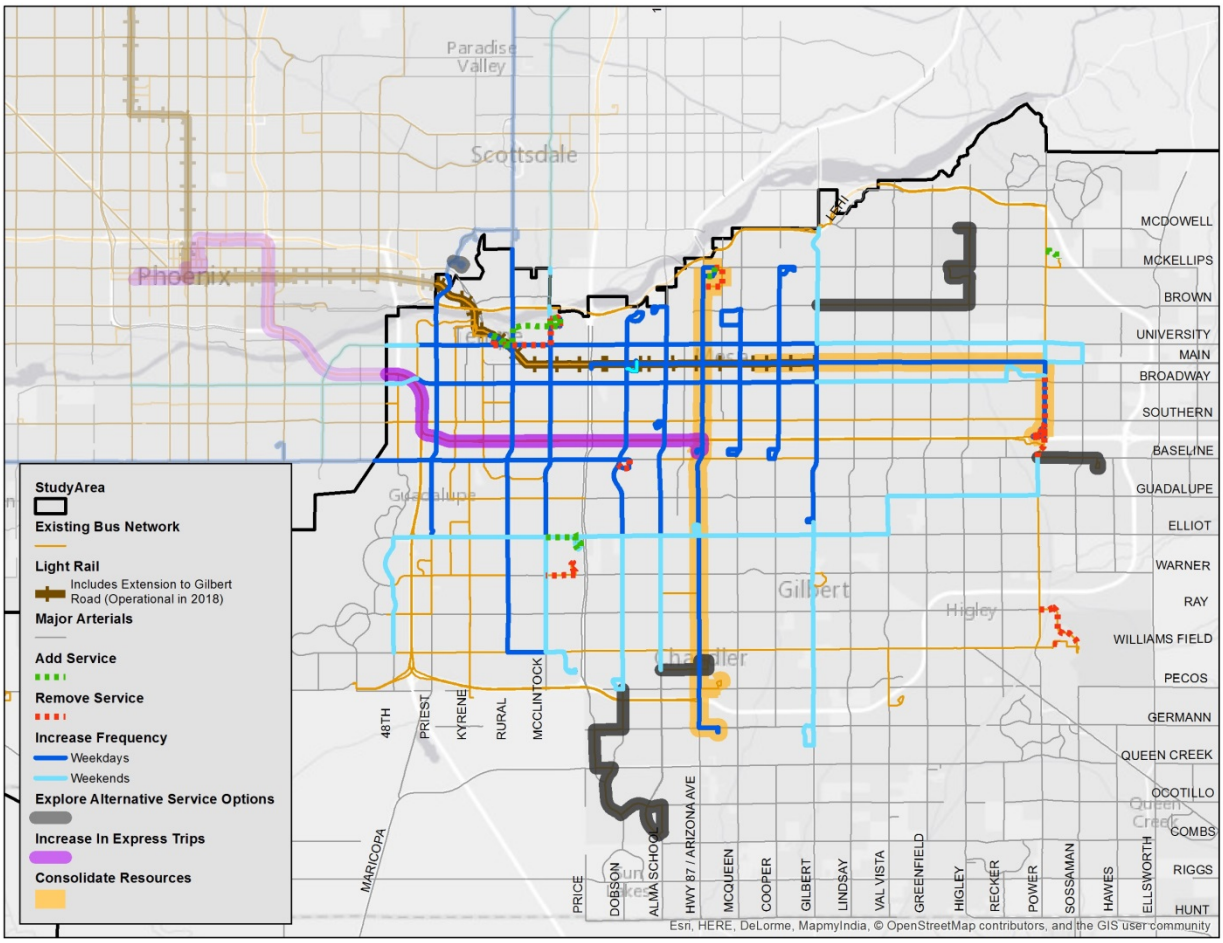
4.1.2 Financial Constraints

The full set of concepts identified in Table 1 would require about 15% additional resources beyond current spending levels in the subregion (for more information on costs, see Appendix B). Given the lack of additional resources in the near-term, the following approach is recommended for phasing or modifying the Optimization concepts to meet financial constraints:

- Rather than the ultimate goal of 15 minute service all day, implement 15-minute peak service on well-performing routes (e.g., Routes 30 to Gilbert Rd., 45 to Power Rd., 77, 81, 96 (to Elliot), 104 (to Elliot), 136 (Main St. to Elliot).
- Consider some routes for 30 minute all-day frequency instead of 15-minute service (e.g., Routes 120 and 128).

The reductions in frequency improvements would allow the other concepts to be more affordable in the near-term, and ultimate frequency improvements could be phased in over time.

Figure 4: Optimization of Existing Services Recommendations



4.2 MID-TERM PLANNING HORIZON

The Mid-term planning timeframe includes project recommendations that expand or fill in the gaps within the existing transit service network in the Southeast Valley. Implementation would occur within 10 years and focus on expanding service to potential growth areas that are located on the fringe of the existing transit network. Projects defined in this timeframe may include recommendations that were deferred from the Optimization of Existing Services timeframe due to cost or relative priorities. Mid-term concepts address route frequency, service extensions, route alignments, route deviations, service types, and connections to currently under-served areas of the subregion. Planning-level cost information is provided in Appendix B.

4.2.1 Detailed Recommendations

Table 2 summarizes and Figure 5 illustrates the recommendations for the Mid-Term planning timeframe for the Southeast Valley.

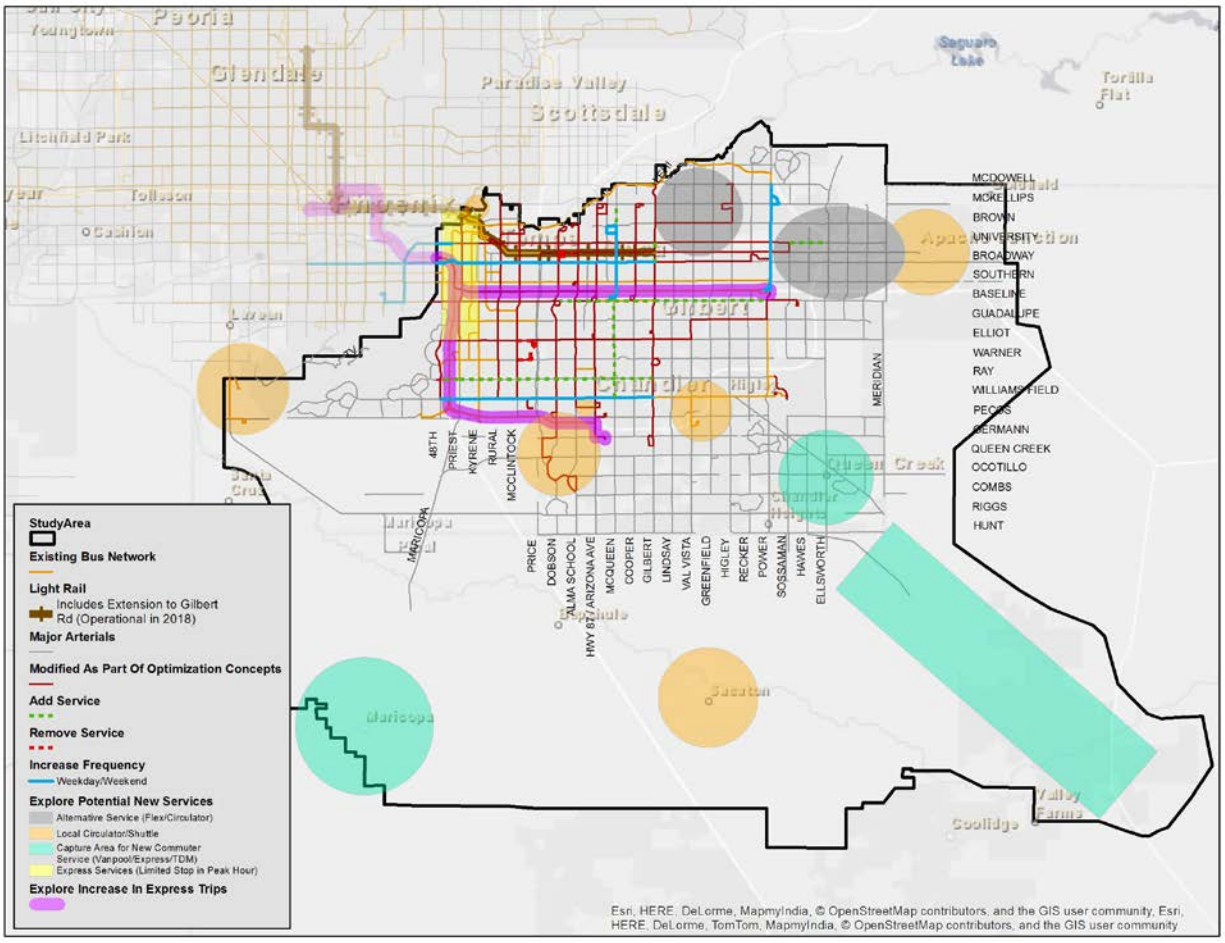
Table 2: Mid-Term Recommendations

Route	Recommendation	Source/Rationale
Route 30 University	• Deviate short line trips to Gilbert Rd. light rail end-of-line as well as Sycamore TC. • Consider expansion further east to Ellsworth Rd. and into Apache Junction as population and employment intensify in the corridor.	• Optimization Analysis • PAC Input • Needs Assessment • RTP Project • Apache Junction Transit Feasibility Study
Route 45 Broadway	• Eliminate Sycamore TC deviation in favor of new Gilbert Rd. end-of-line station. • Improve to 15 minute frequency to Gilbert Rd.	• Optimization Analysis • PAC Input
New service	Examine potential for circulator service in the area surrounding the Zoo and SkySong. • Coordinate among Tempe, Phoenix, and Scottsdale	• Optimization Analysis • PAC Input
Route 77 Baseline	• Extend to Gilbert Rd. (Note: this is already under consideration in SRTP.) with 15 minute service, and continuing service to Power Road at 30 minutes.	• Optimization Analysis • Needs Assessment • RTP Project
Route 81 Hayden/McClintock	• Eliminate Route 81 deviations to ASU Research Park and create more direct connection to LRT.	• PAC Input
Route 96 Dobson	• Explore circulator, flex service, or other service type to serve area south of Fairview St. (See Circulator Services below.)	• Optimization Analysis
Route 104 Alma School	• Monitor boardings on the Frye Rd. segment of Route 104 to determine if the deviation to downtown Chandler is worthwhile or if another service mode (e.g., circulator) would be more efficient.	• Optimization Analysis • PAC Input • Chandler Transportation Plan (explore downtown circulator service)

Route	Recommendation	Source/Rationale
Route 108 Elliot/48th St.	• Explore other service types to the Sunland Village East area, which experienced the elimination of Route 277. Discussion with the community will be necessary. • Remove deviation to ASU Research Park.	• Optimization Analysis • PAC Input
Route 120 Mesa Dr.	• Extend service north to McKellips Rd. • Extend service south to Chandler Blvd.	• Optimization Analysis • PAC Input • Gilbert Transportation Master Plan • RTP Project
Route 136 Gilbert Rd.	• Explore vanpool, TDM, and/or circulator options to serve Boeing most efficiently. • Evaluate elimination of Civic Center deviation based on land use changes.	• Optimization Analysis • PAC Input
Route 156 Chandler Blvd./ Williams Field Rd.	• Improve to 15 minute peak-hour service between 48th St. and Gilbert roads. • As ridership increases, explore ways to eliminate deviation to Gilbert Mercy Hospital to reduce the time penalty for through-riders.	• Optimization Analysis • PAC Input
Route 184 Power Rd.	• Improve to 15 minute service between McDowell and Superstition Springs TC.	• PAC Input • Mesa Transit Plan 2040
New route Ray Rd.	• Add 30-minute service to Ray Rd. between 48th St. and Gilbert Rd.	• PAC Input • Needs Assessment • RTP Project • Chandler Transportation Plan
Route 533 Mesa Express	• Add one AM/PM trip • Address parking limitation at PnR	• Optimization Analysis • PAC Input
Route 542 Chandler Express	• Add one AM/PM trip (Note: this is already under consideration in the SRTP and October 2015 Service Change process.)	• PAC Input • Chandler Transportation Plan
New/modified Express service	• The recent Queen Creek Transit Study suggests Express service using the proposed North-South freeway and US 60. Concepts should be explored using the San Tan (SR 202) freeway and I-10 where HOV lanes are established the entire way to downtown Phoenix.	• PAC Input • Queen Creek Transit Feasibility Study • RTP Project
New pilot flex service	• Pilot flex service (deviated-fixed route) on either Main St. (Apache Trail) or Broadway Rd. to Apache Junction.	• Needs Assessment • Apache Junction Transit Feasibility Study

Route	Recommendation	Source/Rationale
Alternative Service Types: Vanpool and TDM	Promote vanpool to meet commuter demand in the Town of Queen Creek and City of Maricopa • Both locations have strong commute flows to the study area core and central Phoenix, but dispersion of destinations and distance traveled makes affordability and demand incongruent with local/grid bus services at this time • Previous commuter services existed for both but were cancelled due to affordability (City of Maricopa) or insufficient demand (Town of Queen Creek) • Vanpool would reduce VMT by allowing commuters to self-sort into HOVs based on their commute origin-destination pair	• Needs Assessment • Queen Creek Transit Study • Pinal County Transit Feasibility Study
New commuter service	Explore commuter services between South Tempe/North Chandler and downtown Tempe • Consider improved limited stop service during peak • Add a peak hour LRT connector between the Priest/Washington LRT station and the 52nd St/Alameda corridor. Suggest operating one service from rail, either from Priest/Washington or Tempe Transportation Center (based on dominant employee O/D patterns). If the former, Rio Salado route could be reimagined as an Orbit. The corridor may not generate enough ridership to sustain two services.	• PAC Input • Optimization Analysis
New circulator services	• Consider a circulator type operation in Apache Junction	• Needs Assessment • Apache Junction Transit Feasibility Study
	• Consider a circulator type operation in Gilbert surrounding San Tan Mall area	• PAC Input • Gilbert Transportation Master Plan
	• Consider circulator type operations on GRIC serving District 3 and serving Districts 6 and 7.	• GRIC Transit Feasibility Study
	• Explore circulator or flex service type to serve area south of Fairview St. to replace segment of Route 96.	• Optimization Analysis
Facilities	• Evaluate Park-and-Ride locations based on demand for Express services. • Note that Valley Metro is currently working in Phase III of TSPM to identify standards.	• Apache Junction Transit Feasibility Study • Gilbert Transportation Master Plan
Expand Pinal County connections	• Expand connections between Florence and the San Tan Valley	• Pinal County Transit Feasibility Study • Needs Assessment
Promote sharetheride.com	• Promote sharetheride.com and share promotional materials with all City transit staff, as well as with employers, job centers, and neighborhoods without access to fixed route service.	• Needs Assessment

Figure 5: Mid-Term Recommendations



4.3 LONG-TERM PLANNING HORIZON

The Long-term planning timeframe includes project recommendations to extend transit services within the Southeast Valley to areas of future projected growth. Implementation would occur beyond 10 years and focus on expanding service to potential growth areas and providing connections to communities that are not immediately adjacent to the existing transit service areas. Projects defined in this timeframe may include recommendations that have been identified as part of the RTP or other local planning efforts. The long-term concepts address service expansion, new service, route alignments, service types, service facilities, and connections to currently unserved areas of the subregion. Planning-level cost information is provided in Appendix B.

