MARICOPA ASSOCIATION of GOVERNMENTS

# 2018 REGIONAL COMMUTER RAIL SYSTEM STUDY UPDATE

Maricopa Association of Governments | May 2018

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# REGIONAL COMMUTER RAIL SYSTEM STUDY UPDATE

## Appendix A: Methodology for Cost Estimating

**May 2018**

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# 1.0 METHODOLOGY FOR COST ESTIMATING

## 1.1 Purpose

The purpose of this document is to present the methodology that will be used to estimate the capital and the annual operating and maintenance (O&M) costs for the MAG System Study Update commuter rail corridors. The cost estimates will follow the methodology discussed below to the maximum extent practical given that no conceptual engineering has been completed to date. Where no detail for cost estimating is available, unit costs on a major level such as route track mile, complete station, or other lump sum will be utilized.

## 1.2 General

The cost estimates for the MAG System Study Update are based upon:

- Conceptual level design or less.
- Recent costs experienced or estimated for the commuter rail and freight railroad industries.
- Costs experienced on recent commuter rail projects.
- Unit costs obtained from major vendors, as appropriate.
- Federal funding sources and will follow Federal Transit Administration and Federal Highway Administration procedures.

In addition, the following will be included with the cost estimates:

- A comprehensive list of assumptions and all supporting documents supporting line item costs.
- A rational indicating the justification for contingencies to be applied to each line item of work.
- Overall project cost as well as project reserve.

## 1.3 Cost Estimate Format

The format of the capital cost estimates will include:

- Line item description for units of work by procurement/construction cost category.
- Unit of Measure.
- Number of units.
- Cost per Unit.
- Subtotal cost per cost category.
- Total cost for all procurement/construction cost categories.
- Line item description for cost categories based upon a percentage of procurement/construction costs.
- Total procurement/construction and other costs before add-on/contingency costs.

- Cost of future planning, preliminary design, final design, construction, construction management, agency force account, commissioning etc., that will result in a complete operating commuter rail system.
- Contingency on Line Item Sub Total (and or each line item).
- Project Reserve (over and above Contingency).
- Grand Total per Corridor.

## 1.4 Capital Cost Estimates

Sources for the costs include articles printed in the railroad industry press, bid costs, project cost estimates, Class 1 railroad projects in the Western United States, private industry projects, railroad typical “rule of thumb” costs (Class 1 railroads and regional and shortline railroads), and any other valid sources with railroad cost data. In some instances, where costs are a few years old, the costs are inflated to current year costs. It must be noted that many of our projects are “confidential” and the specifics of a cost estimate are not available for use on a different project or for distribution.

Because costs are expressed in many different formats, the capital cost data will be converted to the most common factors available. For example, bridge costs are expressed in cost per square foot or cost per linear foot. Often, the length of a bridge is stated, but the square footage is not. Often, the cost per mile of a project can be calculated because only the total length and cost are stated. The average cost per mile of a project is useful as a “sanity check” on costs that are estimated during the early phases of a project.

When developing cost estimates for a project, it is important to understand the difference between a current project and other projects. For example, track construction for a freight railroad that will need to accommodate many 135-car, 16,000 ton unit trains on a daily basis should cost more than track designed to accommodate a few freight trains and several commuter rail trains on a daily basis. Commuter rail costs differ as route characteristics, design, stations, service levels, and all of the other elements of a corridor or system differ. Knowledge of the differences is just as important as knowledge of the similarities when developing estimated costs.

Capital Cost estimates are shown in Attachment A.

## 1.5 O&M Cost Estimates

The O&M cost estimates will be based upon the operating plans and current costs for current U.S. commuter rail operations. The O&M cost estimates include a variety of factors, including all labor costs associated with the transportation, vehicle maintenance, fixed plant maintenance, security, administration, and support functions necessary for the operation of the transit service. Non-labor expenses include all supplies, parts, materials, vendor contracts, rentals and leases, insurance, user fees, utilities, and various expendables and other appropriate expenses required to properly and safely operate, inspect, service, maintain, repair, overhaul, market, and support the transit system. It is assumed that the annual costs associated with operations and vehicle maintenance would be similar in amount whether performed either by the commuter rail authority or under a separate contract.

The O&M costs will be estimated from the annual revenue vehicle miles operated for the proposed service schedules. Annual revenue vehicle miles will be calculated based upon the

length and number of one-way trips required to operate each hour of each period of service at the specified headway with the specified consist length. For example, an hour of service at a 30-minute headway in each direction with a single vehicle consist over a 10-mile route would result in four one-way trips times 10 miles times one vehicle or 40 revenue vehicle miles. The annual revenue miles include consideration for the number of days per year during which weekday, weekend, holiday, and special service are operated. The annual revenue vehicle miles will then be multiplied by the average cost per annual revenue vehicle mile for the type of equipment and service being operated.

The average cost per revenue vehicle mile is available for several U. S. commuter rail systems currently in operation. These systems all utilize locomotive hauled consists that are operated in push-pull fashion. Push-pull operations have a locomotive pulling the train in one direction and pushing the train in the opposite direction. In the push mode, the train crew operates the train from a cab in the leading car of the train. For the purpose of estimating the annual O&M costs, the average cost per revenue vehicle mile will be based upon the average cost per revenue vehicle mile for the commuter rail systems contained in the National Transit Database.

The annual O&M costs and the commuter rail systems used for the development of the O&M cost estimates were costs for 2016 as contained in the 2016 National Transit Database. The commuter rail systems used included Utah's FrontRunner, New Mexico's Railrunner, Seattle's Sounder, Minnesota's NorthStar, Florida's Tri-Rail, Dallas/Fort Worth's Trinity Railway Express (TRE), San Diego's Coaster, Nashville's Music City Star, and the Stockton/San Jose Altamont Corridor Express (ACE) for LHC vehicle technology. The cost per vehicle revenue mile for these systems ranges from $8.37 to $30.99, or an average of $20.93 for these eight systems. The cost per revenue hour for these eight systems ranged between $289.71 and $1,222.41 with the average being $683.54. The average cost per vehicle revenue mile and hour for all commuter rail systems contained in the 2016 NTD is $17.28 and $545.65, respectively.

The National Transit Database classifies the systems that use the new DMU vehicles as Hybrid Rail. The hybrid rail systems used to develop O&M costs included Denton County's A Line, Austin's MetroRail, San Diego's Sprinter, Portland's Westside Express Service (WES), and New Jersey's River LINE. The cost per vehicle revenue mile for these systems ranges from $19.79 to $77.34, or an average of $38.72 for these five systems. The cost per revenue hour for these five systems ranged between $487.93 and $1,840.81 with the average being $901.54. The average cost per vehicle revenue mile and hour for all commuter rail systems contained in the 2016 NTD is $29.72 and $708.97, respectively.

Operating Cost estimates are shown in Attachment B.

# 2.0 ASSUMPTIONS AND BASIS OF ESTIMATE

The cost estimate for the MAG Commuter Rail Study was generally based upon the following assumptions:

## 2.1 General

- Costs are based on quantities estimated from the project drawings at the conceptual level design or less. **These drawings have not been updated since the 2010 Study, but have been re-examined to ensure that the track plans allow for the level of service proposed for both passenger and freight operations.**

- Costs are presented in 2017 US Dollars.
- Escalation to year of expenditure dollars is not included.
- Total cost for each segment of the study include estimates for construction of guideway, ballasted track, special trackwork, improvements to at-grade rail/highway crossings, stations, park-n-rides, terminals, support facilities, utility relocations, related street and highway modifications, ROW acquisition, vehicle purchase, soft costs, contingencies and an allowance for project reserve.
- The cost for the System Study Update includes the construction of the corridor from Union Station to each end-of-line station. Costs were derived for each of the four corridors but are presented as two cross-region corridors.
- The Union Pacific Railroad and BNSF Railway have not reviewed the conceptual design and the costs of their requirements may not be included in the estimate.

# 3.0 ATTACHMENT A: CAPITAL COST ESTIMATES

**MAG System Study Update 2018**

| Cost Category | Quantity | Unit | Unit Cost | Total Cost | Remarks |
|---|---|---|---|---|---|
| | | | | **Grand Line Corridor** | |
| | | | | **36.4 Route Miles** | |
| Earthwork, Basic Roadbed, Single Track | 10.0 | Mile | $500,000 | $5,000,000 | |
| Earthwork, Basic Roadbed, Double Track | 26.4 | Mile | $1,000,000 | $26,400,000 | |
| At-Grade Class 3 Track, Single Track, 60 mph | | Mile | $1,500,000 | $0 | 141# Rail, Concrete Ties |
| At-Grade Class 3 Track, Double Track, 60 mph | | Mile | $2,600,000 | $0 | 141# Rail, Concrete Ties |
| At-Grade Class 4 Track, Single Track, 80 mph | 10.0 | Mile | $1,750,000 | $17,500,000 | 141# Rail, Concrete Ties |
| At-Grade Class 4 Track, Double Track, 80 mph | 26.4 | Mile | $2,900,000 | $76,560,000 | 141# Rail, Concrete Ties |
| At-Grade Class 6 Track, Double Track, 110 mph | | Mile | $5,500,000 | $0 | 141# Rail, Concrete Ties |
| At-Grade Class 7 Track, Double Track, 125 mph | | Mile | $10,000,000 | $0 | 141# Rail, Concrete Ties |
| Elevated Guideway, Double Trk, Direct Fixation | | Mile | $40,000,000 | $0 | Conc, 27' - 30' clearance |
| Elevated Guideway, Double Trk, Direct Fixation | | Mile | $80,000,000 | $0 | Conc, over 30' clearance |
| Crossover, Universal, #20 | 48 | Each | $1,400,000 | $67,200,000 | |
| Crossover, Universal, #24 | | Each | $1,800,000 | $0 | |
| Crossover, Universal, #32 or higher speed | | Each | $2,400,000 | $0 | |
| Bridge, Single Track, 20' to 200' | | Each | $900,000 | $0 | Concrete or Steel |
| Bridge, Single Track, 201' to 300' | | Each | $2,250,000 | $0 | Concrete or Steel |
| Bridge, Single Track, 301' to 500' | | Each | $3,600,000 | $0 | Concrete or Steel |
| Bridge, Single Track, Other Length | | LF | $9,000 | $0 | Concrete or Steel |
| Bridge, Double Track, 20' to 200' | | Each | $1,600,000 | $0 | Concrete or Steel |
| Bridge, Double Track, 201' to 300' | | Each | $4,000,000 | $0 | Concrete or Steel |
| Bridge, Double Track, 301' to 500' | | Each | $6,400,000 | $0 | Concrete or Steel |
| Bridge, Double Track, Other Length | | LF | $16,000 | $0 | Concrete or Steel |
| At-Grade Crossing w/gates, medians, etc | 43 | Each | $500,000 | $21,500,000 | |
| Automatic Train Control Signal Sys, Single Track | 10.0 | Mile | $2,000,000 | $20,000,000 | Incl cab signaling |
| Automatic Train Control Signal Sys, Double Track | 26.4 | Mile | $3,600,000 | $95,040,000 | Incl cab signaling |
| Communications System | 36.4 | Mile | $500,000 | $18,200,000 | Incl Dispatch Center |
| Reconfiguration of Existing Railroad Facilities | | | | | |
| Railroad Track | | Mile | $1,200,000 | $0 | |
| Industrial Track | 10 | Each | $1,000,000 | $10,000,000 | Assume ten each corridor |
| Other Railroad Facilities | | LS | $5,000,000 | $0 | |
| Terminal Layover/Turnback Facility | 1 | Each | $5,000,000 | $5,000,000 | |
| Local Station | 6.5 | Each | $5,000,000 | $32,500,000 | Shared State Capitol Station |
| **Segment Subtotal** | | | | **$394,900,000** | |

All Unit Costs are in 2012 USD, escalated to 2017 USD, below. ROW excluded.

**MAG System Study Update 2018**

| | | | | Estrella Line Corridor | |
|---|---|---|---|---|---|
| | | | | 30.4 | Route Miles |
| **Cost Category** | **Quantity** | **Unit** | **Unit Cost** | **Total Cost** | **Remarks** |
| Earthwork, Basic Roadbed, Single Track | 20.5 | Mile | $500,000 | $10,250,000 | |
| Earthwork, Basic Roadbed, Double Track | 9.9 | Mile | $1,000,000 | $9,900,000 | |
| At-Grade Class 3 Track, Single Track, 60 mph | | Mile | $1,500,000 | $0 | 141# Rail, Concrete Ties |
| At-Grade Class 3 Track, Double Track, 60 mph | | Mile | $2,600,000 | $0 | 141# Rail, Concrete Ties |
| At-Grade Class 4 Track, Single Track, 80 mph | 20.5 | Mile | $1,750,000 | $35,875,000 | 141# Rail, Concrete Ties |
| At-Grade Class 4 Track, Double Track, 80 mph | 9.9 | Mile | $2,900,000 | $28,710,000 | 141# Rail, Concrete Ties |
| At-Grade Class 6 Track, Double Track, 110 mph | | Mile | $5,500,000 | $0 | 141# Rail, Concrete Ties |
| At-Grade Class 7 Track, Double Track, 125 mph | | Mile | $10,000,000 | $0 | 141# Rail, Concrete Ties |
| Elevated Guideway, Double Trk, Direct Fixation | | Mile | $40,000,000 | $0 | Conc, 27' - 30' clearance |
| Elevated Guideway, Double Trk, Direct Fixation | | Mile | $80,000,000 | $0 | Conc, over 30' clearance |
| Crossover, Universal, #20 | 0 | Each | $1,400,000 | $0 | **None shown in Figures** |
| Crossover, Universal, #24 | | Each | $1,800,000 | $0 | 4 turnouts |
| Crossover, Universal, #32 or higher speed | | Each | $2,400,000 | $0 | 4 turnouts |
| Bridge, Single Track, 20' to 200' | | Each | $900,000 | $0 | Concrete or Steel |
| Bridge, Single Track, 201' to 300' | | Each | $2,250,000 | $0 | Concrete or Steel |
| Bridge, Single Track, 301' to 500' | | Each | $3,600,000 | $0 | Concrete or Steel |
| Bridge, Single Track, Other Length | | LF | $9,000 | $0 | Concrete or Steel |
| Bridge, Double Track, 20' to 200' | | Each | $1,600,000 | $0 | Concrete or Steel |
| Bridge, Double Track, 201' to 300' | | Each | $4,000,000 | $0 | Concrete or Steel |
| Bridge, Double Track, 301' to 500' | | Each | $6,400,000 | $0 | Concrete or Steel |
| Bridge, Double Track, Other Length | | LF | $16,000 | $0 | Concrete or Steel |
| At-Grade Crossing w/gates, medians, etc | 34 | Each | $500,000 | $17,000,000 | |
| Automatic Train Control Signal Sys, Single Track | 20.5 | Mile | $2,000,000 | $41,000,000 | Incl cab signaling |
| Automatic Train Control Signal Sys, Double Track | 9.9 | Mile | $3,600,000 | $35,640,000 | Incl cab signaling |
| Communications System | 30.4 | Mile | $500,000 | $15,200,000 | Incl Dispatch Center |
| Reconfiguration of Existing Railroad Facilities | | | | | |
| Railroad Track | | Mile | $1,200,000 | $0 | |
| Industrial Track | 15 | Each | $1,000,000 | $15,000,000 | Assume 15 in this corridor |
| Other Railroad Facilities | | LS | $5,000,000 | $0 | |
| Terminal Layover/Turnback Facility | 1 | Each | $5,000,000 | $5,000,000 | |
| Local Station | 7.5 | Each | $5,000,000 | $37,500,000 | Shared State Capitol Station |
| **Segment Subtotal** | | | | **$251,075,000** | |

All Unit Costs are in 2012 USD, escalated to 2017 USD, below. ROW excluded.

**MAG System Study Update 2018**

| Cost Category | Quantity | Unit | Unit Cost | Total Cost | Remarks |
|---|---|---|---|---|---|
| | | | | **Kyrene Line Corridor** | |
| | | | | **9.5** | **Route Miles (So. of Tempe Jct)** |
| Earthwork, Basic Roadbed, Single Track | 9.5 | Mile | $500,000 | $4,750,000 | |
| Earthwork, Basic Roadbed, Double Track | | Mile | $1,000,000 | $0 | |
| At-Grade Class 3 Track, Single Track, 60 mph | | Mile | $1,500,000 | $0 | 141# Rail, Concrete Ties |
| At-Grade Class 3 Track, Double Track, 60 mph | | Mile | $2,600,000 | $0 | 141# Rail, Concrete Ties |
| At-Grade Class 4 Track, Single Track, 80 mph | 9.5 | Mile | $1,750,000 | $16,625,000 | 141# Rail, Concrete Ties |
| At-Grade Class 4 Track, Double Track, 80 mph | | Mile | $2,900,000 | $0 | 141# Rail, Concrete Ties |
| At-Grade Class 6 Track, Double Track, 110 mph | | Mile | $5,500,000 | $0 | 141# Rail, Concrete Ties |
| At-Grade Class 7 Track, Double Track, 125 mph | | Mile | $10,000,000 | $0 | 141# Rail, Concrete Ties |
| Elevated Guideway, Double Trk, Direct Fixation | | Mile | $40,000,000 | $0 | Conc, 27' - 30' clearance |
| Elevated Guideway, Double Trk, Direct Fixation | | Mile | $80,000,000 | $0 | Conc, over 30' clearance |
| Crossover, Universal, #20 | 22 | Each | $1,400,000 | $30,800,000 | |
| Crossover, Universal, #24 | | Each | $1,800,000 | $0 | |
| Crossover, Universal, #32 or higher speed | | Each | $2,400,000 | $0 | |
| Bridge, Single Track, 20' to 200' | 1 | Each | $900,000 | $900,000 | Over Superstition Fwy. |
| Bridge, Single Track, 201' to 300' | | Each | $2,250,000 | $0 | Concrete or Steel |
| Bridge, Single Track, 301' to 500' | | Each | $3,600,000 | $0 | Concrete or Steel |
| Bridge, Single Track, Other Length (2000') | 2000 | LF | $9,000 | $18,000,000 | Bridge over I-10 |
| Bridge, Double Track, 20' to 200' | | Each | $1,600,000 | $0 | Concrete or Steel |
| Bridge, Double Track, 201' to 300' | | Each | $4,000,000 | $0 | Concrete or Steel |
| Bridge, Double Track, 301' to 500' | | Each | $6,400,000 | $0 | Concrete or Steel |
| Bridge, Double Track, Other Length | | LF | $16,000 | $0 | Concrete or Steel |
| At-Grade Crossing w/gates, medians, etc | 16 | Each | $500,000 | $8,000,000 | |
| Automatic Train Control Signal Sys, Single Track | 9.5 | Mile | $2,000,000 | $19,000,000 | Incl cab signaling |
| Automatic Train Control Signal Sys, Double Track | | Mile | $3,600,000 | $0 | Incl cab signaling |
| Communications System | 9.5 | Mile | $500,000 | $4,750,000 | Incl Dispatch Center |
| Reconfiguration of Existing Railroad Facilities | | | | | |
| Railroad Track | | Mile | $1,200,000 | $0 | |
| Industrial Track | 10 | Each | $1,000,000 | $10,000,000 | Assume ten each corridor |
| Other Railroad Facilities | | LS | $5,000,000 | $0 | |
| Terminal Layover/Turnback Facility | 1 | Each | $5,000,000 | $5,000,000 | |
| Local Station | 5 | Each | $5,000,000 | $25,000,000 | Shared Sky Harbor and Tempe |
| **Segment Subtotal** | | | | **$142,825,000** | |

All Unit Costs are in 2012 USD, escalated to 2017 USD, below. ROW excluded.

**MAG System Study Update 2018**

| | | | | San Tan Line Corridor | |
|---|---|---|---|---|---|
| | | | | 41.2 | Route Miles |
| **Cost Category** | **Quantity** | **Unit** | **Unit Cost** | **Total Cost** | **Remarks** |
| Earthwork, Basic Roadbed, Single Track | 30.3 | Mile | $500,000 | $15,150,000 | |
| Earthwork, Basic Roadbed, Double Track | 10.9 | Mile | $1,000,000 | $10,900,000 | |
| At-Grade Class 3 Track, Single Track, 60 mph | 1.5 | Mile | $1,500,000 | $2,250,000 | 141# Rail, Concrete Ties |
| At-Grade Class 3 Track, Double Track, 60 mph | 2.9 | Mile | $2,600,000 | $7,540,000 | 141# Rail, Concrete Ties |
| At-Grade Class 4 Track, Single Track, 80 mph | 28.8 | Mile | $1,750,000 | $50,400,000 | 141# Rail, Concrete Ties |
| At-Grade Class 4 Track, Double Track, 80 mph | 8.0 | Mile | $2,900,000 | $23,200,000 | 141# Rail, Concrete Ties |
| At-Grade Class 6 Track, Double Track, 110 mph | | Mile | $5,500,000 | $0 | 141# Rail, Concrete Ties |
| At-Grade Class 7 Track, Double Track, 125 mph | | Mile | $10,000,000 | $0 | 141# Rail, Concrete Ties |
| Elevated Guideway, Double Trk, Direct Fixation | | Mile | $40,000,000 | $0 | Conc, 27' - 30' clearance |
| Elevated Guideway, Double Trk, Direct Fixation | | Mile | $80,000,000 | $0 | Conc, over 30' clearance |
| Crossover, Universal, #20 | 37 | Each | $1,400,000 | $51,800,000 | Upgrade Phase A |
| Crossover, Universal, #24 | | Each | $1,800,000 | $0 | |
| Crossover, Universal, #32 or higher speed | | Each | $2,400,000 | $0 | |
| Bridge, Single Track, 20' to 200' | | Each | $900,000 | $0 | Concrete or Steel |
| Bridge, Single Track, 201' to 300' | | Each | $2,250,000 | $0 | Concrete or Steel |
| Bridge, Single Track, 301' to 500' | | Each | $3,600,000 | $0 | Concrete or Steel |
| Bridge, Single Track, Other Length (1500') | 1500 | LF | $9,000 | $13,500,000 | Over Salt River |
| Bridge, Double Track, 20' to 200' | | Each | $1,600,000 | $0 | Concrete or Steel |
| Bridge, Double Track, 201' to 300' | | Each | $4,000,000 | $0 | Concrete or Steel |
| Bridge, Double Track, 301' to 500' | | Each | $6,400,000 | $0 | Concrete or Steel |
| Bridge, Double Track, Other Length | | LF | $16,000 | $0 | Concrete or Steel |
| At-Grade Crossing w/gates, medians, etc | 48 | Each | $500,000 | $24,000,000 | |
| Automatic Train Control Signal Sys, Single Track | 30.3 | Mile | $2,000,000 | $60,600,000 | Incl cab signaling |
| Automatic Train Control Signal Sys, Double Track | 10.9 | Mile | $3,600,000 | $39,240,000 | Incl cab signaling |
| Communications System | 41.2 | Mile | $500,000 | $20,600,000 | Incl Dispatch Center |
| Reconfiguration of Existing Railroad Facilities | | | | | |
| Railroad Track | | Mile | $1,200,000 | $0 | |
| Industrial Track | 10 | Each | $1,000,000 | $10,000,000 | Assume ten each corridor |
| Other Railroad Facilities | | LS | $5,000,000 | $0 | |
| Terminal Layover/Turnback Facility | 1 | Each | $5,000,000 | $5,000,000 | |
| Local Station | 6 | Each | $5,000,000 | $30,000,000 | Shared Sky Harbor and Tempe |
| **Segment Subtotal** | | | | **$364,180,000** | |

All Unit Costs are in 2012 USD, escalated to 2017 USD, below. ROW excluded.

**MAG System Study Update 2018**

| Cost Category | Quantity | Unit | Unit Cost | SYSTEMWIDE ELEMENTS<br>117.5 Total Route Miles<br>Total Cost | Remarks |
|---|---|---|---|---|---|
| **GRAND/KYRENE LINE SUBTOTAL** | | | | **$537,725,000** | |
| Utilities Allowance | 0.03 | % Cnstn | $537,725,000 | $16,131,750 | |
| Environmental Mitigation Allowance | 0.05 | % Cnstn | $537,725,000 | $26,886,250 | |
| Urban Design, Signage, Landscaping Allowance | 0.03 | % Cnstn | $537,725,000 | $16,131,750 | |
| Professional Services | 0.30 | % Cnstn | $537,725,000 | $161,317,500 | |
| Contingency | 0.40 | | $537,725,000 | $215,090,000 | |
| Subtotal | | | | $435,557,250 | |
| GRAND/KYRENE LINE TOTAL | | | | $973,282,250 | in 2012 Dollars |
| **GRAND/KYRENE LINE TOTAL** | | | | **$1,074,582,248** | Escalated to 2017 Dollars |
| Average Cost per Mile | | | | $23,411,378 | Does not include Union Station, CRMF, or vehicles. |
| **ESTRELLA/SAN TAN LINE SUBTOTAL** | | | | **$615,255,000** | |
| Utilities Allowance | 0.03 | % Cnstn | $537,725,000 | $16,131,750 | |
| Environmental Mitigation Allowance | 0.05 | % Cnstn | $537,725,000 | $26,886,250 | |
| Urban Design, Signage, Landscaping Allowance | 0.03 | % Cnstn | $537,725,000 | $16,131,750 | |
| Professional Services | 0.30 | % Cnstn | $537,725,000 | $161,317,500 | |
| Contingency | 0.40 | | $537,725,000 | $215,090,000 | |
| Subtotal | | | | $435,557,250 | |
| ESTRELLA/SAN TAN LINE TOTAL | | | | $1,050,812,250 | in 2012 Dollars |
| **ESTRELLA/SAN TAN LINE TOTAL** | | | | **$1,160,181,633** | Escalated to 2017 Dollars |
| Average Cost per Mile | | | | $16,203,654 | Does not include Union Station, CRMF, or vehicles. |
| **SEGMENT TOTALS** | | | | **$2,234,763,881** | in 2017 Dollars |
| **SYSTEMWIDE ELEMENTS** | | | | | |
| Phoenix Union Station | 1 | Each | $75,000,000 | $75,000,000 | Assumes 2010 Study Cost |
| Servicing, Maintenance & Storage Facility | 45 | Vehicle | $1,700,000 | $76,500,000 | Five vehicles per trainset |
| **Subtotal Systemwide Elements** | | | | **$151,500,000** | |
| **TOTAL SEGMENTS & SYSTEMWIDE ELEMENTS** | | | | **$2,386,263,881** | |
| LHC Train set, 4-coach trains | 15 | Each | $9,000,000 | $135,000,000 | Both vehicle types include two operational, and one maintenance spare set |
| DMU Train set, (4-car train) (Assumes TEXRail veh) | 15 | Each | $12,000,000 | $180,000,000 | |
| **TOTAL SYSTEM WITH LHC VEHICLES** | | | | **$2,521,263,881** | |
| Average Cost per Mile | | | | $21,457,565 | |
| **TOTAL SYSTEM WITH DMU VEHICLES** | | | | **$2,566,263,881** | |
| Average Cost per Mile | | | | $21,840,544 | |

# 4.0 ATTACHMENT B: OPERATING COST ESTIMATES

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Project: | **MAG System Study Update 2018** | | | | | **Revised:** | **May 2018** |
| Corridor: | **Grand/Kyrene Line Corridor** | | | | | | |
| Technology: | **LHC Push-Pull** | | Peak Headway: | 30 | minutes | | |
| Route Miles: | 53.7 | | One-way Trip Time: | 73 | minutes | 1.50 | |
| Stations | 14 | | Turnback Time | 17 | minutes | | |
| 4-Car Trains | 7 | (incl 1 spare train) | | | | 255 | Weekdays/Year |
| | | | Fleet Size: Locomotive | 7 | | | |
| | | | Cab Car | 7 | | 55 | Sat.-Hol./Year |
| **ANNUAL OPERATING STATISTICS** | | | Coach | 21 | | | |

**Weekday Revenue Service:**

| Service Period | Duration (Hours) | Headway (Minutes) | One-way Trips | Vehicles/ Consist Incl Loco | Trains On-Line | Daily Train Miles | Daily Vehicle Miles | Annual Train Miles | Annual Vehicle Miles | Daily Train Hours | Annual Train Hours | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Transition | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| AM Peak | 2.5 | 30 | 12 | 5 | 6 | 644 | 3,222 | 164,322 | 821,610 | 30 | 7,650 | 5:00 am to 7:30 am |
| Mid-day | 6.0 | 120 | 6 | 5 | 2 | 322 | 1,611 | 82,161 | 410,805 | 12 | 3,060 | 9:30 am to 1:30 pm |
| PM Peak | 3.0 | 30 | 14 | 5 | 6 | 752 | 3,759 | 191,709 | 958,545 | 33 | 8,415 | 3:30 pm to 6:30 pm |
| Evening | 2.0 | 120 | 2 | 5 | 2 | 107 | 537 | 27,387 | 136,935 | 7 | 1,785 | 8:30 PM |
| Transition | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Subtotal | 13.5 | | 34 | | | 1,826 | 9,129 | 465,579 | 2,327,895 | 82 | 20,910 | |

**Weekend/Holiday Revenue Service:**

| Service Period | Duration (Hours) | Headway (Minutes) | One-way Trips | Vehicles/ Consist Incl Loco | Trains On-Line | Daily Train Miles | Daily Vehicle Miles | Annual Train Miles | Annual Vehicle Miles | Daily Train Hours | Annual Train Hours | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Transition | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| AM Peak | 0.0 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Mid-day | 12.0 | 120 | 12 | 5 | 2 | 644 | 3,222 | 35,442 | 177,210 | 22 | 1,210 | 7:00 am to 7:00 pm |
| PM Peak | 0.0 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Evening | 0.0 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Transition | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Subtotal | 12.0 | | 12 | | | 644 | 3,222 | 35,442 | 177,210 | 22 | 1,210 | |
| **Weekday and Weekend/Holiday Totals** | | | | | | 2,470 | 12,351 | **501,021** | **2,505,105** | 104 | **22,120** | |

Annual revenue miles and hours include allowance for 6 holiday schedules per year.

| **Peer Cities** | **Cost/Mile** | **Cost/Hour** |
|---|---|---|
| FrontRunner | $ 8.37 | $ 289.71 |
| RailRunner | $ 21.28 | $ 814.30 |
| Sounder | $ 24.75 | $ 749.30 |
| NorthStar | $ 30.99 | $ 1,222.41 |
| Tri-Rail Florida | $ 25.03 | $ 721.81 |
| TRE | $ 24.01 | $ 564.41 |
| NCTD Coaster | $ 12.20 | $ 482.86 |
| Music City Star | $ 25.59 | $ 685.76 |
| ACE | $ 16.11 | $ 621.31 |
| **8 Agency Avg.** | **$ 20.93** | **$ 683.54** |

| | | | |
|---|---|---|---|
| 8 Agency Average Cost/Mile | $ 20.93 | 8 Agency Average Cost/Hour | $ 683.54 |
| Grand/Kyrene Corridor Cost LHC Vehicles (cost per mile) | **$ 10,486,370** | Grand/Kyrene Corridor Cost LHC Vehicles (cost per Hour) | **$ 15,119,905** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Project: | **MAG System Study Update 2018** | | | | | **Revised:** | **May 2018** |
| Corridor: | **Estrella/San Tan Corridor** | | | | | | |
| Technology: | **LHC Push-Pull** | | Peak Headway: | 30 | minutes | | |
| Route Miles: | 61.4 | | One-way Trip Time: | 83 | minutes | 1.50 | |
| Stations | 16 | | Turnback Time | 7 | minutes | | |
| 4-Car Trains | 7 | (incl 1 spare train) | | | | 255 | Weekdays/Year |
| | | | Fleet Size: Locomotive | 7 | | | |
| | | | Cab Car | 7 | | 55 | Sat.-Hol./Year |
| **ANNUAL OPERATING STATISTICS** | | | Coach | 21 | | | |

**Weekday Revenue Service:**

| Service Period | Duration (Hours) | Headway (Minutes) | One-way Trips | Vehicles/ Consist Incl Loco | Trains On-Line | Daily Train Miles | Daily Vehicle Miles | Annual Train Miles | Annual Vehicle Miles | Daily Train Hours | Annual Train Hours | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Transition | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| AM Peak | 2.5 | 30 | 12 | 5 | 6 | 737 | 3,684 | 187,884 | 939,420 | 30 | 7,650 | 5:00 am to 7:30 am |
| Mid-day | 6.0 | 120 | 6 | 5 | 2 | 368 | 1,842 | 93,942 | 469,710 | 12 | 3,060 | 9:30 am to 1:30 pm |
| PM Peak | 3.0 | 30 | 14 | 5 | 6 | 860 | 4,298 | 219,198 | 1,095,990 | 33 | 8,415 | 3:30 pm to 6:30 pm |
| Evening | 2.0 | 120 | 2 | 5 | 2 | 123 | 614 | 31,314 | 156,570 | 7 | 1,785 | 8:30 PM |
| Transition | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Subtotal | 13.5 | | 34 | | | 2,088 | 10,438 | 532,338 | 2,661,690 | 82 | 20,910 | |

**Weekend/Holiday Revenue Service:**

| Service Period | Duration (Hours) | Headway (Minutes) | One-way Trips | Vehicles/ Consist Incl Loco | Trains On-Line | Daily Train Miles | Daily Vehicle Miles | Annual Train Miles | Annual Vehicle Miles | Daily Train Hours | Annual Train Hours | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Transition | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| AM Peak | 0.0 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Mid-day | 12.0 | 120 | 12 | 5 | 2 | 737 | 3,684 | 40,524 | 202,620 | 22 | 1,210 | 7:00 am to 7:00 pm |
| PM Peak | 0.0 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Evening | 0.0 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Transition | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Subtotal | 12.0 | | 12 | | | 737 | 3,684 | 40,524 | 202,620 | 22 | 1,210 | |
| **Weekday and Weekend/Holiday Totals** | | | | | | 2,824 | 14,122 | **572,862** | **2,864,310** | 104 | **22,120** | |

Annual revenue miles and hours include allowance for 6 holiday schedules per year.

| **Peer Cities** | **Cost/Mile** | **Cost/Hour** |
|---|---|---|
| FrontRunner | $ 8.37 | $ 289.71 |
| RailRunner | $ 21.28 | $ 814.30 |
| Sounder | $ 24.75 | $ 749.30 |
| NorthStar | $ 30.99 | $ 1,222.41 |
| Tri-Rail Florida | $ 25.03 | $ 721.81 |
| TRE | $ 24.01 | $ 564.41 |
| NCTD Coaster | $ 12.20 | $ 482.86 |
| Music City Star | $ 25.59 | $ 685.76 |
| ACE | $ 16.11 | $ 621.31 |
| **8 Agency Avg.** | **$ 20.93** | **$ 683.54** |

| | | | |
|---|---|---|---|
| 8 Agency Average Cost/Mile | **$ 20.93** | 8 Agency Average Cost/Hour | **$ 683.54** |
| Estrella/San Tan Corridor Cost LHC Vehicles (cost per mile) | **$ 11,990,002** | Estrella/San Tan Corridor Cost LHC Vehicles (cost per Hour) | **$ 15,119,905** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Project: | **MAG System Study Update 2018** | | | | | **Revised:** | **May 2018** |
| Corridor: | **Grand/Kyrene Line Corridor** | | | | | | |
| Technology: | **DMU** | | Peak Headway: | 30 | minutes | | |
| Route Miles: | 53.7 | | One-way Trip Time: | 66 | minutes | 1.50 | |
| Stations | 14 | | Turnback Time | 24 | minutes | | |
| 4-Car DMU | 7 | (includes 1 spare train) | | | | 255 | Weekdays/Year |
| | | | Fleet Size: 4-Car DMU | 7 | | | |
| | | | | | | 55 | Sat.-Hol./Year |

**ANNUAL OPERATING STATISTICS**

**Weekday Revenue Service:**

| Service Period | Duration (Hours) | Headway (Minutes) | One-way Trips | 4-Car DMU Consist | Trains On-Line | Daily Train Miles | Daily Vehicle Miles | Annual Train Miles | Annual Vehicle Miles | Daily Train Hours | Annual Train Hours | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Transition | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| AM Peak | 2.5 | 30 | 12 | 1 | 6 | 644 | 644 | 164,322 | 164,322 | 30 | 7,650 | 5:00 am to 7:30 am |
| Mid-day | 6.0 | 120 | 6 | 1 | 2 | 322 | 322 | 82,161 | 82,161 | 12 | 3,060 | 9:30 am to 1:30 pm |
| PM Peak | 3.0 | 30 | 14 | 1 | 6 | 752 | 752 | 191,709 | 191,709 | 33 | 8,415 | 3:30 pm to 6:30 pm |
| Evening | 2.0 | 120 | 2 | 1 | 2 | 107 | 107 | 27,387 | 27,387 | 7 | 1,785 | 8:30 PM |
| Transition | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Subtotal | 13.5 | | 34 | | | 1,826 | 1,826 | 465,579 | 465,579 | 82 | 20,910 | |

**Weekend/Holiday Revenue Service:**

| Service Period | Duration (Hours) | Headway (Minutes) | One-way Trips | 4-Car DMU Consist | Trains On-Line | Daily Train Miles | Daily Vehicle Miles | Annual Train Miles | Annual Vehicle Miles | Daily Train Hours | Annual Train Hours | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Transition | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| AM Peak | 0.0 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Mid-day | 12.0 | 120 | 12 | 1 | 2 | 644 | 644 | 35,442 | 35,442 | 22 | 1,210 | 7:00 am to 7:00 pm |
| PM Peak | 0.0 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Evening | 0.0 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Transition | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Subtotal | 12.0 | | 12 | | | 644 | 644 | 35,442 | 35,442 | 22 | 1,210 | |
| **Weekday and Weekend/Holiday Totals** | | | | | | 2,470 | 2,470 | **501,021** | **501,021** | 104 | **22,120** | |

Annual revenue miles and hours include allowance for 6 holiday schedules per year.

| **Peer Cities** | **Cost/Mile** | **Cost/Hour** |
|---|---|---|
| DCTA | $ 19.79 | $ 487.93 |
| Capital Metro | $ 77.34 | $ 1,840.81 |
| NCTD Sprinter | $ 23.80 | $ 522.79 |
| TriMet WES | $ 48.24 | $ 1,046.16 |
| NJ Transit | $ 24.45 | $ 610.02 |
| **5 Agency Avg.** | **$ 38.72** | **$ 901.54** |

| | | | |
|---|---|---|---|
| 5 Agency Average Cost/Mile | $ 38.72 | 5 Agency Average Cost/Mile | $ 901.54 |
| Grand/Kyrene Corridor Cost DMU Vehicles (cost per mile) | **$ 19,399,533** | Grand/Kyrene Corridor Cost DMU Vehicles (cost per Hour) | **$ 19,942,065** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Project: | **MAG System Study Update 2018** | | | | | **Revised:** | **May 2018** |
| Corridor: | **Estrella/San Tan Corridor** | | | | | | |
| Technology: | **DMU** | | Peak Headway: | 30 | minutes | | |
| Route Miles: | 61.4 | | One-way Trip Time: | 74 | minutes | 1.50 | |
| Stations | 16 | | Turnback Time | 16 | minutes | | |
| 4-Car DMU | 7 | (includes 1 spare train) | | | | 255 | Weekdays/Year |
| | | | Fleet Size: 4-Car DMU | 7 | | | |
| | | | | | | 55 | Sat.-Hol./Year |

**ANNUAL OPERATING STATISTICS**

**Weekday Revenue Service:**

| Service Period | Duration (Hours) | Headway (Minutes) | One-way Trips | 4-Car DMU Consist | Trains On-Line | Daily Train Miles | Daily Vehicle Miles | Annual Train Miles | Annual Vehicle Miles | Daily Train Hours | Annual Train Hours | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Transition | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| AM Peak | 2.5 | 30 | 12 | 1 | 6 | 737 | 737 | 187,884 | 187,884 | 30 | 7,650 | 5:00 am to 7:30 am |
| Mid-day | 6.0 | 120 | 6 | 1 | 2 | 368 | 368 | 93,942 | 93,942 | 12 | 3,060 | 9:30 am to 1:30 pm |
| PM Peak | 3.0 | 30 | 14 | 1 | 6 | 860 | 860 | 219,198 | 219,198 | 33 | 8,415 | 3:30 pm to 6:30 pm |
| Evening | 2.0 | 120 | 2 | 1 | 2 | 123 | 123 | 31,314 | 31,314 | 7 | 1,785 | 8:30 PM |
| Transition | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Subtotal | 13.5 | | 34 | | | 2,088 | 2,088 | 532,338 | 532,338 | 82 | 20,910 | |

**Weekend/Holiday Revenue Service:**

| Service Period | Duration (Hours) | Headway (Minutes) | One-way Trips | 4-Car DMU Consist | Trains On-Line | Daily Train Miles | Daily Vehicle Miles | Annual Train Miles | Annual Vehicle Miles | Daily Train Hours | Annual Train Hours | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Transition | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| AM Peak | 0.0 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Mid-day | 12.0 | 120 | 12 | 1 | 2 | 737 | 737 | 40,524 | 40,524 | 22 | 1,210 | 7:00 am to 7:00 pm |
| PM Peak | 0.0 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Evening | 0.0 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Transition | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Subtotal | 12.0 | | 12 | | | 737 | 737 | 40,524 | 40,524 | 22 | 1,210 | |
| **Weekday and Weekend/Holiday Totals** | | | | | | 2,824 | 2,824 | **572,862** | **572,862** | 104 | **22,120** | |

Annual revenue miles and hours include allowance for 6 holiday schedules per year.

| **Peer Cities** | **Cost/Mile** | **Cost/Hour** |
|---|---|---|
| DCTA | $ 19.79 | $ 487.93 |
| Capital Metro | $ 77.34 | $ 1,840.81 |
| NCTD Sprinter | $ 23.80 | $ 522.79 |
| TriMet WES | $ 48.24 | $ 1,046.16 |
| NJ Transit | $ 24.45 | $ 610.02 |
| **5 Agency Avg.** | **$ 38.72** | **$ 901.54** |

| | | | |
|---|---|---|---|
| 5 Agency Average Cost/Mile | $ 38.72 | 5 Agency Average Cost/Mile | $ 901.54 |
| Estrella/San Tan Corridor Cost DMU Vehicles (cost per mile) | **$ 22,181,217** | Estrella/San Tan Corridor Cost DMU Vehicles (cost per Hour) | **$ 19,942,065** |

# MARICOPA ASSOCIATION OF GOVERNMENTS

# REGIONAL COMMUTER RAIL SYSTEM STUDY UPDATE

## Appendix B: Evaluation of Potential Regional Commuter Rail System Illustrative Corridors

**May 2018**

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# 1.0 INTRODUCTION

As a component of the System Study Update, the Project Team assessed the viability of potential future illustrative extensions to the four System Study corridors under consideration under both 2040 and post-2040 conditions. The extensions analyzed included both extensions to the original base corridors, as well as new extensions that would potentially connect to the base system (see Figure 1):

Extensions to Base Corridors:

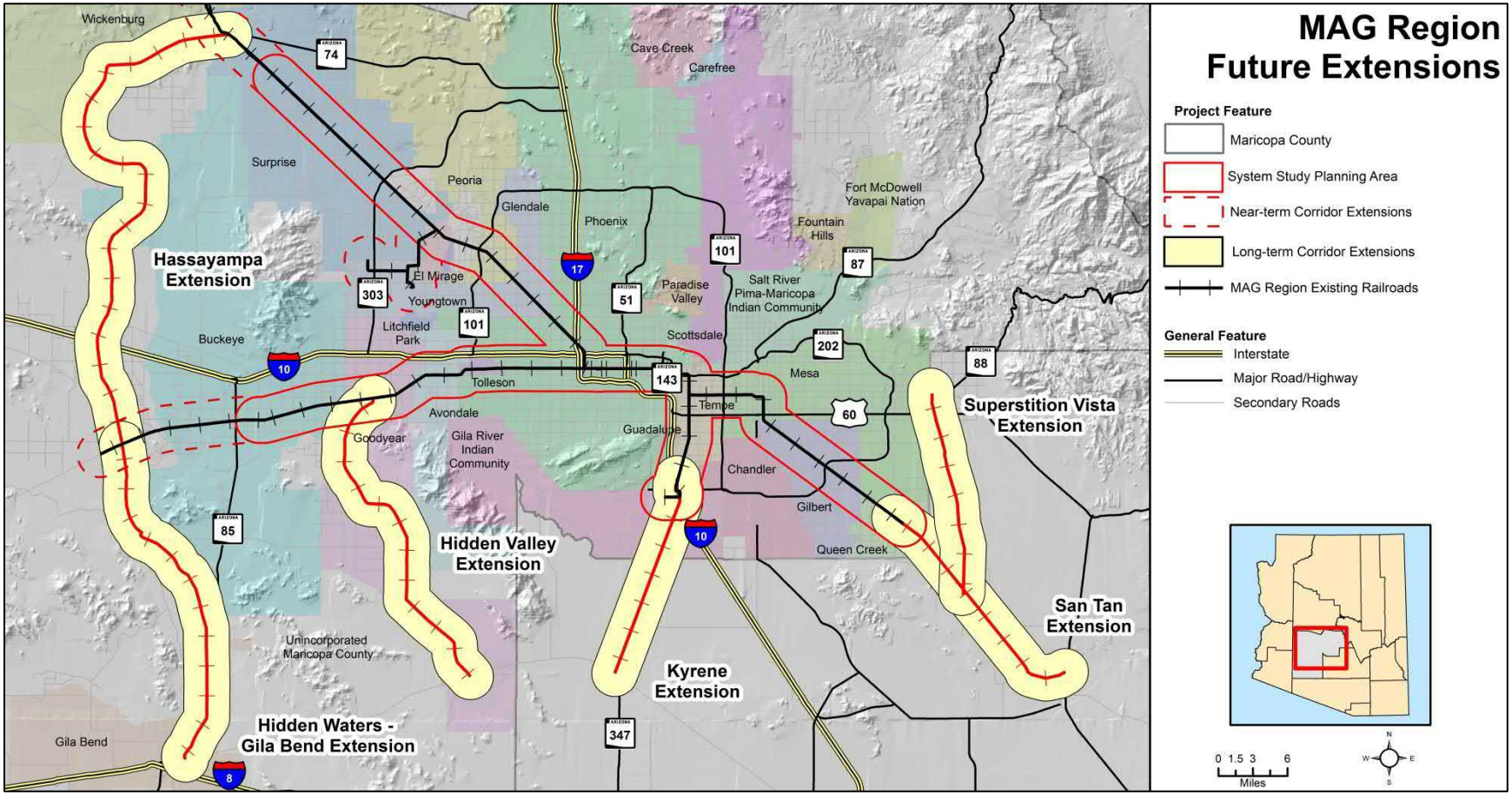
- Grand Line Extension (Wittman to West Wickenburg);
- Estrella Line Extension (Buckeye to Arlington);
- San Tan Line Extension (Queen Creek to Florence); and
- Kyrene Line Extension (Wild Horse Pass/I-10 to Maricopa).

New Extensions:

- Hassayampa Extension (Castle Hot Springs–Morristown to Arlington);
- Hidden Waters Gila Bend Extension (Arlington to Gila Bend);
- Hidden Valley Extension (Downtown Goodyear to Mobile); and
- Superstition Vistas Extension—SE Option (Apache Junction to Florence).

**Please Note: Ridership has not been updated for the future extensions described in this appendix, as these extensions would likely occur far beyond the 2040 Horizon Year. The ridership data shown in this appendix is from the 2010 Study. Also of importance to note is that the Chandler Corridor shown on the figures in this appendix was dropped from further evaluation in this study, as the City of Chandler is focused on a light rail extension which is planned a few blocks from where the commuter rail corridor was proposed.**

**Figure 1: Potential Future Extensions to Base Corridors**




Source: AECOM, 2018.

## 1.1 Year 2040 Extensions Ridership Potential

To assess Year 2040 ridership potential, the potential ridership for the illustrative extensions was estimated by coding the routes into the MAG model and running it with 2040 socioeconomic data. The proposed combination (Grand/Kyrene Line and Estrella/San Tan Line) was used as the base for the first model run, which included all four initial corridors (as two cross-region alignments). The results for all extensions are summarized in Table 1.

**Findings:** Ridership forecasting results for the extensions show that the SE extension (1,420 boardings) has the highest ridership potential in 2040, followed by Superstition Vistas (900-1,010) boardings. The Hidden Valley extension has moderate potential, and Grand, Estrella, Hassayampa, and Hidden Waters extensions have lower ridership potential in 2040, because most of the development expected to occur in the west valley will happen after 2040.

**Table 1: 2040 Commuter Rail Extensions**

| Corridor | Distance | No. of Stations | 2040 Estimated Ridership |
|---|---|---|---|
| **Low Ridership Potential** | | | |
| Hidden Waters | 32 miles | 4 | 10 |
| Hassayampa | 52 miles | 4 | 30 |
| Tempe Extension | 18 miles | 4 | 180 |
| **Moderate Ridership Potential** | | | |
| Hidden Valley | 31 miles | 4 | 490 |
| **High Ridership Potential** | | | |
| Superstition Vistas – to Coolidge | 33 miles | 6 | 900 |
| Superstition Vistas – to Florence | 32 miles | 5 | 1,010 |
| SE Extension | 24 miles | 4 | 1,420 |

Source: AECOM, 2018.

## 1.2 Post-2040 Extensions Ridership Potential

Post-2040 ridership potential for each of the illustrative corridor extensions was determined by using the latest available (2007) MAG future land-use data, because post-2040 socioeconomic data was not available. For each extension corridor, total projected households within eight miles and employment within ½ mile of station target areas were correlated with ridership potential. To normalize values for comparison between the extension corridors, the Project Team calculated households per mile and employment per station target area. Table 2 presents the results of this analysis.

**Table 2: Post-2040 Commuter Rail Extensions**

| Corridor | Distance | No. of Stations | Households per Mile (8 mile buffer) | Employment per Station (1/2 mile buffer) |
|---|---|---|---|---|
| **Low Ridership Potential** | | | | |
| Hidden Waters | 32 miles | 4 | 6,700 | 2,500 |
| **Moderate Ridership Potential** | | | | |
| Hassayampa | 52 miles | 4 | 19,100 | 3,400 |
| Hidden Valley | 31 miles | 4 | 24,900 | 3,300 |
| **High Ridership Potential** | | | | |

| Corridor | Distance | No. of Stations | Households per Mile (8 mile buffer) | Employment per Station (1/2 mile buffer) |
|---|---|---|---|---|
| Superstition Vistas – to Florence | 32 miles | 5 | 35,200 | 15,900 |
| Tempe Extension | 18 miles | 4 | 38,700 | 1,800 |
| Superstition Vistas – to Coolidge | 33 miles | 6 | 38,800 | 13,500 |
| SE Extension | 24 miles | 4 | 39,400 | 1,400 |

Source: AECOM, 2018.

**Findings:** Based on expected development patterns, extensions to each of the illustrative East Valley corridors and both Superstition Vistas corridors would have the highest ridership potential. These findings are consistent with the 2040 modeling, although the Hassayampa and Tempe extensions show increased ridership potential beyond 2040.

A BNSF Railway benefit train cruises Morristown / Castle Hot Springs on its way to Phoenix.
Source: MAG.

Union Pacific Railroad has recently installed double-track near Maricopa's Amtrak depot, a potential future extension of commuter rail service. A new grade separation of SR-347 is being installed here by 2020. Source: MAG.

Arlington Siding, located at 355th Avenue near the Palo Verde NGS, a potential future extension of commuter rail service.
Source: MAG.

Commuter rail service to Sacaton and Gila River Indian Community, located southeast of Chandler and Sun Lakes.
Source: MAG.

# MARICOPA ASSOCIATION OF GOVERNMENTS
# REGIONAL COMMUTER RAIL SYSTEM STUDY UPDATE

## Appendix C: System Study Station Target Area Evaluation

**May 2018**

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# 1.0 INTRODUCTION

This technical memorandum provides the station location screening results for potential east valley commuter rail stations along the Kyrene Line and the San Tan Line. The station locations under consideration were originally identified in the 2003 MAG High Capacity Transit (HCT) Study, and subsequently analyzed again in 2010 and 2017. For a detailed evaluation of the Grand Line and the Estrella Line, refer to the Station Planning Technical Memorandums prepared for each corridor.

This memorandum includes two major components. First, a pre-screening analysis is presented for potential station locations at major intersections along each commuter rail corridor in the east valley. This was deemed necessary because the 2003 HCT Study envisioned the Kyrene Line as light rail (LRT) or bus rapid transit (BRT) corridors. Typically, LRT and BRT stations would have closer spacing than commuter rail stations and thus may not be directly transferable to a commuter rail system. Therefore, this analysis evaluates each of the HCT Study station locations with respect to suitability in a commuter rail corridor.

Second, those station locations carried forward from the pre-screening analysis are assessed as per the evaluation criteria identified in the Station Location Methodology Memorandum. These criteria include demographic and employment projections, land use, connectivity with existing and planned transportation systems, and major activity centers. For the purposes of this evaluation, each station location is identified by the major cross streets closest to the rail crossing throughout the corridor. However, specific parcels were not evaluated and it is expected that later analyses of station locations would consider specific development opportunities in the general vicinity of the intersections identified.

# 2.0 PRESCREENING ANALYSIS

This section evaluates potential station locations at major intersections throughout each east valley corridor, as identified in the HCT Study. The corridors being analyzed include the Kyrene Line Corridor and the San Tan Line Corridor. Note that for the purposes of the pre-screening analysis, the downtown Phoenix and Sky Harbor Airport station locations are not reconsidered, as they are major regional activity centers that would be served by any east valley commuter rail corridor.

## 2.1 Pre-Screening Criteria

Pre-screening criteria includes potential for connectivity to other modes, potential land use conflicts, availability of vacant land, and major activity centers, as listed in Table 1.

**Table 1: Evaluation Criteria**

| Category | Criteria |
|---|---|
| **Connectivity** | • Direct connection or transfer to other transit modes, including:<br>– Local Bus<br>– Express Bus<br>– SuperGrid Service<br>– Circulator<br>– LRT<br>• Access to transportation network facilities, including:<br>– Freeway Access<br>– Bicycle Access<br>– Pedestrian Access |
| **Transit Facilities** | • Existing PNR or Transit Center<br>• Planned PNR or Transit Center |
| **Land Availability** | • Vacant land within the immediate vicinity of the station location |
| **Activity Centers** | • Destinations within 1/4 mile of the station location |

Source: AECOM, 2018.

For the purposes of the pre-screening analysis, a ranking of “Good”, “Moderate” or “Poor” was assigned to measure how well each station location met each evaluation criterion. Tables 2 through 5 list the measures used in the evaluation.

**Table 2: Connectivity Evaluation Criteria**

| Ranking | Connectivity |
|---|---|
| **Good** | Connections to 6 or more transit, freeway, or bicycle and pedestrian networks. |
| **Moderate** | Connections to 4 or 5 transit, freeway, or bicycle and pedestrian networks. |
| **Poor** | Connections to 3 or less transit, freeway, or bicycle and pedestrian networks. |

Source: AECOM, 2018.

**Table 3: Transit Facilities Evaluation Criteria**

| Ranking | Transit Facilities |
|---|---|
| **Good** | Two or more existing and/or planned PNRs and/or Transit Centers located within 1/4 mile of station location. |
| **Moderate** | One existing and/or planned PNR and/or Transit Center located within 1/4 mile of station location. |
| **Poor** | No existing and/or planned PNR and/or Transit Center located within 1/4 mile of station location. |

Source: AECOM, 2018.

**Table 4: Land Availability Evaluation Criteria**

| Ranking | Land Availability |
|---|---|
| **Good** | Available vacant land within the immediate vicinity of the station location. |
| **Poor** | No available vacant land within the immediate vicinity of the station location. |

Source: AECOM, 2018.

**Table 5: Transit Facilities Evaluation Criteria**

| Ranking | Activity Centers |
|---|---|
| **Good** | More than one activity center within 1/4 mile of station location. |
| **Moderate** | One activity center within 1/4 mile of station location. |
| **Poor** | No activity centers within 1/4 mile of station location. |

Source: AECOM, 2017.

The following sections present the results of the pre-screening analysis for each east valley corridor.

## 2.2 Kyrene Corridor

The Kyrene Line Corridor extends from downtown Tempe to West Chandler at 56th Street and Chandler Boulevard plus an additional mile south to Lone Butte Industrial Park and Wild Horse Pass access near I-10/Wild Horse Pass Boulevard. Table 6 lists the station locations that were evaluated throughout the corridor.

Union Pacific Railroad's Phoenix Southeast Line and METRO light rail operate parallel lines just north of Tempe's depot.
Source: MAG.

**Table 6: Revised Screening – Kyrene Line Corridor**

| Station Area | Connectivity | | | | | | | | Transit Facilities | | Land Availability | Activity Centers | Comments and Recommendation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Local Bus | Express Bus | SuperGrid Service | Circulator | LRT | Freeway Access | Bicycle Access | Pedestrian Access | Existing PNR or TC | Planned PNR or TC | | | |
| Ash Avenue/3rd Avenue | X | | | X | X | X | X | X | X | | X | Tempe Arts Center, Tempe Town Lake, ASU, Mill Ave District | Many vacant parcels and parking lots - approximately 4 acres. |
| | Good | | | | | | | | Moderate | | Good | Good | Carry Forward |
| Farmer Avenue/ University Drive | X | | X | X | | | X | X | | | | Tempe Arts Center, Tempe Town Lake, ASU, Mill Ave District | Connected to fewer modes compared to 3rd Avenue site and less land available for future development |
| | Moderate | | | | | | | | Poor | | Poor | Good | Do Not Carry Forward |
| Tempe Line/Chandler Line (Kyrene Line Corridor) | | | | X | | | X | X | | | | St. Luke's Hospital, ASU | Lack of access due to location away from arterial streets. Located within residential neighborhood adjacent to a high school. |
| | Poor | | | | | | | | Poor | | Poor | Good | Do Not Carry Forward |
| Farmer Avenue/ Broadway Road | X | | X | X | | | X | X | | | | St. Luke's Hospital | No available land for development and proximity to local high school could cause issues. |
| | Moderate | | | | | | | | Poor | | Poor | Moderate | Do Not Carry Forward |

**Table 6: Revised Screening – Kyrene Line Corridor**

| Station Area | Connectivity | | | | | | | | Transit Facilities | | Land Availability | Activity Centers | Comments and Recommendation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Local Bus | Express Bus | SuperGrid Service | Circulator | LRT | Freeway Access | Bicycle Access | Pedestrian Access | Existing PNR or TC | Planned PNR or TC | | | |
| Kyrene Road/ Southern Avenue | X | X | X | X | | X | X | X | | | X | Medical Center | Access to Express Route 520. Small vacant parcel on SW corner adjacent to RR intersection - approximately 1.5 acres. |
| | Good | | | | | | | | Poor | | Good | Moderate | Carry Forward |
| Kyrene Road/ Baseline Road | X | X | X | | | X | X | X | | | | Kiwanis Community Park | Express Route 521 along Mill Avenue. Limited access to vacant land that is not located directly on arterial street. |
| | Good | | | | | | | | Poor | | Poor | Moderate | Do Not Carry Forward |
| Kyrene Road/ Guadalupe Road | X | | | | | | X | X | | | X | Kiwanis Community Park, University of Phoenix | Large open parcel on NE corner of approximately10 acres. Lack of enhanced bus service to this location. |
| | Poor | | | | | | | | Poor | | Good | Good | Do Not Carry Forward |
| Kyrene Road/ Elliot Road | X | | X | | | | X | X | | | X | University of Phoenix | Large open parcel on SW corner of approximately 15 acres. This site likely has development potential surrounding the rail line. |
| | Moderate | | | | | | | | Poor | | Good | Moderate | Carry Forward |

**Table 6: Revised Screening – Kyrene Line Corridor**

| Station Area | Connectivity | | | | | | | | Transit Facilities | | Land Availability | Activity Centers | Comments and Recommendation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Local Bus | Express Bus | SuperGrid Service | Circulator | LRT | Freeway Access | Bicycle Access | Pedestrian Access | Existing PNR or TC | Planned PNR or TC | | | |
| Kyrene Road/Warner Road | X | X | | | | | X | X | | | | | Express Route 540 serves Warner Rd. There is no vacant land in the surrounding areas. |
| | Moderate | | | | | | | | Poor | | Poor | Poor | Do Not Carry Forward |
| Kyrene Road/Ray Road | | | X | | | | X | X | | | | | No land available for development, this location sits in the middle of a residential neighborhood with no access to local bus service. |
| | Poor | | | | | | | | Poor | | Poor | Poor | Do Not Carry Forward |

**Table 6: Revised Screening – Kyrene Line Corridor**

| Station Area | Connectivity | | | | | | | | Transit Facilities | | Land Availability | Activity Centers | Comments and Recommendation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Local Bus | Express Bus | SuperGrid Service | Circulator | LRT | Freeway Access | Bicycle Access | Pedestrian Access | Existing PNR or TC | Planned PNR or TC | | | |
| 56th Street/Chandler Boulevard | X | | X | | | X | X | | | | X | | Open parcel on SW corner – of approximately 3.5 acres, large open parcel west of 56th Street of approximately 10 acres. Originally identified as end-of-line for the Kyrene Line. Plus an additional mile south to Lone Butte Industrial Park and Wild Horse Pass access near I-10/Wild Horse Pass Boulevard. |
| | Moderate | | | | | | | | Poor | | Good | Poor | Carry Forward |

Source: AECOM, 2018.

Based on the evaluation above, the following station locations are recommended for further analysis within the Kyrene Line corridor:

1. Ash Avenue/3rd Avenue
2. Kyrene Road/Southern Avenue
3. Kyrene Road/Elliot Road
4. 56th Street/Chandler Boulevard
5. I-10/Wild Horse Pass

The station area surrounding the Kyrene Road/Baseline Road intersection is recognized as an alternative to the Kyrene Road/Southern Avenue location, although there is limited vacant land. However, the Kyrene Road/Southern Avenue intersection is within a mile and is somewhat stronger because of access to the Orbit system (local circulator) and a small amount of vacant land.

## 2.3 San Tan Corridor

The San Tan Line Corridor extends from downtown Tempe to the intersection of Ellsworth Road and Rittenhouse Road in Queen Creek. Table 7 lists the station locations that were evaluated to determine optimal station areas throughout the corridor. There is some overlap with the Kyrene Line Corridor; station locations that are a part of this corridor but are addressed in Table 6 include:

- Ash Avenue/3rd Street;
- Farmer Avenue/University Drive;
- Tempe Line/Chandler Line Junction
- Union Pacific Railroad/Rural Road;
- Union Pacific Railroad/McClintock Road;
- Union Pacific Railroad/SR 101 (Price Freeway)
- Union Pacific Railroad/Dobson Road;
- Union Pacific Railroad/Alma School Road;
- Union Pacific Railroad/Country Club Road;
- Center Street/Broadway Road;
- Center Street/Southern Avenue; and
- Center Street/Baseline Road (Mesa – McQueen Junction).

**Table 7: Initial Screening – San Tan Line Corridor**

| Station Area | Connectivity | | | | | | | | Transit Facilities | | Land Availability | Activity Centers | Comments and Recommendation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Local Bus | Express Bus | SuperGrid Service | Circulator | LRT | Freeway Access | Bicycle Access | Pedestrian Access | Existing PNR or TC | Planned PNR or TC | | | |
| Guadalupe/Cooper Road | | | | | | | X | X | | | X | | Open land surrounding RR – 13 acres. Limited transit access and no activity centers. Proximity to Baseline/ Center Station. |
| | Poor | | | | | | | | Poor | | Good | Poor | Do Not Carry Forward |
| Union Pacific Railroad/ Gilbert Road | X | X | X | | | | X | X | X | | X | Gilbert Historical Center, downtown Gilbert | Access to express route 531. No vacant land in surrounding areas but proximity to existing PNR. |
| | Moderate | | | | | | | | Moderate | | Good | Good | Carry Forward |
| Union Pacific Railroad/ Elliot Road | X | | X | | | | X | X | | | X | Gilbert Historical Center, DT Gilbert | Vacant land adjacent to RR – 7.5 acres. |
| | Moderate | | | | | | | | Poor | | Good | Good | Do Not Carry Forward |
| Union Pacific Railroad/ Lindsey Road | | | | | | | X | X | | | X | DT Gilbert | Open land adjacent to RR – 5 acres. No connectivity to transit network, limited arterial street access. |

**Table 7: Initial Screening – San Tan Line Corridor**

| Station Area | Connectivity | | | | | | | | Transit Facilities | | Land Availability | Activity Centers | Comments and Recommendation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Local Bus | Express Bus | SuperGrid Service | Circulator | LRT | Freeway Access | Bicycle Access | Pedestrian Access | Existing PNR or TC | Planned PNR or TC | | | |
| | Poor | | | | | | | | Poor | | Good | Moderate | Do Not Carry Forward |
| Union Pacific Railroad/ Warner Road | | | | | | | X | X | | | | | No connectivity to transit network with any activity centers. No vacant land available for development. |
| | Poor | | | | | | | | Poor | | Poor | Poor | Do Not Carry Forward |
| Union Pacific Railroad/ Val Vista Road | | | | | | | X | X | | | | | No connectivity to transit network with any activity centers. No vacant land available for development. |
| | Poor | | | | | | | | Poor | | Poor | Poor | Do Not Carry Forward |
| SR 202/Ray Road | | | X | | | X | X | X | | | X | San Tan Regional Mall | Surrounded by vacant land on the north and south of SR 202 intersection. No freeway on/off ramps. |
| | Moderate | | | | | | | | Poor | | Good | Moderate | Do Not Carry Forward |
| Union Pacific Railroad/ Higley Road | X | | X | | | X | X | X | | | | | No vacant land available for development. |
| | Moderate | | | | | | | | Poor | | Poor | Poor | Do Not Carry Forward |

**Table 7: Initial Screening – San Tan Line Corridor**

| Station Area | Connectivity | | | | | | | | Transit Facilities | | Land Availability | Activity Centers | Comments and Recommendation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Local Bus | Express Bus | SuperGrid Service | Circulator | LRT | Freeway Access | Bicycle Access | Pedestrian Access | Existing PNR or TC | Planned PNR or TC | | | |
| Union Pacific Railroad/ Williams Field Road | X | | X | | | X | X | X | | | X | San Tan Regional Mall, ASU Polytech, Airport | Large open land NE of RR – 35 acres. Location shows connectivity to enhanced bus service and future BRT. Location could be considered as part of Power Road location as well. |
| | Moderate | | | | | | | | Poor | | Good | Good | Carry Forward |
| Union Pacific Railroad/ Recker Road | | | | | | | X | | | | X | ASU Polytech, Airport | Surrounded by vacant land. No connectivity to transit network. |
| | Poor | | | | | | | | Poor | | Good | Good | Do Not Carry Forward |
| Union Pacific Railroad/ Power Road | | | | | | | X | | | | X | ASU Polytech, Airport | Surrounded by vacant land. No connectivity to transit network. Potential connection to future BRT (not programmed). |
| | Poor | | | | | | | | Poor | | Good | Good | Carry Forward |

**Table 7: Initial Screening – San Tan Line Corridor**

| Station Area | Connectivity | | | | | | | | Transit Facilities | | Land Availability | Activity Centers | Comments and Recommendation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Local Bus | Express Bus | SuperGrid Service | Circulator | LRT | Freeway Access | Bicycle Access | Pedestrian Access | Existing PNR or TC | Planned PNR or TC | | | |
| Union Pacific Railroad/ Sossmann Road | | | | | | | X | | | | X | | Surrounded by vacant land. No connectivity to transit network |
| | Poor | | | | | | | | Poor | | Good | Poor | Do Not Carry Forward |
| Ellsworth Road/ Rittenhouse Road | | | | | | | X | | | | X | Downtown Queen Creek | Surrounded by vacant land. No connectivity to transit network. This location has been identified as End of Line for the San Tan Line corridor. |
| | Poor | | | | | | | | Poor | | Good | Moderate | Carry Forward |

Source: AECOM, 2018.

Based on the evaluation above, the following station locations are recommended for further analysis in the San Tan corridor:

1. Ash Avenue/3rd Street
2. Union Pacific Railroad/SR 101 (Price Freeway)
3. Center Street/Broadway Road
4. Union Pacific Railroad/Gilbert Road
5. Union Pacific Railroad/Williams Field Road or Union Pacific Railroad/Power Road
6. Ellsworth Road/Rittenhouse Road

It is recommended that the station area located at Power Road in the 2003 HCT Study be shifted north towards the intersection of Williams Field Road and Union Pacific Railroad. The recommendation is based on the Williams Field Road location proximity to regional freeway access, San Tan Regional Mall, ASU/Airport, and access to regionally approved BRT service in the future.

# 3.0 CONCEPTUAL STATION LOCATION SCREENING

The candidate station areas along the east valley corridors that emerged from the pre-screening analysis were further evaluated using qualitative criteria that considers demographic and land use characteristics, intermodal connectivity, and other potential opportunities and constraints as described in Table 8.

**Table 8: Evaluation Criteria**

| Category | Criteria |
|---|---|
| **Demographics** | • Projected population within 2 miles<br>• Projected employment within 2 miles |
| **Land Use** | • Compatibility with land use and transportation plans<br>• Access to activity centers |
| **Intermodal Connectivity** | • Accessibility to vehicle, bus, bicycle, pedestrian transportation<br>• Ability to transfer to other HCT systems |
| **Other Issues** | • Input from stakeholders on potential opportunities and constraints |

Source: AECOM, 2018.

## 3.1 Demographics

To assess potential residential clusters and employment centers, population and employment data were gathered for a larger, 2-mile radius around each candidate station area. As shown in Table 9, this data was assessed to determine whether the station area would serve a high concentration of employment destinations and/or residential populations. A ranking of “Excellent”, “Good” or “Fair” was assigned based on future population and employment projections. Higher projected employment reflects the viability of the station area as a destination for employment, or the local jurisdiction’s plan to facilitate employment growth in the area. Higher population densities suggest a concentration of potential home-based transit riders within proximity of the station area.

**Table 9: Demographic Evaluation Criteria**

| Ranking | Year 2040 Population | Year 2040 Employment |
|---|---|---|
| **Excellent** | More than 150,000 persons | More than 100,000 employees |
| **Good** | 100,000 – 150,000 persons | 30,000 – 100,000 employees |
| **Fair** | Fewer than 100,000 persons | Less than 30,000 employees |

Source: AECOM, 2018.

## 3.2 Land Use

Existing land use data and applicable local plans were reviewed to identify potential opportunities and constraints associated within the candidate station areas. Commercial, office, and mixed use land uses were considered to be more compatible with a station, while residential uses typically would be less compatible due to potential noise, traffic, and other impacts that would be associated with a commuter rail station. Vacant land may provide potential opportunities for either a station location or transit-oriented development. In addition, activity centers were identified that could serve as ridership generators or destinations. The general pattern and mix of land uses within the station area were considered in this analysis; however, specific parcels were not evaluated. The preliminary assessment utilized the criteria and ranking system shown in Table 10.

**Table 10: Land Use Evaluation Criteria**

| Ranking | Evaluation Criteria |
|---|---|
| **Excellent** | Balanced mix of more station-compatible existing and planned land uses (e.g., commercial) with residential or other uses. Municipality or regional governments have planned for commuter rail and/or transit-oriented development. Accessible to multiple activity centers. |
| **Good** | Presence of station-compatible existing and planned land uses and/or vacant land. Accessible to fewer activity centers. |
| **Fair** | Low percentage of station-compatible existing and planned land uses and/or lack of activity centers. |

Source: AECOM, 2018.

## 3.3 Intermodal Connectivity

Transit riders have a number of mode choices when traveling to and from a commuter rail station. An example may be a transit user driving to, and utilizing a park-and-ride adjacent to a commuter rail station. The transit user's transfer to a different transit mode, e.g. commuter rail, represents a change in mode of access. For some metropolitan regions, certain modes of access are higher than others. For example, the use of bus transit to access a rail station terminal is likely a higher percentage compared to a bicycle mode in a more dense land use setting. In other cases, park-and-rides may be used frequently to access commuter train terminals in a more rural environment.

Connectivity was evaluated based on accessibility to vehicle, bus, bicycle, and pedestrian transportation networks as well as the ability to transfer to other HCT systems. The candidate station areas were ranked as "Excellent," "Good," or "Fair" based on the range of connectivity options and how directly accessible intermodal systems would be to the candidate station area. The preliminary assessment utilized the criteria and ranking system identified in Table 11 with respect to intermodal connectivity.

**Table 11: Intermodal Connectivity Evaluation Criteria**

| Ranking | Evaluation Criteria |
|---|---|
| **Excellent** | Connectivity to multiple modes of transportation (both existing and planned). |
| **Good** | Connectivity to one other mode and planned transit enhancements (such as enhanced bus service). Access to freeways. |
| **Fair** | Limited existing or planned intramodal connectivity. Vehicular access primarily via arterial streets. |

Source: AECOM, 2018.

## 3.4 Other Issues

Other issues that are identified include existing rail facilities that may present either opportunities or constraints for locating passenger stations. Additional investigation into these issues is expected as the corridor development plan is prepared.

# 4.0 RESULTS OF PRELIMINARY SCREENING

The Station Area Evaluation Matrix summarizes the evaluation criteria for each station area. The majority of the station areas that emerged from the “pre-screening” are assessed to be "Excellent" or "Good" due to favorable land use patterns in the station area, plans or policies supporting transit-oriented development, and high levels of connectivity to other modes of transportation.

With the Superstition Mountains in the distance, downtown Mesa and the site of the former depot are served by Union Pacific Railroad’s Southeast Line.
Source: MAG.

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**Table 12: Station Area Evaluation Criteria (Revised 2017)**

| Candidate Station Area | Location | EVALUATION CATEGORY/COMMENTS | | | | | | | Preliminary Assessment |
|---|---|---|---|---|---|---|---|---|---|
| | | Demographics | | Land Use | | Connectivity | | Other Issues | |
| | | *Existing – 2017* | *Future – 2040* | *Existing – 2017* | *Future – 2040* | *Existing – 2017* | *Future – 2040* | | |
| **Kyrene Line Corridor** | | | | | | | | | |
| Downtown Phoenix | Union Station | Population: 44,852<br>Employment: 113,232 | Population: 90,725<br>Employment: 138,047 | • Balanced mix of land uses including residential, commercial/office, and public<br>• Access to high concentration of employment and special event activity centers in downtown Phoenix | • Land use patterns expected to be similar<br>• Local plans support transit-oriented development and improved transit to support more walkable land use patterns. | • High level of connectivity to multiple modes (LRT, Bus, Bicycle, Pedestrian)<br>• Walking distance to Central Station and activity centers | • Access to planned local and regional transit expansion including LRT extensions<br>• Enhanced bus service | • May be limitations or opportunities associated with use of Union Station or nearby facilities (constraints for expansion and historic status as well as redevelopment opportunities).<br>• Downtown connectivity with other commuter rail corridors and ease of transfer to all modes has yet to be evaluated in detail. | Excellent. The location is a strong candidate for a potential commuter rail line station location and can provide transit patrons a means to travel to and from the downtown Phoenix employment and activity centers. The station area location supports transit-oriented land use goals established in city plans. Provides connections to LRT and other modal choices. |
| | | Excellent | | Excellent | | Excellent | | | |
| Sky Harbor Airport | 44th Street | Population: 32,335<br>Employment: 66,139 | Population: 50,007<br>Employment: 80,558 | • Primary adjacent use is the Phoenix Sky Harbor Airport, with nearby industrial and vacant land | • Land use patterns expected to be similar. Airport, industrial, parks/open space. | • LRT, Bus, and Bicycle access<br>• Close proximity to Sky Harbor Airport<br>• No pedestrian access | • Enhanced Bus Service<br>• Access to future PHX Sky Train, providing connection between existing LRT and Sky Harbor Airport | • Modeling for other studies shows strong demand along 44th Street corridor. | Excellent. Strong candidate for commuter rail because of Sky Harbor Airport destination and access to potential riders and other modes. |
| | | Good | | Good | | Excellent | | | |
| Downtown Tempe | 3rd Street/ Ash Avenue | Population: 62,340<br>Employment: 81,471 | Population: 112,021<br>Employment: 107,346 | • Balanced mix of land uses including residential, commercial, industrial, mixed use, and nearby public open space<br>• Access to ASU Tempe campus and Mill Avenue | • Land use expected to be primarily mixed-use with some nearby residential and public open space | • High level of connectivity to multiple modes (LRT, Bus, Bicycle, Pedestrian)<br>• Walking distance to Tempe Transit Center and downtown Tempe employment and activity centers<br>• Walking distance to ASU<br>• Close to SR 202 | • Enhanced Bus Service<br>• Access to regional transit expansion including LRT extensions<br>• RTP identifies planned improvements to Tempe Transit Center | • May be constraints related to land availability. | Excellent. Strong attractor because of employment, activity centers such as ASU and special event opportunities. High level of connectivity to other modes and transit-oriented development in already in place. |
| | | Excellent | | Excellent | | Excellent | | | |
| Central Tempe | Southern Avenue/ Kyrene Road | Population: 68,187<br>Employment: 58,130 | Population: 88,922<br>Employment: 66,280 | • Balanced mix of land uses including residential, commercial and industrial<br>• Limited activity centers | • Land use expected to be balanced mix of land uses including residential, commercial, and mixed use | • Connectivity to existing bus routes<br>• Limited pedestrian and bicycle access<br>• No access to LRT<br>• Proximity to Orbit shuttle service<br>• Close to US 60 | • Enhanced bus service<br>• Access to planned HCT extension into south Tempe | • No apparent issues | Good. Good amount of connectivity to other transit and relatively dense population and employment opportunities. |
| | | Good | | Fair | | Good | | | |
| South Tempe | Elliot Road/ Kyrene Road | Population: 43,725<br>Employment: 48,961 | Population: 49,371<br>Employment: 55,340 | • Balanced mix of land uses including residential, commercial, industrial and vacant<br>• Limited activity centers | • Land use expected to be balanced mix of land uses including residential, commercial, industrial and mixed use | • Connection to bus, bicycle, and pedestrian access<br>• Access to multi-use path along Kyrene Canal<br>• No access to LRT | • Enhanced bus service<br>• Access to planned HCT extension into south Tempe | • No apparent issues | Good. Good amount of connectivity to other transit and relatively dense population and employment opportunities. |
| | | Good | | Fair | | Good | | | |

**Table 12: Station Area Evaluation Criteria (Revised 2017)**

| Candidate Station Area | Location | EVALUATION CATEGORY/COMMENTS | | | | | | | Preliminary Assessment |
|---|---|---|---|---|---|---|---|---|---|
| | | Demographics | | Land Use | | Connectivity | | Other Issues | |
| | | *Existing – 2017* | *Future – 2040* | *Existing – 2017* | *Future – 2040* | *Existing – 2017* | *Future – 2040* | | |
| West Chandler | Chandler Boulevard/ 56th Street | Population: 35,545<br>Employment: 44,718 | Population: 41,423<br>Employment: 51,372 | • Current land uses include office, industrial, business park and vacant land<br>• Limited activity centers | • Designated in the general plan as "employment". This includes industrial, business parks, "knowledge intensive employers", and potentially residential uses. | • Connectivity to existing bus routes<br>• Close proximity to SR 202 and I-10<br>• No access to LRT<br>• Limited pedestrian and bicycle access | • Enhanced bus service<br>• No access to planned HCT extensions<br>• Proximity to planned SR 202 South Mountain freeway | • No apparent issues | Good. Good amount of connectivity to other transit and vehicle access. Employment is expected to increase substantially in this area. |
| | | Good | | Good | | Good | | | |
| **San Tan Line Corridor** | | | | | | | | | |
| Downtown Phoenix | Union Station | Population: 44,852<br>Employment: 113,232 | Population: 90,725<br>Employment: 138,047 | • Balanced mix of land uses including residential, commercial/office, and public<br>• Access to high concentration of employment and special event activity centers in downtown Phoenix | • Land use patterns expected to be similar<br>• Local plans support transit-oriented development and improved transit to support more walkable land use patterns. | • High level of connectivity to multiple modes (LRT, Bus, Bicycle, Pedestrian)<br>• Walking distance to Central Station and activity centers | • Access to planned local and regional transit expansion including LRT extensions<br>• Enhanced bus service | • May be limitations or opportunities associated with use of Union Station or nearby facilities (constraints for expansion and historic status as well as redevelopment opportunities).<br>• Downtown connectivity with other commuter rail corridors and ease of transfer to all modes has yet to be evaluated in detail. | Excellent. The location is a strong candidate for a potential commuter rail line station location and can provide transit patrons a means to travel to and from the downtown Phoenix employment and activity centers. The station area location supports transit-oriented land use goals established in city plans. Provides connections to LRT and other modal choices. |
| | | Excellent | | Excellent | | Excellent | | | |
| Sky Harbor Airport | 44th Street | Population: 32,335<br>Employment: 66,139 | Population: 50,007<br>Employment: 80,558 | • Primary adjacent use is the Phoenix Sky Harbor Airport, with nearby industrial and vacant land | • Land use patterns expected to be similar. Airport, industrial, parks/open space | • LRT, Bus, and Bicycle access<br>• Close proximity to Sky Harbor Airport | • Enhanced Bus Service<br>• Access to future PHX Sky Train, providing connection between existing LRT and Sky Harbor Airport | • Modeling for other studies shows strong demand along 44th Street corridor. | Excellent. Strong candidate for commuter rail because of Sky Harbor Airport destination and access to potential riders and other modes. |
| | | Good | | Excellent | | Excellent | | | |
| Downtown Tempe | 3rd Street/ Ash Avenue | Population: 62,340<br>Employment: 81,471 | Population: 112,021<br>Employment: 107,346 | • Balanced mix of land uses including residential, commercial, industrial, mixed use, and nearby public open space<br>• Access to ASU Tempe campus and Mill Avenue | • Land use expected to be primarily mixed-use with some nearby residential and public open space | • High level of connectivity to multiple modes (LRT, Bus, Bicycle, Pedestrian)<br>• Walking distance to Tempe Transit Center and downtown Tempe employment and activity centers<br>• Walking distance to ASU<br>• Close to SR 202 | • Enhanced Bus Service<br>• Access to regional transit expansion including LRT extensions<br>• RTP identifies planned improvements to Tempe Transit Center | • No apparent issues | Excellent. Strong attractor because of employment, activity centers such as ASU and special event opportunities. High level of connectivity to other modes and transit-oriented development in already in place. |
| | | Excellent | | Excellent | | Excellent | | | |
| East Tempe | Price Road/ Loop 101 Park and Ride | Population: 74,177<br>Employment: 41,724 | Population: 109,361<br>Employment: 54,265 | • Current land use includes residential, commercial, and industrial. Also nearby is park and ride lot serving LRT<br>• Limited activity centers | • Land use expected to be primarily mixed-use, with adjacent commercial and industrial uses. | • High level of connectivity to multiple modes (LRT, bus, bicycle)<br>• Limited pedestrian access<br>• Access to multi-use path along Tempe canal<br>• Access to Orbit shuttle service<br>• Adjacent to SR 101<br>• Adjacent to existing Park-and-Ride at Apache/Price Rd | • Enhanced bus service<br>• Potential multi-modal transit station location | • No apparent issues | Good. This location is at the cross-section of many transportation modes. Although land use change is constrained by a lack of vacant land this could function as a multi-model center. |
| | | Good | | Good | | Excellent | | | |