4.3.1 Detailed Recommendations

Table 3 summarizes and Figure 5 illustrates the recommendations for the Long-Term planning timeframe for the Southeast Valley.

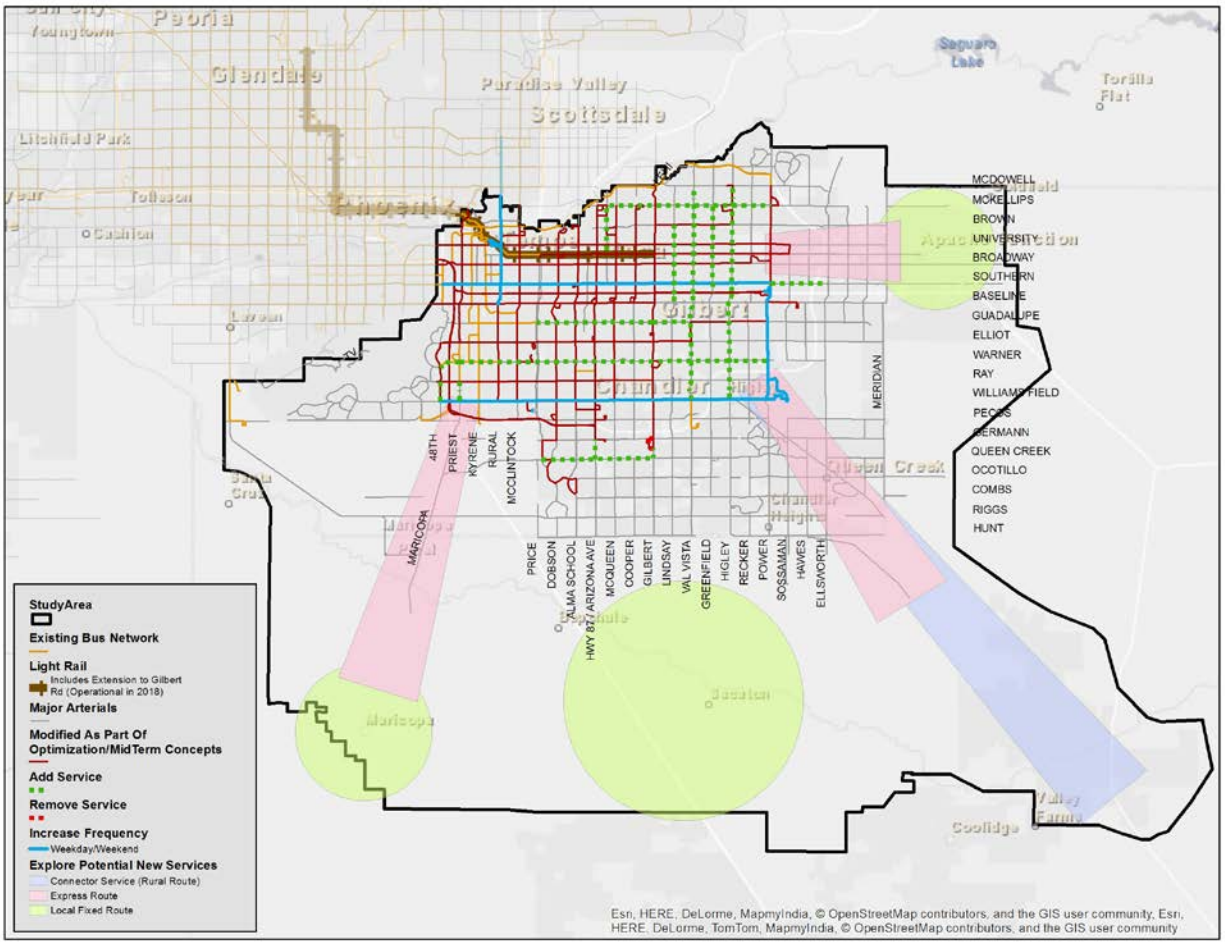
Table 3: Long-Term Recommendations

Route	Concept	Source/Rationale
Route 56 Priest Dr.	• Extend service along Priest (56th St.) and 48th St. to Chandler Blvd.	• PAC Input • RTP Project
Route 61 Southern	• Extend east to Ellsworth Rd. • Higher service levels/enhanced local approach in this corridor.	• Needs Assessment • Mesa Transit Plan 2040
New service	Guadalupe Rd.	• Needs Assessment • RTP Project
Route 72 Scottsdale/Rural	Consider increased frequency (10 minute) between Camelback and Baseline in the long-term.	• Optimization Analysis • PAC Input
Route 112 Arizona Ave.	Extend service south 1-mile to Queen Creek Rd.	• PAC Input • RTP Project
Route 136 Gilbert Rd.	Extend service south 1/2 –mile to Queen Creek Rd.	• PAC Input • Chandler Transportation Plan
Route 156 Chandler Blvd./ Williams Field Rd.	Improve frequency to 15+ minute frequency all day between 48th St. and Power Road, and consider enhanced/limited local service.	• PAC Input • Gilbert Transportation Master Plan • RTP Project
Route 184 Power Rd.	Increased frequency (15 minute) between Superstition Springs TC and ASU Polytechnic	• Mesa Transit Plan 2040 • Gilbert Transportation Master Plan

Route	Concept	Source/Rationale
New service	Warner Rd. • 30 minute frequency between 56th St. and Gilbert Rd.	• Needs Assessment • PAC Input • Chandler Transportation Plan • Gilbert Transportation Master Plan • RTP Project
New service	McKellips Rd. • Connect LRT at Center/Main St. to Power Rd./McKellips • 30 minute frequency	• Mesa Transit Plan 2040
New service	Queen Creek Rd. • Between Price Rd. and Gilbert Rd. or Val Vista. • Extend further east as population and employment grow.	• RTP Project • Gilbert Transportation Master Plan • Chandler Transportation Plan
New service	Consider North/South routes east of Gilbert Rd. to fill in network gaps • Lindsay Rd. between McKellips and Baseline o Extend further south as population and employment grows. • Val Vista Rd. between McDowell and Williams Field Rd. then south to Gilbert Mercy Medical corridor. Greenfield Rd. between McKellips and US 60 • Higley Rd. between McDowell and Williams Field Rd. • As population and employment warrant, extend these routes south to Queen Creek Rd.	• Needs Assessment • RTP Projects • Mesa Transit Plan 2040 • Gilbert Transportation Master Plan
New service	Explore the addition of a rural route that would connect outlying communities in Coolidge/Florence area and on GRIC to the established transit network in the SEV similar to Route 685 (Gila Bend Connector).	• Pinal County Transit Feasibility Study • Needs Assessment
New Express connections	Consider additional Express Routes • Apache Junction • Queen Creek/San Tan Valley • City of Maricopa	• Apache Junction Transit Feasibility Study • Queen Creek Transit Study • Pinal County Transit Feasibility Study
Establish new fixed route	• Consider local fixed route service in Maricopa • Consider local fixed route service in Apache Junction • Consider an internal GRIC local route that will provide district to district connections	• Apache Junction Transit Feasibility Study • GRIC Transit Feasibility Study • Pinal County Transit Feasibility Study

Route	Concept	Source/Rationale
Facilities	If Express services expand, evaluate the addition of Park-and-Ride facilities: • Elliot/I-10 • Coolidge/Florence • City of Maricopa • Queen Creek • San Tan Valley • North/South Freeway area as it develops, to provide a reliever to Superstition Springs. Consider new Transit Centers: • Downtown Chandler • South Chandler • South Tempe	• Apache Junction Transit Feasibility Study • GRIC Transit Feasibility Study • Pinal County Transit Feasibility Study • RTP Projects

Figure 6: Long-Term Recommendations



5.0 IMPLEMENTATION

The implementation of the concepts described in the preceding sections would occur through the prioritization and coordination processes that accompany the programming of projects. The timing and sequence of implementation may be determined by the availability of funding for additional services (discussed in Section 6.0). Key steps that may follow this study are:

- Advance the understanding of productive and cost-effective service types in the areas where alternative service types are recommended for consideration, through site- specific analyses for circulators, vanpools, and/or flex routes would help to identify major origins and destinations, activity centers, and opportunities for improved service in coordination with key stakeholders.
- Initiate collaboration with the cities of Mesa, Chandler, and Gilbert to specifically investigate the steps and opportunities for combining resources along Main St. and Arizona Ave. into one high-frequency service.
- Develop more detailed transit implementation plans at the jurisdictional level to shape these concepts for entry into the programming process or to be available for federal or other funding opportunities that arise.
- Local transit staff may collaborate with planning and development services staff to identify policies or procedures that promote accessibility to transit in corridors that are identified as key corridors for service improvements or new service in the future. These efforts may reduce the likelihood of future deviations and enable more convenient public transit.

The remainder of this section details (1) how this plan relates to the ongoing Transit Standards and Performance Measures (TSPM) efforts and (2) more information on the different service types and transportation demand management (TDM) tools that are available. Figure 7 summarizes the characteristics for each service type referred to throughout the discussion of recommended concepts.

5.1 RELATIONSHIP TO TSPM

This study has identified sets of concepts for optimizing the existing system, or for implementation within the next 10 years (mid-term), or beyond that period (long-term). These recommendations are based on analyses including the Transit Optimization Analysis and the Needs Assessment, and are also substantially influenced by in the input of jurisdictions in the subregion via participation in the PAC. These concepts are intended as a menu of options that may be taken through the programming process (such as the SRTP).

The current TSPM methodologies for Phase I and Phase II provide a route-level, short-term analysis for new service whereas this study (SEVTSS) is an area-wide transit planning process for the southeast valley subregion. This study is considering a longer term planning

horizon in addition to short-term recommendations that integrate TSPM service standards by service type. While this study does not specifically analyze fleet requirements necessary for implementation, Phase III of the TSPM process will analyze fleet, facilities and long-range transit service implementation standards.

5.2 CONSIDERING ALTERNATIVE SERVICE TYPES: TYPICAL CIRCULATOR VEHICLES AND CHARACTERISTICS

Multiple factors are associated with choosing the appropriate transit vehicle and service option for a particular service environment. Considerations that would be taken into account include bus size, carrying capacity, ADA accessibility, and cost. These factors are all likely to have a significant impact on the eventual success of a transit system relying on a bus as the primary mode. Circulator buses can also be designed to fit within the context of the neighborhood it is serving. It is typical to have a separately branded circulator service that distinguishes itself from the traditional fixed route local service.

Figure 7: Service Types

SERVICE TYPE	DESCRIPTION
Demand-Responsive Services	Call-based or prescheduled services that are not on a fixed route or schedule. Often used for ADA-focused services but can have a role in low demand density areas.
Circulator or Shuttle	Fixed-route and schedule intra-community service that connects places within but not between communities. Might have some route deviation.
Local Route	Fixed-route intra- and inter- community service that serves a multitude of origins and destinations along its route.
Limited Stop Route	Fixed-route enhancement to local route with improved speeds due to longer stop spacing.
Bus Rapid Transit (BRT)	Fixed-route enhanced limited stop service that could include upgraded vehicles, stop enhancement, traffic signal priorities, and travelway infrastructure.
Express Service	Fixed-route work trip focused on connection between suburban areas and major employment centers; typically limited to work commute hours.
Regional Service	Fixed-route service connecting the study area to major destinations outside of the study area for work and other trip purposes.

5.2.1 Service

Circulators are designed to kick start, supplement, or replace local fixed route service where traditional size or service types are less practical or desirable because of street patterns, densities, or operating costs. Typical circulator services provide connections to the regional bus network and are designed to connect to activity centers and trip generators located in areas not typically served by the regional network. There are various types of circulator services based on their operating characteristics include both fixed route (more traditional) and route deviation (flex type service). Fixed route circulators are designed to offer direct, timely connections within neighborhoods, communities, and multiple activity centers on a fixed schedule operating on secondary roadways within neighborhood streets. Route deviation circulators differ from traditional fixed route service because, while they still have fixed stop locations, vehicles are allowed to leave the route to provide service to specific areas of the community as needed while still maintaining a service schedule. In both instances, route lengths are much shorter than typical local fixed route transit and provide service to areas of the community that wouldn't normally be considered for transit service due to their land uses or development densities.

5.2.2 Size

Typically, smaller buses are used for circulator systems and may vary in type depending on the streets being navigated, number of passengers, and aesthetic impact on the community. Typical vehicle sizes range from 20 to 35 feet long with the smaller vehicles imposing less impact when traveling through a neighborhood. Passenger capacity is largely dependent on the size of the vehicle, as well as the number of spaces that are reserved for wheel chairs. Passenger capacity for circulator type vehicles typically range between 12 and 30 seated passengers. Total capacity including standing passengers, can reach over 45 on larger buses.

5.2.3 ADA Accessibility

Important considerations in meeting ADA requirements for a fleet of vehicles include wheelchair space, loading ramp placement, and possibly floor height. Compliant loading ramps placement is easier to achieve with low-floor buses because the vehicle's entrance ramp can be more readily lowered to allow for wheelchair access.

5.3 VANPOOL AND TRANSPORTATION DEMAND MANAGEMENT

Valley Metro and MAG encourage various transportation demand management (TDM) strategies, including ridesharing. Carpooling and vanpooling enable groups who ride together to save money on fuel, insurance, and maintenance. Vanpools work especially well for serving employers that have longer than average trip lengths or are relatively isolated from other development or activity centers, and so may be uneconomical to serve with traditional, fixed route transit. Promoting sharetheride.com as part of the short-term solution for communities without the characteristics to support fixed route transit at this time may be

a critical first step toward establishing a rider base that can grow into fixed route transit riders over time. However, it is also important to promote the fixed route changes suggested here through special outreach to employers, job centers, and community planners to promote awareness of transit as a viable option for travel. Commute Solutions is an important implementation partner for connecting to employers and communicating viable transit, carpool, vanpool, telework, walk, and bike options as the transit system expands and changes.