**Table 12: Station Area Evaluation Criteria (Revised 2017)**

| Candidate Station Area | Location | EVALUATION CATEGORY/COMMENTS | | | | | | | Preliminary Assessment |
|---|---|---|---|---|---|---|---|---|---|
| | | Demographics | | Land Use | | Connectivity | | Other Issues | |
| | | *Existing – 2017* | *Future – 2040* | *Existing – 2017* | *Future – 2040* | *Existing – 2017* | *Future – 2040* | | |
| Downtown Mesa | Broadway Road/ Center Street | Population: 79,799<br>Employment: 38,477 | Population: 119,233<br>Employment: 54,707 | • Current land uses include business park, educational and some nearby residential<br>• Access to downtown Mesa municipal buildings and activity centers | • Located adjacent to Town Center designation, this includes such uses as residential, employment and commercial.<br>• Also adjacent to mixed use and public/semi-public. This includes a mix residential, | • Connections to bus, bicycle and pedestrian access<br>• No access to LRT | • Enhanced bus service<br>• Access to future regional transit expansions including LRT extension along Main Street<br>• Proximity to future Park-and-Ride located in downtown Mesa | • No apparent issues | Excellent. Downtown location is suited to transit with a high level of connectivity, access to activity centers, support for transit-oriented development, and projected growth in both population and employment. |
| | | Good | | Excellent | | Excellent | | | |
| Downtown Gilbert | Gilbert Road/ Union Pacific Railroad | Population: 60,236<br>Employment: 25,050 | Population: 69,873<br>Employment: 31,627 | • Current land uses include primarily residential and commercial<br>• Access to downtown Gilbert | • Planning for increased residential and public facility/institutional uses. Part of the identified "village center" and located within the "Heritage District" | • Access to Express Bus service<br>• Access to pedestrian and bicycle connections<br>• No access to LRT | • Enhanced bus service<br>• No HCT extensions planned | • No apparent issues | Good. Access to activity centers in downtown Gilbert and planning for village center. Good connectivity with existing and planned transit. |
| | | Good | | Good | | Good | | | |
| Gateway – ASU Poly | Power Road/ Rittenhouse Road | Population: 49,119<br>Employment: 10,286 | Population: 65,929<br>Employment: 17,807 | • Current land uses include primarily residential, commercial, industrial and vacant land.<br>• Access to ASU Polytechnic Campus and Phoenix Mesa Gateway Airport | • Gilbert has designated the portions of the land in their jurisdiction as residential, general commercial and light industrial<br>• Queen Creek has designated the portion of the land in their jurisdiction as a regional commercial center | • Supergrid bus service to ASU Polytechnic via Chandler Blvd.<br>• Limited bicycle and pedestrian access<br>• No access to LRT | • RTP planned BRT service to ASU polytechnic<br>• Improved bicycle and pedestrian access with development of residential neighborhoods | • No apparent issues | Good. Good access to activity centers and connectivity with other modes. |
| | | Fair | | Excellent | | Good | | | |
| Downtown Queen Creek | Ellsworth Road/ Rittenhouse Road | Population: 20,401<br>Employment: 5,143 | Population: 32,759<br>Employment: 10,793 | • Current land uses include residential, light industrial, and vacant land<br>• Limited activity centers | • Land use is designated as part of the Queen Creek Town Center Redevelopment Plan. This designation includes a variety of uses including commercial, government residential and others. | • No existing bus service<br>• Limited bicycle and pedestrian access<br>• No HCT services<br>• Close proximity to downtown Queen Creek | • No transit services planned in proximity to this location<br>• Improved bicycle and pedestrian access with future residential development | • No apparent issues | Good. Although transit connectivity is low, this area is being planned for redevelopment and substantial population and employment growth is anticipated. |
| | | Fair | | Good | | Fair | | | |

Source: AECOM, 2018.
Station locations presented within this matrix are based on the High Capacity Transit Study dated June 2003.
SR = State Route
TOD = Transit-oriented development
RTP = Regional Transportation Plan
RPTA – Regional Public Transportation Authority

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## 4.5 Summary of Findings

As shown in Table 13, findings of the preliminary screening indicated a number of candidate station areas with an overall ranking of “Excellent”. Station areas that ranked “Excellent” were generally in locations with mixed land use patterns where local plans and policies support transit and/or transit-oriented development, and where a high level of intermodal connectivity exist. Station areas identified with a “Good” overall ranking generally were associated with a higher residential land use component, which suggests both potential constraints with land use compatibility as well as positive ridership potential. Station areas that ranked “Good” also tended to have fewer activity centers and fewer connection options to other modes of travel. Station areas associated with a “Fair” ranking generally had no or few intermodal connectivity opportunities or low populations.

**Table 13: Summary of Preliminary Screening**

| Commuter Rail Corridor | Candidate Station Area | Location | Preliminary Evaluation Rating |
|---|---|---|---|
| | | | |
| All Corridors | Downtown Phoenix | Union Station | Excellent |
| | Sky Harbor Airport | 38th Street | Good |
| | Downtown Tempe | 3rd Street/Ash Avenue | Excellent |
| | *East Tempe | Price Road/Loop 101 PNR | Good |
| | *Downtown Mesa | Broadway Road/Center Street | Good |
| | *Mesa-McQueen Junction | Baseline Road/Center Street | Good |
| | | | |
| Kyrene Line | Central Tempe | Southern Avenue/Kyrene Road | Good |
| | South Tempe | Elliot Road/Kyrene Road | Good |
| | West Chandler | Chandler Boulevard/56th Street | Good |
| | | | |
| San Tan Line | Downtown Gilbert | Gilbert Road/Union Pacific Railroad | Good |
| | Gateway/ASU Poly | Power Road/Rittenhouse Road | Good |
| | Downtown Queen Creek | Ellsworth Road/ Rittenhouse Road | Good |

*Denotes Candidate Station Areas in San Tan Line Corridor Only
Source: AECOM, 2018.

# 5.0 NEXT STEPS

Ridership forecasting will be conducted, and these results will assist in determining adjustments in stations that would optimize ridership on the line(s). Station areas may be refined or eliminated based on those results, or segments or branches may be prioritized.

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# MARICOPA ASSOCIATION OF GOVERNMENTS
# REGIONAL COMMUTER RAIL SYSTEM STUDY UPDATE

## Appendix D: Conceptual Commuter Rail Design Concepts
## (From 2010)

## May 2018

## (Included Under Separate Cover)

The Design Concepts have not been updated since the 2010 Study.
The Design concepts will need to be revisited during subsequent phases of project development.

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# MARICOPA ASSOCIATION OF GOVERNMENTS
# REGIONAL COMMUTER RAIL SYSTEM STUDY UPDATE

## Appendix E: Railroad Conditions and Issues

## May 2018

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# 1 INTRODUCTION

This technical memorandum inventories existing railroad conditions for the Maricopa Association of Governments (MAG) Regional Commuter Rail System Study Update. It includes a description of the physical characteristics of each rail line, such as length, freight operations, rail facilities, and road and bridge crossings. This document also describes the potential physical constraints along each corridor that may impact the implementation of future commuter rail service.

# 2 GRAND LINE CORRIDOR

## 2.1 Existing Railroad Conditions

The BNSF Railway (BNSF) line is single track with a few passing sidings. There is no railroad signal system, referred to as Dark Territory, and train movements are authorized and controlled using Track Warrant Control (TWC), a means of controlling train movements without wayside signals. Maximum operating speed is limited to 49 mph for all trains, both freight and passenger, in accordance with the system timetable. Approximately 10 to 12 through trains and local trains are currently operated per day over the line.

The Arizona & California Railroad (ARZC) has trackage rights over the portion of the line between Matthie (north of Wickenburg at Milepost 135.0) and Mobest Yard (west of downtown Phoenix at MP 191.6). However, since its inception in May 1991, the ARZC has exclusively used the Castle Hot Springs siding (MP 150.3) at Morristown, Arizona in order to swap trains with BNSF. BNSF also interchanges cars with Union Pacific Railroad in downtown Phoenix.

BNSF operates Mobest Yard (MP 191.6) near downtown Phoenix, Phoenix Yard (MP 193.7) between 9$^{th}$ and 17$^{th}$ Avenues, the BNSF Intermodal Facility in Glendale (MP 183.7), and an automobile trans-load facility in El Mirage (MP 174.1).

The Ennis Subdivision extends from Ennis (MP 173.6) on the Phoenix Subdivision to Fennemore, a distance of nine miles. The City of Surprise is working with BNSF and private developers to create a new industrial park along the Ennis Subdivision (Source: State of Arizona Railroad Inventory and Assessment, 2007 by RL Banks/ADOT). The Webb Spur connects the Ennis Subdivision with Luke Air Force Base, a distance of approximately two miles. However, the south end of the Webb Spur into Luke Air Force Base has been severed by a roadway project.

The BNSF right-of-way varies from 75 feet to 200 feet in width, with 200 feet being predominant. There are five passing sidings, numerous switching leads, and 44 bridges between Wickenburg (milepost 139.6) and downtown Phoenix (milepost 193.7). There are also 18 grade separations (nine overpasses and seven underpasses), 46 public, and five private crossings in the corridor. Three of the public crossings (Meeker Boulevard, RH Johnson Boulevard., and 163$^{rd}$ Avenue) are designated quiet zone crossings. Five of the public crossings are among the top 15 worst crossings for train/automobile accidents in the county. The Federal Railroad Administration list was based on the number of incidents in which trains and vehicles collided, or where people were hit by a train. These crossings include:

- West Thomas Road, east of 27$^{th}$ Avenue in Phoenix;
- North 27$^{th}$ Avenue, west of Thomas Road in Phoenix;

- North 35th Avenue, just south of U.S. 60 and West Indian School Road in Phoenix,
- 43rd Avenue and Grand Avenue in Glendale;
- 51st Avenue and Bethany Home Road in Glendale.

## 2.2 Railroad Facilities

Major BNSF facilities in the corridor include the following:

- **Mobest Yard** is located near the intersection of McDowell Road and Grand Avenue in Phoenix and serves as the primary yard for BNSF along the Phoenix Subdivision. The yard was built in 1895 and is 3,000 feet long. BNSF's fueling and sanding facility, turntable, locomotive inspection and repair pits, freight car inspection and repair, and crew facilities are all located within Mobest Yard.
- **The BNSF Intermodal Facility** is located near the intersection of Camelback Road and Grand Avenue. This location is used to transfer freight between trains and trucks. According to the "State of Arizona 2007 Railroad Inventory and Assessment" this facility has a capacity of between 100,000 and 250,000 lifts per year.
- **The Alhambra Yard** is located near Indian School Road and Grand Avenue. The yard is used to store empty cars and for staging of loaded cars for local customers. Some classification work (switching) is also done at the yard.
- **The Glendale North/South Yards** are located between Glendale Avenue and Bethany Home Road. The yards are used for staging loaded and empty cars for local customers. The BNSF would like to connect the two yards in order to provide longer yard tracks.
- **The BNSF Automobile Distribution Center** is located near Thompson Ranch Road and Grand Avenue. This location is used for the distribution of incoming automobiles from freight trains to the Greater Phoenix Area.
- **Ennis Wye** is located off of the Phoenix Subdivision near El Mirage Road and Grand Avenue and was built between 1928 and 1938. The most common commodities carried along the spur include natural gas, fertilizer, and lumber. The maximum speed along the Ennis Wye is 10 miles per hour.
- **A new spur** is being constructed at 83rd Avenue in Peoria in conjunction with Wal-Mart.

## 2.3 Railroad Issues Potentially Impacting Commuter Rail in the Grand Corridor

Potential BNSF actions or changes to tracks or facilities were examined that could impact the proposed Grand Line Corridor commuter rail service. Two of these issues include the BNSF Mobest Yard and the BNSF Intermodal Facility near downtown Phoenix either remaining at their existing locations or, being relocated to a new locations northwest of Surprise. A third potential issue involves the number of at-grade crossings between Phoenix and Glendale and a fourth involves the Hassayampa River Preserve located south of Wickenburg.

### 2.3.1 BNSF Mobest Yard and BNSF Intermodal Facility Remain

If the BNSF Mobest Yard and the BNSF Intermodal Facility near downtown Phoenix remain at their existing locations, the speed of the commuter rail trains will be slowed considerably due to the congestion at each of these BNSF facilities. The current operating speed in the vicinity of

these facilities is limited to yard speed, which is 20 mph. Freight trains are currently assembled on the mainline due to the limited length of the yard tracks. In addition, space is at a premium for the construction of a second main line track. Because both of these facilities are adjacent to Grand Avenue, the potential exists for either having to perform major construction to Grand Avenue or to obtain the nearest yard track from BNSF.

While benefits would accrue to commuter rail operations if these facilities were to be relocated, this Operations Plan assumes that these BNSF facilities will remain at their current locations.

### 2.3.2 BNSF Mobest Yard and BNSF Intermodal Facility Relocated

If the BNSF Mobest Yard and the BNSF Intermodal Facility were to be relocated to a new site in Surprise, rail congestion would be significantly reduced, space would be available for another main line track, commuter rail train speed could be increased, re-construction of Grand Avenue could be avoided, and Mobest Yard could potentially become the location of the maintenance facility for commuter rail operations. BNSF would not relocate all of the capability of the Mobest Yard due to the need to serve customers in the area.

### 2.3.3 At-grade Crossings between Phoenix and Glendale

The frequency and complexity of the at-grade highway/railroad crossings between Phoenix and Glendale pose a potential safety hazard, a source of increased traffic delay, and reduced commuter rail train speeds due to congestion. While eight crossings have been grade-separated, 25 more remain at-grade. Many of the remaining crossings are located in close proximity to one another. As previously noted, five of the public crossings are among the top 15 worst crossings for train/automobile accidents in the country. Additional grade separations and/or road closures/modifications may be necessary in order to alleviate the potential concerns, many of which were described in the MAG COMPASS Study (as summarized on the following page).

**MAG COMPASS Study**

Many of the improvements are included within the MAG COMPASS Study, which designed to mitigate traffic with new grade separations and signaling. Recommendations for new or substantially improved grade separated intersections in the MAG COMPASS study area included:

- **19th Avenue/McDowell Road**: McDowell Road remains as at-grade crossing of 19th Avenue, Grand Avenue, and the BNSF rail line. McDowell Road is planned to be grade separated over 19th Avenue, Grand Avenue, and the BNSF rail line, while the 19th Avenue/ Grand Avenue intersection is proposed to become a roundabout.
- **I-17**: I-17 is four lanes in both directions and it is grade separated below Grand Avenue and the BNSF rail line. Grand Avenue is currently two lanes in each direction, but proposed to become three lanes in each direction.
- **35th Avenue/Indian School Road**: Indian School Road has been grade separated over 35th Avenue, Grand Avenue, and the BNSF rail line; 35th Avenue is an at-grade crossing planned to be grade separated over Grand Avenue and the BNDFS rail line.
- **51st Avenue/Bethany Home Road**: 51st Avenue has been grade separated over Bethay Home Road, Grand Avenue, and the BNSF rail line; Bethany Home Road is an at-grade crossing planned to be grade separated over Grand Avenue and the BNSF rail line.
- **67th Avenue/Northern Avenue**: 67th Avenue has been grade separated over Northern Avenue, Grand Avenue, and the BNSF rail line; Northern Avenue is an at-grade crossing planned to be grade separated over Grand Avenue and the BNSF rail line.
- **75th Avenue/Olive Avenue**: Olive Avenue has been grade separated over 75th Avenue, Grand Avenue, and the BNSF rail line; 75th Avenue is an at-grade crossing planned to be grade separated over Grand Avenue and BNSF rail line.
- **Peoria Avenue and 83rd Avenue**: Peoria Avenue and 83rd Avenue remain as at-grade crossings but both are planned to become grade separated as Grand Avenue and the BNSF rail line would be depressed under a cap between Peoria Avenue and 83rd Avenue (where a public space would be created).
- **91st Avenue**: 91st Avenue remains as an at-grade crossing but is planned to be grade separated over Grand Avenue and the BNSF rail line.
- **99th Avenue**: 99th Avenue remains as at-grade crossing; planned to be grade separated over Grand Avenue and BNSF rail line.
- **103rd Avenue Overpass**: 103rd Avenue remains as at-grade crossing; planned to be grade separated over Grand Avenue and BNSF rail line.
- **107th Avenue/Del Webb Boulevard**: 107th Avenue/Del Webb Boulevard remains as at-grade crossing; this intersection is planned to be grade separated as 107th Avenue/Del Web Boulevard would be depressed under Grand Avenue.
- **111th Avenue Overpass**: 111th Avenue remains as at-grade crossing; planned to be grade separated over Grand Avenue and BNSF rail line.
- **Bell Road**: Bell Road is now grade separated over Grand Avenue and the BNSF rail line.

### 2.3.4 Hassayampa River Preserve (Future Extension to Wickenburg)

The BNSF Grand Corridor runs through the Hassayampa River Preserve south of Wickenburg for approximately eight miles. The track is located along bluffs and the river through the preserve and access to the railroad is very limited. A potential issue is that it will either be very costly to construct sidings or a second mainline track through this area should it be necessary. Any construction on the river side of the existing track will likely be prohibited through the preserve. However, in lieu of double tracking or excavating any of the bluffs through the Hassayampa Canyon Preserve should traffic warrant it, a potential solution could be to reactivate Allah siding (milepost 143.7). This siding was approximately 1,250 feet long, but was removed in the 1970s. The roadbed of this retired siding is still present, and establishing a new passing track potentially entitled 'Hassayampa' would allow a meeting point halfway between Castle Hot Springs and Wickenburg.

# 3 ESTRELLA LINE CORRIDOR

The Estrella Corridor is located along the 136-mile western portion of the 208-mile Phoenix Line of Union Pacific Railroad. The Estrella Corridor extends from downtown Phoenix at milepost 906.0 to Arlington at milepost 861.3, a distance of 45 miles. The remainder of the line from Arlington to Wellton (milepost 770.0) is not used beyond milepost 855.1, located approximately six miles west of Arlington. The Phoenix Line formerly hosted Amtrak's Sunset Limited, but since June 1996, the train uses the Gila Line, or Sunset Route, south of Phoenix. Commuter Rail service in this System Study Update is planned to terminate in Buckeye

## 3.1 Existing Railroad Conditions

The line is single track with passing sidings located at 23rd Avenue in Phoenix (3,661 feet in length), at 107th Avenue in Avondale (4,825 feet in length), at Litchfield Road in Goodyear (3,595 feet in length), in Buckeye (3,707 feet in length), in Dixie (3,537 feet in length), and in Arlington (3,628 feet in length). The line is signaled with Automatic Block Signaling (ABS) and is dispatched by Direct Traffic Control (DTC). The maximum operating speed was 50 to 60 mph for passenger trains, when Amtrak used this portion of the line.

The Estrella Corridor is a single track with a few sidings, frequent industrial leads, and spur tracks. In addition to the multitude of industrial lead and spur tracks, there are 45 public crossings, no private crossings, and three overpasses and underpasses on the line. There are also 56 bridges between Union Station and the Palo Verde Power Plant located just west of Arlington.

Freight traffic on the Estrella Corridor consists of local traffic only as through freight trains use the Gila Line south of Phoenix. Freight cars are delivered and picked up from customers along the line and an average of four to six local freight train movements per day are estimated to be operated along the Estrella Corridor.

## 3.2 Railroad Facilities

Union Pacific Railroad facilities located throughout the corridor include:

- **Union Station** is located near milepost 906.0 at the intersection of 4th Avenue and Harrison Street in downtown Phoenix. It served as the main station for Amtrak passenger service in downtown Phoenix until 1996 when service was stopped.

- **Campo Yard** is located at milepost 902.0 between 43rd Avenue and 35th Avenue in Phoenix and holds 12 sets of tracks. It is located in the middle of many industrial uses and has adjacent spurs that extend both north and south to serve these customers. Should commuter service be implemented, freight traffic to these locations could be impacted based on the potential schedule conflicts.

- **Litchfield Junction** was located near the intersection of Litchfield Road and SR 85 immediately southeast of the Phoenix Goodyear Airport at milepost 889.3 until it was removed in spring 2010. The 2.5-mile Litchfield Industrial Lead connected the City of Goodyear at Litchfield Jct. with the City of Litchfield Park. The north-south line was built in the 1920s to serve primarily agricultural and other local heavy industries. The lead was a single track, non-signaled line composed of 90 pound rail (rolled 1918-1974) with a maximum track speed of 20mph. One customer was served on this line as of late 2006; however, it relocated to a new facility on the Estrella Corridor mainline, which permitted the Union Pacific Railroad file with the Surface Transportation Board to abandon the branch. In 2009, abandonment was granted by the STB. The entire branch was removed and scrapped.

- **Buckeye Yard** is located at milepost 875.7, just east of the intersection of Baseline Road and Miller Road in Buckeye. The former Buckeye depot site-footprint north of the tracks could be used as a potential commuter rail station location as it has ample room for parking and is located close to historic downtown Buckeye. The current Buckeye yard serves customers in the Buckeye area and freight service may be disrupted by passenger rail. All of the existing customers are located on the south side of the tracks, away from the historic passenger station site.

Union Pacific Railroad through Buckeye Yard site
Source: MAG

- **Palo Verde Nuclear Power Plant Spur** is located at milepost 859.3, west of the proposed end of line in the future extension to Arlington. This spur is a single track that serves the nuclear power generation plant. Future commuter service may impact freight traffic coming from the east to serve this destination.

## 3.3 Railroad Issues Potentially Impacting Commuter Rail in the Estrella Corridor

A single issue may potentially impact the implementation of commuter rail service in the Estrella Corridor involving the Campo Yard, located west of Union Station at milepost 902.0. It is an industrial yard used to serve local industries where rail cars coming from local industries are assembled into trains and rail cars going to local customers are broken down from incoming trains. Due to limited right-of-way, routing commuter rail tracks through or around the facility without interfering with the yard activities will be challenging.

# 4 SAN TAN LINE CORRIDOR

The San Tan Corridor constitutes 36 miles of the southeastern portion of the 208-mile Phoenix Line of the Union Pacific Railroad. The Phoenix Line formerly hosted Amtrak's Sunset Limited, but since June 1996, the train uses the Gila Line, or Sunset Route, south of Phoenix.

## 4.1 Existing Railroad Conditions

Freight traffic on the San Tan Corridor consists of local traffic only. Those trains destined for areas not in the MAG region use the Gila Line south of Phoenix. The southeast line between Phoenix and Queen Creek is used by all trains serving the MAG region including those that serve Phoenix by operating out of Tucson. An average of six to eight trains currently operate daily over the San Tan Corridor and operations in and out of the Phoenix area may change once the new Red Rock Yard, located east of Picacho Peak along I-10, is operational. Freight cars are interchanged between Union Pacific Railroad, the Copper Basin Railway and the Magma Arizona Railroad at Magma (east of Queen Creek).

The San Tan Corridor is the route used by all Union Pacific Railroad trains operating to or from the Phoenix area and extends from Central Phoenix at milepost 906.0, to Queen Creek at milepost 938.1, a distance of approximately 32 miles. The line is a single track with four sidings with lengths of 3,835 feet at Tempe; 3,972 feet at Mesa; 2,500 feet at the McQueen Junction; and 5,785 feet at Germann Road. In addition to these sidings, a junction with the Tempe Branch at Tempe Junction (milepost 915.3) and a junction with the Chandler Branch at McQueen Junction (milepost 923.6) also occur on the Phoenix Subdivision. The railroad right-of-way is generally 100 feet throughout the Phoenix Subdivision.

The southeast portion of the San Tan Corridor is controlled by Direct Train Control (DTC), which controls train movements through a dispatch system without the use of wayside signals. In addition to DTC, Automatic Block Signals (ABS) is also used to control train movement throughout the San Tan Corridor. The maximum operating speed is 60 mph for passenger trains.

There are 49 public crossings, five private crossings, 19 overpasses and underpasses, and 16 bridges between Union Station and Queen Creek. In 2010, Union Pacific Railroad installed new 139lb continuous welded rail throughout the San Tan Corridor on the mainline between downtown Phoenix and Queen Creek.

## 4.2 Railroad Facilities

Union Pacific Railroad facilities located on the San Tan Corridor include the Harrison Street Yard (milepost 907.0) located between the 7$^{th}$ Street and 16$^{th}$ Street viaducts, an intermodal facility and an automobile facility located south of, and adjacent to, Harrison Yard, Tempe Yard located at Guadalupe Road, and Mesa Yard located at Country Club Drive.

## 4.3 Railroad Issues Potentially Impacting Commuter Rail in the San Tan Corridor

### 4.3.1 Harrison Street Yard

A single issue may potentially impact the implementation of commuter rail service in the East Valley Corridors of the Systems Study. The Phoenix Harrison Street Yard is located between 7$^{th}$ and 16$^{th}$ Streets in downtown Phoenix at MP 907.0 and consists of a rail yard, intermodal

facility, and an automobile transload facility. Union Pacific Railroad uses the mainline while trains are being made up or broken down from incoming trains. Due to limited right-of-way, routing two commuter rail tracks through or around the facility without interfering with the yard activities would be challenging. However, upgrading two tracks on the north side of the yard may be the most appropriate method in enhancing east-west movement without interfering with car switching and freight yard activity.

### 4.3.2 Tempe Bypass or Trench Design Options

During the *ADOT Arizona Passenger Rail Corridor Study: Tucson to Phoenix* (APRCS), a bypass option emerged in Tempe that would transition the rail line onto an elevated alignment following SR 202 from about Mill Avenue (where the original alignment would turn south over the Salt River) to SR 101, then continuing south on SR 101 where it would reconnect to the original alignment south of Apache Boulevard. The elevated bypass would be approximately 4.5 miles in length. However, the bypass option would only re-route passenger trains and would provide no benefit to the community in terms of the number of at-grade crossings for freight trains.

More recently, there has been a new idea of remaining within the original URRR alignment but trenching the segment between the Salt River and SR 101. From the west, a trench would likely begin south of University Drive and then come back up to grade level before reaching SR 101 on the east. This segment is approximately 3.5 miles in length and could allow a short segment of the Kyrene Line to be trenched to North of Broadway. A trenched alignment would likely require several street closures and new bridge crossings over the rail line, which would likely include 13th Street, Mill Avenue, College Avenue, Rural Road, and McClintock Drive. Mill Avenue and McClintock Drive are grade-separated with the rail line crossing over both on bridge structures. The trench option would lower the number of at-grade crossings, which would be seen as a benefit to the community that lies adjacent to this area.

# 5 KYRENE LINE CORRIDOR

The Kyrene Line is a 19 mile corridor from Phoenix Union Station to the Wild Horse Pass/I-10 Station. This includes a portion of the 208-mile Phoenix Line, and also includes the 9.7-mile Tempe Branch, of the Union Pacific Railroad.

## 5.1 Existing Railroad Conditions

Freight traffic on the proposed Kyrene Corridor consists of local traffic only. Freight service on the Tempe branch is essentially on an as needed basis as a small industrial park is located at the end of the proposed Kyrene Corridor. Freight traffic is delivered and received from various customers along this branch line.

The Kyrene Corridor stretches 19 miles from Phoenix Union Station to the Wild Horse Pass/I-10 Station. This corridor is divided into two segments consisting of 9.3 miles between Union Station and the Tempe Junction and another 9.7 miles with one mile of new track extending to the suggested end of line station at Wild Horse Pass/I-10. The Tempe Branch section of the corridor, also known as the Tempe Industrial Lead, begins at milepost 915.3 at Tempe Junction and ends at milepost 923.1 in West Chandler. On-line customers exist throughout this portion of the corridor but especially between mileposts 916 and 917. In addition, an industrial park extends south beyond the end-of-line for another 1.5 to 2.0 miles.

The Kyrene Corridor is a single track branch with a maximum operating speed of 20 miles per hour. Operation along this branch is controlled by Absolute Block Register designed to monitor train movement along the single track line. Absolute Block Register is used on low traffic lines and involves a train crew registering before using the line and signing off when leaving the line. Only one train at a time is allowed in Absolute Block Register territory.

Throughout the Kyrene Corridor, the track design consists primarily of continuous welded rail of various sizes (112lb-133lb) on wood ties. In 2010, Union Pacific Railroad installed new 139lb continuous welded rail within the Kyrene Corridor on their mainline between downtown Phoenix and Tempe Junction. The recycled welded rail was installed by Union Pacific Railroad in 1999-2000 from Tempe Junction to the end of track at Allison Road (approximately 9 miles). With the exception of the rail located in the industrial park, all of the 21 turnouts located on the branch consist of 10-lb rail. Much of the ballast is fouled with dirt and other materials. There is one bridge (pre-stressed concrete box, 201 feet in length) across US Highway 60 and seven culverts on the branch as well as a total of nine at-grade railroad/highway crossings and one at-grade pedestrian crossing. There are an additional seven at-grade crossings and one highway overpass (SR 202) in the Industrial Park segment. Most of the at-grade crossings on the branch are equipped with active warning devices consisting of bells, flashers, and gates and also have concrete panel crossing surfaces. The crossings in the Industrial Park have passive warning devices consisting of railroad cross-bucks and highway yield signs.

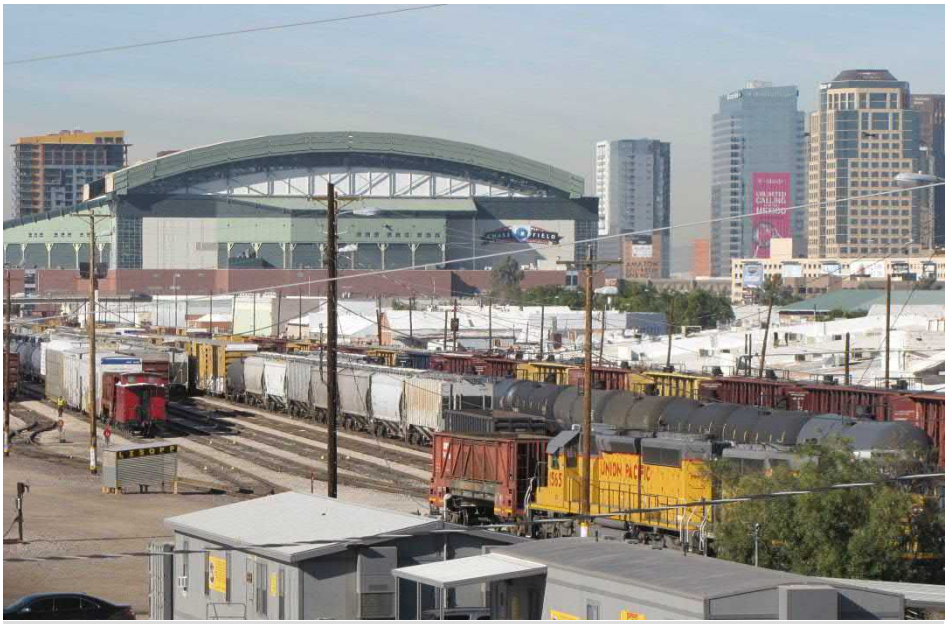
There are 15 public crossings, two private crossings, one overpass, and one bridge on the Tempe Branch. Sections of corridor are being equipped with Quiet Zone appliances and a future, parallel pedestrian corridor is planned for the Tempe section of the right of way.

## 5.2 Railroad Facilities

Union Pacific Railroad facilities located on the Kryene Corridor include the Harrison Street Yard (milepost 907.0) located between the 7$^{th}$ Street and 16$^{th}$ Street viaducts, an intermodal facility and an automobile facility located south of, and adjacent to, Harrison Yard, Tempe Yard located at Guadalupe Road, and Mesa Yard located at Country Club Drive.

## 5.3 Railroad Issues Potentially Impacting Commuter Rail in the Kyrene Corridor

A single issue may potentially impact the implementation of commuter rail service in the East Valley Corridors of the Systems Study. The Phoenix Harrison Street Yard is located between 7$^{th}$ and 16$^{th}$ Streets in downtown Phoenix at MP 907.0 and consists of a rail yard, intermodal facility, and an automobile transload facility. Union Pacific Railroad uses the mainline while trains are being made up or broken down from incoming trains. Due to limited right-of-way, routing two commuter rail tracks through or around the facility without interfering with the yard activities would be challenging. However, upgrading two tracks on the north side of the yard may be the most appropriate method in enhancing east-west movement without interfering with car switching and freight yard activity.



Union Pacific Railroad's Phoenix Harrison Street Yard is the largest in the Valley. Downtown Phoenix' skyline rises to the west.
Source: MAG.

# MARICOPA ASSOCIATION OF GOVERNMENTS
# REGIONAL COMMUTER RAIL SYSTEM STUDY UPDATE

## Appendix F: Commuter Rail Vehicle Technology

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# 1.0 COMMUTER RAIL VEHICLE TECHNOLOGY

The project team evaluated Locomotive Hauled Coaches (LHC) and Diesel Multiple Unit (DMU) technologies to determine which type of commuter rail vehicles would be most appropriate for the MAG commuter rail system. The evaluation primarily took into account the feasibility of implementing LHC vs. DMU. In 2010, an “off-the-shelf” DMU that would be appropriate for use in the Phoenix region was not available. At that time, Colorado Railcar/US Railcar (see discussion below) had announced its intention to manufacture DMUs for the US market, and subsequently, DMUs were produced for South Florida’s Tri-Rail (connecting Miami, Fort Lauderdale and West Palm Beach) and TriMet in Portland for their Westside Express Service (or WES). The project team’s preliminary recommendation was to assume the use of LHC as the commuter rail technology for the MAG system in the 2010 Study.

Since the 2010 Study, Nippon Sharyo and Stadler Rail Group have introduced new FRA-Compliant DMUs in several US cities as described below.

The following white paper describes LHC and DMU vehicle technology options, discusses FRA regulatory compliance, discusses peer city experiences with both technologies, summarizes the evaluation of the two vehicle alternatives, and (4) describes factors to consider in the purchase of equipment.

## 1.1 Vehicle Technology: Alternatives

**LHC:** Most commuter rail systems in the United States use LHCs. LHCs are powered by one diesel-electric locomotive engine and are configured for push-pull operation. In push-pull service, the locomotive pulls the train in one direction and pushes the train in the opposite direction. A cab car with operating controls is put on one end of the train and a locomotive at the other end. LHCs can range between 2-car and 12-car consists, depending on ridership needs.

The seated capacity of each double-deck passenger car, typically used in LHC commuter rail operations, is approximately 140 passengers; therefore, a four-car train (three coaches and one cab control car) would seat approximately 560 passengers.

The San Diego Coaster (left) LHCs connect downtown San Diego to Oceanside, CA. Seattle’s Sounder (right) connects Everett and Lakewood to downtown Seattle. Both lines use a locomotive (left) for power in both directions and a cab control car for operations in the reverse direction. Source: NCTD (left), Sound Transit (right).

**DMU:** A DMU vehicle is powered by a diesel motor rather than a locomotive. Unlike traditional LHCs that pull or push passenger cars, DMU vehicles are self-propelled passenger cars with engines usually placed underneath or between the passenger compartments. As rail vehicles are added, the power available to move the train increases by the necessary amount because each vehicle is self-propelled, (though powered cars can be used in combination with non-powered coaches). Non-powered vehicles are used to increase train capacity when topography does not dictate the need for all vehicles to be powered. DMUs can accelerate faster than LHCs and can be more efficient in corridors that only require short train sets because they eliminate the need to operate a locomotive for only a few passenger cars. DMUs are found throughout Europe and in several transit systems in the Unites States. Many of the DMU's operated in the United States are not FRA-compliant and therefore would not be suitable for the MAG system. However, in recent years, Nippon Sharyo and the Stadler Rail Group have introduced new FRA-Compliant DMUs into the US market.

Nippon Sharyo introduced a new FRA-Compliant DMU for the Sonoma-Marin Area Rail Transit (SMART) in Sonoma and Marin Counties, California (as well as for the Union Pearson Express in Toronto, Ontario, Canada). The vehicles are compliant with FRA's Tier 1 crashworthiness standards. The first cars were delivered in 2015 and service began in August 2017. The Stadler Rail Group has also introduced an FRA-Compliant DMU for use on the TEX Rail line between downtown Fort Worth and Dallas-Fort Worth International Airport (DFW Airport), scheduled to open in 2018. The FLIRT rail cars meet the new Alternate Vehicle Technology (AVT) requirements of the FRA and can operate in mixed traffic with freight trains. Stadler had previously supplied several communities including New Jersey (River Line) Austin, TX (Capital MetroRail Red Line) and Denton County, TX (A-Train) with their GTW series. However, these DMUs were not fully FRA-Compliant and required time separation with freight traffic.

The seated capacity of one DMU vehicle ranges from approximately 90 passengers for a single-vehicle and up to 240 passengers for the TEX Rail consist, with additional standees being able to be accommodated.

The SMART DMUs connecting Santa Rosa and downtown San Rafael, CA (left) operate two-car trainsets, which can be expanded. The TEX Rail DMUs (right) will be operated in four-car consists between downtown Fort Worth and Dallas/Fort Worth International Airport.
Source: SMART (left), TEX Rail (right).

## 1.2 Vehicle Technology: FRA (Federal Railroad Administration) Regulatory Compliance

An important factor in considering rail technology is compliance with FRA regulation 49CFR Part 229 and Part 238 related to structural and safety regulations and standards. Rail vehicles that meet the federal requirements for crashworthiness can share tracks with freight trains and operate concurrently with freight traffic. All LHC coaches are FRA-compliant, but only the DMU vehicles described above are FRA-compliant. As noted above, Colorado Railcar produced FRA-compliant DMU vehicles that are currently in use on two transit systems: South Florida's Tri-Rail and Portland's WES commuter rail. The company went out of business in early-2009 and US Railcar acquired the Colorado Railcar DMU and while it had intended to resume manufacturing both single-level and bi-level rail vehicles, no new contracts have been secured to date.

Today, both the Nippon Sharyo vehicle and the Stadler FLIRT vehicle are both FRA-compliant and could be used for service in the MAG region with no special wavers required as had previously been the case with other DMU vehicles.

## 1.3 Peer City Experience with both Vehicle Technologies

The Table below compares the vehicle technologies from several peer city commuter rail lines that have been implemented relatively recently.

**Table 1: Peer City LHC Vehicles Features and Acquisitions**

| Commuter Rail Corridor | Year Opened | Seating Capacity | Manufacturer | Purchase Year and Cost |
|---|---|---|---|---|
| **Locomotive Hauled Coach Technology** | | | | |
| Northstar, Minnesota MN | 2009 | 140 seated passengers | **Locomotives**: Motive Power, Inc.<br>**Passenger cars**: Bombardier Bi Level Coaches | **Purchase Year**: 2008/2009<br>**Locomotives**: $2.6 million (part of a larger and more cost-efficient contract with multiple transit systems across the country) |
| Sounder, Seattle WA | 2000 | 140 seated passengers | **Locomotives**: General Motors<br>**Passenger cars**: Bombardier Bi Level Coaches | **Purchase Year**: 2001<br>**Locomotives**: $2.4 million<br>**Coaches and cab cars**: $1.84 million |
| FrontRunner, Salt Lake City UT | 2008 | 136 seated passengers | **Locomotives**: Motive Power, Inc.<br>**Passenger cars**: Bombardier Bi Level Coaches | **Purchase Year**: 2008<br>**Coaches and cab cars**: $2.2 million |
| RailRunner Express, Albuquerque NM | 2006 | 151 seated passenger | **Locomotives**: Motive Power, Inc.<br>**Passenger cars**: Bombardier Bi Level Coaches | **Purchase Year**: 2006 |
| **Diesel Multiple Unit Technology** | | | | |
| SMART, Sonoma/ Marin County CA | 2017 | 150 seated passengers per train | **Trainset**: Nippon Sharyo DMU | **Purchase Year**: 2015<br>**Two-Car Trainset**: $6.67 (future railcars may be purchased for $2.9 M per car) |
| TEX Rail, Fort Worth TX | Planned late 2018 | 240 seated passengers per train | **Trainset**: Stadler Rail Group FLIRT | **Purchase Year**: 2015<br>**Four-Car Trainset**: $12,500,000 |

Source: AECOM, 2018.

## 1.4 Recommended Vehicle Technology for the Phoenix Commuter Rail System

**Future Considerations:** While in 2010 the most prudent vehicle technology recommendation was only to pursue the implementation of LHCs for the Phoenix region, it is now recommended that MAG continue to monitor the rail industry for the development and implementation of FRA-compliant DMU vehicles. This is now especially true given the SMART and TEX Rail lines in California and Texas, respectively. With more agencies using DMUs, the costs will become more consistent.

### 1.4.1 Vehicle Features

**Clean Diesel Technology:** Locomotive engines have historically been significant contributors to air pollution, emitting large amounts of nitrogen oxides and particulate matter. New EPA Clean Diesel Standards, however, will reduce pollution by locomotives by (1) decreasing allowable levels of sulfur in fuel used in locomotives by 99 percent; and (2) cutting particulate matter emissions from diesel engines by as much as 90 percent and oxides of nitrogen (NOx) emissions by as much as 80 percent.

In 2009 the Maryland Area Regional Commuter (MARC) rail system replaced their 1970's era locomotives with 26 new locomotives designed to reduce both emissions and fuel consumption. The new fleet of "green" locomotives will reduce emissions of nitrous oxide by 42%, carbon monoxide by 70% and particulates, such as soot, by 67% over the current fleet. (Source: http://www.mtagogreen.com/mtagreen.html)

DMU vehicles are also being built using green technologies. For example, the Nippon Sharyo DMU used on the SMART line features the latest technology Cummins diesel engine, which is the first EPA Tier 4 Final compliant engine in North American rail service.

**Americans with Disabilities Act (ADA) Accessibility.** Any passenger rail car or vehicle operating in the United States must meet ADA requirements for vehicle accessibility. The requirement states that facilities must be "readily accessible to and usable by individuals with disabilities, including individuals who use wheelchairs." The most common methods for commuter rail ADA access are ramps or bridge plates, both of which could be operated manually or powered. Low-floor vehicles are also becoming more common and eliminating the need for wheelchair lifts or "high-block" loading areas at station platforms.

### 1.4.2 Vehicle Acquisition

Several options exist with respect to the acquisition of commuter rail vehicles, although with only the recent use of DMUs, this discussion is mainly geared toward the use of LHC technology, as there are numerous systems throughout the country that use these vehicles. The choice of which method of acquisition to use depends upon the importance of being able to select the specific vehicle desired, the source and availability of funds, and the required delivery schedule.

The basic options for MAG to procure commuter rail vehicles are to (1) purchase or lease new equipment or (2) purchase or lease used reconditioned equipment. New equipment is generally more expensive and has a longer lead time for delivery. Several transit agencies have chosen to utilize rebuilt and refurbished equipment in order to acquire vehicles at a lower capital cost and/or to expedite start up of commuter rail service. Finally, there have been recent examples of agencies using refurbished vehicles on opening day, while new vehicles are procured, as was

the case for the Denton County Transportation Authority (DCTA) in Denton County, TX on the A-train.

**New Vehicles:** Purchasing new commuter rail vehicles may have several advantages, including longer life expectancy of the equipment, the ability to custom order specific vehicle features, and the ability to use FTA funding for vehicle procurement. Many transit agencies opt for purchasing new vehicles. Table 1 lists a few of the commuter rail systems that recently have purchased new equipment and the cost and features of the equipment.

One option to consider in the purchase of new vehicles is an “add-on or tack-on” order, which was the type of order used by Northstar Corridor Development Authority in the purchase of its rail vehicles. This type of order allows two or more transit agencies to combine their orders and buy a larger quantity of vehicles. An add-on order may reduce the cost per vehicle and shorten the lead time for the second transit agency as its order is produced at the end of the first agency’s order. The primary disadvantage to this approach is that the second agency has less choice about the features of its vehicle.

**Used Vehicles:** The sale and purchase of used equipment from one transit agency to another is commonplace. Examples of just a few systems that have purchased used commuter rail vehicles include Nashville’s Music City Star commuter rail, the Virginia Railway Express in northern Virginia, the TRE in Dallas/Fort-Worth, the A-Train in Denton County Texas’ and the Frontrunner in Salt Lake City. The following is a description of several used vehicle procurement transactions:

- In 2008, UTA added 25 refurbished former New Jersey Transit Comet I cars to the FrontRunner vehicle fleet. Bombardier Transportation refurbished the cars, updating the exteriors to match the FrontRunner’s distinctive paint design, updating the interiors to provide modern amenities while maintaining a vintage look, and equipping the rail cars with new heating, air conditioning and wireless internet systems.
- In 1993, thirteen rail diesel cars (RDCs) were purchased in the amount of $1.8 million each from VIA Rail Canada for use on the TRE between Dallas and Fort Worth. These cars had been built in the 1950s and used throughout Canada in intercity service. Over a 20-month period, the cars were redesigned and refurbished to accommodate longer distance commuting. The cars were stripped down to their stainless steel shell and remanufactured with new interiors, including high-back seats with armrests, luggage racks, floors, ceilings, walls, windows, and lighting.
- In 2009, the DCTA negotiated the lease of the TRE RDCs (described above) as interim vehicles to be used temporarily during the start up of their new commuter rail service between Dallas and Denton. In the meantime, DCTA purchased a fleet of new DMUs which went into operation after approximately eighteen months of the commuter rail being in service.

The cost for rehabilitating used rail vehicles is difficult to estimate due to differing conditions of the particular vehicles to be rehabilitated and differing requirements of the new owners. For instance, a transit agency may require power and/or USB outlets, wifi, work tables, bicycle racks or other amenities that will drive up the cost of the work. Used equipment may also have to be upgraded to incorporate the latest regulatory requirements. Another consideration in purchasing used equipment is that a rebuilt rail vehicle will not have the same life expectancy of a new vehicle, thereby requiring added replacement costs at some point in the future.

An important factor for MAG to consider is that purchasing used equipment is generally not preferred if FTA funding is involved.

## 1.5 Conclusions

In summary, the following recommendations can be drawn from the preceding vehicle technology assessment:

- The rail vehicle landscape has changed a great deal in the past couple of years with the implementation of the SMART commuter rail line (in 2017) and the upcoming TEX Rail line (in 2018), both of which are using FRA-compliant DMUs. While DMUs are now being used, LHCs have been used extensively in commuter rail systems across the country, and are an off-the-shelf proven technology.
- MAG should consider advancements in vehicle fuel technology, as well as other vehicle features, such as interior amenities and ADA accessibility equipment, in the planning and design of commuter rail operations. The development of LCH clean diesel technology is continuing to advance in response to new environmental regulations and more commuter rail systems throughout the US are updating their fleets with these fuel technologies.
- MAG should consider the following factors in the decision to acquire new or used commuter rail equipment: the importance of being able to select the specific rail vehicle desired, the source and availability of funds, and the required delivery schedule. As stated earlier, the pursuit of FTA funding for a commuter rail system may preclude the acquisition of used equipment. However, used equipment can be used initially to help open the system while a new equipment order is being fulfilled.

# MARICOPA ASSOCIATION OF GOVERNMENTS
# REGIONAL COMMUTER RAIL SYSTEM STUDY UPDATE

## Appendix G: Commuter Rail Operations Plan

**May 2018**

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# 1 System Study Update Corridor Descriptions

This section provides a general description of each of the proposed System Study Update corridors. It is important to note that the Grand Line and Kyrene Line will be operated as the Grand/Kyrene Line and the Estrella Line and San Tan Line will be operated as the Estrella/San Tan Line. In this appendix, the individual corridors are described separately in some sections.

## 1.1 Grand Line

The BNSF Railway (BNSF) line (that the Grand Line Corridor is proposed to operate on) is single track with a few passing sidings. There is no railroad signal system (often called Dark Territory) and train movements are authorized and controlled using Track Warrant Control (TWC). Maximum operating speed is limited to 49 miles per hour (mph) for all trains, both freight and passenger, in accordance with the system timetable.

## 1.2 Kyrene Line

The Kyrene Line Corridor stretches 18.0 miles along the Union Pacific Railroad line from Phoenix Union Station to the proposed end-of-line station at Wild Horse Pass/I-10. This single-track corridor is divided into two segments consisting of 9.3 miles between Union Station and the Tempe Junction and another 8.7 miles extending to the end-of-line station at Wild Horse Pass/I-10. The section of the corridor between Tempe Junction and Wild Horse Pass/I-10 is also referred to as the Tempe Branch or the Tempe Industrial Lead.

## 1.3 Estrella Line

The Estrella Line corridor is located along the 136-mile western portion of the 208-mile Phoenix Line of Union Pacific Railroad. The Estrella Line corridor extends from downtown Phoenix to Buckeye, a distance of approximately 30 miles. The remainder of the line from Arlington to Wellton is not used beyond approximately six miles west of Arlington. The Phoenix Line formerly hosted Amtrak's Sunset Limited, but since June 1996, the train uses the Gila Line, or Sunset Route, south of Phoenix.

## 1.4 San Tan Line

The San Tan Line corridor stretches approximately 31 miles from Phoenix Union Station (milepost 906.0) to downtown Queen Creek, and is considered part of the Union Pacific Railroad Phoenix Line route used by all Union Pacific Railroad trains operating to or from the Phoenix area. The San Tan Line proposed end-of-line is located at the intersection of Rittenhouse Road and Ellsworth Road in Queen Creek (milepost 941.6).

# 2 Commuter Rail Operations Plan

Commuter rail service over the proposed System Study Update corridors is proposed below. It is assumed that if commuter rail service is implemented on the Estrella/San Tan Line and Grand/Kyrene Line, that both lines will be operated as through service between Buckeye and Queen Creek and Wittmann and Wild Horse Pass/I-10 respectively.

This appendix shows the Operating Plan of the full build-out of the system. It should be noted that the initial year service could be operated with fewer trains and future service (beyond the 2040 horizon year) could be operated with additional trains, depending on ridership needs, freight operations, available funding, and railroad agreements.

## 2.1 Service Level

Commuter rail service would be operated on both lines with 30-minute headways during peak periods in both directions and 120-minute headways during off-peak periods on weekdays. Service would be operated 16.5 hours per day on weekdays and 12 hours per day on Saturdays. Special trains would be operated for major events and sporting events as appropriate. The daily service characteristics would be as follows:

| Service Period | Hours | Headways |
|---|---|---|
| *Weekdays:* | | |
| AM Peak | 5:00 a.m. – 7:30 a.m. | 30 minutes |
| Mid-day | 10:00 a.m. – 2:00 p.m. | 120 minutes |
| PM Peak | 3:30 p.m. – 6:30 p.m. | 30 minutes |
| Evening | 8:30 p.m. – 9:30 p.m. | 120 minutes |
| *Saturdays:* | | |
| Mid-day | 7:00 a.m. – 7:00 p.m. | 120 minutes |

## 2.2 Commuter Rail Technology

This study is now considering both locomotive-hauled coaches (LHC) and Diesel Multiple Unit (DMU) vehicle technologies to operate in the MAG region. Because the System Study commuter rail trains will operate over BNSF and Union Pacific Railroad trackage and right-of-way that is part of the National Railroad Network, the commuter trains will have to comply with the Federal Railroad Administration (FRA) requirements for structural and safety standards (49 CFR Part 238 and Part 229). There are now two FRA-compliant DMU vehicles that meet these requirements.

LHC trains would be operated in push-pull configuration with control cabs located on opposite ends of the train as the locomotive so the crew is always at the front of the train during operations. This arrangement does not require the train to be turned at each end of the route. DMU trains have control cabs at the end of each vehicle like light rail vehicles and can also be operated in both directions without the requirement of turning trains around at each end of the corridor. Commuter rail operations normally do not allow standees because of the typically longer trips and higher speeds than are usually experienced on light rail systems. Station platforms can be either low-level, eight inches above the top of the rail, or floor level boarding. For low-level boarding, ADA access requirements will be accomplished using portable ramps or bridge plates.

LHC trains would consist of a locomotive, one (up to) nine coaches, and one cab control car, depending on ridership projections. (There would likely be one to three coaches in the MAG region along with a cab control car.) The seated capacity of each passenger car is approximately 140; therefore, a three-car train (two coaches and one cab control car) would seat approximately 420 passengers, and the seated capacity of a four-car train (three coaches and one cab control car) is approximately 560 passengers.

DMUs built by Nippon Sharyo that serve the Sonoma–Marin Area Rail Transit (SMART) line in the California Bay Area operate in two-car trainsets. Each two-car train can seat 160 passengers. A very similar model of this DMU that operates in Toronto Canada is operated with three cars per trainset. DMUs are similar to light rail in that they usually operate with a maximum of four-car trainsets. The four-car TEX Rail trains built by Stadler can seat up to 440 passengers per train.

## 2.3 Travel Time and Schedule

The end-to-end travel times range between 66 minutes (DMU) and 73 minutes (LHC) on the Grand/Kyrene Line including stops at stations between Wittmann and Wild Horse Pass/I-10. On the Estrella/San Tan Line, end-to-end travel times range between 74 minutes (DMU) and 83 minutes (LHC) including stops at stations between Buckeye and Queen Creek.

Single corridor travel times to downtown Phoenix along the Grand Corridor range between 38 minutes (DMU) and 42 minutes (LHC). Travel times in the Kyrene Corridor range between 26 minutes (DMU) and 29 minutes (LHC) to downtown Phoenix.

Travel times in the Estrella Corridor to downtown Phoenix range between 34 minutes (DMU) and 39 minutes (LHC). Travel times to downtown Phoenix in the San Tan Corridor range between 37 minutes (DMU) and 41 minutes (LHC).

The station to station distances and travel times for both corridors are shown in Tables 1 through 4. At this level of analysis, travel times are conceptual and acceleration and deceleration rates are assumed to be constant. For example a train is assumed to accelerate to the maximum allowable speed in each segment between two stations. It would travel at this speed until braking at a constant rate for the next station. This method does not specifically take into account curves or other track conditions. To accommodate for these less than ideal track conditions, the maximum speeds were reduced in segments that have these conditions. So while a LHC or DMU train may operate at 79 mph, and the track conditions may allow for trains to operate at this speed, curves, railyards, and other conditions led the team to lower the maximum speed in a segment to account for these conditions.

Mathematically, the distance required to accelerate to maximum speed and the distance required to go from maximum speed back down to zero was subtracted from the total segment distance, and then it was assumed that trains would operate at maximum speed for the remainder of the segment. Commuter rail trains typically dwell for a longer period of time compared to light rail, so it was assumed that all stations would dwell for 30 seconds. One exception to this was at Phoenix Union Station. Because many commuter rail passengers will be destined for downtown Phoenix, this station was assumed to have a dwell of 3-minutes to allow for a large number of passengers to board and alight the train. While operations of commuter rail service focus on two cross-town corridors (Grand/Kyrene and Estrella/San Tan), it is understood that for much of the commuting public, the system would be used a four individual corridors, meaning most riders are expected to board the train during the AM peak period at a

suburban station, travel to downtown Phoenix and then make the reverse commute during the PM peak period.

Example train schedules for both corridors are shown in Tables 5 through 8. Graphic diagrams of the proposed train schedules are shown in the string-line diagrams provided in Attachments A-1 through A-4.

**Table 1: Calculation of Travel Times – Grand/Kyrene Line (LHC Vehicle Technology)**

| Station: | Station: | Distance | Max Speed | Accel. Rate (mph/s) | Accel. Time (sec) | Distance for Accel. (miles) | Decel. Rate (mph/s) | Decel. Time (sec) | Distance for Decel. (miles) | Distance of Accel/Decel (miles) | Cruising Distance (miles) | Cruising Time (min) | Travel Time (min) | Dwell Time (min) | Segment Travel Time (min) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wittmann | North Surprise/Sun City West | 9.7 | 79.0 | 1.00 | 79.00 | 0.87 | 1.00 | 79.00 | 0.87 | 1.73 | 7.97 | 6.05 | 8.68 | 0.50 | 9.18 |
| North Surprise/Sun City West | Surprise | 4.5 | 79.0 | 1.00 | 79.00 | 0.87 | 1.00 | 79.00 | 0.87 | 1.73 | 2.77 | 2.10 | 4.73 | 0.50 | 5.23 |
| Surprise | ElMirage/SunCity/Youngtown | 2.0 | 79.0 | 1.00 | 79.00 | 0.87 | 1.00 | 79.00 | 0.87 | 1.73 | 0.27 | 0.20 | 2.84 | 0.50 | 3.34 |
| ElMirage/Su City/Youngtown | Peoria | 5.8 | 79.0 | 1.00 | 79.00 | 0.87 | 1.00 | 79.00 | 0.87 | 1.73 | 4.07 | 3.09 | 5.72 | 0.50 | 6.22 |
| Peoria | Glendale | 4.1 | 79.0 | 1.00 | 79.00 | 0.87 | 1.00 | 79.00 | 0.87 | 1.73 | 2.37 | 1.80 | 4.43 | 0.50 | 4.93 |
| Glendale | State Capitol | 8.7 | 60.0 | 1.00 | 60.00 | 0.50 | 1.00 | 60.00 | 0.50 | 1.00 | 7.70 | 7.70 | 9.70 | 0.50 | 10.20 |
| State Capitol | **Phoenix** | 1.0 | 35.0 | 1.00 | 35.00 | 0.17 | 1.00 | 35.00 | 0.17 | 0.34 | 0.66 | 1.13 | 2.30 | 0.00 | 2.30 |
| **Phoenix Dwell** | | | | | | | | | | | | | | 3.00 | 3.00 |
| **Phoenix** | Sky Harbor Airport/44th Street | 5.0 | 50.0 | 1.00 | 50.00 | 0.35 | 1.00 | 50.00 | 0.35 | 0.69 | 4.31 | 5.17 | 6.83 | 0.50 | 7.33 |
| Sky Harbor Airport/44th Street | Tempe | 3.3 | 45.0 | 1.00 | 45.00 | 0.28 | 1.00 | 45.00 | 0.28 | 0.56 | 2.74 | 3.65 | 5.15 | 0.50 | 5.65 |
| Tempe | Central Tempe | 1.5 | 79.0 | 1.00 | 79.00 | 0.87 | 1.00 | 79.00 | 0.87 | 1.73 | -0.23 | -0.18 | 2.46 | 0.50 | 2.96 |
| Central Tempe | South Tempe | 3.9 | 79.0 | 1.00 | 79.00 | 0.87 | 1.00 | 79.00 | 0.87 | 1.73 | 2.17 | 1.65 | 4.28 | 0.50 | 4.78 |
| South Tempe | West Chandler | 2.2 | 79.0 | 1.00 | 79.00 | 0.87 | 1.00 | 79.00 | 0.87 | 1.73 | 0.47 | 0.35 | 2.99 | 0.50 | 3.49 |
| West Chandler | Wild Horse Pass/I-10 | 2.1 | 40.0 | 1.00 | 40.00 | 0.22 | 1.00 | 40.00 | 0.22 | 0.44 | 1.56 | 2.33 | 3.67 | 0.50 | 4.32 |
| **TOTAL** | | **53.8** | | | | | | | | | | | | | **72.93** |

Source: AECOM, 2018.

**Table 2: Calculation of Travel Times – Grand/Kyrene Line (DMU Vehicle Technology)**

| Station: | Station: | Distance | Max Speed | Accel. Rate (mph/s) | Accel. Time (sec) | Distance for Accel. (miles) | Decel. Rate (mph/s) | Decel. Time (sec) | Distance for Decel. (miles) | Distance of Accel/Decel (miles) | Cruising Distance (miles) | Cruising Time (min) | Travel Time (min) | Dwell Time (min) | Segment Travel Time (min) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wittmann | North Surprise/Sun City West | 9.7 | 79.0 | 2.00 | 39.50 | 0.43 | 2.00 | 39.50 | 0.43 | 0.87 | 8.83 | 6.71 | 8.03 | 0.50 | 8.53 |
| North Surprise/Sun City West | Surprise | 4.5 | 79.0 | 2.00 | 39.50 | 0.43 | 2.00 | 39.50 | 0.43 | 0.87 | 3.63 | 2.76 | 4.08 | 0.50 | 4.58 |
| Surprise | ElMirage/SunCity/Youngtown | 2.0 | 79.0 | 2.00 | 39.50 | 0.43 | 2.00 | 39.50 | 0.43 | 0.87 | 1.13 | 0.86 | 2.18 | 0.50 | 2.68 |
| ElMirage/SunCity/Youngtown | Peoria | 5.8 | 79.0 | 2.00 | 39.50 | 0.43 | 2.00 | 39.50 | 0.43 | 0.87 | 4.93 | 3.75 | 5.06 | 0.50 | 5.56 |
| Peoria | Glendale | 4.1 | 79.0 | 2.00 | 39.50 | 0.43 | 2.00 | 39.50 | 0.43 | 0.87 | 3.23 | 2.46 | 3.77 | 0.50 | 4.27 |
| Glendale | State Capitol | 8.7 | 60.0 | 2.00 | 30.00 | 0.25 | 2.00 | 30.00 | 0.25 | 0.50 | 8.20 | 8.20 | 9.20 | 0.50 | 9.70 |
| State Capitol | **Phoenix** | 1.0 | 35.0 | 2.00 | 17.50 | 0.09 | 2.00 | 17.50 | 0.09 | 0.17 | 0.83 | 1.42 | 2.01 | 0.00 | 2.01 |
| **Phoenix Dwell** | | | | | | | | | | | | | | 3.00 | 3.00 |
| **Phoenix** | Sky Harbor Airport/44th Street | 5.0 | 50.0 | 2.00 | 25.00 | 0.17 | 2.00 | 25.00 | 0.17 | 0.35 | 4.65 | 5.58 | 6.42 | 0.50 | 6.92 |
| Sky Harbor Airport/44th Street | Tempe | 3.3 | 45.0 | 2.00 | 22.50 | 0.14 | 2.00 | 22.50 | 0.14 | 0.28 | 3.02 | 4.03 | 4.78 | 0.50 | 5.28 |
| Tempe | Central Tempe | 1.5 | 79.0 | 2.00 | 39.50 | 0.43 | 2.00 | 39.50 | 0.43 | 0.87 | 0.63 | 0.48 | 1.80 | 0.50 | 2.30 |
| Central Tempe | South Tempe | 3.9 | 79.0 | 2.00 | 39.50 | 0.43 | 2.00 | 39.50 | 0.43 | 0.87 | 3.03 | 2.30 | 3.62 | 0.50 | 4.12 |
| South Tempe | West Chandler | 2.2 | 79.0 | 2.00 | 39.50 | 0.43 | 2.00 | 39.50 | 0.43 | 0.87 | 1.33 | 1.01 | 2.33 | 0.50 | 2.83 |
| West Chandler | Wild Horse Pass/I-10 | 2.1 | 40.0 | 2.00 | 20.00 | 0.11 | 2.00 | 20.00 | 0.11 | 0.22 | 1.78 | 2.67 | 3.33 | 0.50 | 3.98 |
| **TOTAL** | | **53.8** | | | | | | | | | | | | | **65.74** |

Source: AECOM, 2018.

**Table 3: Calculation of Travel Times – Estrella/San Tan Line (LHC Vehicle Technology)**

| Station: | Station: | Distance | Max Speed | Accel. Rate (mph/s) | Accel. Time (sec) | Distance for Accel. (miles) | Decel. Rate (mph/s) | Decel. Time (sec) | Distance for Decel. (miles) | Distance of Accel/Decel (miles) | Cruising Distance (miles) | Cruising Time (min) | Travel Time (min) | Dwell Time (min) | Segment Travel Time (min) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Buckeye | Buckeye East/Liberty | 6.6 | 79.0 | 1.00 | 79.00 | 0.87 | 1.00 | 79.00 | 0.87 | 1.73 | 4.87 | 3.70 | 6.33 | 0.50 | 6.83 |
| Buckeye East/Liberty | Goodeyear/Estrella | 3.0 | 79.0 | 1.00 | 79.00 | 0.87 | 1.00 | 79.00 | 0.87 | 1.73 | 1.27 | 0.96 | 3.60 | 0.50 | 4.10 |
| Goodeyear/Estrella | Goodyear Airport | 4.3 | 79.0 | 1.00 | 79.00 | 0.87 | 1.00 | 79.00 | 0.87 | 1.73 | 2.57 | 1.95 | 4.58 | 0.50 | 5.08 |
| Goodyear Airport | Avondale | 3.2 | 79.0 | 1.00 | 79.00 | 0.87 | 1.00 | 79.00 | 0.87 | 1.73 | 1.47 | 1.11 | 3.75 | 0.50 | 4.25 |
| Avondale | Tolleson | 3.2 | 79.0 | 1.00 | 79.00 | 0.87 | 1.00 | 79.00 | 0.87 | 1.73 | 1.47 | 1.11 | 3.75 | 0.50 | 4.25 |
| Tolleson | West Phoenix | 5.0 | 79.0 | 1.00 | 79.00 | 0.87 | 1.00 | 79.00 | 0.87 | 1.73 | 3.27 | 2.48 | 5.11 | 0.50 | 5.61 |
| West Phoenix | State Capitol | 4.1 | 50.0 | 1.00 | 50.00 | 0.35 | 1.00 | 50.00 | 0.35 | 0.69 | 3.41 | 4.09 | 5.75 | 0.50 | 6.25 |
| State Capitol | **Phoenix** | 1.0 | 35.0 | 1.00 | 35.00 | 0.17 | 1.00 | 35.00 | 0.17 | 0.34 | 0.66 | 1.13 | 2.30 | 0.00 | 2.30 |
| **Phoenix Dwell** | | | | | | | | | | | | | | 3.00 | 3.00 |
| **Phoenix** | Sky Harbor Airport/44th Street | 5.0 | 50.0 | 1.00 | 50.00 | 0.35 | 1.00 | 50.00 | 0.35 | 0.69 | 4.31 | 5.17 | 6.83 | 0.50 | 7.33 |
| Sky Harbor Airport/44th Street | Tempe | 3.3 | 45.0 | 1.00 | 45.00 | 0.28 | 1.00 | 45.00 | 0.28 | 0.56 | 2.74 | 3.65 | 5.15 | 0.50 | 5.65 |
| Tempe | Price SR 101 (Price Freeway) | 3.2 | 55.0 | 1.00 | 55.00 | 0.42 | 1.00 | 55.00 | 0.42 | 0.84 | 2.36 | 2.57 | 4.41 | 0.50 | 4.91 |
| Price SR 101 (Price Freeway) | Mesa | 3.4 | 55.0 | 1.00 | 55.00 | 0.42 | 1.00 | 55.00 | 0.42 | 0.84 | 2.56 | 2.79 | 4.63 | 0.50 | 5.13 |
| Mesa | Gilbert | 5.0 | 79.0 | 1.00 | 79.00 | 0.87 | 1.00 | 79.00 | 0.87 | 1.73 | 3.27 | 2.48 | 5.11 | 0.50 | 5.61 |
| Gilbert | Gateway Airport/ASU Tech | 6.1 | 79.0 | 1.00 | 79.00 | 0.87 | 1.00 | 79.00 | 0.87 | 1.73 | 4.37 | 3.32 | 5.95 | 0.50 | 6.45 |
| Gateway Airport/ASU Tech | Queen Creek | 5.0 | 79.0 | 1.00 | 79.00 | 0.87 | 1.00 | 79.00 | 0.87 | 1.73 | 3.27 | 2.48 | 5.11 | 0.50 | 5.61 |
| **TOTAL** | | **61.4** | | | | | | | | | | | | | **82.36** |

Source: AECOM, 2018.

**Table 4: Calculation of Travel Times – Estrella/San Tan Line (DMU Vehicle Technology)**

| Station: | Station: | Distance | Max Speed | Accel. Rate (mph/s) | Accel. Time (sec) | Distance for Accel. (miles) | Decel. Rate (mph/s) | Decel. Time (sec) | Distance for Decel. (miles) | Distance of Accel/Decel (miles) | Cruising Distance (miles) | Cruising Time (min) | Travel Time (min) | Dwell Time (min) | Segment Travel Time (min) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Buckeye | Buckeye East/Liberty | 6.6 | 79.0 | 2.00 | 39.50 | 0.43 | 2.00 | 39.50 | 0.43 | 0.87 | 5.73 | 4.35 | 5.67 | 0.50 | 6.17 |
| Buckeye East/Liberty | Goodeyear/Estrella | 3.0 | 79.0 | 2.00 | 39.50 | 0.43 | 2.00 | 39.50 | 0.43 | 0.87 | 2.13 | 1.62 | 2.94 | 0.50 | 3.44 |
| Goodeyear/Estrella | Goodyear Airport | 4.3 | 79.0 | 2.00 | 39.50 | 0.43 | 2.00 | 39.50 | 0.43 | 0.87 | 3.43 | 2.61 | 3.92 | 0.50 | 4.42 |
| Goodyear Airport | Avondale | 3.2 | 79.0 | 2.00 | 39.50 | 0.43 | 2.00 | 39.50 | 0.43 | 0.87 | 2.33 | 1.77 | 3.09 | 0.50 | 3.59 |
| Avondale | Tolleson | 3.2 | 79.0 | 2.00 | 39.50 | 0.43 | 2.00 | 39.50 | 0.43 | 0.87 | 2.33 | 1.77 | 3.09 | 0.50 | 3.59 |
| Tolleson | West Phoenix | 5.0 | 79.0 | 2.00 | 39.50 | 0.43 | 2.00 | 39.50 | 0.43 | 0.87 | 4.13 | 3.14 | 4.46 | 0.50 | 4.96 |
| West Phoenix | State Capitol | 4.1 | 50.0 | 2.00 | 25.00 | 0.17 | 2.00 | 25.00 | 0.17 | 0.35 | 3.75 | 4.50 | 5.34 | 0.50 | 5.84 |
| State Capitol | **Phoenix** | 1.0 | 35.0 | 2.00 | 17.50 | 0.09 | 2.00 | 17.50 | 0.09 | 0.17 | 0.83 | 1.42 | 2.01 | 0.00 | 2.01 |
| **Phoenix Dwell** | | | | | | | | | | | | | | 3.00 | 3.00 |
| **Phoenix** | Sky Harbor Airport/44th Street | 5.0 | 50.0 | 2.00 | 25.00 | 0.17 | 2.00 | 25.00 | 0.17 | 0.35 | 4.65 | 5.58 | 6.42 | 0.50 | 6.92 |
| Sky Harbor Airport/44th Street | Tempe | 3.3 | 45.0 | 2.00 | 22.50 | 0.14 | 2.00 | 22.50 | 0.14 | 0.28 | 3.02 | 4.03 | 4.78 | 0.50 | 5.28 |
| Tempe | Price SR 101 (Price Freeway) | 3.2 | 55.0 | 2.00 | 27.50 | 0.21 | 2.00 | 27.50 | 0.21 | 0.42 | 2.78 | 3.03 | 3.95 | 0.50 | 4.45 |
| Price SR 101 (Price Freeway) | Mesa | 3.4 | 55.0 | 2.00 | 27.50 | 0.21 | 2.00 | 27.50 | 0.21 | 0.42 | 2.98 | 3.25 | 4.17 | 0.50 | 4.67 |
| Mesa | Gilbert | 5.0 | 79.0 | 2.00 | 39.50 | 0.43 | 2.00 | 39.50 | 0.43 | 0.87 | 4.13 | 3.14 | 4.46 | 0.50 | 4.96 |
| Gilbert | Gateway Airport/ASU Tech | 6.1 | 79.0 | 2.00 | 39.50 | 0.43 | 2.00 | 39.50 | 0.43 | 0.87 | 5.23 | 3.97 | 5.29 | 0.50 | 5.79 |
| Gateway Airport/ASU Tech | Queen Creek | 5.0 | 79.0 | 2.00 | 39.50 | 0.43 | 2.00 | 39.50 | 0.43 | 0.87 | 4.13 | 3.14 | 4.46 | 0.50 | 4.96 |
| **TOTAL** | | **61.4** | | | | | | | | | | | | | **74.02** |

Source: AECOM, 2018.

**Table 5: Example Schedule – Grand/Kyrene Line (LHC Vehicle Technology)**

| Station | Segment Trip Time | Train Number | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Southbound** | | | | | | | | | | | | | | | | | | |
| | | 102 | 104 | 106 | 108 | 110 | 112 | 114 | 116 | 118 | 120 | 122 | 124 | 126 | 128 | 130 | 132 | 134 |
| Wittmann | | 500 | 530 | 600 | 630 | 700 | 730 | 930 | 1130 | 1330 | 1530 | 1600 | 1630 | 1700 | 1730 | 1800 | 1830 | 2030 |
| North Surprise/Sun City West | 9 | 509 | 539 | 609 | 639 | 709 | 739 | 939 | 1139 | 1339 | 1539 | 1609 | 1639 | 1709 | 1739 | 1809 | 1839 | 2039 |
| Surprise | 5 | 514 | 544 | 614 | 644 | 714 | 744 | 944 | 1144 | 1344 | 1544 | 1614 | 1644 | 1714 | 1744 | 1814 | 1844 | 2044 |
| El Mirage/Sun City/Youngtown | 3 | 517 | 547 | 617 | 647 | 717 | 747 | 947 | 1147 | 1347 | 1547 | 1617 | 1647 | 1717 | 1747 | 1817 | 1847 | 2047 |
| Peoria | 6 | 523 | 553 | 623 | 653 | 723 | 753 | 953 | 1153 | 1353 | 1553 | 1623 | 1653 | 1723 | 1753 | 1823 | 1853 | 2053 |
| Glendale | 5 | 528 | 558 | 628 | 658 | 728 | 758 | 958 | 1158 | 1358 | 1558 | 1628 | 1658 | 1728 | 1758 | 1828 | 1858 | 2058 |
| State Capitol | 11 | 539 | 609 | 639 | 709 | 739 | 809 | 1009 | 1209 | 1409 | 1609 | 1639 | 1709 | 1739 | 1809 | 1839 | 1909 | 2109 |
| **Arrive Phoenix** | 2 | **541** | **611** | **641** | **711** | **741** | **811** | **1011** | **1211** | **1411** | **1611** | **1641** | **1711** | **1741** | **1811** | **1841** | **1911** | **2111** |
| **Leave Phoenix** | 3 | **544** | **614** | **644** | **714** | **744** | **814** | **1014** | **1214** | **1414** | **1614** | **1644** | **1714** | **1744** | **1814** | **1844** | **1914** | **2114** |
| Sky Harbor Airport/44th Street | 7 | 551 | 621 | 651 | 721 | 751 | 821 | 1021 | 1221 | 1421 | 1621 | 1651 | 1721 | 1751 | 1821 | 1851 | 1921 | 2121 |
| Tempe | 6 | 557 | 627 | 657 | 727 | 757 | 827 | 1027 | 1227 | 1427 | 1627 | 1657 | 1727 | 1757 | 1827 | 1857 | 1927 | 2127 |
| Central Tempe | 3 | 600 | 630 | 700 | 730 | 800 | 830 | 1030 | 1230 | 1430 | 1630 | 1700 | 1730 | 1800 | 1830 | 1900 | 1930 | 2130 |
| South Tempe | 5 | 605 | 635 | 705 | 735 | 805 | 835 | 1035 | 1235 | 1435 | 1635 | 1705 | 1735 | 1805 | 1835 | 1905 | 1935 | 2135 |
| West Chandler | 4 | 609 | 639 | 709 | 739 | 809 | 839 | 1039 | 1239 | 1439 | 1639 | 1709 | 1739 | 1809 | 1839 | 1909 | 1939 | 2139 |
| Wild Horse Pass/I-10 | 4 | 613 | 643 | 713 | 743 | 813 | 843 | 1043 | 1243 | 1443 | 1643 | 1713 | 1743 | 1813 | 1843 | 1913 | 1943 | 2143 |
| **Total Trip Time** | **73** | | | | | | | | | | | | | | | | | |
| **Northbound** | | | | | | | | | | | | | | | | | | |
| | | 101 | 103 | 105 | 107 | 109 | 111 | 113 | 115 | 117 | 119 | 121 | 123 | 125 | 127 | 129 | 131 | 133 |
| Wild Horse Pass/I-10 | | 500 | 530 | 600 | 630 | 700 | 730 | 930 | 1130 | 1330 | 1530 | 1600 | 1630 | 1700 | 1730 | 1800 | 1830 | 2030 |
| West Chandler | 4 | 504 | 534 | 604 | 634 | 704 | 734 | 934 | 1134 | 1334 | 1534 | 1604 | 1634 | 1704 | 1734 | 1804 | 1834 | 2034 |
| South Tempe | 4 | 508 | 538 | 608 | 638 | 708 | 738 | 938 | 1138 | 1338 | 1538 | 1608 | 1638 | 1708 | 1738 | 1808 | 1838 | 2038 |
| Central Tempe | 5 | 513 | 543 | 613 | 643 | 713 | 743 | 943 | 1143 | 1343 | 1543 | 1613 | 1643 | 1713 | 1743 | 1813 | 1843 | 2043 |
| Tempe | 3 | 516 | 546 | 616 | 646 | 716 | 746 | 946 | 1146 | 1346 | 1546 | 1616 | 1646 | 1716 | 1746 | 1816 | 1846 | 2046 |
| Sky Harbor Airport/44th Street | 6 | 522 | 552 | 622 | 652 | 722 | 752 | 952 | 1152 | 1352 | 1552 | 1622 | 1652 | 1722 | 1752 | 1822 | 1852 | 2052 |
| **Arrive Phoenix** | 7 | **529** | **559** | **629** | **659** | **729** | **759** | **959** | **1159** | **1359** | **1559** | **1629** | **1659** | **1729** | **1759** | **1829** | **1859** | **2059** |
| **Leave Phoenix** | 3 | **532** | **602** | **632** | **702** | **732** | **802** | **1002** | **1202** | **1402** | **1602** | **1632** | **1702** | **1732** | **1802** | **1832** | **1902** | **2102** |
| State Capitol | 2 | 534 | 604 | 634 | 704 | 734 | 804 | 1004 | 1204 | 1404 | 1604 | 1634 | 1704 | 1734 | 1804 | 1834 | 1904 | 2104 |
| Glendale | 11 | 545 | 615 | 645 | 715 | 745 | 815 | 1015 | 1215 | 1415 | 1615 | 1645 | 1715 | 1745 | 1815 | 1845 | 1915 | 2115 |
| Peoria | 5 | 550 | 620 | 650 | 720 | 750 | 820 | 1020 | 1220 | 1420 | 1620 | 1650 | 1720 | 1750 | 1820 | 1850 | 1920 | 2120 |
| El Mirage/Sun City/Youngtown | 6 | 556 | 626 | 656 | 726 | 756 | 826 | 1026 | 1226 | 1426 | 1626 | 1656 | 1726 | 1756 | 1826 | 1856 | 1926 | 2126 |
| Surprise | 3 | 559 | 629 | 659 | 729 | 759 | 829 | 1029 | 1229 | 1429 | 1629 | 1659 | 1729 | 1759 | 1829 | 1859 | 1929 | 2129 |
| North Surprise/Sun City West | 5 | 604 | 634 | 704 | 734 | 804 | 834 | 1034 | 1234 | 1434 | 1634 | 1704 | 1734 | 1804 | 1834 | 1904 | 1934 | 2134 |
| Wittmann | 9 | 613 | 643 | 713 | 743 | 813 | 843 | 1043 | 1243 | 1443 | 1643 | 1713 | 1743 | 1813 | 1843 | 1913 | 1943 | 2143 |
| **Total Trip Time** | **73** | | | | | | | | | | | | | | | | | |

Source: AECOM, 2018.