Route deviations to serve major employers (or other activities) may be vital for commuters who use the service, yet inefficient for the transit operator and discouraging to riders who find themselves losing time during the deviations. In some cases, Valley Metro and the community may be able to work with employers or other sponsors to help pay for shuttle service. The transit agency could explore the feasibility of in-kind assistance, such as use of a surplus small bus or van at a reduced rate. Although an extra transfer between vehicles may deter some, efficient connections and employer incentives may help compensate. As a non-employment example, shuttles may connect light rail with the attractions in Papago Park, replacing Route 56 with a more frequent and flexible option.

5.4 FLEXIBLE SERVICE

Flexible service (or Flex service) is a service type that combines non-ADA demand responsive service with flexible routes over a specific geographic area where traditional fixed route service operates inefficiently. These services can be applied over a single independent coverage area or used as an overlay to traditional fixed route service options. Flex service would be anchored at an existing transit facility such as a park and ride or at well-known landmarks like shopping centers or downtown areas. These anchors would provide a connection to higher level transit services throughout the rest of the region. Flex service could take the form of a specialized peak period service, and during periods of lower demand may include curb-to-curb, reservation-based service that will pick up riders and take them anywhere within the specified service zone.

Flex service could be used in the Southeast Valley to provide trips between the fixed route transit services of the MAG region and the surrounding area through timed connections at specified transfer points, although other non-scheduled trips could also be allowed. Flex service would be operated all day with specific stops at park and rides, specified local fixed route bus stops, and at neighborhood circulator connections during the peak travel periods of the day. Customers would be able to directly contact the driver for pick-up or make online reservations for trips anywhere within the service zone.

The benefit of operating flex service within the Southeast Valley would be to keep costs down while providing improved local circulation as well as connections to the MAG regional transit network. Savings could be obtained over fixed route service not only because the vehicle and service type is less expensive, but because fewer vehicle and vehicle hours would be necessary for the same service area compared to traditional fixed route service.

6.0 FUNDING STRATEGIES

The implementation of recommended concepts identified in Section 4.0 is generally dependent on funding decisions that will be made through other processes. Planning level cost information has been estimated for the concepts identified in Section 4.0 and is included in Appendix B. This section describes the existing funding sources in the Southeast Valley and inventories possible sources for future funding requirements.

6.1 EXISTING FUNDING

Some Southeast Valley routes are funded locally (i.e., via city/town general funds), some regionally (from the Public Transportation Fund or PTF) and some by a combination of both, depending on the community or jurisdiction. Several routes also receive Arizona Lottery Fund (ALF) dollars, which are considered to be regional funding. Table 4 lists the funding types for each route. Of the current 23 numbered local bus routes, 16 receive general or dedicated funds from one or more cities, 16 receive regional PTF funds and 6 receive ALF. The two LINK routes are fully funded from regional sources, as are the 500-series Express routes, except one (542) that receives ALF. The I-10 RAPID service and all community circulators are funded locally and in some cases with ALF funds.

Table 4: Southeast Valley Bus Operations Funding by Fund Type

Route	Funding	Notes
30 – University	Local	
40 – Apache/Main	Regional	
45 – Broadway	Local, Regional	Local in Phoenix & Tempe; Local & Regional in Mesa
48 – 48th St/Rio Salado	Local, Regional	Regional in Phoenix; Local in Tempe
52 – Roeser	Local, Regional	
56 – Priest	Local, Regional	Guadalupe segment is regionally funded
61 – Southern	Local, Regional	Local in Phoenix; Regional in Mesa except selected school trips; Regional in Tempe
62 – Hardy/Guadalupe	Local	
65 – Mill/Kyrene	Local	
66 – Mill/Kyrene	Local, Regional, Other	Regional in Chandler; Local in Tempe; also GRIC & JARC $ in Chandler, GRIC
72 – Scottsdale/Rural	Regional,	
77 – Baseline	Local, Regional	Local in Phoenix & Mesa; Regional in Tempe
81 – McClintock	Regional	Regional in Chandler; Regional in Tempe
96 – Dobson	Regional	Regional in Chandler; Regional in Mesa
104 – Alma School	Local, Regional	Regional in Chandler; Local in Mesa
108 – Elliot/48th St	Local, Regional	Regional in Chandler, Gilbert & Mesa; Local in Phoenix & Tempe
112 – Country Club/Arizona	Regional	Regional in Chandler; Regional in Mesa and Gilbert
120 – Mesa	Local	
128 – Stapley	Local	
136 – Gilbert	Regional	
156 – Chandler/Williams Field	Local, Regional	Regional in Mesa; Local & Regional in Chandler, Gilbert, and Phoenix
184 – Power	Regional	
251 – 51st Ave/Baseline	Local	Gila River Indian Community (GRIC)

Route	Funding	Notes
520-522, 531, 533, 535, 541	Regional	
542 – Chandler Express	Regional	
I-10 East RAPID	Local, Lottery	
Arizona/Country Club LINK	Regional	
Main St. LINK	Regional	
Community Circulators	Local, Regional	Tempe Orbit routes receive Regional ALF funds. Arizona State University shuttles operate as well.

Source: Valley Metro, February 2015. Please note that the types of funding sources for each route may vary over time. Prior to FY 2016, the Chandler segment of Route 184 also received JARC funds.

Table 5 below shows the estimated operating cost of each bus transit mode operating in the Southeast Valley in FY 2015. Note that these costs are based on the estimates in each jurisdiction's intergovernmental agreement (IGA) schedules dated February 2015 and are not static; costs are regularly estimated, adjusted due to service changes, and reconciled. For the latest estimates, please contact Valley Metro or refer to the adopted Intergovernmental Agreement for fiscal year 2015.

The five large cities of Chandler, Gilbert, Mesa, Phoenix and Tempe account for the vast majority of bus service in the study area. Exceptions include small amounts of service operated in the Town of Guadalupe (a short segment of Route 56) and the GRIC (Route 251 and a piece of Route 66). Because many of the Phoenix routes operate largely outside the study area, their costs (and funding) have been prorated according to the proportion of their Phoenix route miles in the Southeast Valley. Tempe and Mesa have by far the most Southeast Valley service and hence the highest operating expenditures, with Tempe ahead primarily because of its extensive circulator network.

Table 5: FY 2015 Southeast Valley Operating Cost and Funding by Jurisdiction: Weekday Bus Service

Mode	Chandler	Gilbert	Mesa	Phoenix	Tempe	Subregion*
Local Bus	$4.2M	$3.0M	$12.2M	$1.1M	$12.3M	$34M
Express & RAPID	$0.3M	$0.07M	$0.6M	$2.5M	$0.3M	$3.7M
Circulator	0	0	$0.3M	$0.5M	$6.6M	$7.4M
LINK	$0.6M	$0.05M	$2.4M	0	0	$3.0M
Total	$5.1M	$3.1M	$15.5M	$4.1M	$19.2M	$48.1M

*Adds three route segments that operate in Guadalupe and the GRIC.
Source: Valley Metro, February 2015. Note that the estimated and actual costs varies regularly; for updated information please contact Valley Metro. Numbers may not sum due to rounding.

Table 6 cross-tabulates the distribution of FY 2015 weekday operating costs for bus service by funding source and by community. Thanks to its dedicated funding source for transit, Tempe contributes by far the largest local share of any Southeast Valley community – 23% of all funding. Annual local (community) weekday transit operating funds *per capita* (not shown in Table 6) range from zero in some communities to $7.13 in Mesa and $66.71 in

Tempe. Valley Metro operating expenditures *per capita* are more evenly distributed among the four Southeast Valley cities, ranging from $11.32 in Gilbert to $14.68 in Mesa.

Regional funding for local transit routes tends to focus on designated "Supergrid" routes that serve the busiest arterial corridors and connect activity centers in different communities. Such corridors include Southern Ave., Chandler Blvd. /Williams Field Rd., Scottsdale/Rural Rd., Gilbert Rd. and Power Rd. However, shortfalls in sales tax collections have sometimes necessitated a lower level of service than anticipated. Special cases include routes 40 and 112, where Valley Metro funds local buses that supplement LINK service.

Overall, the largest share of Valley Metro operating funds goes to Mesa (accounting for 14% of all Southeast Valley transit funding), which has the highest population of any city lying wholly within the study area. Smaller shares are allocated to Chandler, Gilbert and Tempe. Most of the fares come from Mesa and Tempe, which also have the most transit service and riders. Over 90% of operating funds in the Southeast Valley come from the communities (37%), Valley Metro (33%) and fares (21% – nearly the same as in the entire region, and 4% below the 25% performance objective). PM funds obtained through Section 5307 accounts for most of the other 10%.

The Valley Metro proportion of transit operating funds also differs by mode of service: 73% for LINK, 36% for local buses and 42% for Express plus RAPID service. When the Phoenix-funded I-10 RAPID is removed from the mix, however, Valley Metro pays 61% of Express bus operating cost from the Public Transportation Fund. Community circulators (ALEX, BUZZ, FLASH and Orbit) in Mesa, Phoenix and Tempe are funded locally and in some cases with ALF as well.

Table 6: FY 2015 % Distribution of Southeast Valley Bus Operating Funds by Source and Community

Funding Source	Chandler	Gilbert	Mesa	Phoenix	Tempe	Subregion
Community	0	0.0	4.1	4.8	22.3	33.0
ALF (Lottery)	<1	0.0	2.7	0.0*	1.0	4.1
Valley Metro	7.3	5.4	14.0	2.0	4.4	33.4
Fares**	1.9	<1	8.5	1.3	8.3	20.6
PM	1.0	<1	2.9	<1	3.8	8.8
Federal (JARC)	0.0	0.0	0.0	0.0	0.0	0.1
Total	10.6	6.4	32.2	8.5	39.9	100.0

Please note that the types of funding sources for each route may vary over time. Horizontal totals also include service in Guadalupe and the GRIC, so the rows do not add to the numbers in the last column. Small amounts of additional ALF funds are also allocated to Guadalupe and Apache Junction.

*ALF funds were applied outside of the study area in Phoenix.

**Fares were not available for Route 52 or the I-10 RAPID.

Table 7 shows farebox recovery (fares as a percent of gross operating cost) by major city and service type in the Southeast Valley study area. Unlike the preceding tables, Table 7 excludes the eight community circulator routes in Mesa, Phoenix and Tempe, which charge no fare. It therefore provides a realistic base with which to measure transit financial performance against expectations. Farebox recovery is lowest in cities (Chandler and Gilbert) that recently introduced transit service, have had less time to build high ridership or population density, and are located farther from urban activity centers and light rail. It is higher in Mesa and Tempe, with their older and longer established bus systems. Phoenix occupies an anomalous position because many of its included routes are largely outside the study area. The portions in the study area may be less productive segments near the edge of the city.

Overall, the 24% farebox recovery for those routes that charge a fare approximates the Valley Metro objective of 25%. The Express/RAPID and LINK services show somewhat lower farebox recovery than the local bus system. To a degree, this may reflect the performance issues raised in the working paper on system optimization. Even among local routes, however, farebox performance differs substantially, ranging from 2% to 41%. Vanpool fares work differently, as costs are set by van and collected monthly by the driver. Vanpool operations, including fuel and vehicle maintenance, are fully funded by its passengers through the monthly fare.

Table 7: FY 2015 % Farebox Recovery of Southeast Valley Bus Routes (excluding circulators)

Mode	Chandler	Gilbert	Mesa	Phoenix*	Tempe	Entire Subregion
Local Bus	17.7	5.5	28.3	26.0	32.1	25.6
Express & RAPID	33.2	64.5	28.1	13.1	21.9	18.6
LINK	11.8	14.2	19.7	No service	No service	18.0
Total	17.9	6.9	27.0	17.1	31.9	24.4

* Fares were not available for Route 52 or the I-10 RAPID.

6.2 FUTURE FUNDING STRATEGIES AND OPPORTUNITIES

Potential future funding possibilities are described in more detail in *Working Paper 8: Financial Analysis*. The primary potential sources include:

Maximizing Service Efficiencies - There may be some ability to discontinue less productive service or evaluate service design to reduce inefficiencies. A financially unconstrained, data-driven service design analysis was conducted as part of this study (see Appendix A). Since the system is already well-managed, there are limited opportunities to generate additional revenue to be reinvested, and there is often a desire to maintain existing service if it provides service coverage to key areas such as veterans' hospitals, medical corridors, and schools, even if ridership is relatively low.

Federal Funding - Federal funding is a key element of most transit systems and this is expected to continue, however a long-term transportation funding program has not been outlined at this time and so future funding streams are uncertain.

Regional Funding - The current 0.5% regional sales tax that funds transit service is set to expire after 2025. About a third of the revenue from this source is allocated to transit, with the remainder to highways and arterial roadways. If an extension is referred to Maricopa County voters, it is not clear what the percent of the tax will be or what proportion will be dedicated to public transit. A higher allocation for transit from a future regional tax may be possible, especially with the freeway system built out except in the outer fringes of the metropolitan area. The forecast of available revenue from an extended regional sales tax will depend on:

- Duration of the tax
- Amount of the tax
- Proportion of the tax dedicated to transit
- Modal split or restrictions (if specified in the ballot proposition)
- Any "off the top" set-asides (e.g., to complete the adopted light rail system)
- Revenue from the tax during the previous 20-year period
- Allowance for growth in taxable retail sales
- Allowance for expected change in macroeconomic conditions
- Distribution of revenue among communities, after any set-asides
- Contingency funds or reserves

An extension of the one-half-cent sales tax would provide continued support for local services and the addition of new service.

The ALF is another source of funds, from multistate Powerball lottery revenues that the Arizona legislature allocates to Maricopa County for transit. Valley Metro disburses the money among member municipalities and has been using a population-based formula to distribute funds through an application process wherein member cities identify the targeted use for the funds. Powerball revenue may fluctuate from year to year. Proceeds available for transit have varied from $5 million to $18 million. The estimated amount of available to Maricopa County in FY 2015 is approximately $11.2 million.