**Table 6: Example Schedule – Grand/Kyrene Line (DMU Vehicle Technology)**

| Station | Segment Trip Time | Train Number | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Southbound** | | | | | | | | | | | | | | | | | | |
| | | 102 | 104 | 106 | 108 | 110 | 112 | 114 | 116 | 118 | 120 | 122 | 124 | 126 | 128 | 130 | 132 | 134 |
| Wittmann | | 500 | 530 | 600 | 630 | 700 | 730 | 930 | 1130 | 1330 | 1530 | 1600 | 1630 | 1700 | 1730 | 1800 | 1830 | 2030 |
| North Surprise/Sun City West | 8 | 508 | 538 | 608 | 638 | 708 | 738 | 938 | 1138 | 1338 | 1538 | 1608 | 1638 | 1708 | 1738 | 1808 | 1838 | 2038 |
| Surprise | 5 | 513 | 543 | 613 | 643 | 713 | 743 | 943 | 1143 | 1343 | 1543 | 1613 | 1643 | 1713 | 1743 | 1813 | 1843 | 2043 |
| El Mirage/Sun City/Youngtown | 3 | 516 | 546 | 616 | 646 | 716 | 746 | 946 | 1146 | 1346 | 1546 | 1616 | 1646 | 1716 | 1746 | 1816 | 1846 | 2046 |
| Peoria | 6 | 521 | 552 | 621 | 652 | 721 | 752 | 952 | 1152 | 1352 | 1552 | 1621 | 1652 | 1721 | 1752 | 1821 | 1852 | 2051 |
| Glendale | 4 | 526 | 556 | 626 | 656 | 726 | 756 | 956 | 1156 | 1356 | 1556 | 1626 | 1656 | 1726 | 1756 | 1826 | 1856 | 2056 |
| State Capitol | 10 | 536 | 606 | 636 | 706 | 736 | 806 | 1006 | 1206 | 1406 | 1606 | 1636 | 1706 | 1736 | 1806 | 1836 | 1906 | 2106 |
| **Arrive Phoenix** | 2 | **538** | **608** | **638** | **708** | **738** | **808** | **1008** | **1208** | **1408** | **1608** | **1638** | **1708** | **1738** | **1808** | **1838** | **1908** | **2108** |
| **Leave Phoenix** | 3 | **541** | **611** | **641** | **711** | **741** | **811** | **1011** | **1211** | **1411** | **1611** | **1641** | **1711** | **1741** | **1811** | **1841** | **1911** | **2111** |
| Sky Harbor Airport/44th Street | 7 | 548 | 618 | 648 | 718 | 748 | 818 | 1018 | 1218 | 1418 | 1618 | 1648 | 1718 | 1748 | 1818 | 1848 | 1918 | 2118 |
| Tempe | 5 | 553 | 623 | 653 | 723 | 753 | 823 | 1023 | 1223 | 1423 | 1623 | 1653 | 1723 | 1753 | 1823 | 1853 | 1923 | 2123 |
| Central Tempe | 2 | 555 | 625 | 655 | 725 | 755 | 825 | 1025 | 1225 | 1425 | 1625 | 1655 | 1725 | 1755 | 1825 | 1855 | 1925 | 2125 |
| South Tempe | 4 | 559 | 629 | 659 | 729 | 759 | 829 | 1029 | 1229 | 1429 | 1629 | 1659 | 1729 | 1759 | 1829 | 1859 | 1929 | 2129 |
| West Chandler | 3 | 602 | 632 | 702 | 732 | 802 | 832 | 1032 | 1232 | 1432 | 1632 | 1702 | 1732 | 1802 | 1832 | 1902 | 1932 | 2132 |
| Wild Horse Pass/I-10 | 4 | 606 | 636 | 706 | 736 | 806 | 836 | 1036 | 1236 | 1436 | 1636 | 1706 | 1736 | 1806 | 1836 | 1906 | 1936 | 2136 |
| **Total Trip Time** | **66** | | | | | | | | | | | | | | | | | |
| **Northbound** | | | | | | | | | | | | | | | | | | |
| | | 101 | 103 | 105 | 107 | 109 | 111 | 113 | 115 | 117 | 119 | 121 | 123 | 125 | 127 | 129 | 131 | 133 |
| Wild Horse Pass/I-10 | | 500 | 530 | 600 | 630 | 700 | 730 | 930 | 1130 | 1330 | 1530 | 1600 | 1630 | 1700 | 1730 | 1800 | 1830 | 2030 |
| West Chandler | 4 | 504 | 534 | 604 | 634 | 704 | 734 | 934 | 1134 | 1334 | 1534 | 1604 | 1634 | 1704 | 1734 | 1804 | 1834 | 2034 |
| South Tempe | 3 | 507 | 537 | 607 | 637 | 707 | 737 | 937 | 1137 | 1337 | 1537 | 1607 | 1637 | 1707 | 1737 | 1807 | 1837 | 2037 |
| Central Tempe | 4 | 511 | 541 | 611 | 641 | 711 | 741 | 941 | 1141 | 1341 | 1541 | 1611 | 1641 | 1711 | 1741 | 1811 | 1841 | 2041 |
| Tempe | 2 | 513 | 543 | 613 | 643 | 713 | 743 | 943 | 1143 | 1343 | 1543 | 1613 | 1643 | 1713 | 1743 | 1813 | 1843 | 2043 |
| Sky Harbor Airport/44th Street | 5 | 518 | 548 | 618 | 648 | 718 | 748 | 948 | 1148 | 1348 | 1548 | 1618 | 1648 | 1718 | 1748 | 1818 | 1848 | 2048 |
| **Arrive Phoenix** | 7 | **525** | **555** | **625** | **655** | **725** | **755** | **955** | **1155** | **1355** | **1555** | **1625** | **1655** | **1725** | **1755** | **1825** | **1855** | **2055** |
| **Leave Phoenix** | 3 | **528** | **558** | **628** | **658** | **728** | **758** | **958** | **1158** | **1358** | **1558** | **1628** | **1658** | **1728** | **1758** | **1828** | **1858** | **2058** |
| State Capitol | 2 | 530 | 600 | 630 | 700 | 730 | 800 | 1000 | 1200 | 1400 | 1600 | 1630 | 1700 | 1730 | 1800 | 1830 | 1900 | 2100 |
| Glendale | 10 | 540 | 610 | 640 | 710 | 740 | 810 | 1010 | 1210 | 1410 | 1610 | 1640 | 1710 | 1740 | 1810 | 1840 | 1910 | 2110 |
| Peoria | 4 | 544 | 614 | 644 | 714 | 744 | 814 | 1014 | 1214 | 1414 | 1614 | 1644 | 1714 | 1744 | 1814 | 1844 | 1914 | 2114 |
| El Mirage/Sun City/Youngtown | 6 | 550 | 620 | 650 | 720 | 750 | 820 | 1020 | 1220 | 1420 | 1620 | 1650 | 1720 | 1750 | 1820 | 1850 | 1920 | 2120 |
| Surprise | 3 | 553 | 623 | 653 | 723 | 753 | 823 | 1023 | 1223 | 1423 | 1623 | 1653 | 1723 | 1753 | 1823 | 1853 | 1923 | 2123 |
| North Surprise/Sun City West | 5 | 558 | 628 | 658 | 728 | 758 | 828 | 1028 | 1228 | 1428 | 1628 | 1658 | 1728 | 1758 | 1828 | 1858 | 1928 | 2128 |
| Wittmann | 8 | 606 | 636 | 706 | 736 | 806 | 836 | 1036 | 1236 | 1436 | 1636 | 1706 | 1736 | 1806 | 1836 | 1906 | 1936 | 2136 |
| **Total Trip Time** | **66** | | | | | | | | | | | | | | | | | |

Source: AECOM, 2018.

**Table 7: Example Schedule – Estrella/San Tan Line (LHC Vehicle Technology)**

| Station | Segment Trip Time | Train Number | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Eastbound** | | | | | | | | | | | | | | | | | | |
| | | 202 | 204 | 206 | 208 | 210 | 212 | 214 | 216 | 218 | 220 | 222 | 224 | 226 | 228 | 230 | 232 | 234 |
| Buckeye | | 500 | 530 | 600 | 630 | 700 | 730 | 930 | 1130 | 1330 | 1530 | 1600 | 1630 | 1700 | 1730 | 1800 | 1830 | 2030 |
| Buckeye East/Liberty | 7 | 507 | 537 | 607 | 637 | 707 | 737 | 937 | 1137 | 1337 | 1537 | 1607 | 1637 | 1707 | 1737 | 1807 | 1837 | 2037 |
| Goodeyear/Estrella | 4 | 511 | 541 | 611 | 641 | 711 | 741 | 941 | 1141 | 1341 | 1541 | 1611 | 1641 | 1711 | 1741 | 1811 | 1841 | 2041 |
| Goodyear Airport | 5 | 516 | 546 | 616 | 646 | 716 | 746 | 946 | 1146 | 1346 | 1546 | 1616 | 1646 | 1716 | 1746 | 1816 | 1846 | 2046 |
| Avondale | 4 | 520 | 550 | 620 | 650 | 720 | 750 | 950 | 1150 | 1350 | 1550 | 1620 | 1650 | 1720 | 1750 | 1820 | 1850 | 2050 |
| Tolleson | 4 | 524 | 554 | 624 | 654 | 724 | 754 | 954 | 1154 | 1354 | 1554 | 1624 | 1654 | 1724 | 1754 | 1824 | 1854 | 2054 |
| West Phoenix | 6 | 530 | 600 | 630 | 700 | 730 | 800 | 1000 | 1200 | 1400 | 1600 | 1630 | 1700 | 1730 | 1800 | 1830 | 1900 | 2100 |
| State Capitol | 6 | 536 | 606 | 636 | 706 | 736 | 806 | 1006 | 1206 | 1406 | 1606 | 1636 | 1706 | 1736 | 1806 | 1836 | 1906 | 2106 |
| **Arrive Phoenix** | 2 | **538** | **608** | **638** | **708** | **738** | **808** | **1008** | **1208** | **1408** | **1608** | **1638** | **1708** | **1738** | **1808** | **1838** | **1908** | **2108** |
| **Leave Phoenix** | 3 | **541** | **611** | **641** | **711** | **741** | **811** | **1011** | **1211** | **1411** | **1611** | **1641** | **1711** | **1741** | **1811** | **1841** | **1911** | **2111** |
| Sky Harbor Airport/44th Street | 7 | 548 | 618 | 648 | 718 | 748 | 818 | 1018 | 1218 | 1418 | 1618 | 1648 | 1718 | 1748 | 1818 | 1848 | 1918 | 2118 |
| Tempe | 6 | 554 | 624 | 654 | 724 | 754 | 824 | 1024 | 1224 | 1424 | 1624 | 1654 | 1724 | 1754 | 1824 | 1854 | 1924 | 2124 |
| Price SR 101 (Price Freeway) | 5 | 559 | 629 | 659 | 729 | 759 | 829 | 1029 | 1229 | 1429 | 1629 | 1659 | 1729 | 1759 | 1829 | 1859 | 1929 | 2129 |
| Mesa | 5 | 604 | 634 | 704 | 734 | 804 | 834 | 1034 | 1234 | 1434 | 1634 | 1704 | 1734 | 1804 | 1834 | 1904 | 1934 | 2134 |
| Gilbert | 6 | 610 | 640 | 710 | 740 | 810 | 840 | 1040 | 1240 | 1440 | 1640 | 1710 | 1740 | 1810 | 1840 | 1910 | 1940 | 2140 |
| Gateway Airport/ASU Polytech | 7 | 617 | 647 | 717 | 747 | 817 | 847 | 1047 | 1247 | 1447 | 1647 | 1717 | 1747 | 1817 | 1847 | 1917 | 1947 | 2147 |
| Queen Creek | 6 | 623 | 653 | 723 | 753 | 823 | 853 | 1053 | 1253 | 1453 | 1653 | 1723 | 1753 | 1823 | 1853 | 1923 | 1953 | 2153 |
| **Total Trip Time** | **83** | | | | | | | | | | | | | | | | | |
| **Westbound** | | | | | | | | | | | | | | | | | | |
| | | 201 | 203 | 205 | 207 | 209 | 211 | 213 | 215 | 217 | 219 | 221 | 223 | 225 | 227 | 229 | 231 | 233 |
| Queen Creek | | 500 | 530 | 600 | 630 | 700 | 730 | 930 | 1130 | 1330 | 1530 | 1600 | 1630 | 1700 | 1730 | 1800 | 1830 | 2030 |
| Gateway Airport/ASU Polytech | 6 | 506 | 536 | 606 | 636 | 706 | 736 | 936 | 1136 | 1336 | 1536 | 1606 | 1636 | 1706 | 1736 | 1806 | 1836 | 2036 |
| Gilbert | 7 | 513 | 543 | 613 | 643 | 713 | 743 | 943 | 1143 | 1343 | 1543 | 1613 | 1643 | 1713 | 1743 | 1813 | 1843 | 2043 |
| Mesa | 6 | 519 | 549 | 619 | 649 | 719 | 749 | 949 | 1149 | 1349 | 1549 | 1619 | 1649 | 1719 | 1749 | 1819 | 1849 | 2049 |
| Price SR 101 (Price Freeway) | 5 | 524 | 554 | 624 | 654 | 724 | 754 | 954 | 1154 | 1354 | 1554 | 1624 | 1654 | 1724 | 1754 | 1824 | 1854 | 2054 |
| Tempe | 5 | 529 | 559 | 629 | 659 | 729 | 759 | 959 | 1159 | 1359 | 1559 | 1629 | 1659 | 1729 | 1759 | 1829 | 1859 | 2059 |
| Sky Harbor Airport/44th Street | 6 | 535 | 605 | 635 | 705 | 735 | 805 | 1005 | 1205 | 1405 | 1605 | 1635 | 1705 | 1735 | 1805 | 1835 | 1905 | 2105 |
| **Arrive Phoenix** | 7 | **542** | **612** | **642** | **712** | **742** | **812** | **1012** | **1212** | **1412** | **1612** | **1642** | **1712** | **1742** | **1812** | **1842** | **1912** | **2112** |
| **Leave Phoenix** | 3 | **545** | **615** | **645** | **715** | **745** | **815** | **1015** | **1215** | **1415** | **1615** | **1645** | **1715** | **1745** | **1815** | **1845** | **1915** | **2115** |
| State Capitol | 2 | 547 | 617 | 647 | 717 | 747 | 817 | 1017 | 1217 | 1417 | 1617 | 1647 | 1717 | 1747 | 1817 | 1847 | 1917 | 2117 |
| West Phoenix | 6 | 553 | 623 | 653 | 723 | 753 | 823 | 1023 | 1223 | 1423 | 1623 | 1653 | 1723 | 1753 | 1823 | 1853 | 1923 | 2123 |
| Tolleson | 6 | 559 | 629 | 659 | 729 | 759 | 829 | 1029 | 1229 | 1429 | 1629 | 1659 | 1729 | 1759 | 1829 | 1859 | 1929 | 2129 |
| Avondale | 4 | 603 | 633 | 703 | 733 | 803 | 833 | 1033 | 1233 | 1433 | 1633 | 1703 | 1733 | 1803 | 1833 | 1903 | 1933 | 2133 |
| Goodyear Airport | 4 | 607 | 637 | 707 | 737 | 807 | 837 | 1037 | 1237 | 1437 | 1637 | 1707 | 1737 | 1807 | 1837 | 1907 | 1937 | 2137 |
| Goodeyear/Estrella | 5 | 612 | 642 | 712 | 742 | 812 | 842 | 1042 | 1242 | 1442 | 1642 | 1712 | 1742 | 1812 | 1842 | 1912 | 1942 | 2142 |
| Buckeye East/Liberty | 4 | 616 | 646 | 716 | 746 | 816 | 846 | 1046 | 1246 | 1446 | 1646 | 1716 | 1746 | 1816 | 1846 | 1916 | 1946 | 2146 |
| Buckeye | 7 | 623 | 653 | 723 | 753 | 823 | 853 | 1053 | 1253 | 1453 | 1653 | 1723 | 1753 | 1823 | 1853 | 1923 | 1953 | 2153 |
| **Total Trip Time** | **83** | | | | | | | | | | | | | | | | | |

Source: AECOM, 2018.

**Table 8: Example Schedule – Estrella/San Tan Line (DMU Vehicle Technology)**

| Station | Segment Trip Time | Train Number | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Eastbound** | | | | | | | | | | | | | | | | | | |
| | | 202 | 204 | 206 | 208 | 210 | 212 | 214 | 216 | 218 | 220 | 222 | 224 | 226 | 228 | 230 | 232 | 234 |
| Buckeye | | 500 | 530 | 600 | 630 | 700 | 730 | 930 | 1130 | 1330 | 1530 | 1600 | 1630 | 1700 | 1730 | 1800 | 1830 | 2030 |
| Buckeye East/Liberty | 6 | 506 | 536 | 606 | 636 | 706 | 736 | 936 | 1136 | 1336 | 1536 | 1606 | 1636 | 1706 | 1736 | 1806 | 1836 | 2036 |
| Goodeyear/Estrella | 3 | 509 | 539 | 609 | 639 | 709 | 739 | 939 | 1139 | 1339 | 1539 | 1609 | 1639 | 1709 | 1739 | 1809 | 1839 | 2039 |
| Goodyear Airport | 4 | 513 | 543 | 613 | 643 | 713 | 743 | 943 | 1143 | 1343 | 1543 | 1613 | 1643 | 1713 | 1743 | 1813 | 1843 | 2043 |
| Avondale | 4 | 517 | 547 | 617 | 647 | 717 | 747 | 947 | 1147 | 1347 | 1547 | 1617 | 1647 | 1717 | 1747 | 1817 | 1847 | 2057 |
| Tolleson | 4 | 521 | 551 | 621 | 651 | 721 | 751 | 951 | 1151 | 1351 | 1551 | 1621 | 1651 | 1721 | 1751 | 1821 | 1851 | 2051 |
| West Phoenix | 5 | 526 | 556 | 626 | 656 | 726 | 756 | 956 | 1156 | 1356 | 1556 | 1626 | 1656 | 1726 | 1756 | 1826 | 1856 | 2056 |
| State Capitol | 6 | 532 | 602 | 632 | 702 | 732 | 802 | 1002 | 1202 | 1402 | 1602 | 1632 | 1702 | 1732 | 1802 | 1832 | 1902 | 2102 |
| **Arrive Phoenix** | 2 | **534** | **604** | **634** | **704** | **734** | **804** | **1004** | **1204** | **1404** | **1604** | **1634** | **1704** | **1734** | **1804** | **1834** | **1904** | **2104** |
| **Leave Phoenix** | 3 | **537** | **607** | **637** | **707** | **737** | **807** | **1007** | **1207** | **1407** | **1607** | **1637** | **1707** | **1737** | **1807** | **1837** | **1907** | **2107** |
| Sky Harbor Airport/44th Street | 7 | 544 | 614 | 644 | 714 | 744 | 814 | 1014 | 1214 | 1414 | 1614 | 1644 | 1714 | 1744 | 1814 | 1844 | 1914 | 2114 |
| Tempe | 5 | 549 | 619 | 649 | 719 | 749 | 819 | 1019 | 1219 | 1419 | 1619 | 1649 | 1719 | 1749 | 1819 | 1849 | 1919 | 2119 |
| Price SR 101 (Price Freeway) | 4 | 553 | 623 | 653 | 723 | 753 | 823 | 1023 | 1223 | 1423 | 1623 | 1653 | 1723 | 1753 | 1823 | 1853 | 1923 | 2123 |
| Mesa | 5 | 558 | 628 | 658 | 728 | 758 | 826 | 1026 | 1226 | 1426 | 1526 | 1656 | 1626 | 1756 | 1726 | 1856 | 1826 | 2126 |
| Gilbert | 5 | 603 | 633 | 703 | 733 | 803 | 833 | 1033 | 1233 | 1433 | 1633 | 1703 | 1733 | 1803 | 1833 | 1903 | 1933 | 2133 |
| Gateway Airport/ASU Polytech | 6 | 609 | 639 | 709 | 739 | 809 | 839 | 1039 | 1239 | 1439 | 1639 | 1709 | 1739 | 1809 | 1839 | 1909 | 1939 | 2139 |
| Queen Creek | 5 | 614 | 644 | 714 | 744 | 814 | 844 | 1044 | 1244 | 1444 | 1644 | 1714 | 1744 | 1814 | 1844 | 1914 | 1944 | 2144 |
| **Total Trip Time** | **74** | | | | | | | | | | | | | | | | | |
| **Westbound** | | | | | | | | | | | | | | | | | | |
| | | 201 | 203 | 205 | 207 | 209 | 211 | 213 | 215 | 217 | 219 | 221 | 223 | 225 | 227 | 229 | 231 | 233 |
| Queen Creek | | 500 | 530 | 600 | 630 | 700 | 730 | 930 | 1130 | 1330 | 1530 | 1600 | 1630 | 1700 | 1730 | 1800 | 1830 | 2030 |
| Gateway Airport/ASU Polytech | 5 | 505 | 535 | 605 | 635 | 705 | 735 | 935 | 1135 | 1335 | 1535 | 1605 | 1635 | 1705 | 1735 | 1805 | 1835 | 2035 |
| Gilbert | 6 | 511 | 541 | 611 | 641 | 711 | 741 | 941 | 1141 | 1341 | 1541 | 1611 | 1641 | 1711 | 1741 | 1811 | 1841 | 2041 |
| Mesa | 5 | 516 | 546 | 616 | 646 | 716 | 746 | 946 | 1146 | 1346 | 1546 | 1616 | 1646 | 1716 | 1746 | 1816 | 1846 | 2056 |
| Price SR 101 (Price Freeway) | 5 | 521 | 551 | 621 | 651 | 721 | 751 | 951 | 1151 | 1351 | 1551 | 1621 | 1651 | 1721 | 1751 | 1821 | 1851 | 2051 |
| Tempe | 4 | 525 | 555 | 625 | 655 | 725 | 755 | 955 | 1155 | 1355 | 1555 | 1625 | 1655 | 1725 | 1755 | 1825 | 1855 | 2055 |
| Sky Harbor Airport/44th Street | 5 | 530 | 600 | 630 | 700 | 730 | 800 | 1000 | 1200 | 1400 | 1600 | 1630 | 1700 | 1730 | 1800 | 1830 | 1900 | 2100 |
| **Arrive Phoenix** | 7 | **537** | **607** | **637** | **707** | **737** | **807** | **1007** | **1207** | **1407** | **1607** | **1637** | **1707** | **1737** | **1807** | **1837** | **1907** | **2107** |
| **Leave Phoenix** | 3 | **540** | **610** | **640** | **710** | **740** | **810** | **1010** | **1210** | **1410** | **1610** | **1640** | **1710** | **1740** | **1810** | **1840** | **1910** | **2110** |
| State Capitol | 2 | 542 | 612 | 642 | 712 | 742 | 812 | 1012 | 1212 | 1412 | 1612 | 1642 | 1712 | 1742 | 1812 | 1842 | 1912 | 2112 |
| West Phoenix | 6 | 548 | 618 | 648 | 718 | 748 | 818 | 1018 | 1218 | 1418 | 1618 | 1648 | 1718 | 1748 | 1818 | 1848 | 1918 | 2118 |
| Tolleson | 5 | 553 | 623 | 653 | 723 | 753 | 823 | 1023 | 1223 | 1423 | 1623 | 1653 | 1723 | 1753 | 1823 | 1853 | 1923 | 2123 |
| Avondale | 4 | 557 | 627 | 657 | 727 | 757 | 827 | 1027 | 1227 | 1427 | 1627 | 1657 | 1727 | 1757 | 1827 | 1857 | 1927 | 2127 |
| Goodyear Airport | 4 | 601 | 631 | 701 | 731 | 801 | 831 | 1031 | 1231 | 1431 | 1631 | 1701 | 1731 | 1801 | 1831 | 1901 | 1931 | 2131 |
| Goodeyear/Estrella | 4 | 605 | 635 | 705 | 735 | 805 | 835 | 1035 | 1235 | 1435 | 1635 | 1705 | 1735 | 1805 | 1835 | 1905 | 1935 | 2135 |
| Buckeye East/Liberty | 3 | 608 | 638 | 708 | 738 | 808 | 838 | 1038 | 1238 | 1438 | 1638 | 1708 | 1738 | 1808 | 1838 | 1908 | 1938 | 2138 |
| Buckeye | 6 | 614 | 644 | 714 | 744 | 814 | 844 | 1044 | 1244 | 1444 | 1644 | 1714 | 1744 | 1814 | 1844 | 1914 | 1944 | 2144 |
| **Total Trip Time** | **74** | | | | | | | | | | | | | | | | | |

Source: AECOM, 2018.

## 2.4 Fleet Size

Ridership results for the two cross-town lines, forecast approximately 10,830 riders in 2040 for the Grand/Kyrene Line and 10,100 riders in 2040 for the Estrella/San Tan Line. The total system ridership is projected to be nearly 21,000 for the system in 2040.

Fleet size is based upon the total round trip time, plus terminal turn-back time, divided by the peak-period headway, multiplied by the number of cars in a peak period train, plus one operational spare train for each corridor, and a maintenance spare train. This operating plan assumes a minimum of 7 minutes for terminal turn-back time at each terminal.

For the System Study Update Grand/Kyrene and Estrella/San Tan corridors, the process for estimating the commuter rail fleet sizes for Locomotive Hauled Coaches and Diesel Multiple Units for the year 2040 is shown in Tables 9, 10, and 11. Table 11 shows an operational spare train in each corridor, with a maintenance spare train added at the end. It is common for commuter rail systems to have some level of spare equipment for either operations or for maintenance. Both vehicle types assume an additional maintenance spare.

**Table 9: Ridership – LHC or DMU Vehicle Technology**

| Corridor | Daily Ridership | Number of Riders in Highest Segment | Inbound Trains in AM Peak Period | Seats per Car (LHC)/ Train (DMU) | Cars per Train |
|---|---|---|---|---|---|
| **Locomotive Hauled Coach Vehicle Technology** | | | | | |
| Grand/Kyrene | 10,100 | 1,655 | 5 | 150 | 2.21 |
| Estrella/San Tan | 10,830 | 1,820 | 5 | 150 | 2.43 |
| **Diesel Multiple Unit Vehicle Technology** | | | | | |
| Grand/Kyrene | 10,100 | 1,655 | 5 | 450 | 0.8 |
| Estrella/San Tan | 10,830 | 1,820 | 5 | 450 | 0.8 |

Notes: Cars per train based on seated capacity of 150 passengers per bi-level car.
Source: AECOM, 2018.

**Table 10: Trains in Service – LHC or DMU Vehicle Technology (all Times in Minutes)**

| Corridor | 1-Way Trip Time | Turnback Time | Total 1-way Trip Time | Peak Headway | Trains in Service |
|---|---|---|---|---|---|
| **Locomotive Hauled Coach Vehicle Technology** | | | | | |
| Grand/Kyrene | 73 | 17 | 90 | 30 | 6 |
| Estrella/San Tan | 83 | 7 | 90 | 30 | 6 |
| **Diesel Multiple Unit Vehicle Technology** | | | | | |
| Grand/Kyrene | 66 | 24 | 90 | 30 | 6 |
| Estrella/San Tan | 74 | 16 | 90 | 30 | 6 |

Source: AECOM, 2018.

**Table 11: Fleet Size – LHC or DMU Vehicle Technology**

| Corridor | Locomotive Hauled Coach Vehicle Technology | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Locomotives | | | Cab Cars | | | Coaches | | |
| | Service | Spare | Total | Service | Spare | Total | Service | Spare | Total |
| Grand/Kyrene | 6 | 1 | 7 | 6 | 1 | 7 | 18 | 3 | 21 |
| Estrella/San Tan | 6 | 1 | 7 | 6 | 1 | 7 | 18 | 3 | 21 |
| **Total System** | **15 (14 + 1 Maint. Spare)** | | | **15 (14 + 1 Maint. Spare)** | | | **45 (42 + 3 Maint. Spares)** | | |
| **Corridor** | **Diesel Multiple Unit Vehicle Technology** | | | | | | | | |
| | **4-Car Service Trains** | | | **4-Car Spare Trains** | | | **4-Car Total Trains** | | |
| Grand/Kyrene | 6 | | | 1 | | | 7 | | |
| Estrella/San Tan | 6 | | | 1 | | | 7 | | |
| **Total System** | | | | | | | **15 (14 + 1 Maint. Spare)** | | |

Source: AECOM, 2018.

# 3 Commuter Rail Operations

Normal and abnormal commuter rail operations concepts are described below.

## 3.1 Normal Commuter Rail Operations

Because the System Study Update commuter rail service would be operating over BNSF and Union Pacific Railroad trackage that is part of the national railroad network, commuter rail operations would be conducted in accordance with all of the current applicable Federal regulations contained in 49 CFR Part 40 and Parts 200 through 299.

Commuter rail operations would be conducted in accordance with established operating rules, procedures, and railroad agreements. All train movements and maintenance vehicle access on the System Study Update Corridors would be made under the authorization and control of the Dispatcher utilizing Positive Train Control (PTC). Train dispatching would most likely be done by one of the freight railroads.

Positive Train Control refers to technology that is capable of preventing train-to-train collisions, overspeed derailments, and casualties or injuries to roadway workers (e.g., maintenance-of-way workers, bridge workers, and signal maintainers) operating within their limits of authority as a result of unauthorized incursion by a train. PTC is also capable of preventing train movements through a switch left in the wrong position. PTC systems vary widely in complexity and sophistication based on the level of automation and functionality they implement, the system architecture utilized, the wayside system upon which they are based (i.e., non-signalized, block signal, cab signal, etc.), and the degree of train control they are capable of assuming. Prior to October 2008, PTC systems were being voluntarily installed by various carriers. However, the Rail Safety Improvement Act of 2008 (RSIA) (signed by the President on October 16, 2008, as Public Law 110-432) has amended the widespread installation of PTC systems by December 2015 (Federal Railroad Administration – March 10, 2009).

On December 4, 2015, President Obama signed the Fixing America's Surface Transportation (FAST) Act (114-94) into law. The FAST Act provides $199 million from the Mass Transit Account of the Highway Trust Fund for Fiscal Year 2017 to assist commuter railroads with PTC implementation. At the request of an eligible application, the FAST Act allows these funds to be used either for grants or to pay the subsidy and administrative costs of loans under the Railroad Rehabilitation and Improvement Financing (RRIF) Program.

The deadline has been extended until the end of 2018 and now, in some circumstances, railroads can apply for an extension until 2020. Positive train control was installed on 24 percent of the nation's passenger route miles and 45 percent of freight route miles as of September 30, 2017.

## 3.2 Abnormal Commuter Rail Operations

Abnormal commuter rail operations result from the response to emergencies including failures, severe weather, derailments, accidents, and other unforeseen events and conditions. Emergencies would be handled in accordance with the Emergency Preparedness Plan and passenger train emergency simulations conducted in compliance with 49 CFR Part 239.

If delays or problems are encountered during the peak period, recovery priority would be given to trains operating in the peak direction. For delays or problems occurring during the mid-day off-peak period, recovery efforts would give priority to preparing for the evening peak period service.

Safety of passengers, the public, and system employees will take precedence during emergency or failure conditions.

Failure recovery would implement one or more of the following actions, as may be appropriate for a specific situation.

### 3.2.1 Train Failures or Incidents

1. Continue a train in service at reduced speed to a terminal station and then remove it from service.

2. Continue a train in service to the next station and then remove it from service.

3. Stop a train immediately and remove it from service. If necessary, the failed train would be pushed or pulled to remove it from the main line. Passengers may remain on board if it is safe to do so or they may be off-loaded to another train or to buses.

4. An operational spare train positioned at the layover or maintenance facility would be put into service to replace a failed train.

### 3.2.2 Wayside Failures or Incidents

1. Restrict operating speed on all trains operating past an incident location.

2. Hold trains outside of an incident area until the incident can be resolved (short duration incident of up to two hours).

3. Discontinue service in the area of an incident and implement a bus bridge between stations on each side of the incident area (long duration incident of more than two hours).

# 4 Commuter Rail Maintenance Philosophy

Initially, the operation and rolling stock maintenance for the System Study Update commuter rail service may be contracted to BNSF or Union Pacific Railroad, a shortline, or to another qualified

rail operator. The maintenance-of-way function will most likely be performed by BNSF or Union Pacific Railroad (depending on the line). The operation and maintenance associated with the commuter rail service will be performed in accordance with an agreement or agreements with the BNSF or Union Pacific Railroad. The commuter rail maintenance philosophy relative to layover, rolling stock maintenance, and maintenance-of-way facilities is discussed below.

## 4.1 Layover Facility

Even when a train storage and maintenance facility is provided on-line, layover facilities need to also be provided at the opposite end, or ends, of the corridor. Some trains are kept at the storage and maintenance facility and some are kept at the layover facility in order to allow trains to begin or end the service day from each end of the system. This allows equal service to be operated in both directions much sooner than if all of the trains had to start or end from one end of a corridor. The layover facility should be located near the terminal station, or stations, at the end of the line in order to minimize the travel distance between the station and the layover facility.

### 4.1.1 Layover Facility Functional Requirements

The layover facility will accommodate the following functions:

- Train operator reporting facilities and operations supervision offices
- Interior car cleaning
- Minor repair and replacement of brake shoes, air hoses, and other small parts
- Facilities (restrooms, lockers, etc.) for car cleaners and rolling stock maintenance personnel
- Limited outdoor material storage for maintenance-of-way materials such as rail, ties, ballast, etc.
- Employee parking
- Storage tracks for the maximum number and length of trains to be kept at the layover facility. The tracks should be double-ended, accommodate no more than three trains per track, be spaced on alternate track centers of 16 feet and 25 feet, and should have at least 50 feet of additional track between trains and at each end of a stored train.
- Crossovers on the main line at each end of the layover facility if the main line is double track
- Site lighting, fencing, security system, and appropriate fire protection and environmental systems.

## 4.2 Commuter Rail Maintenance Facility

The commuter rail maintenance facility will accommodate train operations and maintenance functions that involve daily, routine activities that are of short duration. A maintenance facility could either be provided on the corridor or be performed at a local railroad facility, even if the heavy repair functions are contracted to an outside vendor. Having the maintenance facility on-line precludes the need to constantly move vehicles to and from an off-line facility for basic, routine inspection, servicing, and maintenance.

### 4.2.1 Functional Requirements

The functional requirements for the maintenance facility are:

- Train storage and consist changing
- Head-end power yard connections (for train heating and air conditioning)
- Train yard air connections (for train air brakes)
- Exterior train washing
- Interior train cleaning
- Toilet servicing
- Daily and other FRA required inspections, tests, and maintenance (including periodic or preventive maintenance, and brake tests)
- Fueling and sanding facility with storage for at least a 10-day supply (note that fuel can also be supplied by a local dealer and delivered directly to the locomotives)
- Repairs due to wear-out and failure
- Wheel truing
- Parts, material, supplies, spares and storage
- Employee facilities for transportation and rolling stock personnel (restrooms, lockers, conference and training rooms, etc.)

Train storage tracks should be capable of holding all of the trains in the fleet. Tracks should be double-ended, tangent track allowing for at least 50 feet of space between the turnouts and the trains, and at least 50 feet of space between trains. A maximum of three trains should be stored on each track.

Other requirements for the maintenance facility are:

- Drip pans where locomotives are parked
- Alternating storage track spacing of 16 feet and 25 feet in order to accommodate service aisles
- Train wash track with distance for one train on each end of at least a 250-foot long wash facility. The train washer should be located between the terminal station and the maintenance facility if at all possible.
- Yard run-around/bypass track and one or two tracks for switching consists
- Lead tracks to main line with sufficient length to allow one maximum length train between the first yard switch and the main line signal
- Blue flag protection for each storage and shop track

The rolling stock maintenance shop building requirements are:

- One track with inspection pit and roof access platform
- One floor level track with capability for jacking vehicles using portable electric jacks for wheel and truck and other large component removal

- One track with wheel truing and locomotive wheel drop table
- Parts and material storage with shipping and receiving dock area, including fuel and sand storage
- Shop air and lubrication dispensing system, if required
- Staff offices and facilities for transportation, rolling stock, and support personnel including training and conference rooms
- Parking spaces for train operations and rolling stock shop employees
- Yard security, fire protection, and environmental systems, storm-water retention and wastewater treatment
- Utilities including yard train air, head-end train power, hot and cold water, electrical outlets, etc.
- Site roadways and service aisles
- Site fencing and lighting
- Site capability to accommodate expansion in the future

### 4.2.2 Heavy Maintenance Facilities

Heavy maintenance involves extensive, long-duration work on locomotives and cars. Heavy maintenance work will be contracted to BNSF or Union Pacific Railroad or to an outside vendor until such time as it becomes economical to do such work in the maintenance facility.

## 4.3 Maintenance-of-Way Facilities

Maintenance-of-way involves the inspection, maintenance, and repair of the fixed plant such as track, bridges, railroad signaling, stations, and highway crossings. The maintenance-of-way function will most likely be performed by BNSF or Union Pacific Railroad under an agreement with MAG. The maintenance-of-way facilities can be located either in conjunction with the rolling stock maintenance facility or at a separate site.

### 4.3.1 Functional Requirements

Facilities for maintenance-of-way will require the following:

- Outdoor material storage (rail, ties, ballast, etc.)
- Building for offices, employee facilities, materials and supplies storage, tools, component workspace, and maintenance vehicle storage bay
- Parking for maintenance-of-way employees and maintenance trucks and equipment
- Security, fire protection, and environmental systems, storm-water retention and wastewater treatment
- Fencing and lighting

### 4.3.2 Potential Layover and Maintenance Facility Locations

The potential locations for layover facilities for the System Study Update include Phoenix Union Station, Wittmann, Buckeye, Queen Creek, and Wild Horse Pass/I-10. It is likely that some level of layover will be used at each end-of-line station, at least during the day between the AM and

PM peak periods. At a minimum, tail tracks should be built at or near each end-of-line station and at Phoenix Union Station to hold one or two trains (depending on final operational requirements).

The potential locations for a maintenance facility for the System Study Update include the BNSF Mobest Yard, Union Pacific Railroad Harrison Street Yard, Union Pacific Railroad Campo Yard (located between 35th Avenue and 43rd Avenue), or another such site near downtown Phoenix provided sufficient space is available.

With South Mountain on the horizon and the State Capitol at left, BNSF's Phoenix-Mobest Yard may be a prime location for a centrally located commuter rail maintenance facility (CRMF).
Source: MAG.