Local Sales Tax - Local sales taxes for transit could be used to generate additional funding in the event that continued regional funding does not materialize, or that it is insufficient to support the level of services desired by the subregion or a specific jurisdiction. *Working Paper 8: Financial Analysis*, investigates the potential for revenue generation in the Southeast Valley; even a small increment in sales tax could result in a substantial increase in transit service.

Special Districts and Other Local Funding Mechanisms. In addition to a sales tax initiative, there are many other mechanisms that could be used to generate local funding for transit services. A utility tax concept may be viable because it may distribute the burden more fairly to both residents and businesses that will benefit from transit; however, it would require adjustments to either sales tax rates on utilities or utility franchise fees. A sales tax on utilities by each jurisdiction could be implemented with a vote of each city council. Changing the use of utility franchise fees would involve the corporation commission. The idea of generating revenue through public-private partnerships is another potential option, but it is not likely to provide enough additional funding to make a substantial difference in the level of transit service provided.

Working Paper 8 also looked at two property-value-based means of funding local transit services. The first is the concept of a property tax specifically for transit, levied either across the entire service area or on properties in special districts that would directly benefit from the transit service. This approach has many advantages, in that the funding potential is large, the cost burden is widely distributed and there is precedent in Arizona for such enhanced services districts. Once the benefit area is determined, it would be possible to levy a small incremental property tax for transit services. Such an option is included in Chandler's 2010 Transportation Plan as a potential funding mechanism for a potential west Chandler and Ahwatukee circulator. However, it may be very difficult to implement this funding mechanism across a multijurisdictional region, especially considering that some jurisdictions currently do not have a city property tax.

7.0 SUMMARY AND CONCLUSION

A set of concepts have been identified for each the Optimization of Existing Services; Mid-term (within 10 years), and Long-term (beyond 10 years). The development of these concepts were based largely on a Transit Optimization Analysis, which analyzed boardings data and the current service design, and a Needs Assessment that analyzed trends in demographics, land uses, and travel patterns. In addition, a Project Advisory Committee, which included representation from each of the jurisdictions within the study area, provided input to refine these concepts based on adopted local plans, community goals and objectives, and specific local conditions and experiences. Implementation of these concepts may occur through the programming process based on evolving priorities, and available funding.

APPENDIX A: INITIAL OPTIMIZATION RECOMMENDATIONS

This Appendix includes documentation of data-driven recommendations generated by the analysis of available data on boardings and the service design review. These are financially unconstrained and were later refined in collaboration with the PAC members to account for community goals and objectives, and specific local conditions and experiences. This Appendix includes:

- SEVTSS DRAFT Service Recommendations, March 30, 2015
- Service Design Review, December 2014
- SE Valley Estimated Recommended Network Weekday Operating Resources, including Illustrative Cost-Neutral Approach to Service Recommendations, March 2015

SEVTSS DRAFT Service Recommendations, March 30, 2015

Guiding Principles and Design Strategies

Following the SEVTSS Transit Optimization Analysis (TOA), seven Guiding Principles were developed to serve as a framework for forming draft service recommendations. They ensure that the recommendations:

- Focus transit investment to maximize the effectiveness of Valley Metro resources
- Position the network to meet the growing demand for service
- Improve the customer experience

1. Strengthen the Grid Network

The grid network is an effective and efficient structure for service in the Southeast Valley. The portions of the study area with a complete grid network have the highest productivity and ridership. However, there is an opportunity to maximize the effectiveness of the grid by developing a frequent 15-minute network that fosters spontaneous-use. With this frequent network structure, ridership will increase as more customers will be able to use transit without consulting a schedule, benefiting both regular trip-making and inciting new transit travel. The higher frequencies make transfers more convenient, an integral part of traveling throughout a grid network.

The TOA found that productivity is strongly tied to population and employment densities. Valley Metro currently focuses resources on maintaining the grid in the highest density areas in the Southeast Valley. The recommendations will continue build upon this practice. Two services are proposed to be extended in the near-term: Route 77 - Baseline Rd should be extended to Gilbert Rd and service on Guadalupe Rd should be extended to span from Priest Dr to Gilbert Rd. These emerging corridors feature a stronger mix of land uses and will help complete the grid between Baseline Rd and Elliot Rd.

2. Increase Service Frequency where Warranted

The proposed 15-minute, spontaneous use network was determined based on existing service performance as well population and employment densities. The urban core for 15-minute service is bounded by University Dr in the north, Arizona Ave in the east, Baseline Rd in the south, and Priest Dr in the west augmented by the area south to Elliot Rd between Priest Dr and Arizona Ave and east to Gilbert Rd between University Dr and Baseline Rd.

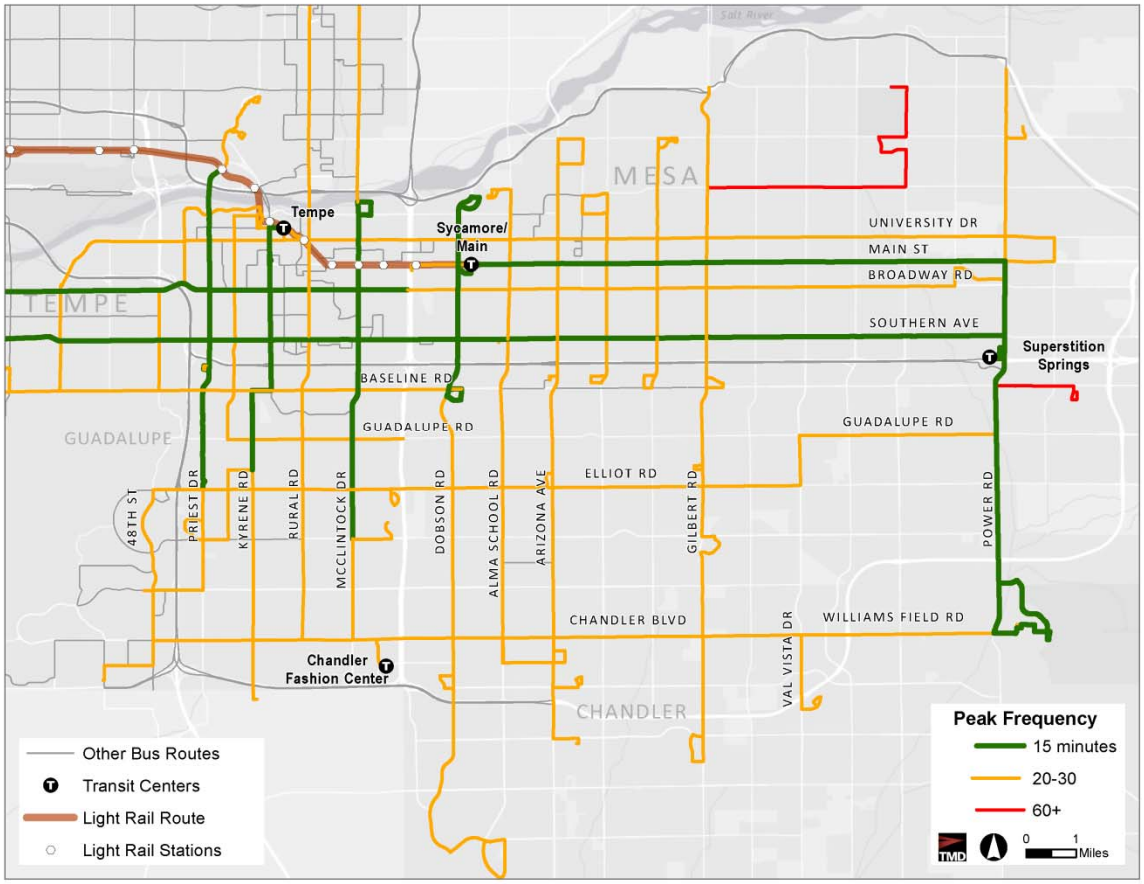
Outside of the core area, services should operate at 30-minute frequency on weekdays. Exceptions to this are Route 72 – Rural Rd and AZAV LINK which carry 15-minute frequency south of Elliot Rd to their southern termini and Route 61 – Southern and the Main St LINK which have 15-minute or better frequency east of Gilbert Rd to Superstition Springs.

These frequency recommendations apply to both the peak and off-peak periods. For the majority of routes, midday productivity is just as great as or greater than peak productivity, indicating a sustained travel demand throughout the day. Maintaining high frequencies throughout the day attracts additional

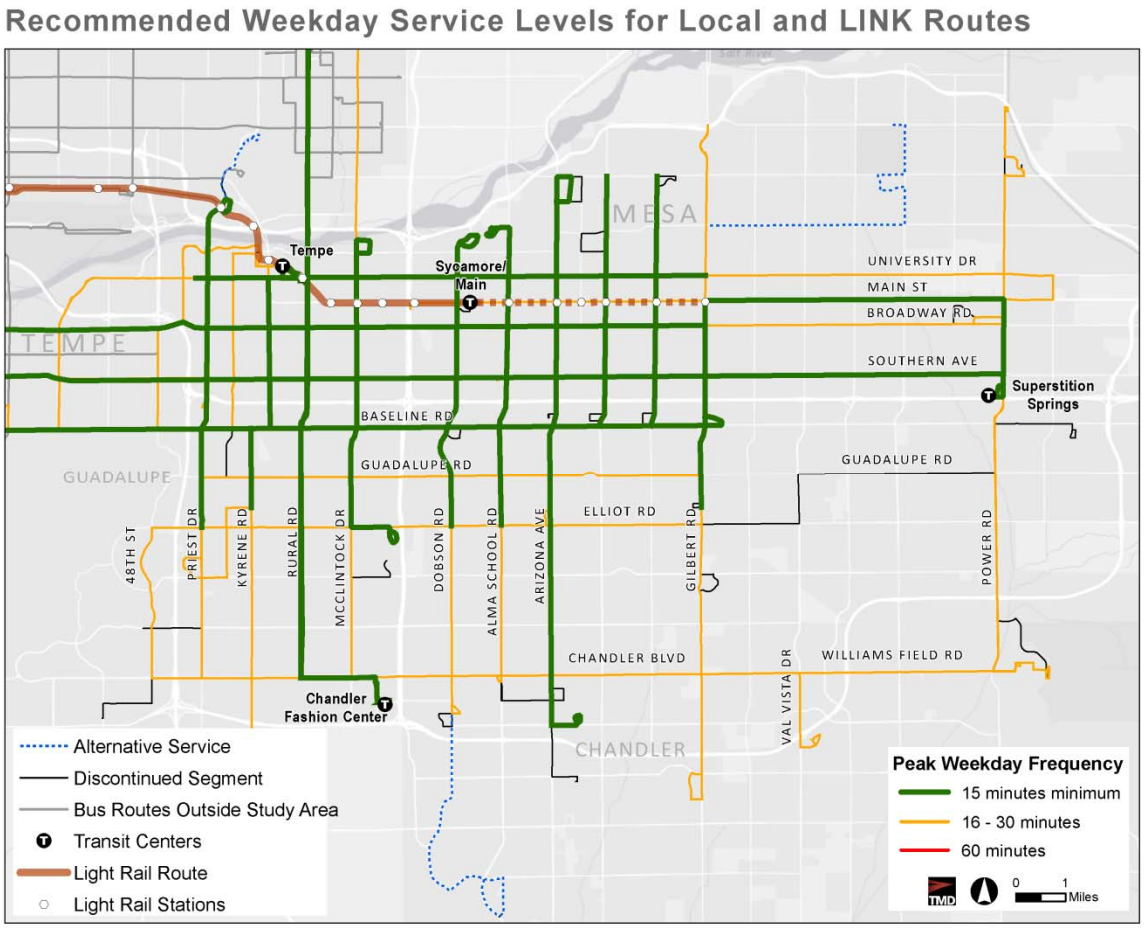
discretionary ridership by non-commute-oriented passengers and supports growing community sustainability initiatives (ST-LUIS).

Existing and Proposed Route Frequencies									
Route Number	Route Name	Existing Frequency				Proposed Frequency			
		Peak	Off-Peak	Sat.	Sun.	Peak	Off-Peak	Sat.	Sun.
30	University	30	30	30/60	60	15/30	15/30	30	30
40	Apache/Main St	30	30	30	30	30	30	30	30
45	Broadway	15/30	30	30/60	30 short	15/30	15/30	30	30
48	48th Street/Rio Salado	30	30	30	30	30	30	30	30
56	Priest Drive	15/30	30	30	30	15/30	15/30	30	30
61	Southern	15	15	30	30/60	15	15	30	30
62	Hardy/Guadalupe	30	30	30	30	30	30	30	30
65	Mill/Kyrene	30	30	60	60	30	30	60	60
66	Mill/Kyrene	30	30	60	60	30	30	60	60
72	Scottsdale Rd/Rural	20	20	30	30	15	15	30	30
77	Baseline	30	30	30	30	15	15	30	30
81	Hayden/McClintock	15/30	30	60	60	15/30	15/30	30	30
96	Dobson	15/30	30	30	30 short	15/30	15/30	30	30
104	Alma School	30	30	60 short	--	15/30	15/30	30	30
108	Elliot Rd	30	30	60	60	30	30	30	30
110	Guadalupe Rd	--	--	--	--	30	30	30	30
112	Country Club/Arizona Ave	30	30	60	60	--	--	--	--
120	Mesa Dr	30	30	60	--	15	15	30	30
128	Stapley	30	30	60	--	15	15	30	30
136	Gilbert Rd	30	30	30/60	--	15/30	15/30	30	30
156	Chandler/Williams Field	30	30	30	30	30	30	30	30
184	Power Rd	15/30	30	60	60	30	30	60	60
AZAV	LINK - Arizona Ave	25	25	60	60	12	12	30	30
MAIN	LINK - Main St	15	25	--	--	12	12	30	30

Peak Service Levels for Local and LINK Routes



This map shows existing service frequencies for routes in the Southeast Valley.



This map shows proposed frequencies for routes in the Southeast Valley.

3. Streamline Service to Minimize Out-of-Direction Travel and Route Duplication

Routes alignments should be streamlined to improve travel times, minimize mileage costs, and enhance the passenger experience. Deviations can result in significant costs to both Valley Metro and its passengers. The project team analyzed each route deviation to identify opportunities for streamlining. The team evaluated factors such as the passenger walk environment, access to key destinations, network synergy, and ridership levels and patterns to assess each deviation's role in the overall network. Deviations with significant impact on through-riders, low ridership, or added unproductive resources were proposed for removal because of their impact on the network. Route duplication was also minimized to simplify the network for passengers and reduce route mileage costs across the system.