# 5 Attachment A: String-line Diagrams

Attachment A-1: String-line Diagram – Grand/Kyrene Line (LHC)

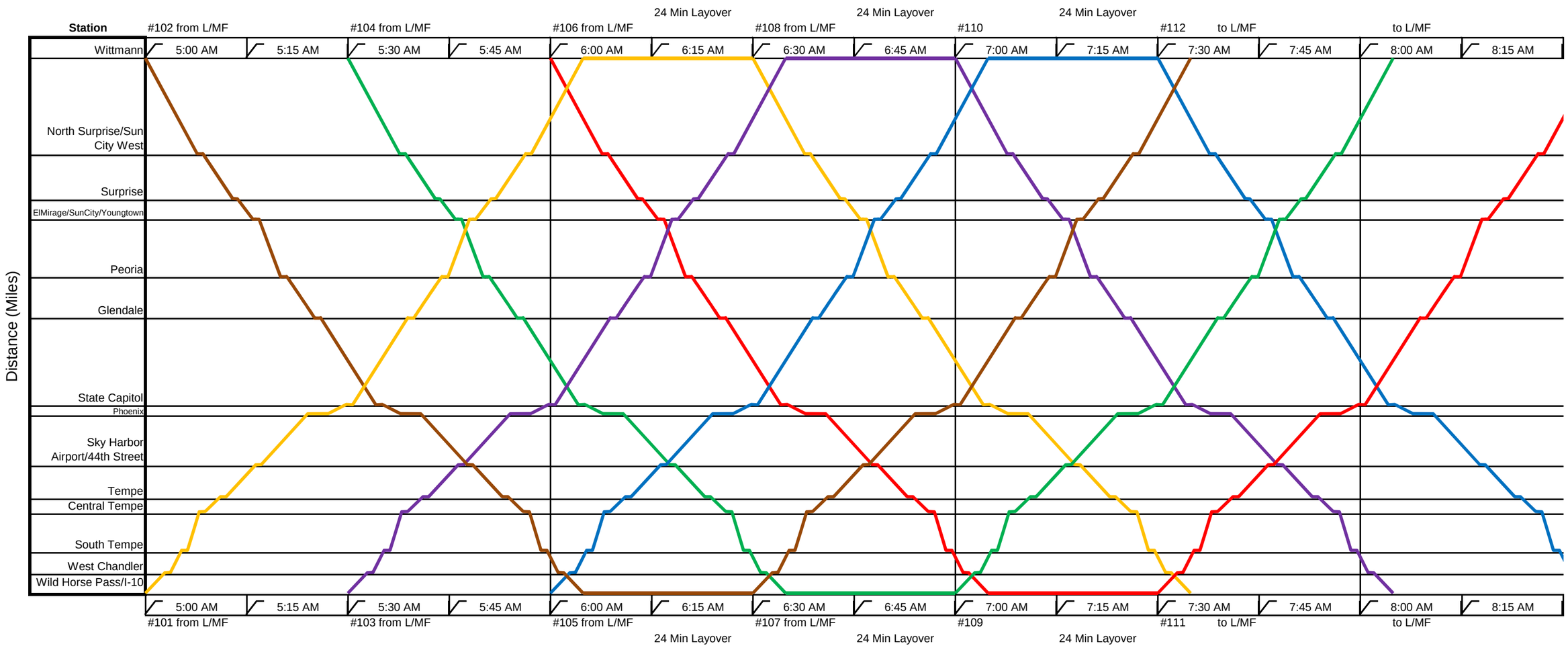
Attachment A-2: String-line Diagram – Grand/Kyrene Line (DMU)

Attachment A-3: String-line Diagram – Estrella/San Tan Line (LHC)

Attachment A-4: String-line Diagram – Estrella/San Tan Line (DMU)

MAG Regional Commuter Rail System Study Update (2018)
Commuter Rail Stringline Diagram

Grand/Kyrene Line Corridor
Diesel Multiple Unit

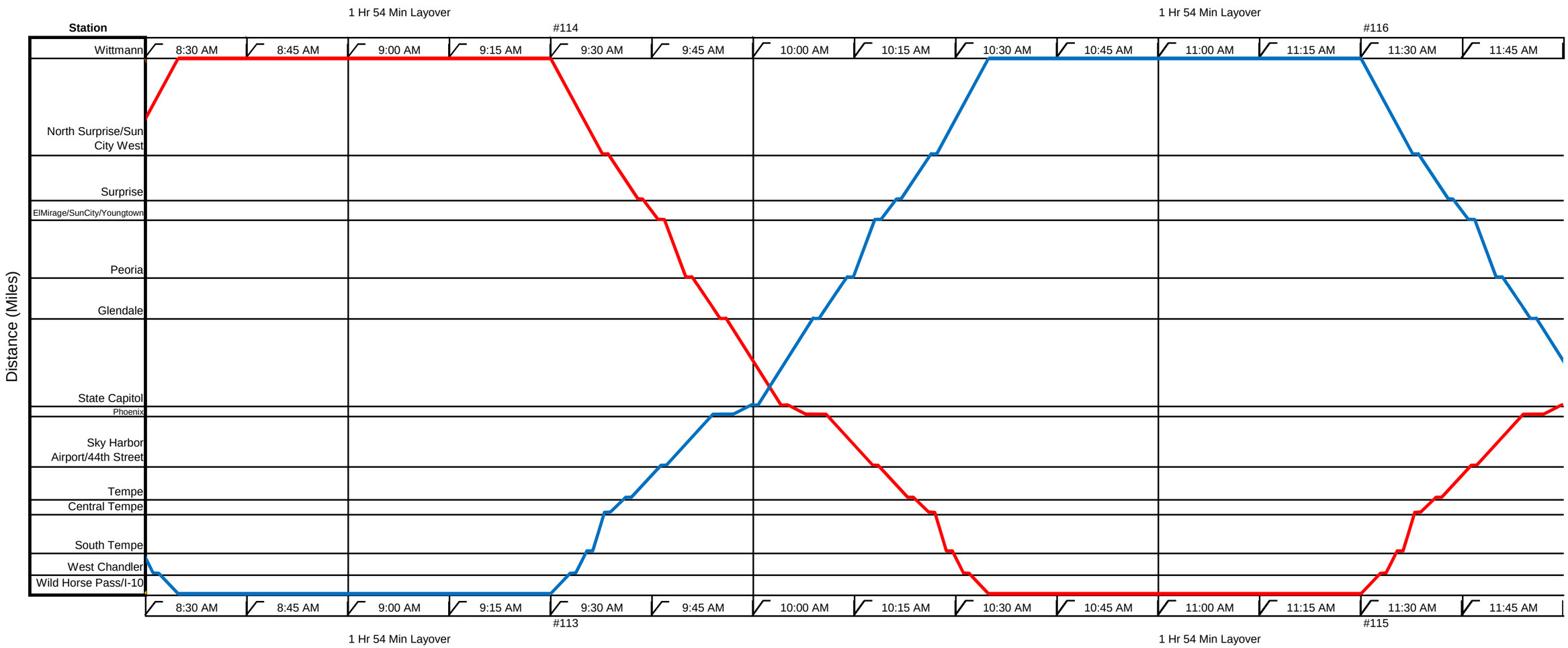



Scale:
1" = 10 Miles Vertical
1" = 15 Minutes Horizontal

L/MF=Layover/Maintenance Facility

MAG Regional Commuter Rail System Study Update (2018)
Commuter Rail Stringline Diagram

Grand/Kyrene Line Corridor
Diesel Multiple Unit




Scale:
1" = 10 Miles Vertical
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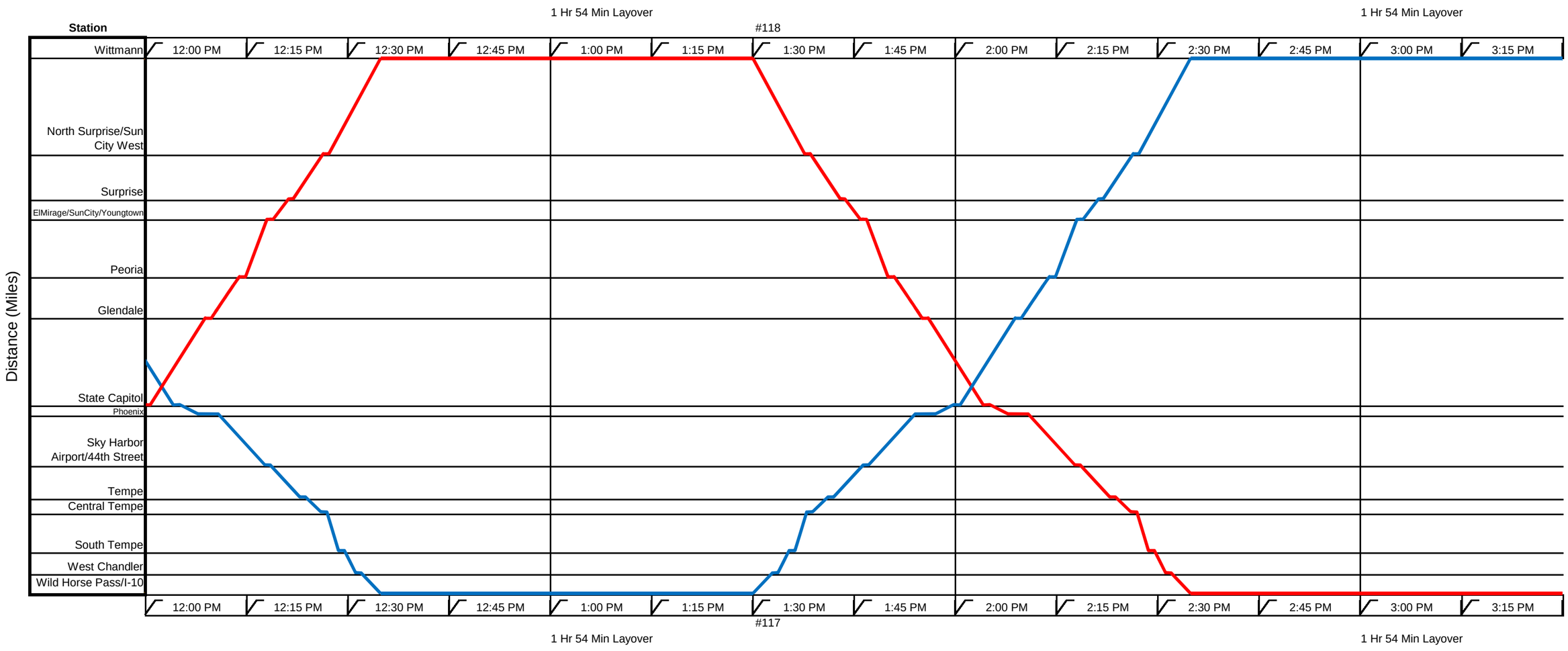
L/MF=Layover/Maintenance Facility

MAG Regional Commuter Rail System Study Update (2018)
Commuter Rail Stringline Diagram

Grand/Kyrene Line Corridor
Diesel Multiple Unit

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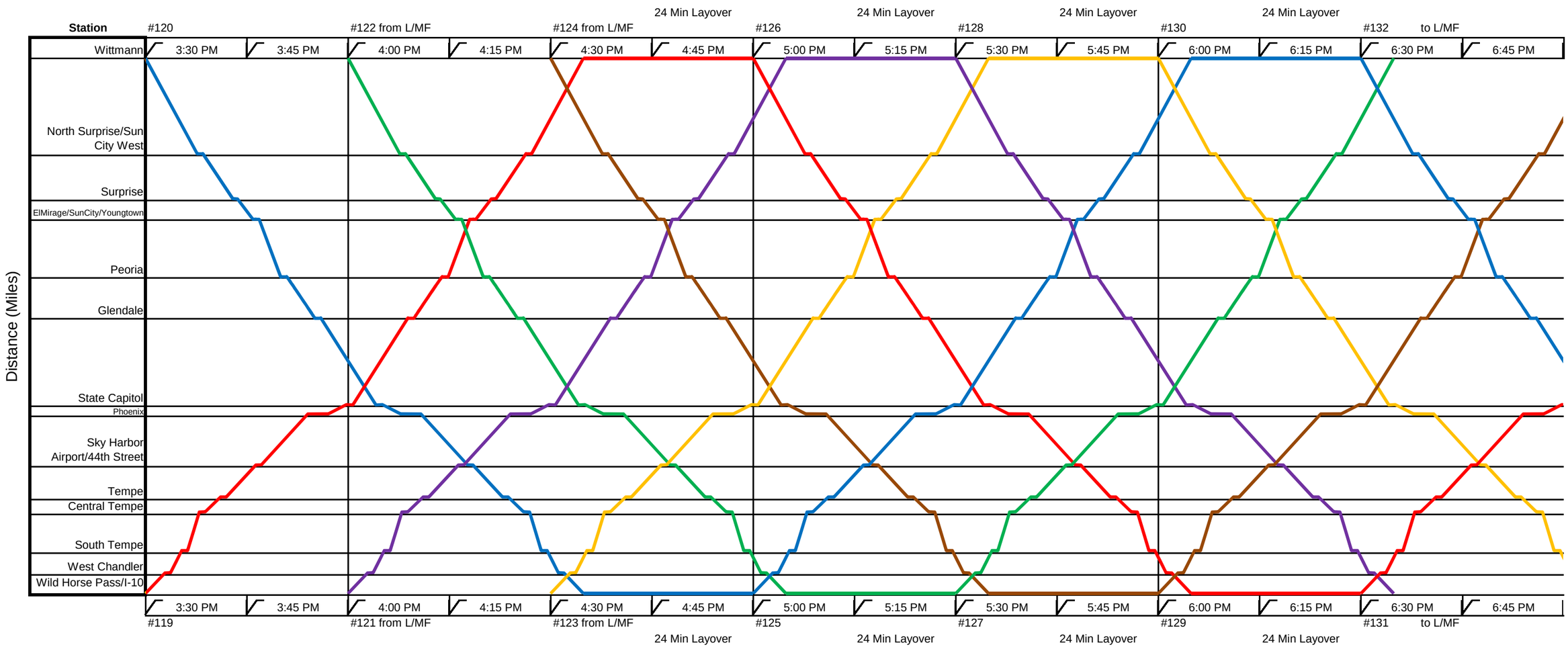


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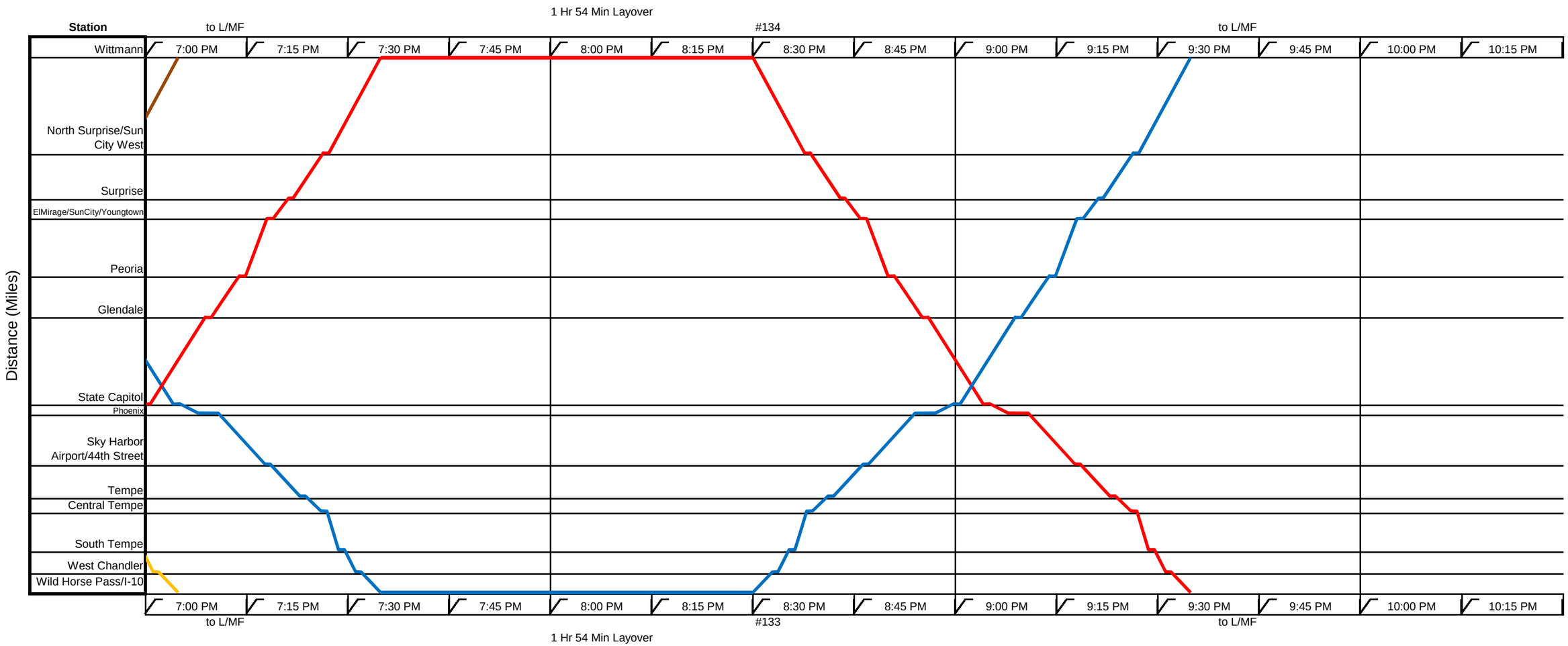


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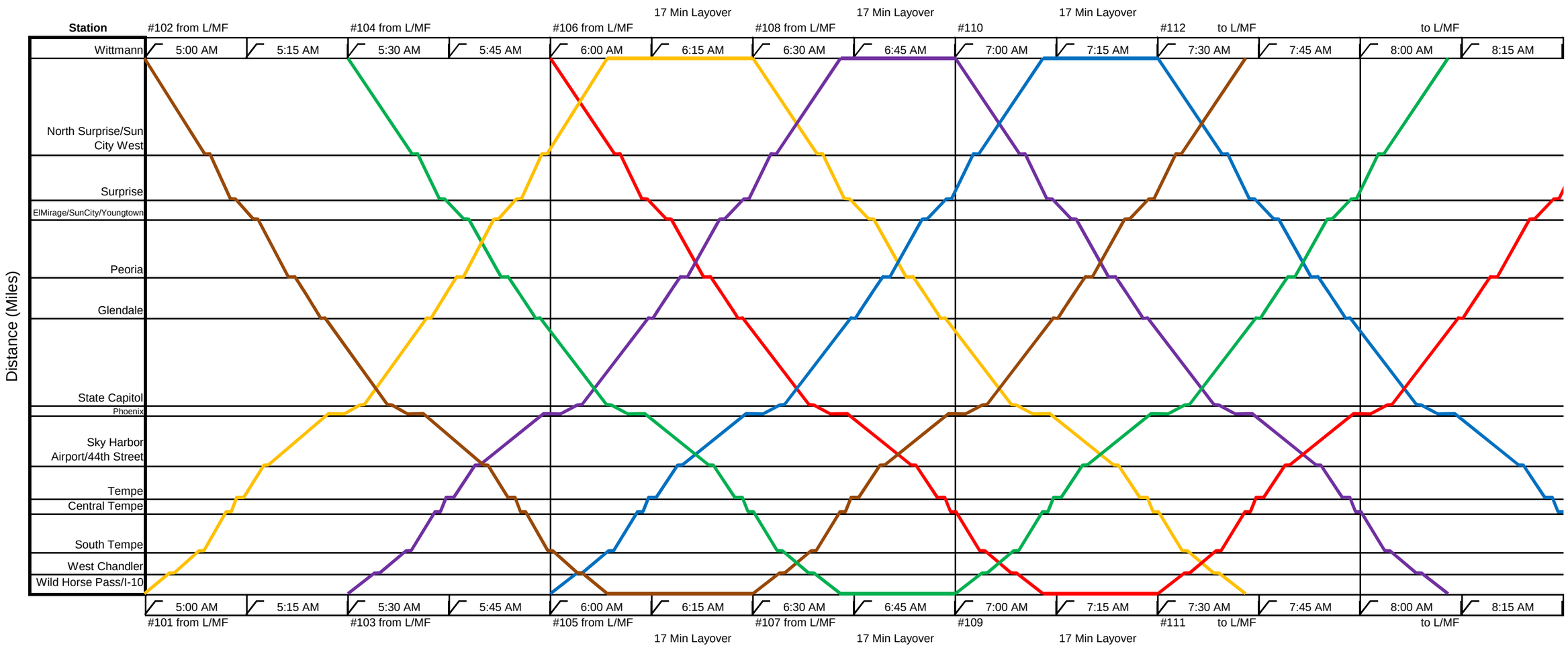


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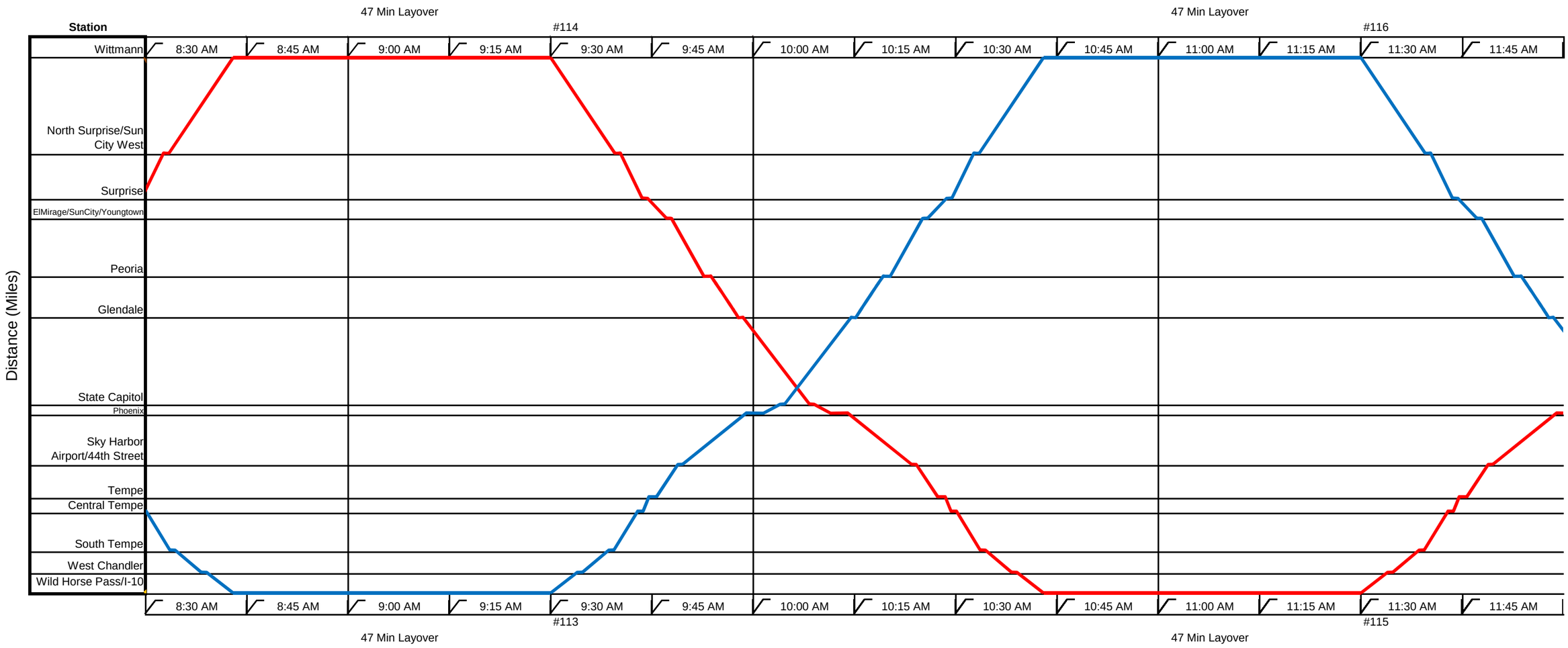


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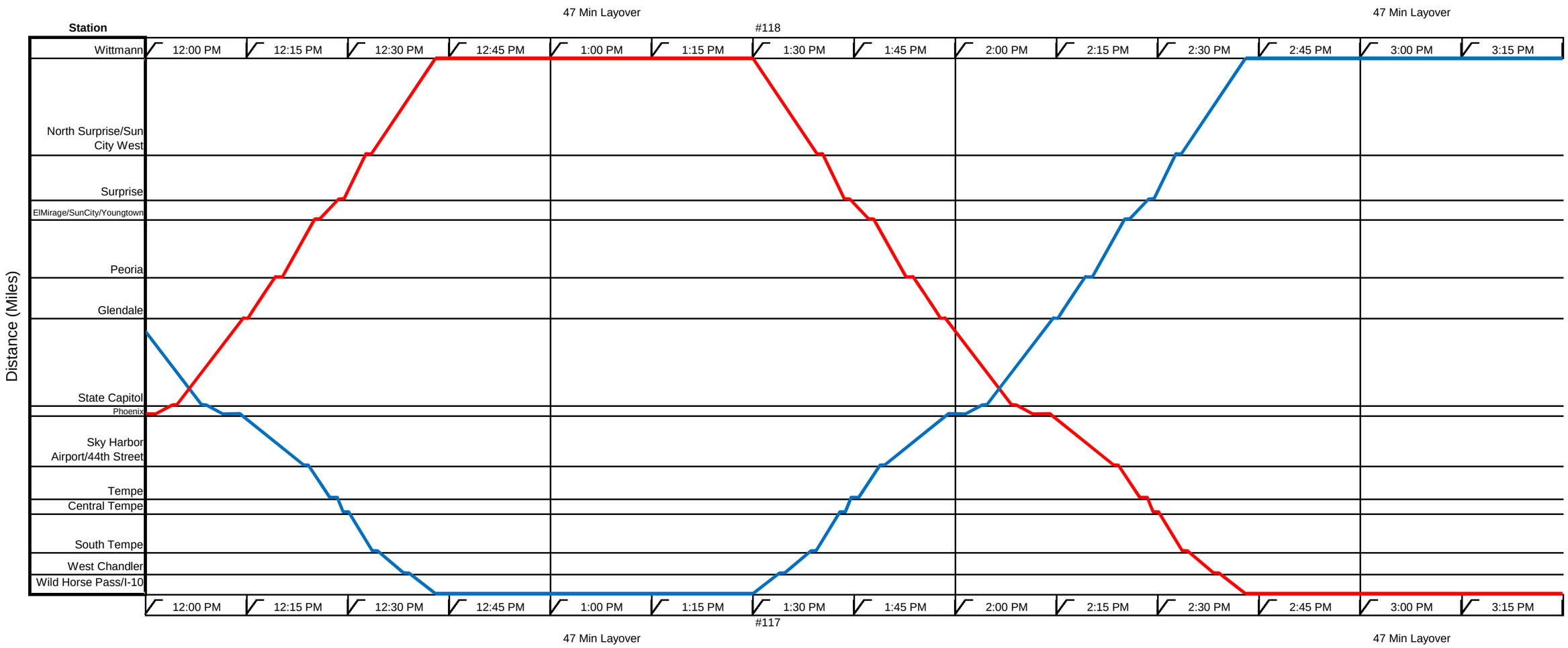


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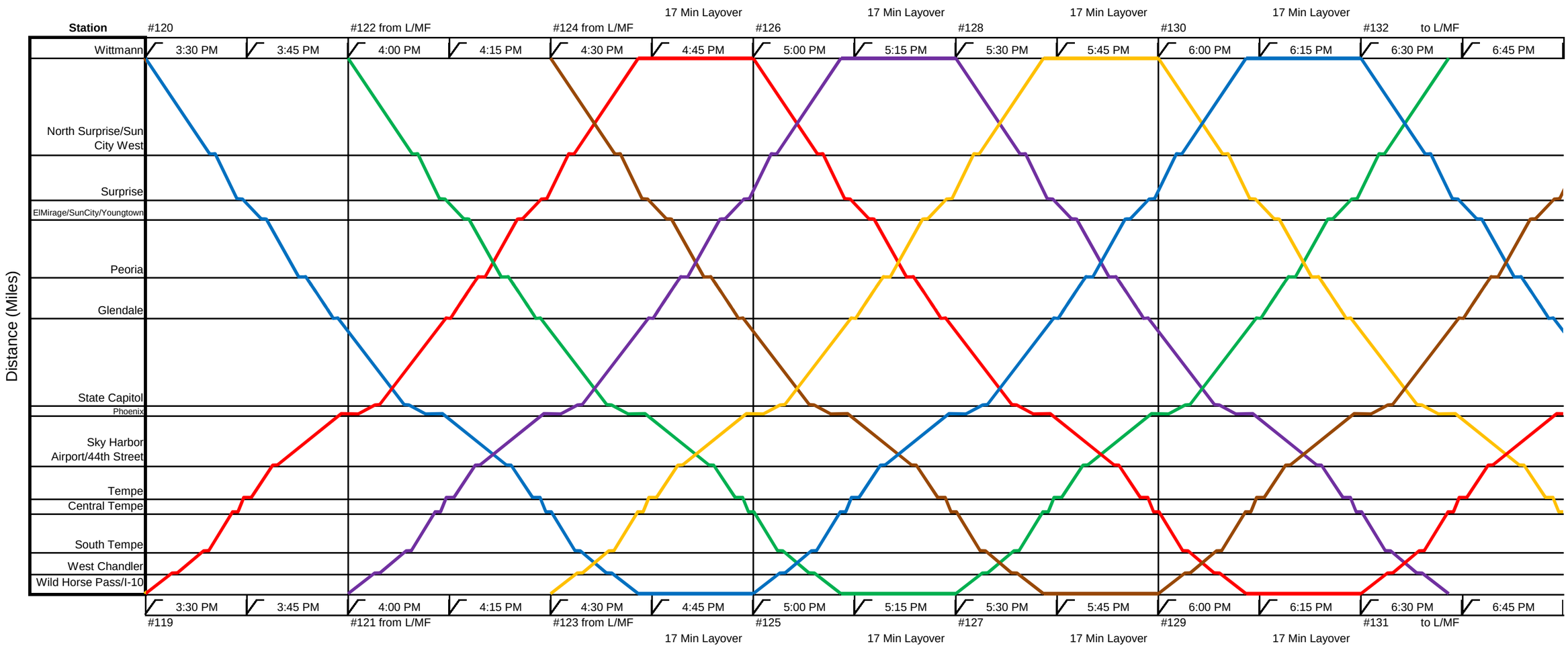


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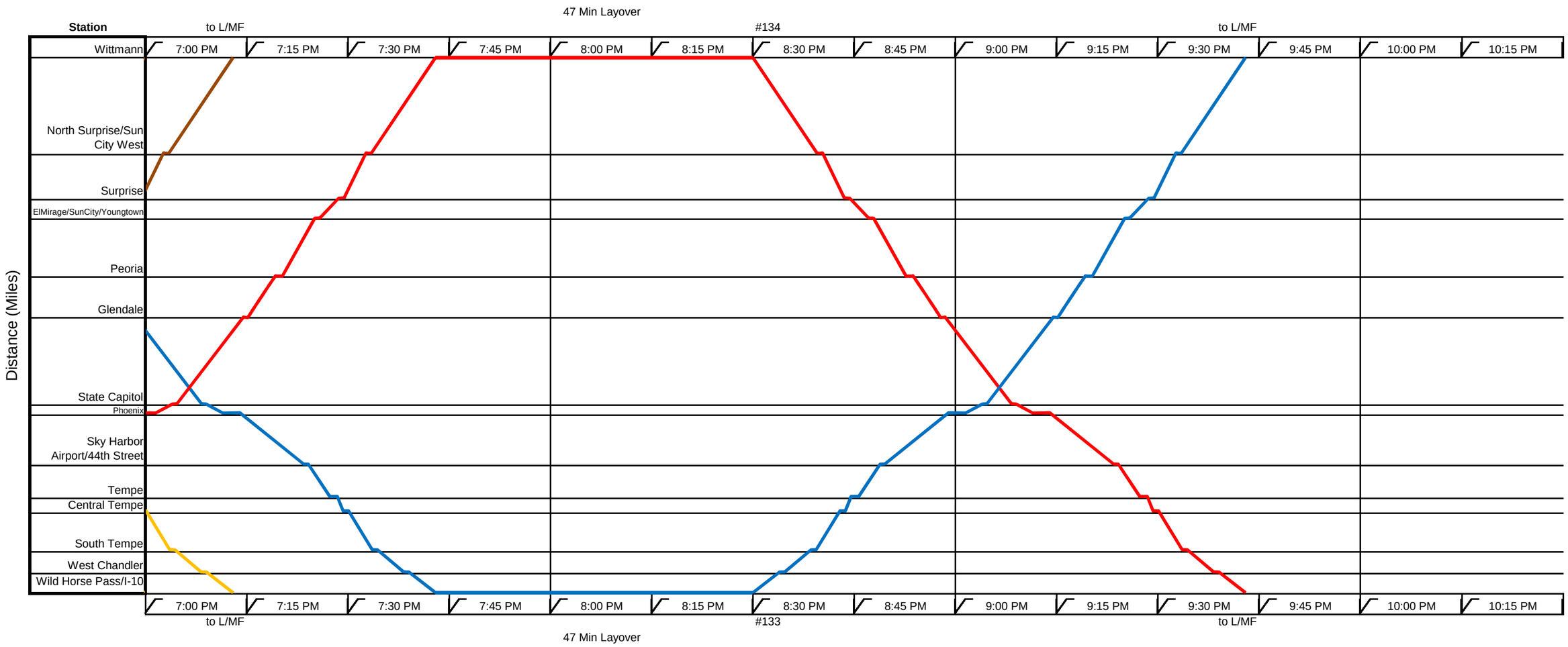


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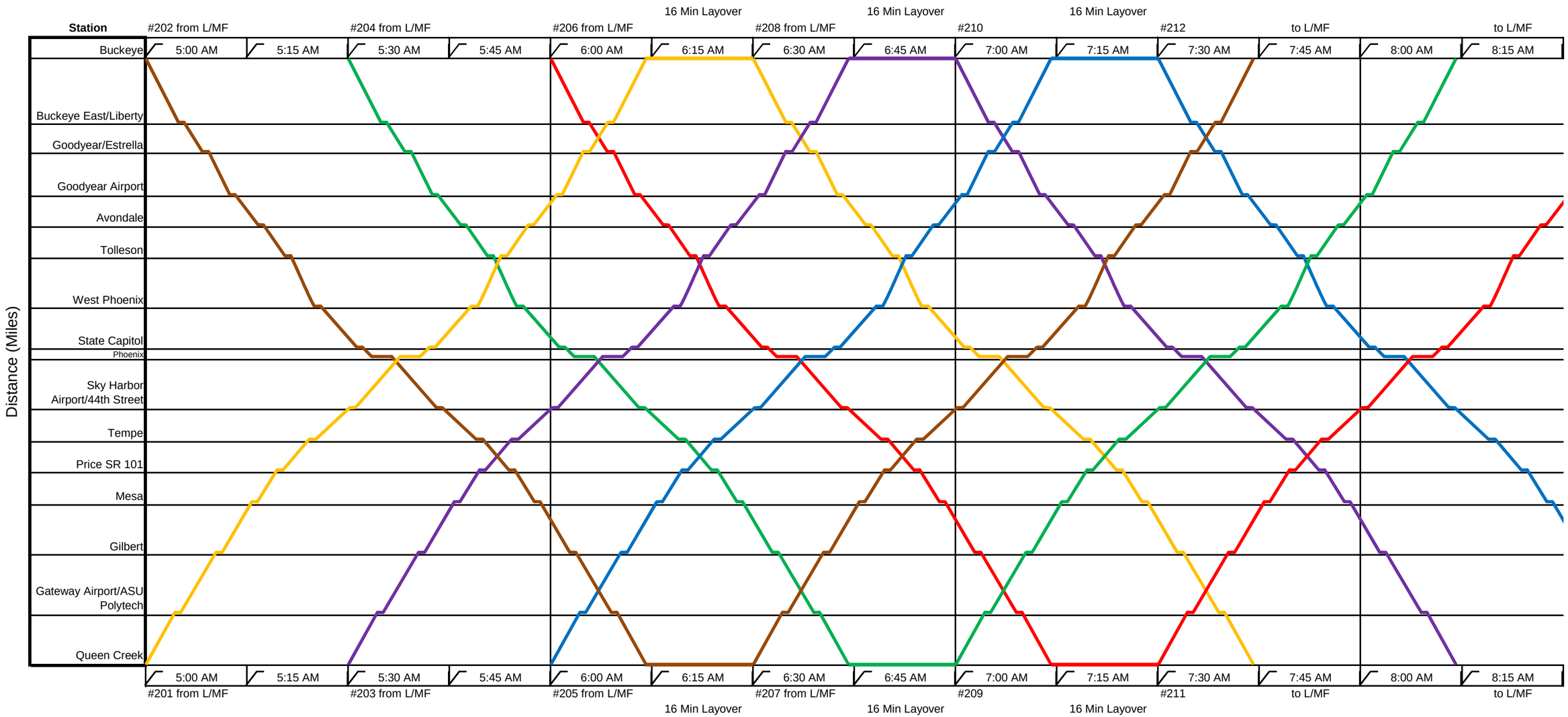


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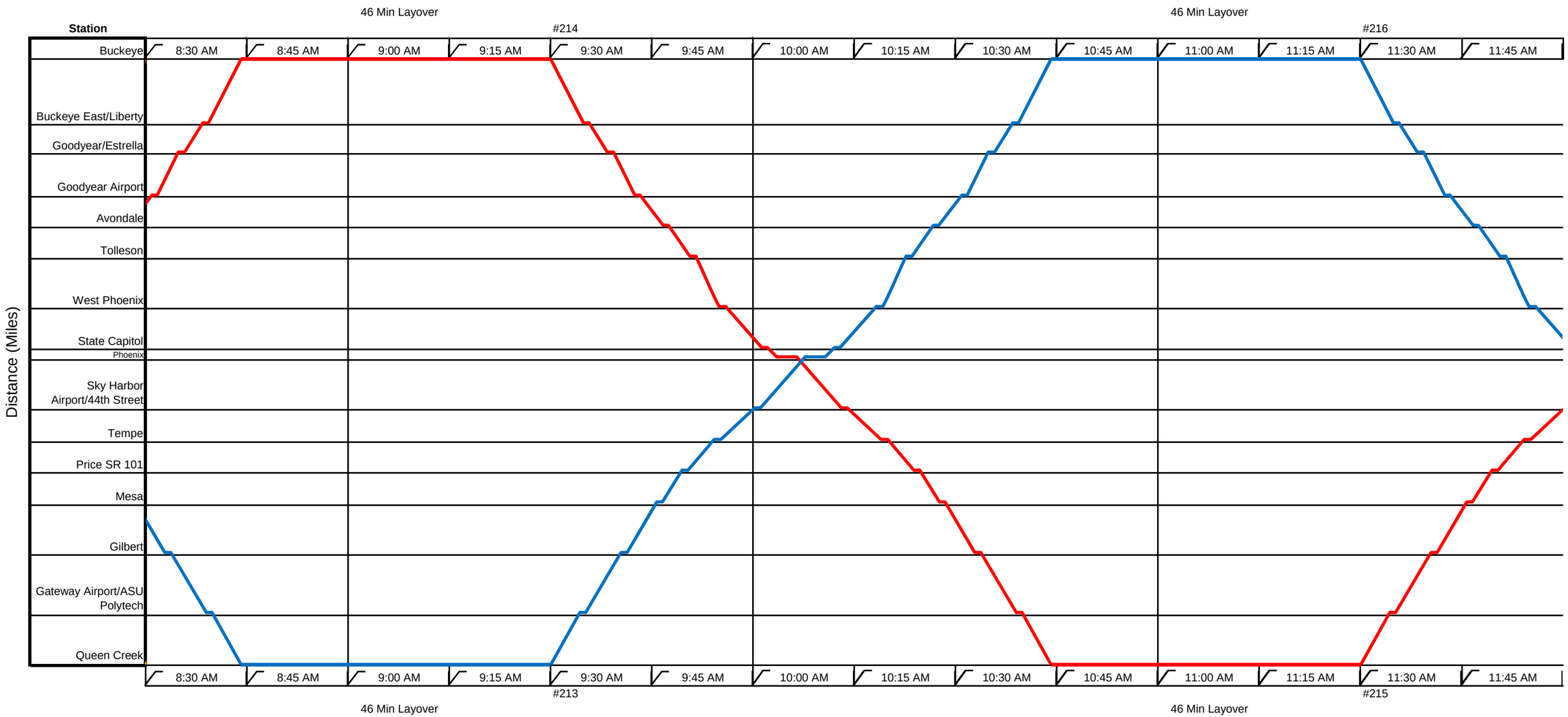


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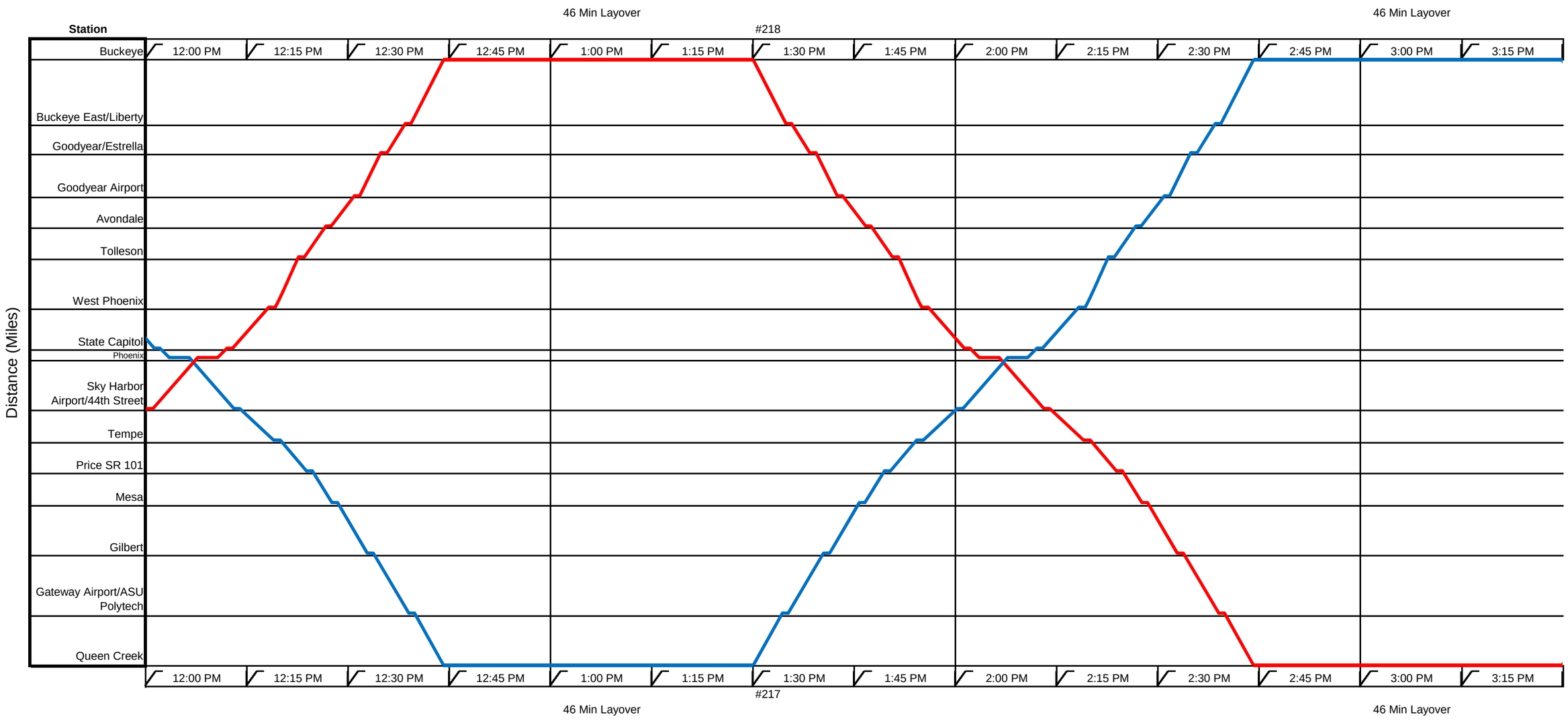