4. Better Integrate Local Bus with Rail Service

Light rail service accounts for 22 percent of weekday ridership and serves as a primary method for passengers to get into downtown Phoenix and other network areas. Recommendations are designed to leverage the high-investment rail infrastructure by connecting bus into rail wherever efficient and effective. The recommendations also respond to the extension of light rail to Gilbert Rd. As the extension continues east, most of north/south corridors will operate frequently (15 minutes or better) to provide convenient connections to LRT's 12-minute frequency.

Route 40 is proposed to provide community circulation on top of LRT between Price Rd and Gilbert Rd every 30 minutes. Along this corridor segment, light rail station spacing is roughly a mile apart and the bus route will be a local collection-distribution service for those who cannot or do not wish to walk to rail.

5. Interlining

Interlining or inter-scheduling service between two routes was applied in two cases in order to improve network efficiency. *First*, interlines were used when turnaround locations at the ends of routes were undesirable or resource intensive. Instead of using extra resources for long end of line turnarounds, route pairs were interlined to eliminate the need for an off-corridor turnaround location. Interlined routes operating on parallel streets when they reach the end of a route will simply turn the corner and deadhead to the start of the new route on the parallel corridor. This tactic was used in the following cases: Route 120 – Mesa Dr / Route 128 – Stapley Dr; Route 96 – Dobson Rd / Route 104 – Alma School Rd (shortline); Route 48 – 52nd St / Route 62 – Hardy Dr; and Route 108 – Elliot Rd / new Guadalupe Rd service.

Second, interlines were used when cycle times of standalone routes resulted in excess layover and inefficient service delivery. The Service Efficiency Review found that multiple routes have excess layover, often totaling over 20 percent of running time. Interlining reduces these inefficiencies by combining two services with excessive layover into a single route pair with an efficient round trip cycle time that uses fewer resources.

An example of interlining being used for resource efficiency is seen in the case of Route 56 – Priest Dr. For the new proposal, the roundtrip running time for each branch is 92 minutes. As standalone routes, each branch would require the use of four vehicles (8 total) to operate at a 30-minute frequency and would have 28 minutes of layover (30 percent of running time). Interlining the two routes leads to a 184-minute cycle time by adding the two running times together. With 26 minutes of layover (14 percent of running time), this interline pair can operate on a combined 210-minute cycle using 7 buses. Here, interlining saves one vehicle and 30 minutes of excess layover time.

6. Stop Consolidation

Existing stops on local services should be consolidated to reduce vehicle dwell time picking up passengers and speed up service. When determining stop spacing, it is important to balance short walk access for passengers and providing a fast trip for on-board passengers. Local service should have stops roughly every quarter of a mile to achieve this balance. Candidates for stop consolidation are low ridership stops closer than a quarter of a mile to another stop or a pair of stops on the nearside and farside of the same intersection (with farside being the preferred location to minimize traffic signal delay).

7. Create an All-Week Network

Having an all-day all-week network is crucial to long term transit success in the sustainable areas of the Southeast Valley. Passengers who only have access to transit service six days a week, but would use it on the seventh, have to find alternative modes of transportation for that final day. In many cases, they use the alternative method, most likely a car, the rest of the week and do not end up using transit. Having service all week gives passengers more flexibility in their travel schedule, increasing the likelihood that they will use transit especially in sustainable community areas.

Recommendations

LINK Service

The TOA found that the performance potential of existing LINK service is limited because market conditions are not strong enough to support two distinct transit services on LINK corridors. Consolidating LINK and local service into one frequent service would more effectively serve the corridors. It is proposed that the two LINK services combine resources from the existing local and LINK services to create enhanced services for Arizona Ave and Main St that combine the stopping patterns of both services.

The goal for LINK is that it is an enhanced local service embodying certain BRT best practice toolbox elements. This means investing in farside stops, transit signal priority, and appropriate stop spacing. A target stop spacing of 1/4 to 1/3 mile requires a review of current local and LINK stops where none closer than 1/4 mile are retained and of those with virtually no ridership are eliminated (pushing the average spacing slightly above 1/4 mile). Most existing local service with an average stop spacing of ¼ mile has stops even closer together, causing the bus to stop far too frequently. Valley Metro should commit to discontinuing any nearside/farside stop pairs, underused stops, and stops closer together than ¼ mile.

Main St LINK

This route will continue to function as a rail extension east of the last train station to Superstition Springs Transit Center (Sycamore/Main in the near-term and Gilbert Rd when rail is extended). It will operate every 12 minutes stopping every 1/4-1/3 mile to emulate rail as much as possible.

Arizona Ave LINK

This route will operate every 12 minutes with stops every 1/4-1/3 mile to serve as a fast north/south connection to rail. It will maintain the existing termini of Route 112 – Arizona Ave with a tighter northern turnaround to reduce route mileage. In the south, the route will terminate at Morelos St where Route 112 ends today. Service on this corridor will be discontinued south of Pecos. Ridership at the Chandler Park-and-Ride (PNR) was found to be primarily riders using the express Route 542 which provides a faster connection to downtown Phoenix than taking Arizona Ave to light rail.

Local Service

Local services vary greatly in ridership and performance and serve areas of the Southeast Valley that vary significantly in population and employment density. Further, each local route has a specific role in the network at large that influences service levels. All of these factors contribute to the recommended service frequencies by day of week and time of day.

Route 40 – Main St

This route is proposed to become a LRT local underlay collection-distribution service that operates every 30 minutes between Price Rd and the end of the rail line (Mesa Dr or Gilbert Rd depending on the stage

of the rail expansion). In this area, LRT stations are spaced roughly one mile apart, and the new Route 40 will provide local service for those who cannot or do not wish to walk to rail.

Route 30 – University Dr

This route serves as a local alternative to rail and serves a largely sustainable corridor. Service is proposed to operate every 15 minutes with a short line pattern between 52nd St and Gilbert Rd with only these short line trips serving the new train station at Gilbert Rd once it opens. Service on the rest of the route will operate every 30 minutes and not deviate into the LRT terminal station. The deviation to the Sycamore/Main St TC will be discontinued.

45 – Broadway Rd

This route also serves as a local alternative to rail along a sustainable corridor and will operate similarly to Route 30 – University Dr. Service will operate every 15 minutes from the western terminus at Broadway Rd & 19th Ave to Gilbert Rd. The short line trips will deviate and end at the new LRT station there, while the long trips will operate every 30 minutes east of Gilbert Rd without deviating. The deviation to the Sycamore/Main St TC will be discontinued. The portion of the route on Power Rd will also be discontinued due to duplication, and the route will terminate around the Banner Baywood Medical Center at Power Rd. Service south along Power Rd to Superstition Springs Transit Center will continue to be provided by the Main LINK and 184 – Power Rd routes.

Route 48 – 48th St

Route 48 – 48th St will be interlined with Route 62 – Hardy Dr where Baseline Rd intersects Priest Dr instead of terminating at Arizona Mills Mall to improve operating efficiency. While the route segment on Rio Salado Pkwy has very low ridership, planned developments on this corridor are expected to generate more ridership in the future.

Route 56 – Priest Dr

Route 56 – Priest Dr will operate every 15 minutes from Washington LRT station to Elliot Rd, then splitting into two 30-minute service branches. The segment north of Washington LRT should be discontinued with service to the zoo and botanic garden covered by a community shuttle connecting rail with these two destinations. Also, Route 3 – Van Buren should also terminate at the Washington LRT station instead of at the zoo. South of Elliot Rd, Route 56 will split into two branches, each one operating every 30 minutes. One will continue south on Priest Dr to Chandler Blvd. The other will serve 48th St to Chandler Blvd (replacing current Route 108 – Elliot Rd). These two branches will be interlined via Chandler Blvd to balance running times and maintain efficiency.

Route 61 – Southern Ave

There are no alignment changes for this route. Due to the strength of the performance on this route, it should operate 15-minute service all day. In the future this should become a consolidated LINK service like that proposed for both Main St and Arizona Ave.

Route 62 – Hardy Dr

This route will be split into two services – one on Hardy Dr and one on Guadalupe Rd. Route 62 will continue as the Hardy Dr service with a new route serving Guadalupe Rd. This service will operate every 30 minutes on Hardy Dr between Tempe TC and Arizona Mills Mall. This route will be interlined with Route 48 – 48th St where Baseline Rd intersects Priest Dr, just south of Arizona Mills Mall.

Route 65 and 66 – Mill Ave/Kyrene Rd

There are no proposed changes to these routes. They have strong performance and appropriate frequencies. While the tail end of Route 65 does not follow the grid network, it provides connections to important activity centers.

Route 72- Scottsdale/Rural Rd

Rural Rd is a future LINK corridor. Frequencies should be improved all day from 20-minute to 15-minute frequencies in order to provide better connections with surrounding 15-minute and 30-minute services with LINK infrastructure improvements following. There are no alignment recommendations.

Route 77 – Baseline Rd

Baseline Rd is a strong corridor that warrants additional investment. The existing alignment should be extended from Dobson Rd to Gilbert Rd to provide east/west service to commercial centers and the southern ends of Route 120 – Mesa Dr and Route 128 – Stapley Dr. It should operate at 15-minute frequency all day.

Route 81 – McClintock Dr

This route should keep its original alignment and operations and operate 15-minute frequency between Tempe Marketplace and ASU Research Park with the short line serving ASU Research Park via Elliot Rd like the deviation off Route 108 instead of entering the park off of Warner Rd to reduce mileage. The long line will continue to provide 30-minute south of Elliot Rd.

Route 96 – Dobson Rd

Route 96 – Dobson Rd should operate with a short line/long line structure with service every 15 minutes from Mesa Riverview to Elliot Rd with the long line providing 30-minute service further south. The deviation to the Sycamore/Main St TC should be discontinued as should the turnaround for the shortline at Baseline Rd. The route should have its southern terminus at Fairview St just south of Chandler Regional Hospital. The segment south of Fairview St requires an extra bus for operation and does not generate enough ridership to warrant 30-minute service and should be discontinued. If the city wishes to continue to serve this area, it can be served by a community shuttle. The shortline of this route will be interlined with Route 104 – Alma School Rd via Elliot Rd to deliver efficient operations.

Route 104 – Alma School Rd

This route should operate 15-minute service from Mesa Riverview to Elliot Rd with a short line/long line structure. The deviation to the Sycamore/Main St TC should be discontinued once the rail station opens at Alma School Rd. The 30-minute long line should have its southern terminus at the southwest corner of Chandler Blvd & Alma School Rd. The segment on Frye Rd to Downtown Chandler is duplicative with existing service on Chandler Blvd and Arizona Ave and does not follow the principles of a grid network. The shortline of this route will be interlined with Route 96 – Dobson Rd via Elliot Rd.

Route 108 – Elliot Rd

Route 108 – Elliot Rd has low ridership and low performance. Keeping the most productive segments of the route, the new Route 108 will operate every 30 minutes on Elliot Rd between Priest Dr and Gilbert Rd. Service will be completely discontinued east of Gilbert due to very low ridership and performance in the near term. The segment on 48th St will be covered by Route 56 – Priest Dr. The 40th St/Pecos PNR is primarily used by I-10E RAPID riders. Discontinue service to Sunland Village East due to low ridership.

Route 112 – Arizona Ave

Service consolidated with AZAV LINK.

Route 120 – Mesa Dr

This route should increase to 15-minute service when the rail station opens at Mesa Dr. Service should be extended north to McKellips Rd to match the alignment of Route 128 – Stapley Dr. These routes will be interlined at McKellips Rd and Baseline Rd to improve service efficiency.

Route 128 – Stapley Dr

This route should increase to 15-minute service when the rail station opens at Stapley Dr. This route will be interlined with Route 120 – Mesa Dr at McKellips Rd and Baseline Rd.

Route 136 – Gilbert Rd

Service on Gilbert Rd varies greatly in productivity. The most productive segments between Gilbert PNR and University Dr warrant 15-minute service. Consequently, it is proposed that this route operate as two 30-minute services, one from McDowell Rd to Elliot Rd and one from the Gilbert LRT Station at Main St to Ryan Rd. These two services will overlap for 15-minute service between Elliot Rd and Main St. Eliminate Civic Center Dr and Boeing deviations due to low ridership. If Boeing still wants to be served, a partnership can be made with Boeing to sponsor an employee shuttle or station vans/vanpools from the LRT station.

Route 156 – Chandler Blvd

There are no recommendations for this service at this time. However, the Gilbert Mercy Hospital deviation is a formidable out-of-direction deviation for customers and should be served independently of Route 156. The 11-minute deviation is a serious deterrent for through riders, costing the route significant potential ridership. Serving the deviation also requires adding a vehicle to the route to allow it to cycle efficiently. The ridership gained along this deviation is not enough to justify the expenditure of an entire daily bus to serve it. In the future, cities should work closely with Valley Metro when planning new social service developments to ensure they are built on existing transit corridors to avoid making such costly deviations.

Route 184 – Power Rd

This route has the lowest productivity of the local routes in the Southeast Valley and the third lowest ridership. 15-minute service between ASU Poly Tech and Superstition Springs in the peak is not warranted given ridership and surrounding density. This route should instead operate at 30-minutes all day along the entire alignment. The Red Mountain Mesa Community College deviation should be restructured so the route does not double-back on itself on McKellips Rd to save time and mileage by using both entrances. The southern alignment should be restructured to eliminate one-way service on Sossaman Rd. The current one-way terminus loop adds considerable mileage to the route while generating few passengers. The proposed alignment traveling south on Power Rd is to enter the ASU Poly Tech campus via Williams Field Rd, merge onto Innovation Way, continue on Innovation Way N and E, turn left onto E Texas Ave, and terminate at the Phoenix-Mesa Gateway Airport terminal. The route should reverse this alignment for the northbound trips.

Route 110 - New Guadalupe Rd

Evaluation of market conditions found that Guadalupe Rd between Priest Dr and Gilbert Rd has strong potential to support successful transit service. Portions of this corridor are covered by existing Route 62 – Hardy/Guadalupe Rd. Recommendations propose introducing a new 30-minute Guadalupe Rd service between Priest Dr and Gilbert Rd that will fill in the network gap between Baseline Rd and Elliot Rd.

Express Service

Express services serve an important role in the network by providing fast connections over longer distances. However, because express services travel far distances and do not pick up passengers along their entire alignment, the cost of providing service can be substantial, especially per passenger. In Valley Metro's case where service is paid for on a per mile basis, the hourly cost of providing express service is greater than the hourly cost of providing local service. Industry best practices state that the cost effectiveness tipping point is usually at or above 30 passengers per trip.

Express services should focus on serving PNR lots and not doing street pick-ups except for connections with major transit routes. As well, effective Express services generally stop at no more than two PNR lots: one at the beginning of the route and one in the middle of the route, as riders generally will

tolerate only one short deviation off the freeway. Stopping frequently on local streets weakens the success of the route. These stops gain few passengers and deter other passengers from riding by slowing down the service.

The existing express services in the Southeast Valley vary greatly in their daily ridership and benefit to the system.

Express 533 – Mesa Express

This is the strongest express service, averaging over 40 riders per trip. This route would benefit from adding a later trip in the morning and an earlier trip in the afternoon. The latest trip in the AM arrives downtown at 7:57 AM, and a trip should be added to arrive around 8:20 AM to accommodate employees who may start work at 9:00 AM. Existing trips can be re-timed to allow this later trip to operate without requiring the use of an additional vehicle. Similarly, a trip should leave in the afternoon around 3:15 PM. Workers arriving downtown by 6:00 AM on the first trip may wish to go home earlier that 3:40 PM.

Express 535 – Northeast Mesa/Downtown

This is the second strongest express service, averaging 33 riders per trip. There are no changes proposed for this route.

Express 531 – Mesa Express

This is another strong route with an average of 29 riders per trip. Local stops should be consolidated, and the route should only stop at the Gilbert and West Mesa PNRs to increase the speed of the service and improve its attractiveness to commuters.

Express 541 – Chandler Express

This route should start at the West Mesa PNR where the route attracts most of its riders, potentially allowing more efficient use of resources. Local service south of Baseline Rd duplicates service provided by Route 104 – Alma School Rd and the AZAV LINK, both of which provide direct connections to light rail which serves downtown. Trips should be scheduled in between Express 531 trips to increase the frequency of trips traveling between West Mesa PNR and downtown Phoenix.

Express 542 – Chandler/Downtown Express

This is a strong route, and there are no recommended changes.

Express 520/521/522 Tempe Express

These services should be discontinued due to low ridership and the high cost of providing service. At best, these routes have half the ridership of the stronger performing express services. Together, these three routes use ten vehicles during peak hours, taking up considerable resources that could be used to increase frequencies of local services which would benefit more riders.

Circulator Routes

The ALEX, BUZZ, FLASH, and Orbit routes are all free services that provide service to key destinations within communities. They are attractive to passengers because they are free, operate at high frequencies, and reduce walk distances to access transit services. However, circulator services should still follow the design principles applied to fixed-route services. Alignments should be as linear as possible with minimal out-of-direction deviations. One-way loops should be avoided because they increase travel time for passengers. As much as possible, circulators should provide connections into nearby LRT stations.

Weekend Service

In order to create an all-week network, Sunday service is proposed for Routes 104 – Alma School Rd, 120 – Mesa Dr, 128 – Stapley Dr, and 136 – Gilbert Rd. When the Gilbert Rd LRT extension is implemented, each of these routes will serve a light rail station on Main St, further increasing the importance of having Sunday service on these corridors. Sunday service should operate every 30 minutes to connect with rail service. MAIN LINK should operate on weekends at a frequency that exactly matches rail (15 minutes on Saturdays and 20 minutes on Sundays) to continue its role as a rail extension on weekends. AZAV LINK is proposed at operate every 30 minutes.

With a few exceptions, Valley Metro should operate a 30-minute weekend network in the Southeast Valley. Corridors with strong Saturday productivities (above 30 passengers per revenue hour) warrant 15-minute service. These include Route 40 – Main St (already covered by MAIN LINK), Route 61 – Southern Ave, Route 72 – Rural Rd, and Route 77 – Baseline Rd. Sunday frequencies on these routes should remain at 30 minutes. The only services that should operate at 60-minute frequency on weekends on Route 156 – Chandler Blvd and Route 184 – Power Rd (which can be scheduled as an efficient interline couplet). These routes serve as lifeline coverage routes and have low weekend performance. All other services currently operating at 60-minute frequency on weekends should increase to 30-minute frequency to allow for more convenient transfers and travel throughout the network.

Service Design Review

Scheduling Performance and Efficiency

Technical Memorandum

Introduction

Task 4 of the Transit Optimization Analysis (TOA) for the Southeast Valley Transit System Study (SEVTSS) included a review of current Valley Metro scheduling practices and their related outcomes. For this analysis, existing service effectiveness and operational efficiency were reviewed to provide a data-driven understanding of current performance and to build a foundation for developing recommendations.

The review primarily is focused on the application of the HASTUS scheduling software, and related tools, for the scheduling of the routes within the study area, which is confined to the Tempe and Mesa operating garages.

The kick-off for this task included familiarization with the HASTUS database organization and route structures within the study area. All key HASTUS scheduling related components, except runcutting and rostering, were examined.

The emphasis of this section of the study will determine if there are additional cost-savings or efficiency opportunities that can be achieved through improved scheduling practices or utilization of technology. TMD undertook evaluation of the scheduling processes at the district, garage, and route level.

Methodology

Communicating directly with Tempe staff, TMD discussed practices and procedures followed during the scheduling process. Remote access to the HASTEST database allowed TMD staff to analyze HASTUS Vehicle schedule tables, reports, and statistics in order to identify opportunities to improve the scheduling process and/or maximize resource utilization. Recovery times and in-service operating speeds were reviewed, deadhead and running time versions evaluated, and runtime data for three randomly selected routes was analyzed in HASTUS ATP. FY2014 On-Time Performance, blocking methodologies, blocking solutions, and garage assignment strategies were also examined.

Results and Recommendations

Overview

TMD was provided access to the Phoenix HASTEST database containing Tempe/Mesa schedule data within the "TMOT14" booking, which was subsequently used for this analysis. Scheduled, fixed route bus service, at the Tempe and Mesa garages is operated under contract by First Transit for 21 Local, 9 Express, 9 Community Circulator, and 2 LINK connector routes. All Local and selected Express routes operate standard 40-foot or articulated buses while Circulator, LINK and most Express routes are assigned specialized fleet types.

- Most local routes operate on weekdays every 30 minutes with several routes providing 15 minute service during the AM and PM peak periods. Half of the weekday routes operate from

approximately 5:00am until midnight with others terminating between 6:00pm and 10:00pm. On weekends, local routes may operate less frequently with reduced service spans. Express routes provide weekday peak hour tripper service only.

- Neighborhood Circulator routes operate weekdays from approximately 6:00am until 10:00pm with frequencies ranging from 10 minutes to 30 minutes. More than half of the Circulator routes operate on Saturdays and/or Sundays with modified hours and frequencies. One circulator operates in one direction only.

- The Arizona Avenue LINK line operates 7 days a week. Weekday service operates every 35 minutes between approximately 5:00am and 8:30pm. On weekends, hourly service is provided from approximately 6:30 until 11:00pm. The Main Street LINK line operates 15 minute peak frequency and an alternating 25/35 minute off peak frequency on weekdays from approximately 4:00am until 10:00pm.

Phoenix staff maintains the HASTUS variant and itinerary data and Tempe staff with feedback from Valley Metro operations staff defines scheduled running times. Phoenix provides headway information to Tempe schedulers who prepare initial vehicle schedules and blocking solutions. Proposed schedules are reviewed by Phoenix staff prior to approval of the final blocking solutions and garage assignments. Tempe staff may make additional blocking and/or scheduling adjustments to reduce vehicle requirements, balance garage assignments, or improve the blocking solution. For this process, Tempe staff builds and blocks the schedules in a non-production environment (HASTEST). These new solutions are then replicated in the production database (HASTUS). This would be a less time consuming and redundant task if Tempe staff were allowed to access the HASTUS environment to directly enter the schedule and block data [the usual process for multiple users or agencies], while still allowing for review and oversight by Valley Metro operations staff.

When the vehicle scheduling phase is complete, the contractor (First Transit) is responsible for the runcut and roster processes necessary for operational implementation. Currently, First Transit has the City of Phoenix staff undertake this effort for them.

Performance Measurements

Schedule Recovery Percent – A minimum 10% recovery is the target for Valley Metro routes assigned to the Tempe and Mesa garages. Recovery percent represents the ratio of extra time available in a round trip to help assure the next trip departs on-time. Since it protects service reliability, it is standard industry practice to include recovery time in total revenue hours. Recovery time beyond the minimum deemed necessary for reliability is considered inefficient and often lowers productivity. Excess recovery time may, however, be unavoidable under certain circumstances resulting from route design, headway, frequency, timed transfers, and other criteria that affect round trip cycle time efficiency.

Recovery times were analyzed for each schedule day type operated by First Transit from the Tempe and Mesa garages as shown in Table 1. The average recovery ratio for Community Circulator, LINK, and Local routes indicates more than adequate overall recovery has been provided for each service type (weekday, Saturday, and Sunday). It was noted that excess recovery over the 10% minimum exists for all service types other than express as highlighted in Table 1 below. In some of these cases re-blocking would reduce excess recovery and vehicle requirements while continuing to respect "Vehicle Type" restrictions. In all instances the service redesign recommendations should consider adjustments to the routes to minimize the inefficient round trip cycles that result in excess recovery time. Particular attention should be given to the LINK routes (all service days) and Local routes (especially on weekends). Attention to the impact of deviations on cycle time efficiency is also important to avoid the cost of an extra all-day bus with 1-2 operators when adding or continuing service deviations. Examples of excess recovery time where ¼ to ⅓ of the time is spent unproductively include:

Routes with excess recovery time (over 10%) should be reviewed and adjusted where feasible to minimize cycle time inefficiencies. Where not feasible, interlines should be considered.

- 120 – Mesa Dr (34%)
- 48 - 48th Street/Rio Salado (28%)
- Arizona Ave LINK (27%)

Express routes are not subject to the 10% recovery ratio target, since the service is tripper-based, rather than schedule-based. As a result, Express blocks normally operate only one or two one-way trips, generally only in the peak direction.

Recovery Percentages by Service Type			
Service Type	Weekday	Saturday	Sunday
Local	15.1%	18.7%	20.2%
LINK	27.9%	45.1%	44.3%
Circulator	13.2%	13.9%	15.5%
Express	1.9%	--	--

Table 1: Recovery Percentages by Service Type

Pull and Deadhead Time Percent – Pull and deadhead time percentage is the ratio of non-revenue hours to revenue hours and is shown in Table 2. "Pull Time", also referred to as "Garage Deadhead", is the time between the garage and route terminals. "Deadhead Time" is the time spent operating out of service from one terminal to another. Both Pull and Deadhead times are unproductive and should be minimized where possible.[1]

There are 395 deadhead trips scheduled in the TMOT14 booking with approximately 110 traveling to different terminal locations. For longer deadhead trips, using HASTUS Minbus [vehicle blocking optimizer] will likely find more suitable links to reduce unproductive time.

[1] Under the current operating contracts, the cost is based only on revenue miles at a set rate per mile. However, this rate per mile proposed by the contractor is based on the total revenue and non-revenue cost of the service operation divided by the planned revenue miles. Consequently, higher deadhead and pull time and miles manifest as a higher unit cost per revenue mile.

Many interline and non-interline deadheads have identical "Start" and "End" locations but require non-revenue travel between ending and starting points. Although these points are likely directly across the street, in some cases deadhead distances are in excess of 1.5 miles. This is an indication that simple turn-around opportunities are limited. The service design process should consider this, as well as a review of blocking strategies in order to reduce vehicle requirements. The result could be fewer pull trips and unnecessary vehicle assignments (single trip express buses, trippers etc.), as well as reduced high differentials in peak and off-peak bus requirements [peak-to-base ratio].

The Express routes have a very high percentage of non-revenue hours resulting from single trip blocks combined with more pull trips and longer pull durations, which are not unusual for express service and are reflected in the higher per trip costs associated with express operations. All other services have low pull and deadhead percentages, which is expected for services operating with low peak-to-base ratios.

Pull and Deadhead Time Percentages by Service Type			
Service Type	Weekday	Saturday	Sunday
Local	7.5%	6.0%	6.7%
LINK	7.4%	6.7%	7.7%
Circulator	4.0%	3.8%	4.6%
Express	43.1%	--	--

Table 2: Pull and Deadhead Time Percentages by Service Type

Operating Speeds – Operating speed reflects how fast trips are scheduled between timepoint segments. Scheduled operating speeds are based on segment conditions including traffic, signals, road speeds, number of stops, and expected ridership. Speeds that are excessively low or high are often reflected in poor on-time performance. This can cascade throughout entire the schedule and is a major cause of "Bus Bunching". Operators respond to excessive and insufficient running time inconsistently and this often results in additional, unnecessary resources and a poor experience for customers (reliability is the key factor for customer retention). Operating speeds as shown in Table 3 are within expected ranges for each service type.

Average Operating Speed by Service Type (mph)			
Service Type	Weekday	Saturday	Sunday
Local	15.4	15.8	16.1
LINK	18.8	22.9	22.7
Circulator	10.1	10.6	10.5
Express	25.5	--	--

Table 3: Average Operating Speed by Service Type

Scheduled operating speeds for Tempe/Mesa based Valley Metro routes vary depending on route characteristics. The average scheduled speed for free neighborhood "Circulator" routes is lower and those for "Express" routes, serving non-stop and freeway segments, are scheduled much faster. The LINK routes, which only stop at major intersections, are scheduled at an average speed of 18.8 mph with local routes somewhat slower at 15.4 mph. Based on the FY2014 on-time performance data, these scheduled speeds may be a bit slow for current travel conditions given high incident of early running (Table 4).

On-time Performance – As noted earlier, service reliability is the top issue for customer retention, which makes on-time performance a key transit metric. Using the typical On-Time Performance (OTP) standard of "no more than 1 minute early or five minutes late", overall FY2014 OTP for Tempe/Mesa based routes is just 61%. Early or "hot" running (> 1 minute early) represent 32% and with late running (> 5 minutes late) just 7% of recorded observations. This is unusual to have early running so prevalent given operating and scheduling best practice recognizing that running hot has a much more significant impact on the customer.

Adjust OTP "on-time" range to "up to one minute early to five minutes late" with both early and late running outside of the acceptable range.