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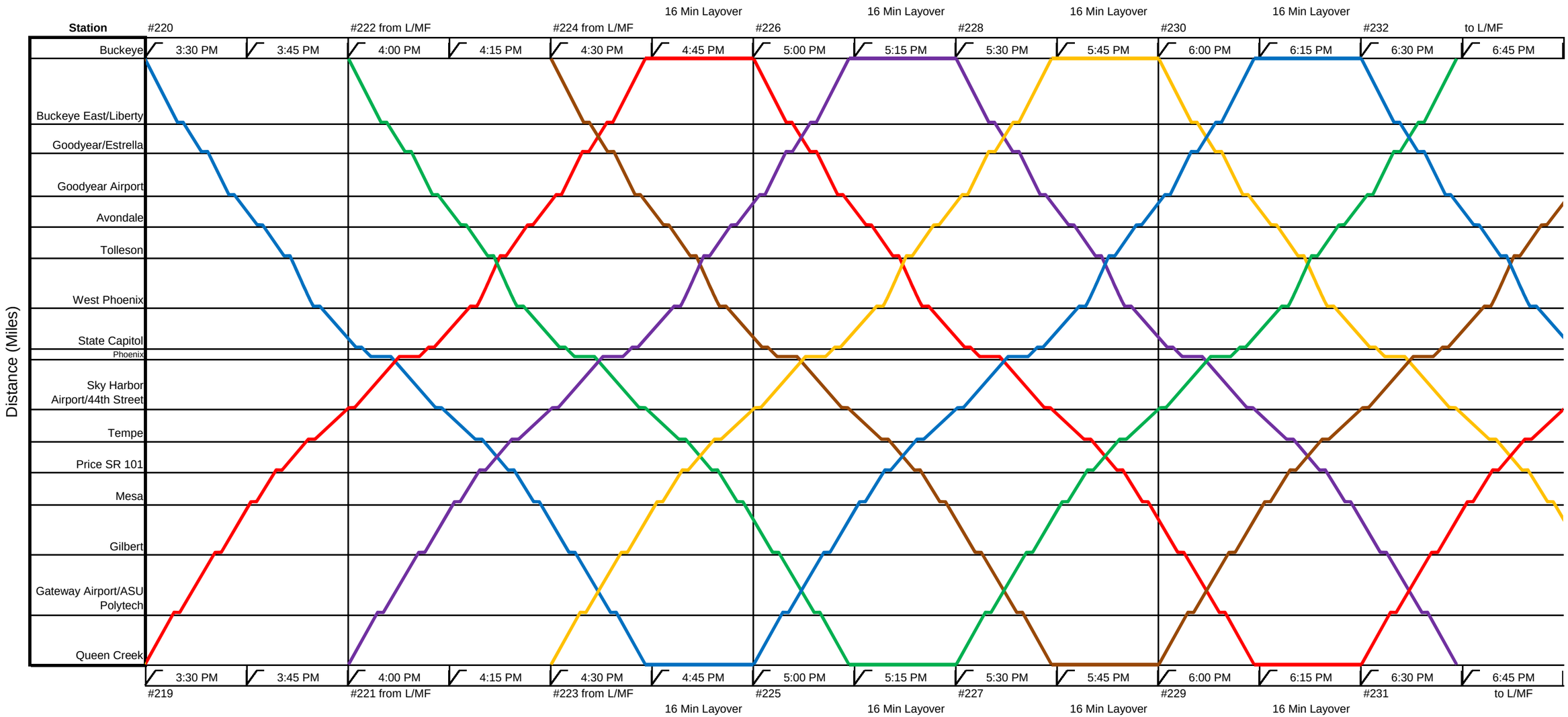


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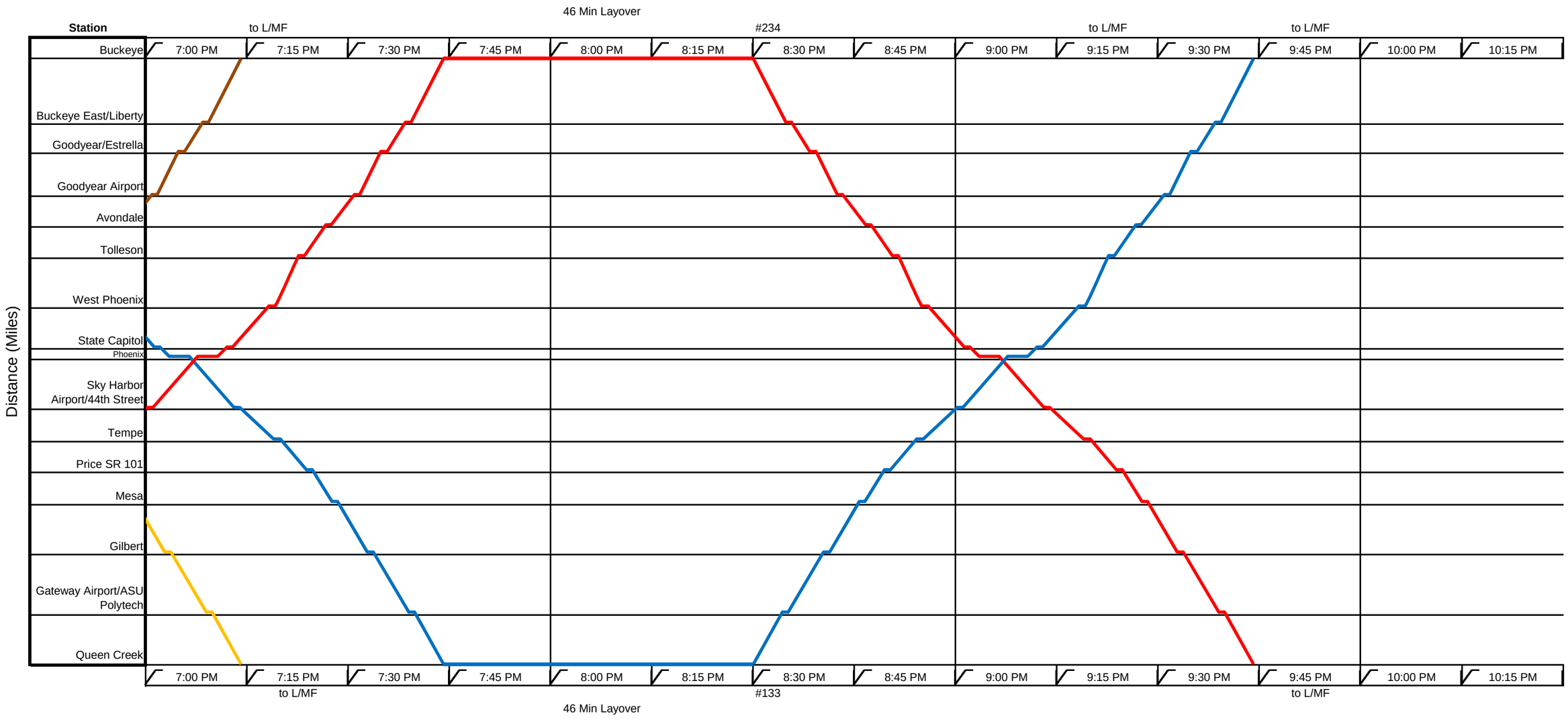


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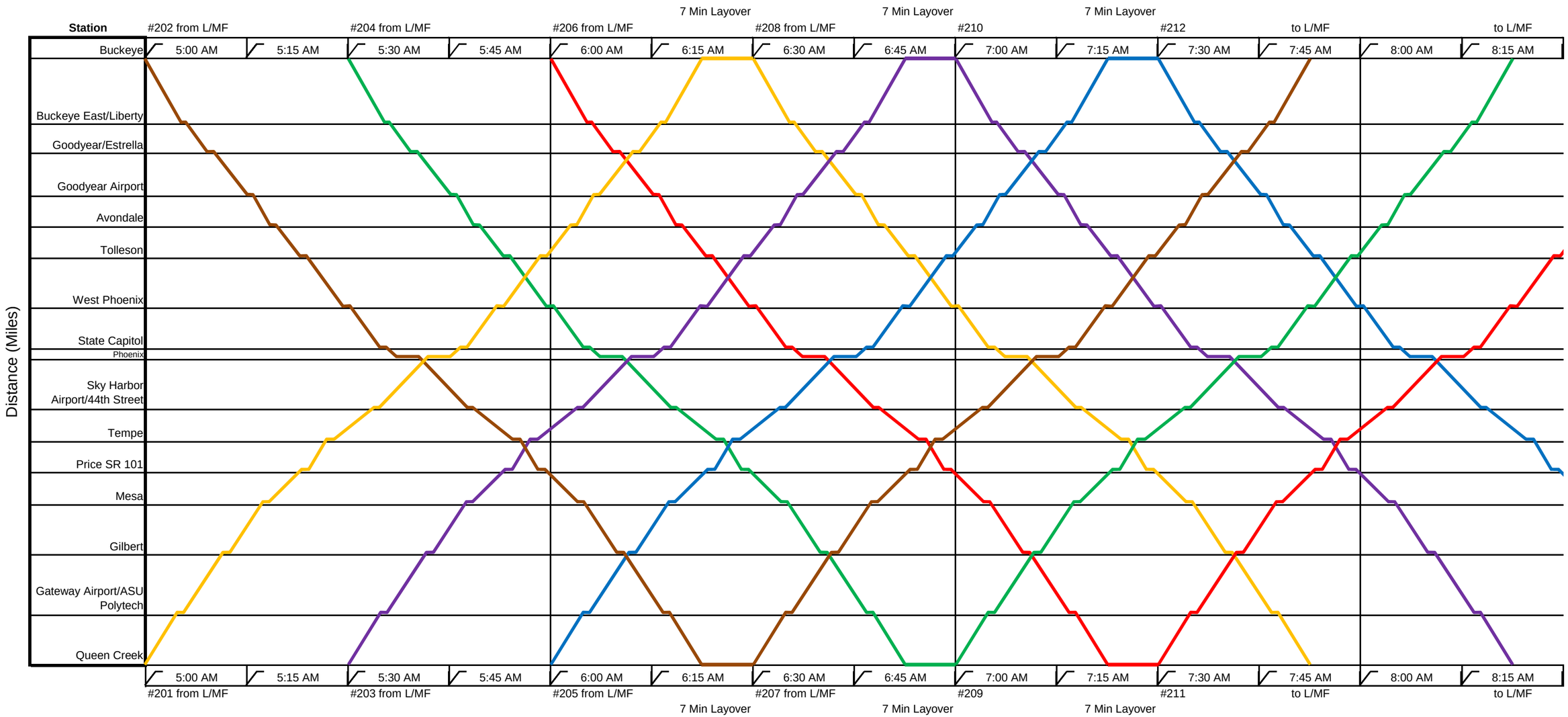


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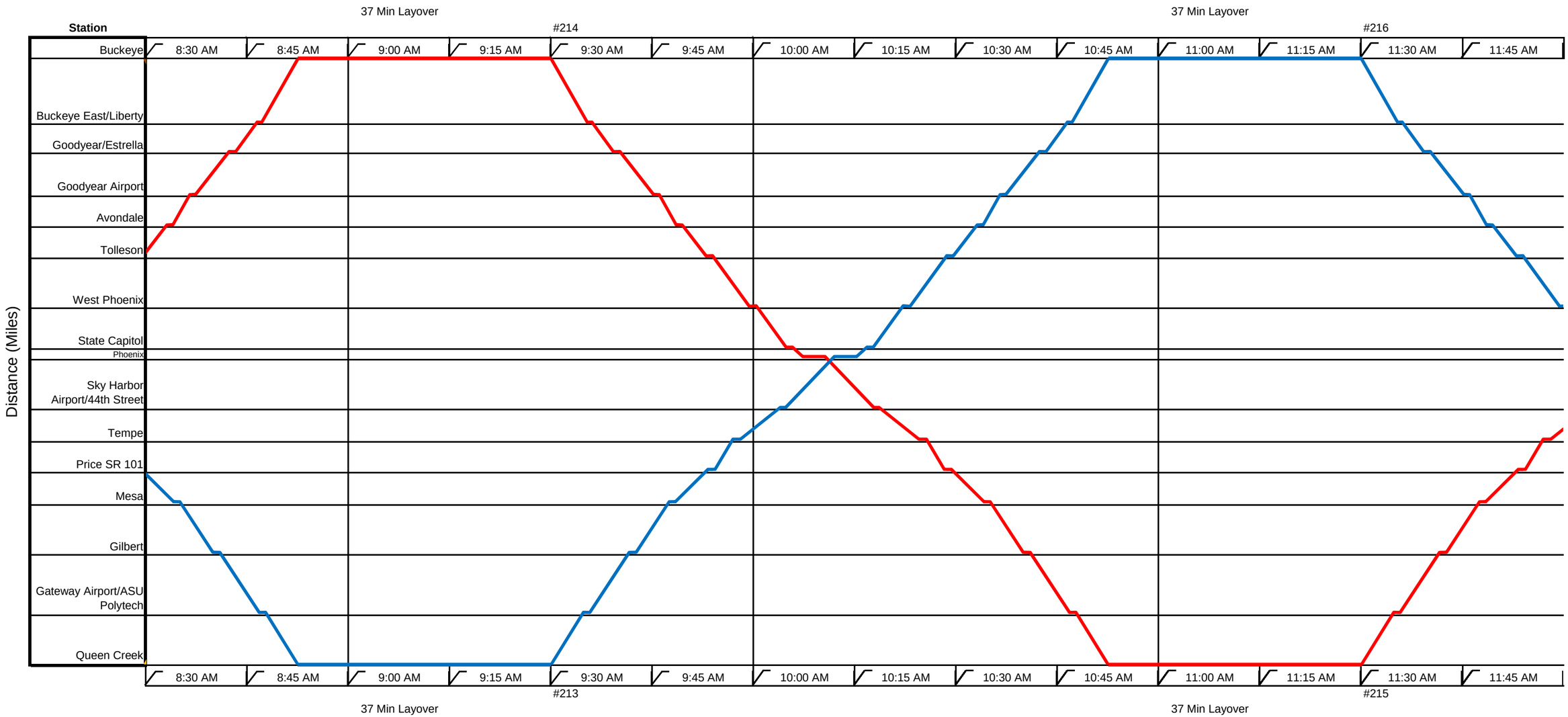


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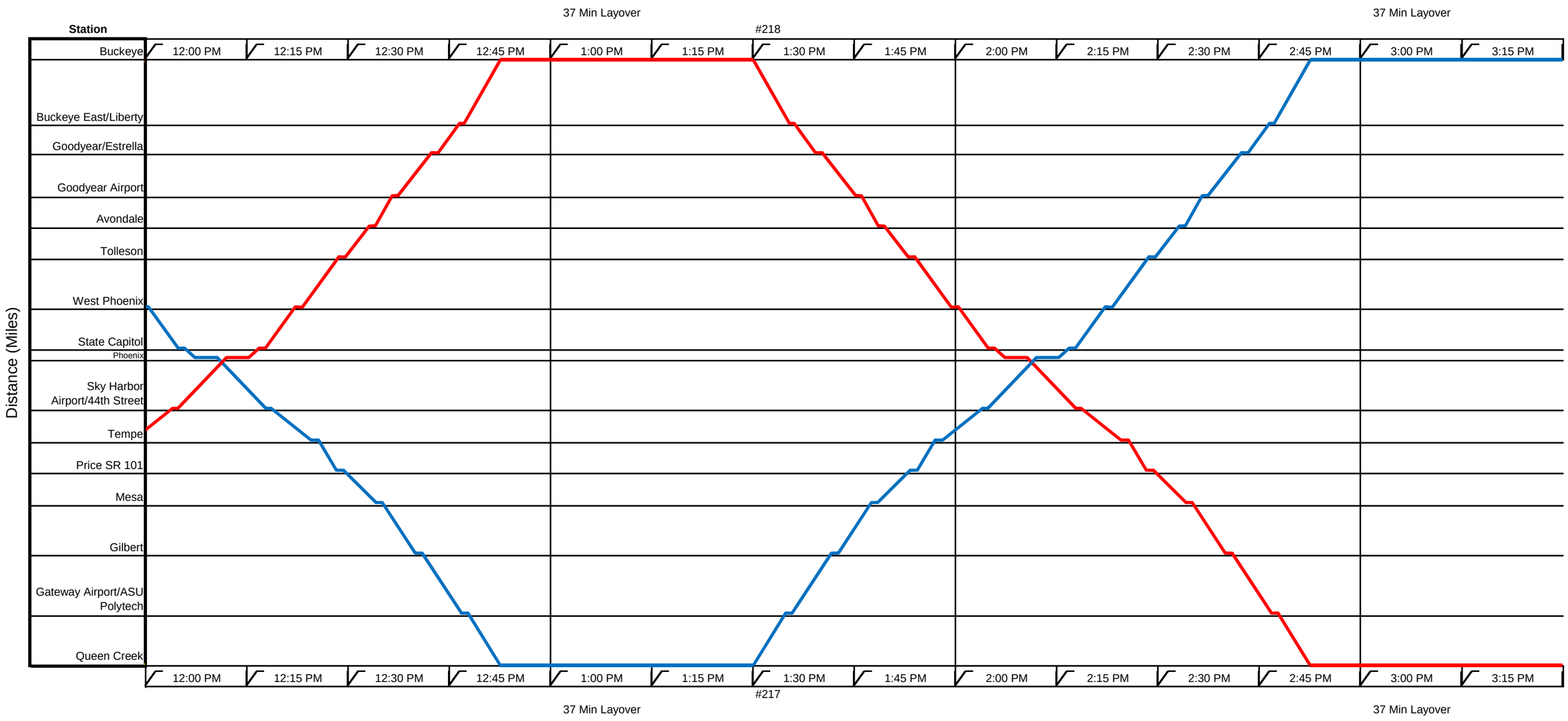


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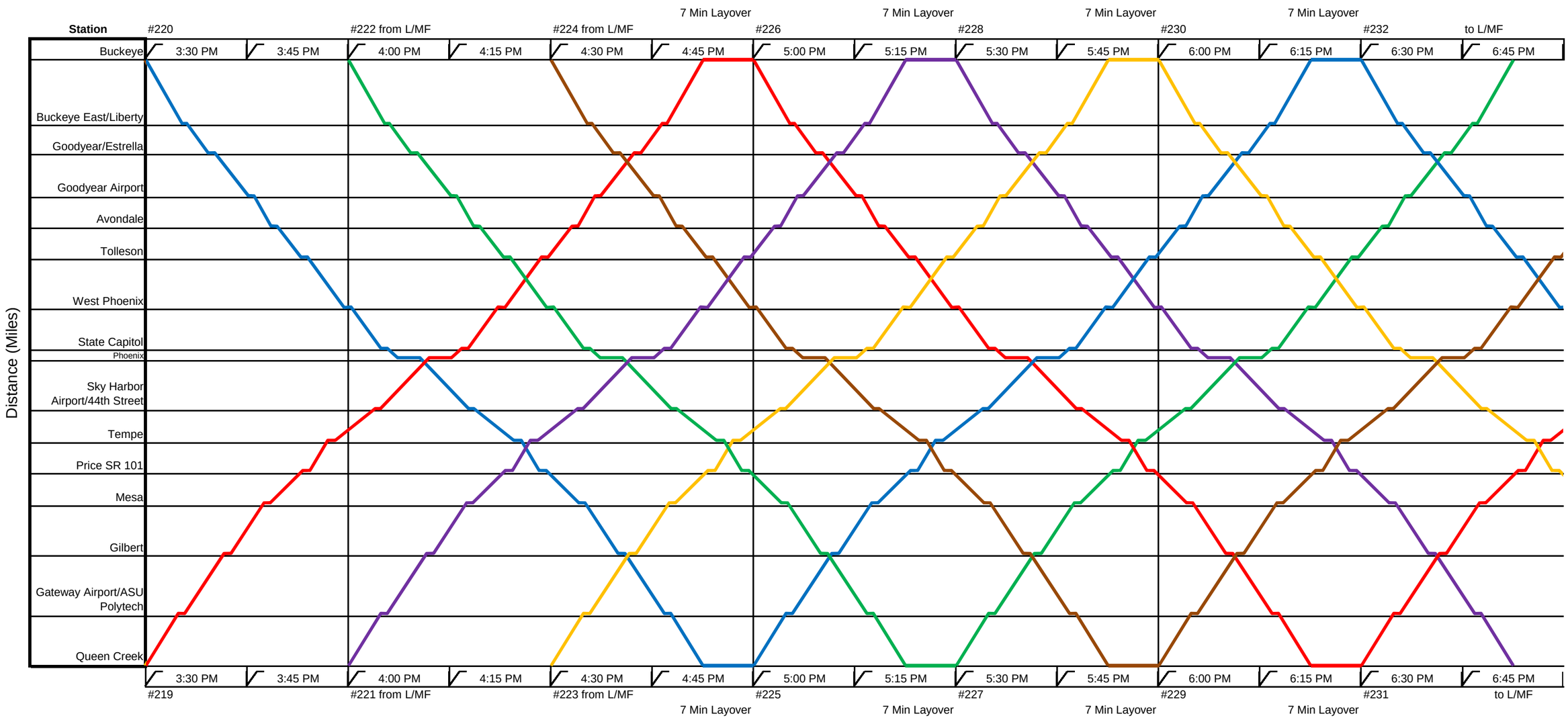


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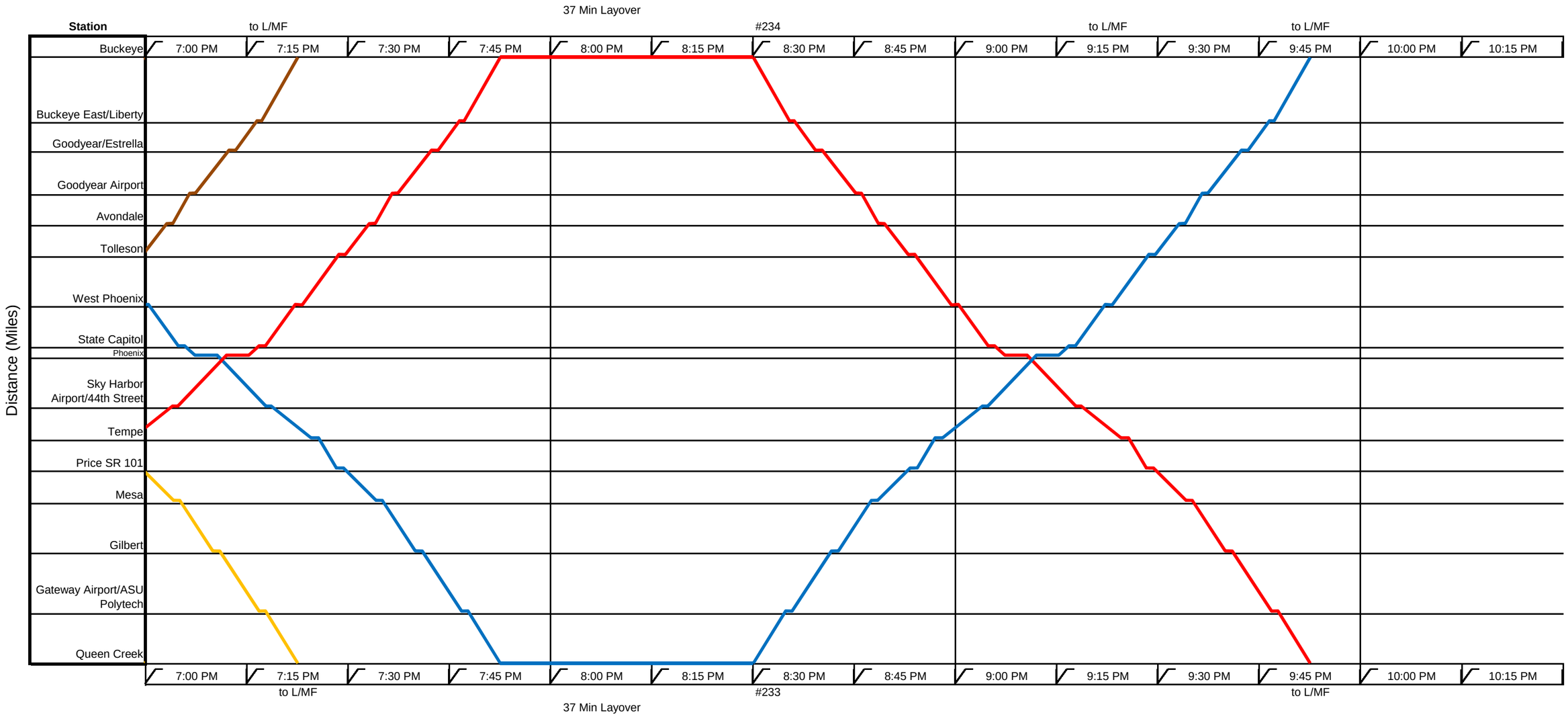


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# MARICOPA ASSOCIATION OF GOVERNMENTS

# REGIONAL COMMUTER RAIL SYSTEM STUDY UPDATE

## Appendix H: Commuter Rail Maintenance Facility Description and Evaluation

**May 2018**

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# 1.0 INTRODUCTION

The purpose of this white paper is to describe the purpose of commuter rail maintenance facilities (CRMFs) and to begin advance planning for CRMFs to serve the MAG commuter rail system. Specifically, the white paper (1) describes the purpose, types and functions of CRMFs; (2) depicts CRMFs currently in operation using peer city examples; (3) discusses key factors to consider when locating CRMFs; (4) describes various scenarios for siting CRMFs and proposes a list of potential candidate CRMF sites; and (5) summarizes preliminary CRMF costs and operating considerations.

# 2.0 DESCRIPTION OF COMMUTER RAIL MAINTENANCE FACILITIES

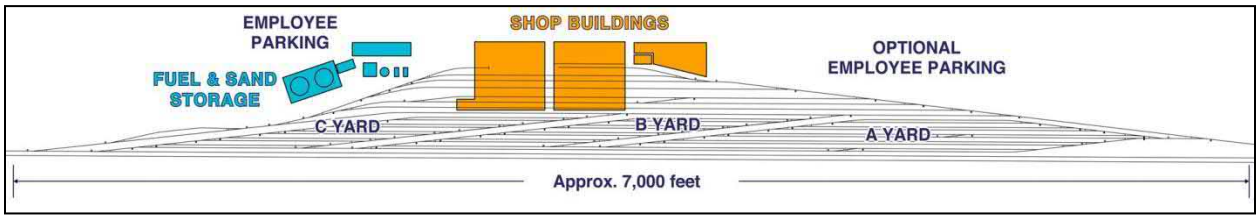
CRMFs are the facilities used to repair, maintain, clean, fuel, and store commuter rail vehicles that serve a commuter rail line or system. In addition, control center rail operations and maintenance-of-way (MOW) facilities are necessary and are often components of larger CRMFs. MOW includes facilities required to maintain the track, stations, signaling, bridges, at-grade crossings and other fixed facilities along a given passenger rail corridor. Maintenance facilities generally operate 24 hours a day, seven days a week. Figure 1 depicts the site layout of the Metra Western Avenue CRMF located in Chicago, Illinois.

**Figure 1: Metra (Chicago, IL) Western Avenue Maintenance Facility**

Source: Project Team, 2009.

Figure 2 depicts the typical site layout for a CRMF, however, CRMFs are designed based on specific needs of the corridors they serve (mostly based on ridership and vehicle fleet size, along with track configuration), and the size and shape of a selected site.

**Figure 2: Typical CRMF Site Layout**




Source: Project Team, 2009.

Federal Railroad Administration (FRA) regulations stipulate safety standards to maintain locomotives and rolling stock. The specific parts of the Code of Federal Regulations (CFR) are 49 CFR Parts 229 and 238. The list of activities and facility components that are required for a CRMF to function are provided below.

Federal Railroad Administration (FRA) regulations stipulate safety standards to maintain locomotives and rolling stock. The specific parts of the Code of Federal Regulations (CFR) are 49 CFR Parts 229 and 238. The list of activities and facility components that are required for a CRMF to function are provided below:

- Train/vehicle storage and consist changing area
- Power and air (for HVAC systems and air brakes) yard connections
- Train/vehicle washing and cleaning
- Toilet servicing
- Train inspections (FRA required and other)
- Fueling and sanding
- Scheduled vehicle maintenance
- Component removal and replacement
- Vehicle repair and wheel truing
- Materials storage (indoor and outdoor)
- Dispatch center (if not managed by Railroad)
- Employee facilities (offices, restrooms, lockers, break room)
- Maintenance shop activities, supplies and facilities (heavy and daily maintenance activities)

The pictures in Figure 3 depict the interior and exterior of a maintenance facility shop building at the Metra Western Avenue heavy maintenance facility in Chicago, IL.

**Figure 3: Interior and Exterior of a Maintenance Facility Shop Building**

# 3.0 EXAMPLES OF CRMF'S FROM PEER CITIES

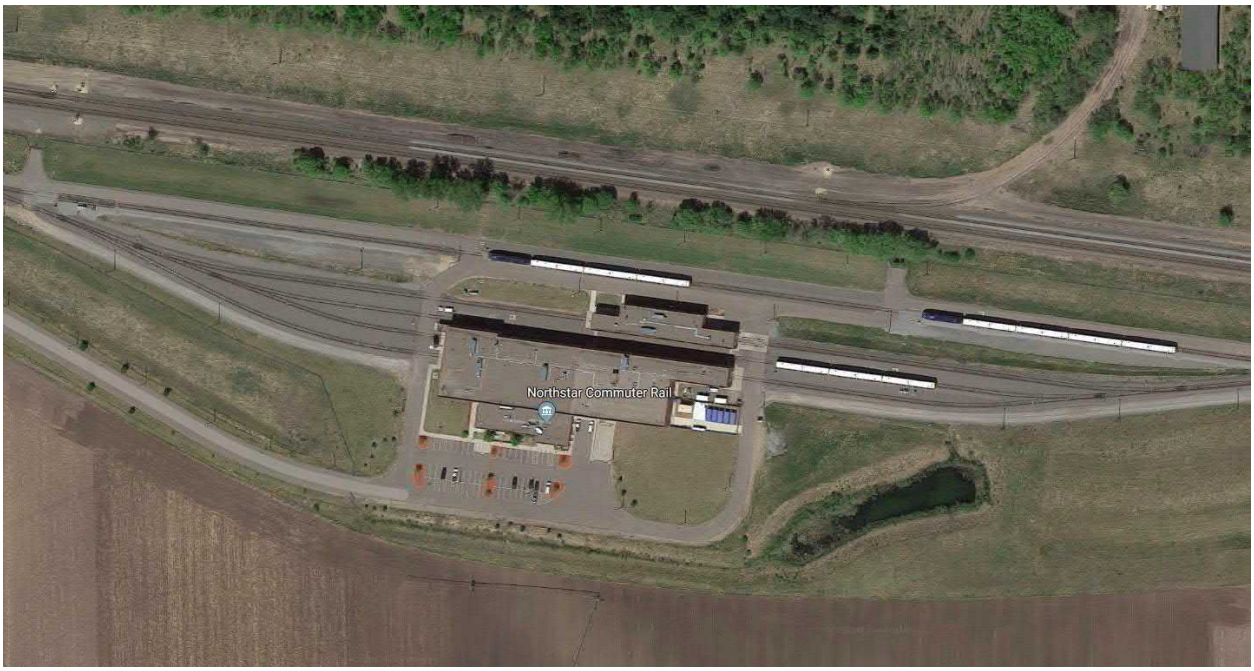
**Trinity Railway Express (TRE), Dallas-Fort Worth, Texas.** This 35-mile commuter rail system currently has two maintenance facilities. The larger maintenance facility is the TRE equipment maintenance facility depicted in Figure 4 located between the CentrePort/DFW Airport and West Irving Stations.

**Figure 4: TRE Equipment Maintenance Facility**

Source: Google, 2018.

**Northstar Commuter Rail, Minneapolis, Minnesota.** The 40-mile Northstar commuter rail line opened in 2009 and connects Big Lake to Downtown Minneapolis. There are approximately 30 employees at the facility, including administrators, mechanics, and support staff. Northstar's 19 train cars and six locomotives are washed, inspected and serviced at the facility. There is indoor storage for up to 2 locomotives and five train cars. The remainder of the fleet is stored on outdoor tracks. The CRMF is depicted in Figure 5.

**Figure 5: Northstar CRMF**

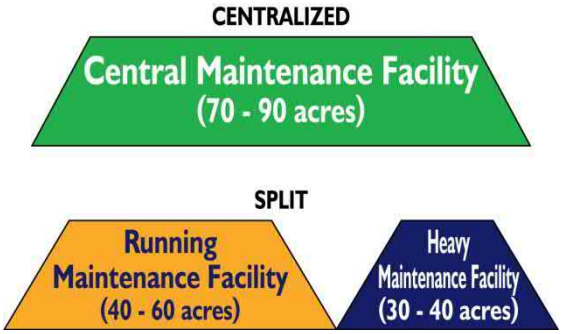



Source: Google, 2018.

# 4.0 CRMF AND LAYOVER/TAIL TRACK FUNCTIONS

## 4.1 CRMF Facilities

The two primary facilities included in a CRMF are Running Service and Inspection (Routine Maintenance, Repair and Storage) Facilities and Heavy (Major Repairs and Overhaul) Maintenance Facilities. A Running Facility conducts all daily and routine scheduled maintenance and repair activities required to keep the trains running. A Heavy Maintenance Facility provides longer term, more complex, heavier type maintenance service such as major overhaul, component overhaul, body painting, and body and engine repair activities.




The two facilities should be kept as close as possible to the commuter rail terminal to avoid time traveling in non-revenue service (operating without paying passengers) and keep service running efficiently. A general rule of thumb is to locate maintenance facilities between one and five miles from the terminal.

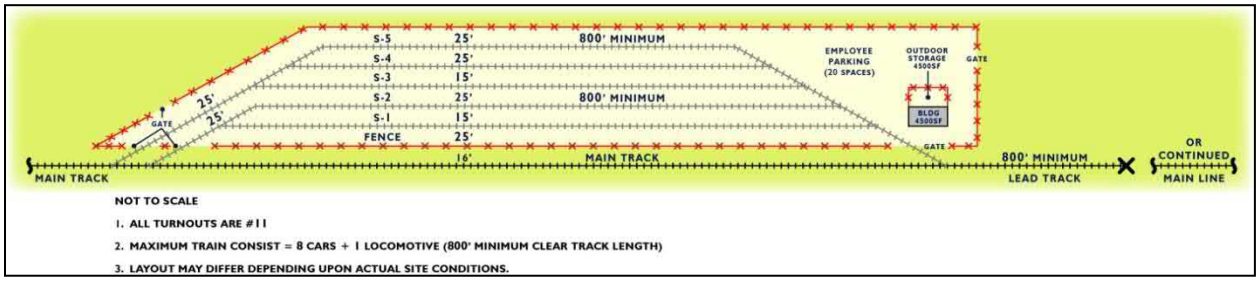
Options for locating and designing CRMFs are to (1) house all the maintenance functions in one larger centralized facility, or (2) split the facilities and have two or more facilities that conduct the full-service in combination. However, the multiple-facility approach, that splits the running maintenance facility and heavy maintenance facility, often results in duplication of personnel and facilities. Splitting the CRMF functions between two sites is usually an attractive option only when desirable land is not available on large enough parcels to house all CRMF facilities in one location.

## 4.2 Layover/Tail Track Facilities

Layover/tail track facilities are smaller facilities than a CRMF and serve the primary purpose of vehicle storage and minor vehicle cleaning and inspection. Layover/tail track facilities provide vehicle storage at both ends of a rail corridor line, allowing commuter rail service to begin at both ends of line. Layover/tail track facilities store, at most, half the fleet of trains at end of line so they can be ready for initiation of the AM and PM peak commuter rail service. The facilities are often 6-10 acres, but the actual size is dependent on service line needs.

A typical layover facility site layout is depicted in Figure 6.

**Figure 6: Typical Layover/Tail Track Facility Layout**




Source: AECOM, 2009.

# 5.0 CRMF PLANNING CONSIDERATIONS

Several factors should be considered in locating and designing CRMFs. It is important to note that as commuter rail systems expand, the needs of CRMFs change based on the size and location of the lines implemented.

Initial planning for a CRMF site is dependent upon the following factors:

- Vehicle technology (multiple vehicle types requires a larger facility).
- Site shape and orientation to mainline – (recommended shape is rectangular 1' width to every 3' length).
- Location relative to line/system (near end or central to multiple lines is preferred).
- Number of functions housed at facility (more functions require a larger site).
- Future fleet – CRMFs should be capable of accommodating future fleet expansion.
- Site size requirements:
    - A very general acre/vehicle ratio for a CRMF is estimated to be approximately .4 to.6 acre per vehicle (not train) as a rough order of magnitude (for fleets over 100 vehicles).

- However, approximately 1.0 to 1.5 acres per vehicle may be required for a maintenance facility when introducing the first commuter rail line of a system.
- As the commuter rail system grows and more vehicles are serviced, CRMF space requirements per vehicle at an existing shop may decrease until the facility eventually reaches its capacity.

# 6.0 MAG SYSTEM CRMF LOCATION SCENARIOS

CRMFs would be needed to support the commuter rail operations currently under consideration along the following corridors:

- Grand Line (service from downtown Phoenix to Wittmann);
- Estrella Line (service from downtown Phoenix to Buckeye);
- San Tan Line (service from downtown Phoenix to Queen Creek); or
- Kyrene Line (service from downtown Phoenix to Wild Horse Pass)

## 6.1 Preliminary Ridership and Operations

Ridership estimates play an important role in determining the needs of associated maintenance facilities for commuter rail, as they dictate the service levels and the fleet size. Fleet size then determines the maintenance needs of a given system. Preliminary ridership estimates were initially developed in association with the Commuter Rail Strategic Plan (Strategic Plan) process of 2007 and were updated during the 2010 Study. Ridership forecasts are currently being updated as part of the MAG Commuter Rail System Study Update using the MAG 4-Step Model. At this time, the assumed technology for the proposed MAG commuter rail system would either be locomotive hauled coach (LHC) or Diesel Multiple Unit (DMU).

## 6.2 Fleet Size

In terms of maintenance facility needs, the preliminary MAG commuter rail system projected fleet size ranges from 15 locomotives, 15 cab cars, and 45 coaches for the LHC vehicle technology or 15 four-car DMU train sets like those used for the TEX Rail system in Fort Worth, TX as shown in Table 1. The table shows an operational spare train in each corridor, with a maintenance spare train added at the end. It is common for commuter rail systems to have some level of spare equipment for either operations or for maintenance. Both vehicle types assume one additional maintenance spare trainset.

**Table 1: Fleet Size – LHC or DMU Vehicle Technology**

| Corridor | Locomotive Hauled Coach Vehicle Technology | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Locomotives | | | Cab Cars | | | Coaches | | |
| | Service | Spare | Total | Service | Spare | Total | Service | Spare | Total |
| Grand/Kyrene | 6 | 1 | 7 | 6 | 1 | 7 | 18 | 3 | 21 |
| Estrella/San Tan | 6 | 1 | 7 | 6 | 1 | 7 | 18 | 3 | 21 |
| System Total | **15 (14 + 1 Main. Spare)** | | | **15 (14 + 1 Main. Spare)** | | | **45 (42 + 3 Main. Spares)** | | |
| **Corridor** | **Diesel Multiple Unit Vehicle Technology** | | | | | | | | |
| | **4-Car Service Trains** | | | **4-Car Spare Trains** | | | **4-Car Total Trains** | | |
| Grand/Kyrene | 6 | | | 1 | | | 7 | | |
| Estrella/San Tan | 6 | | | 1 | | | 7 | | |
| System Total | | | | | | | **15 (14 + 1 Main. Spare)** | | |

Source: AECOM, 2018.

### 6.2.1 MAG System CRMF Scenarios

The following scenarios describe a range of options for providing maintenance and layover facilities for the four corridors for the proposed MAG commuter rail system. During the 2010 Study, it was assumed that the four corridors would be constructed sequentially as funding became available for subsequent corridors. Today it is believed that the entire system would be implemented concurrently so the number of scenarios is more limited compared to those described in the 2010 Study.

**Single Regional CRMF with Multiple Layover Facilities**

- Build single full-service CRMF in or near the downtown Phoenix area to serve the Grand/Kyrene Line and the Estrella/San Tan Line (central facility 40-60 acres)
- Provide layover facilities at or near end-of-line stations at Wittmann, Buckeye, Queen Creek, and Wild Horse Pass (2-10 acres at each site).
- Provide layover facility at Phoenix Union Station to store trains during mid-day (2-5 acres).