Overall On-Time Performance for All Routes		
On-Time Status	Number of Observations Recorded	Percent of Total Observations
Early (>0h01)	1,413,920	31.57%
Late (>0h05)	330,501	7.38%
On-Time	2,734,329	61.05%
OTP Reported to RPTA		**92.62%**

Table 4: Overall On-Time Performance

On-Time measurements are not available for individual service types (Weekday, Saturday, & Sunday). The OTP measurements reflect the combined annualized on-time percentage. First Transit requires an on time operation of at least 90%, to meet the minimum performance standard. To achieve this, the On-Time Percentage is determined by adding the Early and On-Time measurements which result in On-Time Performance of 92.6%. *Again, early running is a major observed issue and the OTP target does not follow industry best practice which includes a range of up to one minute early to five minutes late as "on-time" and "early running" (greater than one minute ahead of schedule) as not on-time.*

Runtime Calibration – Runtime calibration is the process of refining in-service times between timepoints and timepoint segments. While runtimes are normally defined by route, which is the practice at Phoenix, it is not uncommon for system running times to be established and shared between routes operating along common corridors. As travel conditions change, it is also common for running times to vary throughout the day. These variances are implemented within HASTUS as "Runtime Periods." Runtimes affect operating speeds and schedule performance. Runtime periods, and the running times themselves, should be reflective of operating conditions, and be based on organizational and industry best practices.

In order for a complete and effective runtime analysis to occur, sufficient and accurate observed trip data needs to be available. The AVL system, installed on the majority of the Tempe/Mesa fleet, provides such data, which, when cleansed of erroneous or outlier records, is ideal for feeding into a running time analysis tool such as HASTUS ATP.

Tempe schedulers initially develop running times using preset operating speeds. For local routes, 12 mph in urban areas, 15 mph for suburban areas and up to 20 mph in suburban areas with low ridership. Higher operating speeds are used for Express type routes. Proposed route segments are then driven to

validate times. Driver and/or passenger complaints as well as low on-time performance cause routes to be reviewed.

As part of this study, TMD performed test ATP analyses on three local routes, using available AVL data (pre-loaded into HASTUS ATP). However, as a result of missing specific point data, it was not possible collect end to end or segment running times to verify on-time data. Furthermore, "ORBI" buses assigned to "Circulator" routes are not AVL equipped.

Although Tempe staff recently began using HASTUS ATP to assist in reviewing running times, it was found that the AVL data used was sometimes incomplete and contained erroneous records. It is therefore recommended that a review of the AVL data collection and cleansing process be performed. Additionally, the method used to load this data into the HASTUS environment should be assessed, as many instances of questionable measurements were observed. Valley Metro's AVL vendor (ACS), and or specialists should be able to assist with this. Procedures for on-going review of route running times, using ATP, should also be developed and implemented. Following this, HASTUS ATP should be used to perform a comprehensive analysis and calibration of running times for Mesa/Tempe based routes.

Runtime periods should also be reviewed and redefined. Runtimes for many routes do not adequately reflect changing driving conditions throughout the day. Several routes operate the same running time during peak and off-peak periods and several others carry the same running times over the course of the entire day. Valid AVL measurements, combined with a comprehensive ATP runtime analysis, will assist in identifying appropriate running times and runtime periods. *The unacceptably high levels of early running and the potential impact on resource requirements make runtime calibration a priority.*

Recommended next steps are a) identify a representative period of days to use for runtime analysis; b) clean the AVL data removing outliers and erroneous records; c) import into HASTUS ATP; d) review data in ATP and update running time periods (can vary by route); e) recalibrate running and recovery times following an industry best practice approach[2]; f) develop new service schedules (use MinBus to smooth transitions between time periods); g) implement and monitor; and h) recalibrate as needed to meet OTP targets.

Fleet Requirement and Assignment – Fleet assignments can have a significant effect on system operating efficiency. For this study, TMD reviewed vehicle group constraints by route, specialty bus type assignments, and garage capacities.

Seven vehicle types operate fixed route service from the Tempe and Mesa garages, including several specialty vehicles assigned to specific routes having restricted interline opportunities. "LINK" vehicles are assigned to LINK routes, with "ORIB" & "BUZZ" vehicles assigned to "Community Circulator" routes. "COMP" & "NX12" vehicles operate exclusively on "Express" routes and "ARTC" vehicles are assigned to both "Local" and selected "Express" blocks. "LC40" vehicles are assigned to "Local" as well as

[2] Current industry best practice calls for setting runtimes by a) targeting the 50-65 percentile operator performance; b) setting for cumulative timepoint runtimes (i.e., set A-B, then set A-C with B-C being the differential of A-C and A-B and so on); and c) setting recovery time based on ensuring that a percentage of the trips can start their next journeys exactly to the minute on-time (usually set at 95%). This approach achieves desired OTP performance with appropriate operator oversight and training in a balanced cost-effective and efficient manner.

"Downtown Circulator" routes. "ARTC" vehicles are assigned to blocks that are cut (to return to the garage) after the PM peak so they do not operate in the evenings where passenger loads are lighter.

There are no capacity issues at either the Tempe or Mesa garages and about two-thirds of the fleet is based at the larger Tempe garage. Garage distribution assignments are reviewed by Tempe staff and blocks can be reassigned based on proximity to route terminals (pull times and distances). It is not uncommon for routes to be split between garages. For maintenance and other purposes, certain specialty vehicles are assigned to a garage regardless of the proximity to the terminals. The use of MinBus can help define where changes to garage assignments and fleet distribution may balance and/or reduce peak vehicle requirements. With properly calibrated rules and parameters, Hastus MinBus is ideally suited for this task *but is not currently used*.

Tempe staff manually assign vehicle groups to blocks after the vehicle schedules have been transferred (by Phoenix staff) to the HASTEST database, and made available to Tempe staff. If using MinBus to generate blocking solutions, vehicle grouping constraints will be respected when interlining trips and assigning garages. Although vehicle groups can be assigned at the trip level, this can be a cumbersome process and it is easier to assign and manage vehicle groups when they are assigned at the route level (which can be overridden at the trip level if required). Currently, vehicle group information is not assigned at either route or trip levels. This would be necessary for MinBus to efficiently assign vehicles during the blocking process.

With properly calibrated rules and parameters, HASTUS MinBus is ideally suited for optimizing vehicle schedules and fleet assignment. It should be utilized to optimize each booking.

HASTUS Parameters – Establishing and fine tuning HASTUS rules and parameters, to optimize schedule performance and vehicle blocking efficiencies, is an essential component in the scheduling process. MinBus rules and parameters are used to direct trip linking, interlining, possible trip-shifting, garage assignment, pulls, deadheads, and travel activities. MinBus is a powerful tool for identifying opportunities to improve the efficiency and reliability of on-street operations.

Although Tempe staff often modify blocking solutions, they do not use MinBus for production scenarios. If rules and parameters were properly tuned then the tasks most commonly performed by Tempe staff (trip linking, interlining, trip shifting, and garage assignment changes), could be completed quickly and efficiently using MinBus.

It is recommended that the Tempe staff become familiar with and skilled in using the MinBus application. MinBus should be used to perform the blocking tasks now performed manually. However, process changes will need to be made and MinBus rules and parameters created to accomplish this. Reviewing and updating deadhead tables to reflect current conditions, defining vehicle types and groups as well as garage bus inventories and garage capacities, would allow MinBus to efficiently assign and/or reassign blocks to create daily vehicle assignments.

Future Contract Implications – Although the cities have third party service operating contracts (First Transit currently), changes to service, network design and vehicle scheduling provisions should be planned to improve the performance of future contracts. These changes should allow more efficient use

of operator resources, leading to lower costs as future contracts are negotiated.[3] While the contractor is compensated per revenue mile in the current contract, the efficiency of the operator runcut (contractor controlled) as well as the vehicle schedules (VM/Tempe/Mesa controlled) both influence the contracted cost per revenue mile. In fact, the runcut efficiency has significantly more impact on the contract cost (70% hourly based versus 30% mileage based). Therefore, it is in VM/Tempe/Mesa/VM's best interest to develop service and vehicle schedules that can be efficiently runcut.

The First Transit/ATU bargaining agreement and informal past practices, relating to driver assignments, were reviewed for potential cost savings. Current contract provisions appear to provide flexibility for daily and weekly assignments to be generated in a cost effective manner. A maximum spread of up to fourteen hours on weekdays, with no spread penalty, allows two peaks to be covered cost effectively by a single operator. Current indications are that the 55% weekday straight run requirement does not seem to be an impediment to the runcut efficiency.

The 1.43 peak to base ratio at the Tempe garage closely matches the 1.43 ratio at the Mesa garage. Both garages have a slightly higher PM peak requirement.

Although the straight run requirement on weekends is 100% (no splits), trippers are cut and allowed to be included in roster solutions. However, if 75% to 80% split duties were allowed, the trippers could be cut and matched as splits with higher work times. This may decrease the number of weekend duties and, in turn, reduce roster positions, as well as improve the runcut efficiency.

Split days off are allowed and are assigned to a limited number of roster positions. Several non-contractual, roster related concessions have been implemented which are intended to improve driver relations and, hopefully customer service. These concessions are minor and do not appear to have any negative impact on the roster solution.

Summary

The Service Design Review defined several areas of the scheduling process where efficiencies and improvements could be realized by modifying certain practices and fully incorporating and utilizing HASTUS tools. Tempe staff do skillfully use sound scheduling methods to create and implement scheduling solutions. Trips are re-blocked and interlined where possible to minimize vehicle requirements and are reassigned to appropriate garages where needed.

The more effective and regular use of HASTUS MinBus and ATP in the scheduling process, however, could increase productivity and efficiency in schedule production, on-street operation and overall cost. Realizing improved blocking solutions using MinBus will require implementing new blocking strategies as well as updating and maintaining appropriate sets of rules and parameters. A comprehensive, clean and valid set of on-street, point-to point runtime measurements is needed for reliable ATP analyses. The more valid data collected the more complete and dependable the ATP analysis will be. Recognizing that

[3] VM/Tempe/Mesa may wish to consider using a two or three part payment approach for future contracts that more fully reflect major cost centers and how those cost accrue and allow for more accurate and fair cost adjustments to service changes over the life of the contract. The suggested approach is a) hourly unit costs plus b) mileage unit costs (both of these are direct costs) plus c) fixed overhead costs (that do not usually change over the life of the contract).

the FY2014 on-time performance is just 61%, it is recommended this task be seriously considered. On-time operation is vital to the positive transit experience needed to attract and retain customers.

Recommendations (Short Term)

1. Minimize recovery time.
    a. Consider schedule efficiency in route design including seeking optimized alignment and round trip cycle time to minimize unproductive recovery time where feasible.
    b. Interline routes and trips to reduce bus requirements or improve reliability where optimal route design is not feasible.
2. Redefine on-time performance (OTP) to reflect just 1 minute early to 5 minutes late to reflect consumer needs.
3. Recalibrate running and recovery times by time of day and day of week to reflect actual street operations. With over 30% of service operating ahead of schedule, overall result should be tighter running times in the Southeast Valley.
    a. Address AVL data quality issues to assure that accurate data is available on an ongoing basis.
    b. Add circulator routes (ORBI buses) to the AVL covered services.
4. Build new weekday, Saturday, and Sunday schedules.
    a. Base on the recalibrated running and recovery times.
    b. Use HASTUS, especially MinBus, to maximum advantage allowing interlining and trip-shifting while respecting timed transfers.
5. Update Operating Contract parameters – introduce multiple unit cost drivers that better represent real costs in terms of hours and miles and fixed versus variable. Suggested for consideration are: variable cost per revenue hour, variable cost per revenue mile, and fixed administration/facility overhead.

Glossary of Terms

Blocking: The process of determining the sequence of trips a vehicle will make in the course of one day.

Booking: A new operating period with updated service schedules, vehicle blocks, and operator runs. Also known as a sign-up, bid, pick, or shake-up.

Cycle Time: The amount of time it takes a bus to get back to its starting location. This includes outbound and inbound trip running times and any recovery time taken before the start of the next trip.

Deadhead: This is be measured in hours and miles and refers to the time or distance a vehicle is in motion but not in passenger service. Usually deadhead occurs when a bus is traveling between the garage/dispatching facility and the start or end of the route, but also includes time and distance out-of-service between routes during an interline. Deadhead adds costs but does not generate revenue since passengers are not carried during this time. Therefore, efforts should be made to minimize deadhead where feasible.

HASTUS Parameters: HASTUS parameters can be split into hard and soft parameters. Hard parameters are parameters in the scheduling process that must be met due to contractual or physical constraints, such as a maximum number of hours for a work shift, or actual travel time to operate a particular route. Soft parameters are ideal features of a schedule that would improve the quality of the schedule but are not absolutely necessary. A soft parameter example is in MinBus where an interline is only considered where it will save a vehicle. These parameters vary by system and situation.

Interlining: Interlining improves resource efficiency by allowing one vehicle to operate multiple routes without going back to the garage. Typically, a vehicle finishing one route will continue on a different route either from the same or nearby terminal. This provides opportunities to improve efficiency by optimizing operator time and reducing vehicle requirements.

Peak to Base Ratio: This refers to the ratio of vehicles in service during peak hours compared to the vehicles in service during off-peak (base) hours.

Platform Hours: The total time a vehicle is on the road. This includes deadhead, running, and recovery (layover) time.

Recovery (Layover) Time: A short period of time taken at the end of the route for vehicle operators to take a rest break (operator layover) and to provide a time “cushion” to ensure that the next trip leaves on-time (schedule recovery). Confusion over who “owns” this end-of-line time (the operator or the schedule) is a contributor to lower OTP.

Revenue Hours: The time a vehicle is in passenger service. This includes running time and recovery time, but does not include deadhead time.

Run Cut: A run is the schedule of trips that an operator drives in one day. The runcutting process takes the blocks assigned to vehicles and cuts them into daily assignments, i.e.”runs” for vehicle operators.

Runs usually are divided into two categories: “Straight” Runs (one continuous shift) or “Split” Runs (a shift is split over multiple periods of time separated by a break where the operator does not work).

Running Time: The time it takes a vehicle to operate each one-way trip. This usually varies by time of day and day of week due to changing roadway traffic and passenger loading conditions. Running time is also known as “in-service” time and does not include layover/recovery or deadhead time.

SE Valley Estimated Recommended Network Weekday Operating Resources

Route	Service Improvements (blue highlighting indicates a change from the unconstrained recommendations)	Weekday Existing			Weekday Proposed - Unconstrained			Weekday Proposed - Cost-Neutral		
		Revenue Hours	Revenue Miles	Peak Buses	Revenue Hours	Revenue Miles	Peak Buses	Revenue Hours	Revenue Miles	Peak Buses
Route 30 - University Ave	Added 15-minute frequency from 52nd to Gilbert in peaks	146	1,942	8	178	2,291	12	150	1,930	12
Route 40 - Main St	Discontinued service east of Gilbert Rd	83	956	5	35	415	2	35	415	2
Route 45 - Broadway Ave	Shortened to PowerRd, shortline frequency 15 min in peaks	189	2,273	13	218	2,677	14	173	2,088	14
Route 48 - 52nd St	Streamlined to 5th St, interline efficiency with 62	52	579	3	39	454	2	35	407	2
Route 56 - Priest Dr	Shortened to Washington St, added service on 48th St	92	1,161	7	112	1,399	7	112	1,399	7
Route 61 - Southern Ave	Added 15-minute frequency midday	219	2,745	14	296	3,788	19	296	3,788	19
Route 62 - Hardy Dr	Shortened to Baseline, interline efficiency with 48	74	932	4	39	454	2	35	407	2
Route 65 - Kyrene Rd	No changes	51	587	3	54	598	3	54	598	3
Route 66 - Kyrene Rd	No changes	54	697	3	55	700	3	55	700	3
Route 72 - Rural Rd	No changes	227	2,966	13	267	3,547	18	227	2,984	14
Route 77 - Baseline Rd	Extended service to Gilbert Rd, 15-minutes peaks	107	1,516	6	244	3,534	16	194	2,816	16
Route 81 - McClintock Dr	15-minute frequency peaks, scheduling efficiency	159	2,142	11	151	2,206	9	137	2,003	9
Route 96 - Dobson Rd	Shortened to Chandler, 15-min in peaks to Elliot, interline with 104	90	1,065	8	96	1,114	6	80	927	6
Route 104 - Alma School Rd	15-minute frequency to Elliot in peaks, interline efficiency with 96	65	834	5	105	1,207	6	86	1,004	6
Route 108 - Elliot Rd	Discontinued service east of Gilbert Rd	106	1,678	6	54	759	3	52	715	3
Route 110 - Guadalupe Rd	New service on Guadalupe Rd between Price and Gilbert	0	0	0	54	759	3	52	715	3
Route 112 - Arizona Ave	Consolidated with Arizona LINK	69	773	5	0	0	0	0	0	0
Route 120 - Mesa Dr	30-minute frequency all day, interline efficiency with 128	24	214	2	58	702	4	28	339	2
Route 128 - Stapley Dr	30-minute frequency all day, interline efficiency with 120	26	289	2	58	702	4	28	339	2
Route 136 - Gilbert Rd	15-minutes Main St to Elliot Rd in peaks, discontinued Boeing service	62	887	5	69	1,004	5	57	781	5
Route 156 - Chandler Blvd	Removed hospital deviation, interline efficiency	92	1,405	6	72	1,096	5	68	1,025	5
Route 184 - Power Rd	30-minute frequency all day, interline efficiency	75	1,085	6	55	826	4	51	773	4
Main LINK	12-minute frequency all day, no service west of Gilbert Rd	84	1,183	6	109	1,512	6	104	1,436	6
Arizona LINK	15-minute frequency all day using resources from 112	57	734	4	113	1,562	7	110	1,513	7
Route 520	Discontinued service	4	78	2	0	0	0	0	0	0
Route 521	Discontinued service	7	144	4	0	0	0	0	0	0
Route 522	Discontinued service	7	167	4	0	0	0	0	0	0
Route 531	No changes	13	308	5	13	308	5	13	308	5
Route 533	Added two trips	12	347	4	14	402	4	14	402	4
Route 535	No changes	10	280	4	10	280	4	10	280	4
Route 541	No changes	9	213	4	9	213	4	9	213	4
Route 542	No changes	12	334	6	12	334	6	12	334	6
Service Day Total		**2,275**	**30,510**	**178**	**2,587**	**34,843**	**183**	**2,275**	**30,637**	**175**
		Percent Increase in Resources			**14%**	**14%**	**3%**	**0%**	**0%**	**-2%**

APPENDIX B: PLANNING LEVEL COST ESTIMATES

APPROACH TO ESTIMATING COST OF RECOMMENDATIONS

The recommendations presented in the Optimization, Mid-Term, and Long-Term timeframes (Tables 1, 2, and 3 in the main report) represent a "pick-list" of improvement ideas from which elements can be selected to support development of the future transit programs. These recommendations are but one of several sources to inform that process.

Appendix B focuses on planning level operating costs for transit services recommended for the Mid-Term and Long-Term planning horizons in Tables 2 and 3 from the main final report. Revenue miles of weekday transit service by service type are used as the representative measure of operating cost to compare to existing service levels in the Southeast Valley. Capital cost in terms of peak fleet requirements is also represented for new services in the Mid- and Long-Terms, but not for enhancements to existing services. This approach is an adjustment to the method originally outlined and is deemed sufficient for the high level set of recommendations. This approach was also presented in the final PAC meeting. Services based on revenue hours instead of revenue miles were converted to equivalent revenue miles. The revenue miles accounted for in this Appendix are for possible future services that are not funded in the RTP for the corresponding timeframe. The Southeast Valley currently has about 30,000 weekday revenue-miles of local and limited-stop bus services which provides a point of reference. The Southeast Valley also has a substantial paratransit service.

Additional Revenue-Miles of Service for Mid-Term Recommendations

Table B-1 shows the estimated additional weekday revenue miles of transit service for the Mid-Term Recommendations described in the report and listed in Table 2. A key assumption for these calculations is that the recommendations in the Optimization of Existing Transit Services (Table 1 in the main report) provide the starting point for Mid-Term recommendations. Thus, if a service frequency improvement is recommended in the Optimization, then the Mid-Term assumes that improvement is in place and builds on that improvement for the Mid Term as appropriate. Furthermore the revenue miles are only accounted for if they are not paid for in the RTP for 2026. Table B-1 shows added revenue-miles of just over 5,000 weekday revenue miles. This value is just under 20% above the existing 30,000 revenue miles of bus service in the Southeast Valley. The focus should be on the magnitude of the rollup of the total added revenue miles and less on the individual items. That increase is not out of scale with projected increases in population and employment by 2026.

Additional Revenue-Miles of Service for Long-Term Recommendations

Table B-2 shows the estimated additional weekday revenue miles for the Long-Term Recommendations presented in the final report and summarized in Table 3. Table B-2 shows an increase on the order of 6,000 revenue miles not covered by the RTP. The Long-Term Recommendations build on the results of the Mid Term Recommendations. Those increases are not out of scale with projected increases in population and employment by 2035. (Refer to the Needs Assessment section.)

Capital Cost Requirements for Vehicles

Bus transit services are dominated by operating and maintenance (O/M) costs. Capital costs are a much smaller component of local bus transit when compared to high capacity transit. If the O/M funding cannot be identified for local bus transit then there is little need to identify capital costs. (Note that capital/infrastructure costs for bus can be more significant for services such as BRT – e.g. LINK type service – if built to LINK design criteria.)

Listed below are the in service peak fleet requirements for Mid- and Long-Term recommendations for new services only (not enhancements to existing services) that are not otherwise funded in their respective RTP timeframe. Fleet requirements for expanding existing services would be in addition to the numbers shown below.

1. **Mid-Term 29 total buses**

a.	5 cutaways (flex services)	$0.4 million
b.	14 circulators	$2.3 million
c.	10 transit (local or express)	$6.0 million
	29 Total	$8.7 million

2. **Long-Term 38 total buses**

a.	14 circulators	$2.3 million
b.	24 transit	$14.4 million
	38 Total	$16.7 million

Estimating full fleet requirements for the Mid- and Long-terms would involve putting to rest the optimization concepts, converting this pick-list approach to a set of integrated transit plans and comparing those plans to the RTP service plan in the respective timeframe. Fleet replacement cycles would also need to be incorporated. Fleet requirements can better be estimated as ideas from the pick-lists are advanced into the transit programming process.

Table B-1: Additional Weekday Revenue Miles of Bus Service for Mid-Term Recommendations (Table 2) That Are Not Funded in RTP

Item	sub item	Route	Recommendation	element added weekday rev-miles	total item net added rev-miles	service type	included in fleet estimate	Remarks
1	-	LINK	all	0	0	local/ltd		Resources reallocated. No additional resources needed.
2	a	Rte 30 - University	Deviate to Gilbert LRT	0	0			Done in Optimization so no new resources mid-term.
	b		Extend to Ellsworth	144	144	local/ltd		Net additional rev-miles above Optimization and RTP funding.
3	a	Rte 45 Broadway	Trade Syc LRT for Gilbert LRT	0				No net change to swap deviation to LRT.
	b		To 15 freq all day to Gilbert Rd	424	424	local/ltd		Net additional rev-miles above Optimization. No RTP funding.
4	a	New Zoo/SkySong service	Examine potential for circulator.	240	240	circulator	y	New Zoo/SkySong circulator. No RTP funding.
5	-	Rte 77 Baseline	Extend to Power Rd	240	240	local/ltd		15 min to Gilbert then 30 to Power. Some RTP funding. Net above RTP.
6	-	Rte 81 Hayden/McClintock	Explore deviation to ASU Research Park	0	0			Optimization anchors short pattern to ASU. Long pattern already skips ASU.
7	-	Rte 96 Dobson	Explore alt services s/o Fairview:					
	a		If eliminate #96 s/o Fairview	-198		local/ltd		Rev miles reduced if segment eliminated.
	b		New flex svce s/o Fairview	170	-28	circulator	y	Flex service replaces dropped #96 s/o Fairview.
8	-	Rte 104 Alma School	Monitor boardings to downtown Chandler.					
	a		Explore elim downtown Chandler segment	-100		local/ltd		If eliminated.
	b		Replace with alt service.	170	70	circulator	y	Added one flex service route.
9	a1	Rte 108 Elliot	Explore alt service for Sunland Village:	-6		local/ltd		
	a2		Replace with alt service.	170		circulator	y	Replaces Sunland deviation.
	b		Explore elim of ASU Research Pk - no replacemer	-57	107	local/ltd		
10		Rte 120 Mesa Dr	Extend north to McKellips	88				
			Extend south to Chandler	45	133			RTP covers part of this service.
11	a1	Rte 136 Gilbert Rd	Explore elim of Boeing segment.	-196		local/ltd		Only selected trips serve Boeing.
	a2		Explore replace Boeing with alt service.	170		circulator	y	Added one flex service route.
	b		Explore elim of Civic Ctr deviation	-36	-62	local/ltd		If deviation eliminated.
12		Rte 156 Chandler Blvd	To 15 min 48th St to Gilbert Rd	264				
			Explore elim of Gilbert Mercy Hosp segment.	-186		local/ltd		Not affected by 15 min above.
			Replace with alt service.	170	248	circ	y	Added on flex route
13		Rte 184 Power Rd	To 15 min all day McDowell to Super Spgs TC	312	312	local/ltd		
14		New Rte Ray Rd	30 min 48th St to Gilbert Rd	704	704	local/ltd	y	
15		Added Exp 533 Mesa	Add one AM/PM trip Mesa Exp	58	58	express	y	Added one trip each peak period.
16		Added Exp 542 Chandler	Add one AM/PM trip Chandler	54	54	express	y	Added one trip each peak period.
17		New Queen Creek Exp	New QC express	320	320	express	y	4 trips each peak period.
18		New pilot flex Apache Jct	New service to Apache Junction	336	336	circulator	y	AJ to Gilbert Rd LRT.
19		Alt services Van, TDM	Various locations	0	0	TDM		No added cost at our level of analysis
20		New service S Tempe	Added service S Tempe	120	120	local/ltd		Add peak period limited service from S Tempe to dt Tempe
21		New circulator Apache Jct	initial circulator AJ	480	480	circ	y	
22		New circulator San Tan		480	480	circ	y	
23		New circulators GRIC		0	0	circ		New D3 and D6/D7 circulators implemented Summer 2015. No add'l O/M.
24		Circ rte 96 s/o Fairview		0	0	circ		see Rte 96 above
25		Pinal County connector	From Florence	960	960	reg'l	y	See Pinal County study - Reg'l rte R4.
					5,340			

Note: fleet estimated only for new isolated services.
Note: "s/o" = south of

Table B-2: Additional Weekday Revenue Miles of Service for Long Term Recommendations (Table 3) That Are Not Funded in RTP

Item	sub item	Route	Recommendation	element added weekday rev-miles	total item net added rev-miles	service type	included in fleet estimate	Remarks
1		Rte 56 - Priest	Extend along Priest (56th St) and 48th St to Chandler Blvd	0		local/ltd		RTP intended to cover.
2		Rte 61 - Southern	Extend east to Ellsworth.	0		local/ltd		RTP intended to cover.
3		new Guadelupe service	Extend to Power Rd	804	804	local/ltd	y	Start at end of 62 Hardy/Guadelupe route
4		Rte 72 Rural/Scottsdale	Improve to 10 min freq	216	216	local/ltd		Tempe TC to Baseline
5		Rte 156 Chandler/ Williams Field Rd	Improve freq to 15 min all day	552	552	local/ltd		48th to Power (15 min to Gilbert)
6		Rte 184 - Power	Increase freq to 15 min all day	300	300	local/ltd		To 15 min all day Superstition Spgs TC to ASU/Poly
7		New Warner Rd	30 min 48th St to Gilbert Rd	0		local/ltd		RTP intended to cover.
8		New McKellips Rd	30 min service	704	704	local/ltd	y	LRT at Center/Main to Power/McKellips
9		New Queen Ck Rd	30 min service	0	0	local/ltd		RTP intended to cover.
10	a	New Lindsay Rd	30 min service	0		local/ltd		RTP intended to cover.
	b	New Higley Rd	30 min service	704		local/ltd	y	McDowell to Williams Field Rd
	c	New Val Vista	30 min service	0		local/ltd		RTP intended to cover.
	d	New Greenfield Rd	30 min service	832	1,536	local/ltd	y	McKellips to Baseline to Val Vista to Gilbert Mercy Med Ctr
11		New rural route	Coolidge to 40th/Pecos via GRIC	400	400	circulator	y	Coolidge to I-10 thru GRIC to 40th St/Pecos
12		New express AJ		240		express	y	
		New express QC		0		express		Accounted for in Mid-Term
		New express Maricopa		264	504	express	y	
13		New fixed routes	Maricopa	360		circulator	y	
			Apache Junction	480		circulator	y	
			GRIC Connectors	410	1,250	circulator	y	Implement GRIC connectors - converted to equivalent rev miles
					6,266			

Note: fleet estimated only for new isolated services.

MARICOPA ASSOCIATION of GOVERNMENTS

VALLEY METRO