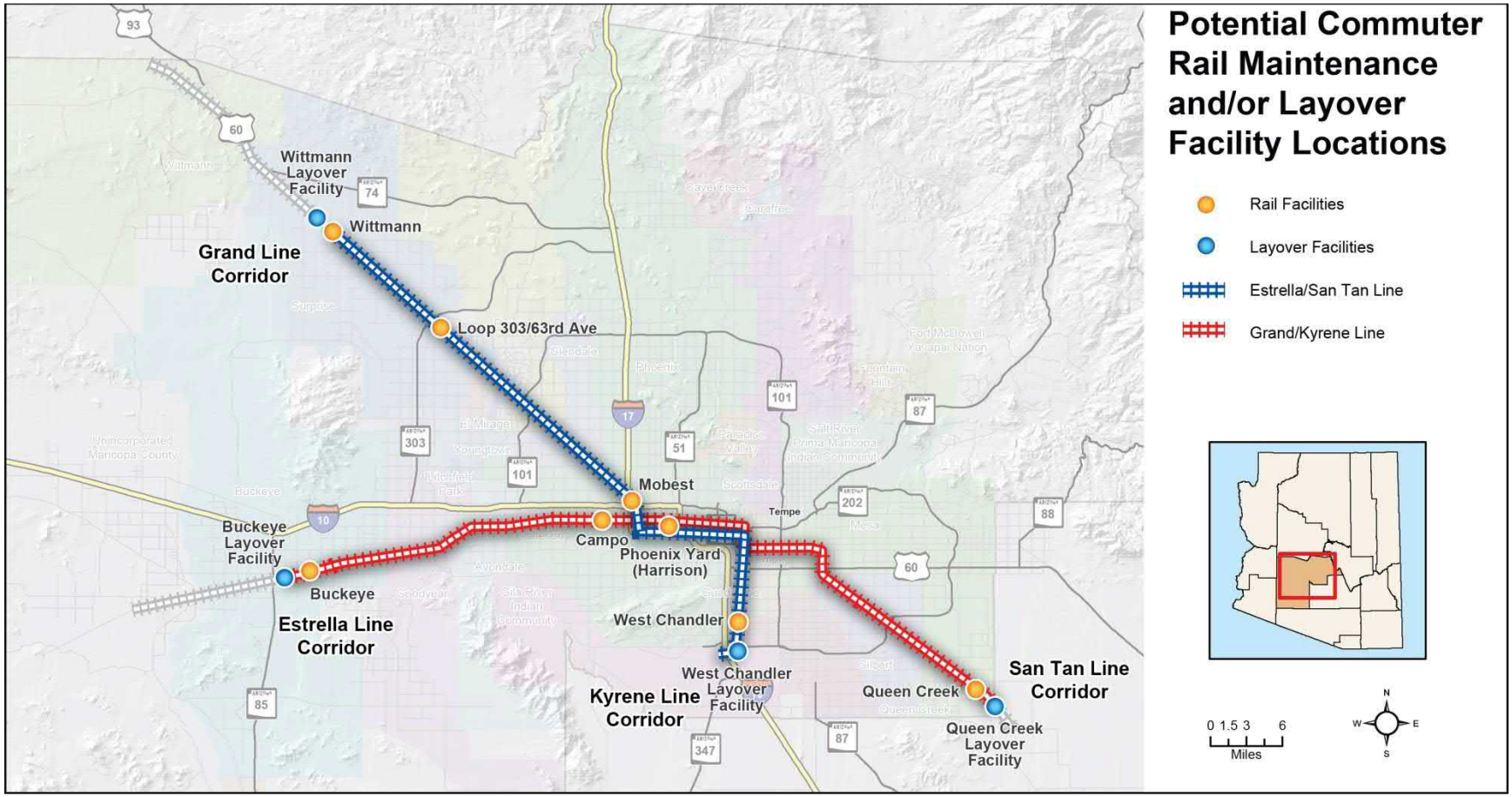
**Two Corridor Specific CRMFs with Multiple Layover Facilities**

- Build two smaller full-service CRMFs; one near Wittmann or Wild Horse Pass to service Grand/Kyrene Line and one near Buckeye or Queen Creek to serve Estrella/San Tan Line (heavy facility 20-40 acres each).
- Provide layover facilities at or near opposite end-of-line station as maintenance facilities are located (2-10 acres at each site).
- Provide layover facility at Phoenix Union Station to store trains during mid-day (2-5 acres).

### 6.2.2 MAG System Potential Maintenance and/or Layover Facility Sites

Based on these scenarios, Figure 7 depicts potential locations for maintenance and/or layover facilities along the proposed MAG system corridors. It should be noted that the railroad yard sites may not be available. However, the recommendation of considering existing rail yards avoids potential major land use impacts and could save costs, if the railroads and the transit agency can come to agreement on price and operation.

**Figure 7: Potential Commuter Rail Maintenance and/or Layover Facility Locations**




Source: AECOM, 2018.

# 7.0 CRMF PRELIMINARY CAPITAL COST ESTIMATES

Using the CRMF scenarios presented above, cost estimates have been developed assuming $5-10 million for a Layover Facility, $40-50 million for a Corridor Facility, and $75-100 million for a Central Facility. See Table 2 below.

**Table 2: Preliminary Maintenance Facility Scenario Cost Estimates**

| Scenario | Layover/Tail Tracks (2-10 acres) | Corridor Facility (20-40 acres) | Central Facility (40-60 acres) | Total |
|---|---|---|---|---|
| Single Regional CRMF with Multiple Layover Facilities | $5-10 M (x5) | NA | $75-100 M | $100-150 M |
| Two Corridor Specific CRMFs with Multiple Layover Facilities | $5-10 M (x3) | $40-50 M | NA | $55-80 M |

Source: AECOM, 2018.

# 8.0 CONSIDERATIONS FOR CRMF OVERSIGHT

The general options for oversight of operating and maintaining the commuter rail system include having the public agency oversee these activities, sourcing them out to a qualified contractor/ concessionaire, or involving the railroad companies. The factors to consider for these options are discussed below.

**Public Agency Oversight**

- Cost and liabilities run higher with agency oversight compared to outsourcing as higher established agency salary requirements may apply and some liabilities may be taken on by the concessionaire.
- Agencies often pair operations and maintenance in their outsourcing contracts.

**Outsourcing Oversight**

- Requires a comprehensive contract to ensure public agency control and quality of service are preserved/maintained.

**Railroad Involvement**

- Railroads most often perform their own maintenance of way activities regardless of the entity overseeing passenger rail operations and maintenance, unless the agency purchases the railroad ROW from the railroad.

# 9.0 CONCLUSIONS

Understanding the factors to consider in locating and designing a CRMF is essential to planning for a technologically feasible, politically acceptable, and cost-effective CRMF. The project team recommends MAG continue to consider the following in the planning for CRMFs.

- Pursue a centrally located CRMF site (Downtown Phoenix area) large enough to serve all four corridors with room for future expansion, but continue to evaluate the following sites for maintenance and/or layover functions:
  - BNSF Mobest Yard (downtown Phoenix)
  - UP Phoenix Yard (Harrison)(downtown Phoenix)
  - UP Campo Yard (4 miles west of Phoenix Union Station along Estrella line)
  - Buckeye (14 miles east of Arlington)
  - North Surprise and 163rd Avenue
  - Queen Creek near Station
- Consolidate functions at one site or share space with other existing facilities.
- Keep maintenance facilities within industrial zoned areas and as far from other residences and businesses as possible.
- Avoid a CRMF design that is stub-ended – this will be more efficient and avoid costly delays in service when disruptions (derailments) occur.
- Obtain political acceptance for CRMFs as early in the planning process as possible. It is not uncommon for a planned CRMF location to change due to unforeseen issues that arise during negotiations with the railroads or due to lack of community support.

BNSF Mobest Yard (downtown Phoenix), Source: MAG.

# MARICOPA ASSOCIATION OF GOVERNMENTS

# REGIONAL COMMUTER RAIL SYSTEM STUDY UPDATE

## Appendix I: Commuter Rail Governance and Operating Structures

**May 2018**

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# 1.0 INTRODUCTION

This appendix describes and evaluates potential governance strategies for the MAG Commuter Rail System Study. It has been updated since the initial 201 Study. One of the most significant issues to be resolved in the implementation of commuter rail in the MAG region (which now includes a portion of northern Pinal County) is the question of who will be the responsible party for managing, constructing and operating the system. A commuter rail system inherently goes farther and cuts across more jurisdictional boundaries than most other types of transit service. In the MAG region, this means that the commuter rail service area will cross through and expand beyond the political boundaries of existing local transit service areas. Implementation of a commuter rail system will likely require a change from the region's current governance structure in order to reflect new financial, political, and representational patterns of the areas served by commuter rail.

The purpose of this appendix is to provide examples of governance models from other areas of the country in order to have an informed basis for discussion in exploring potential commuter rail governance strategies in the MAG region.

# 2.0 EXAMPLES OF GOVERNANCE MODELS IN OTHER REGIONS

Generally, the institutional arrangements for regional or commuter rail service throughout the country range from state-run regional rail operations to large single-purpose regional rail authorities that extend service into multiple political jurisdictions, to regional transit authorities that are responsible for multimodal services, to sub-regional agreements between cities to contribute to the management of a rail service in a common corridor.

There are several recent commuter rail systems currently in operation or being considered across the country. From these networks there is a wealth of information and experience on which to draw for the analysis of possible governance structures.

The more mature systems are significantly larger in size than the newer ones, primarily because they have built ridership as the region has grown around them. Each has been a catalyst for successful service in corridors or in the region. Ridership has followed, growing steadily as the train became a preferred commuter option for local residents. In many of these locations, commuter rail has been added after the regional urban form and transportation network had already been established. This has required close coordination among regional and local jurisdictions, the railroads, private businesses, and residents in order to be successful. Regional agencies such as the Metropolitan Planning Organization (MPO) or the transit agency have often taken the lead in initiating this coordination.

Table 1 illustrates the array of institutional arrangements that characterize typical commuter rail governance structures throughout the U.S.

**Table 1: Existing Governance Models**

| Governance Structure | Governing Authority/ District | Commuter Rail Service Description |
|---|---|---|
| Regional Transit Authority/District (Multi-Modal) | Sound Transit District, Washington | Sounder between Seattle and Everett and Seattle and Tacoma |
| | Tri-County Metropolitan District, Oregon | Westside Express Service (WES) between Wilsonville, Tualatin, Tigard and Beaverton |
| Regional Rail Authority/District (Single-Purpose) | Sonoma-Marin Area Rail Transit, California | Planned commuter rail between Cloverdale in Sonoma County and the San Francisco-bound ferry terminal in Larkspur, Marin County (initial phase to open in 2017 with future stations planned to open in 2018). |
| Joint Powers Authority | Peninsula Corridor Joint Powers Board, California | Caltrain between San Francisco, San Jose, and Gilroy |
| | South Florida Regional Transportation Authority, Florida | Tri-Rail between Miami, Fort Lauderdale and West Palm Beach |
| | Virginia Railway Express, Virginia | Virginia Railway Express (VRE) two lines connecting Washington, DC to Manassas and Fredericksburg |
| Division of State Department of Transportation | Maryland Transit Administration, Maryland | Maryland Area Regional Commuter (MARC) between Maryland and Union Station in Washington, DC, operating three commuter rail lines |
| Division of Metropolitan Planning Organization | Initially, New Mexico Mid-Region Council of Governments, New Mexico | Rail Runner Express between Albuquerque, Santa Fe, and Belen |

Source: AECOM, 2018.

The following sections describe the governance structures and corresponding examples listed in Table 1.

## 2.1 Regional Transit Authority/District (Multi-Modal)

Regional transit authorities or districts are usually characterized by appointed boards, with representation closely aligned with area political subdivisions, and the authority to impose voter-approved taxes to balance financial resources with service demands. In many of the mature transit systems throughout the country, a regional transit authority will manage and operate several types of transit services, such as light rail, commuter rail, bus, streetcar, etc. Valley Metro is the existing Regional Public Transportation Authority (RPTA) for the Phoenix metropolitan area; however, it currently does not have the authority and jurisdiction to manage commuter rail.

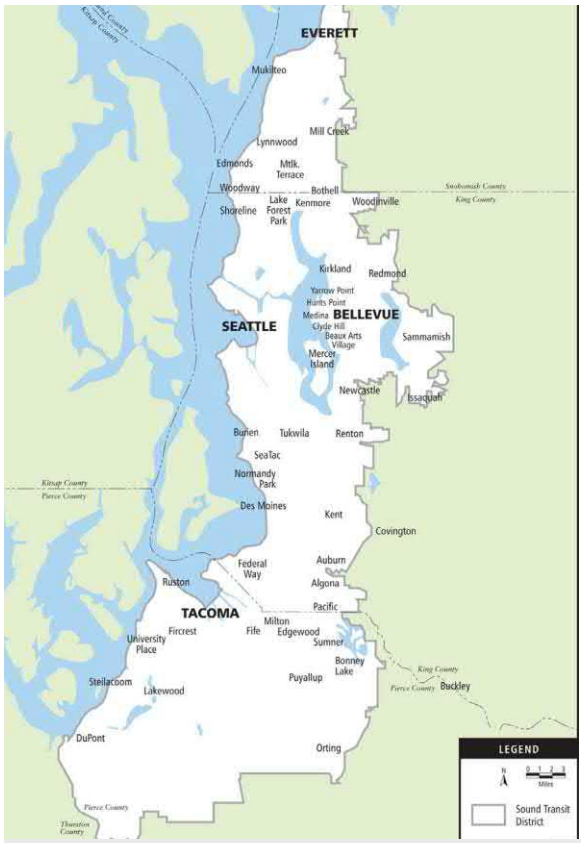
The following is a brief description of two regional transit authorities: Sound Transit in the Seattle region and TriMet in the Portland area.

### 2.1.1 Sound Transit District

**Commuter Rail Service Description:** Sound Transit operates the Sounder commuter rail service between Seattle and Everett and Seattle and Tacoma, Washington, a distance of approximately 82 miles. Service to Tacoma was initiated in 2000 and service to Everett was initiated in 2003. In 2016, the system carries just under 14,700 passengers per day.

**Governance and Administration Structure:** In 1993, the state Legislature passed enabling legislation for Snohomish, King, and Pierce Counties to create a single regional transit agency, the Central Puget Sound Regional Transit Authority (more popularly known as Sound Transit). The state legislature charged the agency with planning, building and operating a high-capacity transit system. In 1996, voters approved a plan that provides the foundation of that system and included regional express buses, commuter rail and light rail services. The Sound Transit District boundary generally follows the urban growth boundaries created by each county in accordance with the state Growth Management Act.

Sound Transit is governed by an 18-member Board of Directors; 17 members are local elected officials, and the 18th member is the state Department of Transportation Secretary. Local elected officials include mayors, city council members, county executives, and county council members from within the Sound Transit District. State law requires appointments by an elected city official representing the largest city in the participating county and proportional representation from other cities and unincorporated areas. To ensure coordination between local and regional transit plans, half of the appointments in each county must be elected officials who serve on the local transit agency governing authority.



The Sound Transit District boundary generally follows the urban growth boundaries created by each county in accordance with the state Growth Management Act.

Sound Transit generally purchases buses and plans and constructs rail lines that are then operated and maintained by partner agencies, such as King County Metro, Pierce Transit, and Community Transit. The Sounder Commuter rail is operated on tracks owned and maintained by the BNSF Railway, which also provides operating crews for the commuter rail service.

**Funding Structure:** Sound Transit imposes voter-approved taxes to plan, build and operate the regional mass transit system. These taxes include a sales and use tax and a 0.3 percent motor vehicle excise tax (MVET) within the boundaries of the Sound Transit District. The Sound Transit plan is intended to deliver fair share of investments to each of Sound Transit's five geographic areas, which include East King County, Snohomish County, South King County, North King County, and Pierce County. According to Sound Transit, “the principle of subarea equity assures that Sound Transit taxes raised in each subarea are used for capital projects and operations that directly benefit that area.” (Source: https://www.soundtransit.org/About-Sound-Transit/regional-transit-taxes) Each subarea has its own budget based on its projected share of local taxes, borrowed funds, federal grants, farebox revenues, etc. System-wide elements that improve mobility throughout the region are funded through a percent of local tax revenues contributed by each of the five subareas. On large rail projects, this funding structure can be a drawback, not allowing for funding flexibility, with one area’s funding used to advance projects region-wide.

### 2.1.2 Tri-County Metropolitan District (TriMet)

**Commuter Rail Service Description:** TriMet operates the Westside Express Service (WES) commuter rail line connecting Wilsonville, Tualatin, Tigard and Beaverton, Oregon, a distance of approximately 15 miles. Service was initiated in February 2009, and in 2016 the system carries approximately 1,800 passengers per day.

**Governance and Administration Structure:** The TriMet District is a municipal corporation established by the state legislature in 1969 to take over local bus systems and provide regional transit service. Since that time, TriMet has managed and operated bus, light rail, streetcar, and most recently, the Westside Express Service (WES) commuter rail. TriMet is governed by a seven-member Board of Directors, appointed by the Governor of Oregon. Board members represent, and must live in, certain geographical districts.

The early planning efforts for the WES commuter rail were funded and lead by Washington County, before it was turned over to TriMet. WES is now managed and funded by TriMet, but the service is operated by the local freight carrier, the Portland & Western Railroad. Metro is the metropolitan planning organization for the area, responsible for the planning of the region's transportation system, though TriMet operates most of the region's buses and the MAX Light Rail system.

TriMet serves 750 square miles of the urban portions of the tri-county area, which include Washington, Multnomah, and Clackamas Counties.

**Funding Structure**: Capital costs for the WES commuter rail line came from federal and state sources. TriMet receives its operating revenue from payroll and self-employment taxes that are collected and administered by the state Department of Revenue. In 2003, the state Legislature provided TriMet with the authority to increase the tax rate over ten years to help pay for new transit service throughout the region. The rate increases annually by 1/100 of a percent.

## 2.2 Regional Rail Authority/District (Single-Purpose)

A new regional transit authority or district could conceptually be a single provider of commuter rail service with its own board and all or some of the following functions: planning, design, construction, operations and maintenance. A new regional authority can be formed in one of two ways: (1) by a legislative statute at the state level that defines and grants authority to a district; or (2) by a direct popular vote of the electorate in which voters opt-in to form a regional transit district. Like a regional transit authority responsible for multi-modal services, a single-purpose regional rail authority is also usually characterized by an appointed board with representation closely aligned with area political subdivisions, and ideally has the authority to impose voter-approved taxes for balancing financial resources with service demands.

Only a handful of single-purpose regional rail authorities exist throughout the county. The Sonoma-Marin Area Rail Transit District is described below.

### 2.2.1 Sonoma-Marin Area Rail Transit (SMART)

**Commuter Rail Service Description:** The SMART Project is a passenger rail project located in San Francisco's North Bay between Cloverdale in Sonoma County and the San Francisco-bound ferry terminal in Larkspur, Marin County. The project will provide rail service along 70 miles (when fully complete) of the Northwestern Pacific Railroad alignment. Service on the initial 43 mile segment between the Sonoma County Airport and San Rafael began in 2017.

**Governance and Administration Structure:** In 2003, the California state legislature established SMART as a new regional transportation district to oversee the development and implementation of passenger rail service in Sonoma and Marin Counties. Specifically, the SMART District is charged with planning, engineering, evaluating and implementing passenger train service and corridor maintenance from Cloverdale to a Ferry Terminal that connects to San Francisco.

The SMART District is governed by a 12-member board consisting of elected officials. Representatives include:

- Two County Supervisors each from Marin and Sonoma counties,
- Three appointed City Council members from each county, and
- Two representatives from the Golden Gate Bridge District.

The SMART DMUs connecting Santa Rosa and downtown San Rafael, CA operate two-car trainsets, which can be expanded.

SMART began by working with local transit operators – including Golden Gate Transit, Marin County Transit, and Sonoma County Transit – to ensure that commuter rail service would be seamlessly integrated into a complete multi-modal network.

**Funding Structure:** The SMART commuter rail project was estimated to cost $541 million (in current year dollars) to build, including rail vehicles, stations, track upgrades, bridge reconstruction and other capital costs. Annual operating costs are projected to be approximately $19 million (current dollars). In 2008, Sonoma and Marin County voters approved a quarter-cent sales tax for the commuter rail project. Other potential sources of funding include a retail sales tax in Marin and Sonoma Counties, passenger fares, property leasing and development, and freight user fees.

## 2.3 Joint Powers Authority

A Joint Powers Authority (JPA) is a common governance model for commuter rail transit operations. A JPA is an institution permitted under the laws of some states whereby two or more public authorities can operate collectively. A JPA is distinct from the member authorities and has separate operating boards of directors that can be given any of the powers inherent in all of the participating agencies. Unlike a new transit district, which would have its own source of funding as a taxing entity, a JPA relies on funding through its constituent members. A JPA can have

legal standing at the state level or can be a partnership entered into between its constituent members via intergovernmental agreements at the local or regional level.

The rationale for forming JPAs to govern commuter rail systems varies. In some cases, a JPA is formed during the planning and design phases of commuter rail, while in other cases a JPA is formed to take over governance from another agency, such as a state Department of Transportation.

Examples of JPA's include California's Caltrain (Peninsula Corridor Joint Powers Board), the South Florida's Tri-Rail (South Florida Regional Transit Authority), and northern Virginia's Virginia Railway Express (VRE). A brief description of each is provided below.

The northern terminus of the Caltrain commuter rail service is in San Francisco, (4th and King Streets), and the southern terminus is in Gilroy.

### 2.3.1 Peninsula Corridor Joint Powers Board (PCJPB)

**Commuter Rail Service Description:** The PCJPB is the governing body for the Caltrain Peninsula commuter rail service between San Francisco, San Jose, and Gilroy, a distance of approximately 77 miles. Service was operated for many years under private ownership (the Southern Pacific railroad) before public ownership and funding and in 2016, the system carries an average of 62,500 passengers per weekday.

**Governance and Administration Structure:** The PCJPB was formed in 1987 to oversee the Caltrain service, and in July 1992 assumed the total operating and funding responsibilities for running Caltrain from the state Department of Transportation. The PCJPB consists of three member agencies from the three counties in which Caltrain line serves: the City and County of San Francisco, San Mateo County and Santa Clara County. Currently, the San Mateo County Transit District (SamTrans) is the managing agency for Caltrain, and performs capital planning, service planning, budgeting, marketing, and customer service functions, in addition to supervising train operation. The PCJPB contracts with Amtrak to operate the trains (conductors, locomotive engineers, and other operating personnel) and maintain the tracks and rolling stock.

The PCJPB consists of three representatives from each of the three counties served by Caltrain. Representatives include:

- San Francisco: 1 seat appointed by the Mayor, 1 seat appointed by the S.F. Public Transportation Commission (MUNI), 1 appointed by the County Board of Supervisors;
- San Mateo County: 1 seat appointed by the Cities Selection Committee, 1 seat appointed by the San Mateo County Transit District (SamTrans), 1 appointed by the County Board of Supervisors;

- Santa Clara County: 1 seat for the County Board of Supervisors representative on the MTC, 2 seats appointed by the Santa Clara Valley Transportation Authority (VTA)

**Funding Structure:** Through the PCJPB, Caltrain commuter rail service is jointly funded by the City and County of San Francisco, San Mateo County Transit District, and Santa Clara Valley Transportation Authority.

### 2.3.2 South Florida Regional Transportation Authority (SFRTA)

**Commuter Rail Service Description:** The SFRTA is the governing body for the Tri-Rail commuter rail service between Miami, Fort Lauderdale and West Palm Beach, Florida, a distance of approximately 72 miles. Service was initiated in 1989 as a mitigation measure during construction on I-95. The system currently carries an average of 14,000 passengers per day. Tri-Rail also connects to the Metrorail heavy rail transit system in Miami.

The operation of Tri-Rail service is administered by the SFRTA, which is comprised of three county transit agencies.

**Governance and Administration Structure:** The SFRTA is a tri-county transit authority created in 2003 by the state legislature to replace the Tri-County Commuter Rail Authority. The new umbrella authority was charged with developing a regional multi-modal travel system by expanding cooperation between the Tri-Rail commuter rail operations and the three existing county public transport authorities of Broward County Transit, Miami-Dade Transit, and Palm Tran. The Tri-Rail commuter rail service is solely operated by SFRTA.

The SFRTA is governed by a ten-member board, with equal representation from the three member counties, one state Department of Transportation representative, and three governor appointees. While the SFRTA currently serves Miami-Dade, Broward, and Palm Beach Counties, its service area can be expanded by mutual consent of the authority and the board of county commissioners representing the proposed expansion area.

Tri-Rail shares its track with Amtrak's Silver Meteor and Silver Star and CSX's Miami Subdivision. The Florida Department of Transportation purchased the track from CSX in 1989.

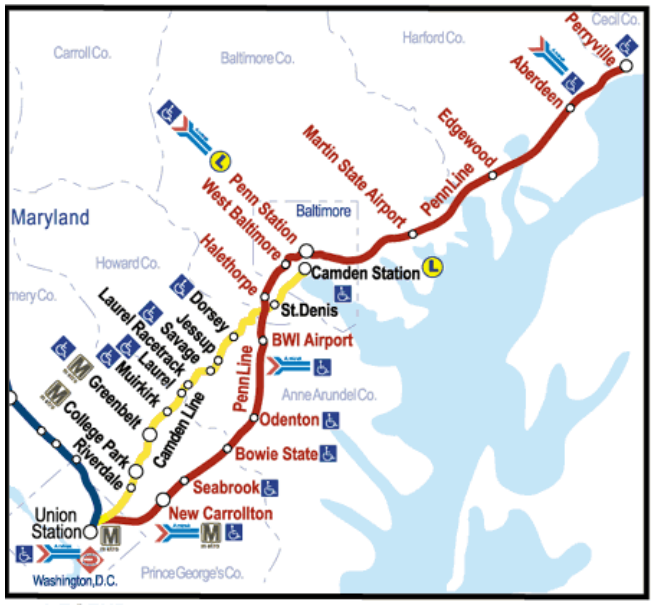
**Funding Structure:** Each county served by the SFRTA is required to dedicate $2.67 million to the authority annually. This funding may come from each county's share of the ninth-cent fuel tax, the local option fuel tax, or any other source of local gas taxes or other nonfederal funds available to the counties. In addition, the state Legislature has authorized the levy of an annual $2 vehicle registration or renewal tax for the counties served by the authority. Each participating county is also required to contribute $1.565 million annually for the operations of the SFRTA.

## 2.4 Division of State Department of Transportation

The provision of regional transportation services by state agencies is more common in small states with one dominant metropolitan area. Both Boston, Massachusetts and Baltimore, Maryland are examples of commuter rail systems that are planned and operated by a state department of transportation. The latter is described below.

### 2.4.1 Maryland Transit Administration (MTA)

**Commuter Rail Service Description:** The Maryland Area Regional Commuter (MARC) train service is a commuter rail system that operates along three lines. The Penn Line operates between Baltimore's Penn Station and Union Station in Washington, D. C. The Brunswick Line operates between Brunswick, Maryland and Union Station in Washington, D. C. The Camden Line operates between downtown Baltimore and Union Station in Washington D.C. Together, the three lines carry an average of 33,900 passengers per weekday.



The MTA operates three lines between Maryland and Union Station in Washington D.C.: the Penn Line, Brunswick Line, and Camden Line.

**Governance and Administration Structure:** The MTA is a division of the State's Department of Transportation and operates local and commuter bus, light rail, subway, and commuter rail service. This division also coordinates rail freight logistics throughout the state.

The MTA contracts with CSX and AMTRAK to provide MARC rail commuter service on the three lines.

**Funding Structure:** MARC train service is funded by the state of Maryland.

## 2.5 Division of Metropolitan Planning Organization

While Metropolitan Planning Organizations (MPOs) generally play a significant role in the planning for regional commuter rail service, they are usually not the entity responsible for the governance and administration of commuter rail service. One exception to this is New Mexico's recently opened Railrunner Express, as described below.

### 2.5.1 New Mexico Mid-Region Council of Governments (MRCOG)

**Commuter Rail Service Description:** The New Mexico Rail Runner Express provides commuter rail service between Belen, Albuquerque, and Santa Fe, New Mexico, a distance of approximately 97 miles. The first phase of service, between Belen and Bernalillo, was initiated in 2006. The second phase, an extension of the line to Santa Fe, opened in December 2008.

**Governance and Administration Structure:** The MRCOG is a multi-county governmental agency responsible for identifying and initiating coordinated regional planning strategies in central New Mexico and was the lead agency in the implementation of the Rail Runner Express. MRCOG and the New Mexico Department of Transportation began planning for the commuter rail service between Albuquerque and Santa Fe in 2005. In that same year, the State of New Mexico purchased the railroad corridor from the BNSF Railway to ensure the priority of commuter trains along the line. MRCOG also assumed the lead in the design, construction and operation of the commuter rail service.

In 2008, the Rio Metro Transit District was formed and included Sandoval, Bernalillo, and Valencia Counties. Rio Metro developed a plan and budget for an integrated, regional transit system. And in July 2009, Rio Metro became the agent for the New Mexico Department of Transportation to operate and manage the Rail Runner Express.

**Funding Structure:** State and local funds covered the capital costs of the Rail Runner project. Funding for operations of the commuter rail service has largely been covered by federal Congestion Management and Air Quality (CMAQ) funds, along with ticket revenues and some state and local funds. However, in November 2008, two separate gross receipts tax measures for regional transit were approved by voters to fund the Rail Runner commuter rail service and new transit connections.

The Rio Metro Transit District has approved an intergovernmental agreement with the North Central Regional Transit District (NCRTD) whereby the NCRTD will help fund Rail Runner operations by providing one-half of the revenue generated in Santa Fe County from the recently approved 1/8 of one-percent regional transit gross receipts tax. Funding for the Rail Runner will also be provided by the New Mexico Department of Transportation.

The MRCOG was initially the lead agency in the implementation of the Rail Runner Express, now this is done by Rio Metro Transit District.

## 3.0 FINDINGS FROM GOVERNANCE MODELS IN OTHER REGIONS

Based on a review of existing commuter rail system governance structures listed above, it is clear that there is no single appropriate structure for governing a commuter rail system.

However, based on the decisions regarding governance made in the most recent commuter rail projects, two key factors are likely to determine the success of a governance structure. These factors include the ability of the institutional arrangement to (1) balance local control with the need for regional system performance; and (2) provide stable funding opportunities. With these factors in mind, a set of typical responsibilities for the entity that manages the system may include:

- Provide a seamless transportation service;
- Raise funds from a variety of sources including: fares, local/state/federal transit or rail programs, private developers, etc.;
- Coordinate with other transit providers regarding schedules, public information and integrated fare systems;
- Participate in priority-setting in RTP process;
- Facilitate growth of the network and provide transit options in off-peak periods;

- Develop long-range plans for system development;
- Coordinate with the private freight railways;
- Knowledge and experience with the FRA.
- Manage operations and maintenance (often through contracts with private operators); and
- Build ridership by encouraging development at stations.

These responsibilities require the close working relationship among existing transit operators and the cities served by the network.

# 4.0 POTENTIAL GOVERNANCE STRUCTURES IN THE MAG REGION

The existing structure of transit service providers in the Phoenix metropolitan region is a complex mix of historical operations such as the City of Phoenix transit system, as well as the Regional Public Transportation Authority (RPTA) known as Valley Metro and Valley Metro Rail Inc. (operating Valley Metro Light Rail). In 1993, the RPTA Board adopted the name Valley Metro as the identity for the regional transit system in the Phoenix metropolitan area. Under the Valley Metro brand, local governments joined to fund the Valley-wide transit system that operates today. Valley Metro Board member agencies include Avondale, Buckeye, Chandler, El Mirage, Gilbert, Glendale, Goodyear, Maricopa County, Mesa, Peoria, Phoenix, Scottsdale, Surprise, Tempe, Tolleson and Wickenburg. In 2002, Valley Metro Rail Inc., a nonprofit, public corporation was formed and is charged with the design, construction, and operation of the region's 66-mile high-capacity transit system. Valley Metro Rail Board member cities include Phoenix, Tempe, Mesa, Glendale and Chandler.

Defining appropriate governance structures for a commuter rail system would depend upon opportunities that arise for cooperation and use of railroad right-of-way. This could be for one commuter rail project or a series of projects. It would require all of the major transportation providers and funding partners (including the City of Phoenix, Valley Metro, MAG, and ADOT at a minimum) to participate at some level to determine the most appropriate governance structure for the design, construction, and operation of a mode of transport new to the region. Arizona Department of Transportation (ADOT) has initiated some governance planning options between the MAG and PAG regions through its 2017 ADOT Passenger Rail Study – Tucson to Phoenix.

The options described above could all be appropriate institutional structures for regional commuter rail, based on both the national experience and the local situation in the Phoenix metropolitan area. Each option and how it could be applied is summarized below.

**Regional Transit Authority/District (Multi-Modal)**: Under its current organization, Valley Metro, the regional public transit authority, does not have the authority and/or jurisdiction to operate commuter rail within the region. Therefore should the MAG region consider this model for the implementation of commuter rail, it would likely entail a revision to the current agency, which was authorized in 1985 by the State Legislature.

**Regional Rail Authority/District (Single-Purpose)**: The application of a newly formed regional rail authority with the sole purpose of implementing commuter rail in the MAG region would involve membership by Maricopa County and potentially other counties if service is expanded in the future, or if intercity rail would be included as part of the commuter rail program. The more

expansive a commuter rail network, the more a Regional Rail Authority/District makes sense because funding a larger system could be spread over a greater number of residents. If only one or two lines develop, the efficiency gained through one authority/agency is not as great. Because commuter rail is the only transit mode regulated by FRA a clear benefit of one single-purpose entity would be the ability of this entity to the focus on one, FRA regulated service.

**Joint Powers Authority**: In the MAG region, a JPA would be formed by aggregating authorities from two or more cities, towns, Indian tribes, counties, councils of governments, metropolitan planning organizations, metropolitan public transit authorities or regional public transportation authorities, entering into an agreement to establish a joint powers commuter rail authority. For example, an agency could enter into an agreement with the cities to be served by commuter rail to form a JPA responsible for the design, construction, and operation of commuter rail service. The mission of an agency could be expanded, building upon the existing staff resources that are currently focused on light rail services, for example. In this case, each of the partner agencies would be responsible for providing project funding, rather than funding coming from a single taxing authority, as is the case with a regional district. Depending on the structure of the JPA, individual jurisdictions may tax their constituents or rely on annual appropriations.

Another option may be for those jurisdictions that would be served by commuter rail, but are not currently within the boundaries of an agency or participants on an agency's board to form one or more regional transit districts that could enter into a JPA with the agency for the purposes of implementing commuter rail. This governance model is the most flexible, as it can be formed to fit whatever combined structure makes the most sense locally. However, a JPA would not generate any new taxing authority, and would likely need a strong leader to identify and further a common vision among the member entities. The board of directors of the JPA would be composed of persons appointed by the governing bodies of the cities, towns, Indian tribes, counties, councils of governments, metropolitan planning organizations, metropolitan public transit authorities or regional public transportation authorities that are members of the commuter rail authority. Without a defined funding source, a JPA would have to depend on annual funding commitments from member agencies, which could fluctuate year to year.

**Division of the Arizona Department of Transportation**: While this model is primarily found in smaller states with a single metropolitan area, it may have an application in the MAG region, particularly in conjunction with a state-sponsored intercity rail connection between Tucson and Phoenix and a statewide passenger rail system. ADOT developed a Statewide Rail Framework Study in which it considered the establishment of a state rail organization that would be empowered to negotiate with railroads for a unified statewide passenger rail system. Further, determining the responsible agency for regional or statewide rail operation, governance, and oversight is a key implementation element that would need to be addressed and identified. It should be noted that there are often equity decisions associated with statewide funding or governance discussions. These often focus on urban vs. rural issues, but can be geographic as well. In the case of Arizona with two large metropolitan areas, equity between urban regions could also come into play.

**Division of a Metropolitan Planning Organization**: This governance model would require expanding the charter of MAG to include the operation of commuter rail, which is currently not described in the charter. This expansion would require a clarification in state law and the creation of an operational division of MAG. Another consideration is that the commuter rail service area would all operate within the MAG region, but intercity rail would extend beyond MAG region.

Table 2 summarizes the potential advantages and disadvantages of theses governance structures.

**Table 2: Potential Governance Structures**

| Governance Structure Option | Potential Advantages | Potential Disadvantages |
|---|---|---|
| Regional Transit Authority/ District (Multi-Modal) | • One transit service provider would create greater efficiencies and coordination between all transit modes to help ensure integrated regional system. | • May lack focus; if Valley Metro's role is expanded to include commuter rail, as it has typically focused on bus and paratransit services.<br>• May be cumbersome political process to expand taxing authority to outlying areas (could create an issue of taxing equity), particularly if services are expanded to Pinal County.<br>• Would present a learning curve for Valley Metro to manage a rail program, especially a FRA rail program. |
| Regional Rail Authority/ District (Single-Purpose) | • Single focus on commuter rail and FRA, rather than competition for resources being distributed among transit modes, may help ensure success.<br>• With creation of new taxing district, all funding partners would be equally represented from the outset.<br>• Could be added to Valley Metro organizational responsibilities. | • Would require close coordination with Valley Metro to ensure integrated regional transit system.<br>• Adds another entity to the mix.<br>• If formed by popular vote, would be unable to serve jurisdictions which do not vote to join, leaving gaps in representation/service.<br>• Cost and start-up time to form new authority may be greater. |
| Joint Powers Authority | • Would provide maximum flexibility in the formation and responsibilities of a governing body.<br>• Does not require legislative authority.<br>• If Valley Metro mission is expanded, JPA will benefit from similar rail expertise with LRT. | • May result in potential overlapping responsibilities among or within representative entities.<br>• Each participating entity would be required to secure its own funding source through annual appropriations or voter-approved taxes, which may result in less-stable funding.<br>• May start "turf war" between entities if a new JPA is formed.<br>• Would present a learning curve as LRT and commuter rail have different regulatory environments, operating characteristics and institutional arrangements and serve different travel markets.<br>• Would require "unwinding provisions" if one or more forming entities desire to withdraw. |
| Division of State Department of Transportation | • A state agency could apply for funding from federal programs that a local entity may not be able to obtain.<br>• Could empower single railroad | • ADOT has not traditionally been an operator of systems, and there could be an institutional learning curve.<br>• May rely primarily on state legislative appropriations. |

| Governance Structure Option | Potential Advantages | Potential Disadvantages |
|---|---|---|
| | negotiator and greater coordination for unified statewide passenger rail service. | • May bring into question equity between regions of the state.<br>• Increases state influence over local/regional decisions.<br>• Typically State Departments of Transportations are focused on Highway projects and issues. |
| Division of Metropolitan Planning Organization | • MAG could continue its role as lead implementation agency and pass-through funding entity. | • Could require continued/greater collaboration and coordination among existing transit authorities.<br>• Northern Pinal County is part of Central Arizona Association of Governments, or CAAG, (not within MAG region). Unless limited to commuter rail operations, Pinal County jurisdictions would be involved in other modal planning for the region. This may add confusion within the MAG and CAAG transportation planning processes.<br>• Would require expansion of MAG charter.<br>• MPOs typically don't have an operations mindset. Would require establishment of new operational division within MAG. |

Source: AECOM, 2018.

# 5.0 SOURCES OF INFORMATION

Web pages for all metropolitan transit agencies reviewed, including:

https://www.soundtransit.org/About-Sound-Transit

https://www.soundtransit.org/About-Sound-Transit/Board-of-Directors

https://trimet.org/about/governance.htm

http://www.sonomamarintrain.org/about-district

http://www.bayrailalliance.org/pcjpb

http://www.sfrta.fl.gov/overview.aspx

https://mta.maryland.gov/marc-train

https://www.riometro.org/about/mission-and-services

# MARICOPA ASSOCIATION OF GOVERNMENTS
# REGIONAL COMMUTER RAIL SYSTEM STUDY UPDATE

## Appendix J: Conceptual Memorandum of Understanding

**May 2018**

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# 1.0 STEPS IN THE NEGOTIATION PROCESS

Early in the negotiation process for railroad access rights, assuming an agreement appears possible; it usually benefits the public body to develop a summary of the possible transaction and present it to the railroad as a “Memorandum of Understanding” (MOU) or also referred to as a “Term Sheet”. A MOU may be only two to four pages, is non-binding on either Party, but highlights most of the issues identified below, outlining in broad terms the basis of an agreement. Typical MOUs have a page or more of “recitals”, “Whereas” clauses that give the factual basis of the transaction, some history, and a statement that both parties desire to come to an agreement. Below is a summary of the key elements in a typical Capacity Rights Agreement that may be addressed in the first MOU presented to the railroad after the initial discussions take place.

## 1.1 Compensation

Because the Public is not acquiring the line, but rather is only acquiring the right to operate a specified number of trains, compensation discussions with the railroad, in this case Union Pacific Railroad or BNSF Railway, are actually much more complicated than in a sale agreement. Determining an appropriate “value” to assign to the right to operate the first, second, third, etc. round trip passenger rail train is difficult at best. The reference here to the cost for the “right” to operate a train is separate from the actual operating cost (fuel, engineers, conductors, etc.) to run the train. The Public entity acquiring the passenger rights usually asserts that much of the compensation that flows to the railroad is associated with the publicly funded infrastructure improvements (track, signals, new/rebuilt bridges & structures, etc.) that are required to operate passenger rail service. These infrastructure improvements are, of course, also utilized by the railroad in its operations. Although a significant part of the compensation to the railroad is the value of the track, signal, and other improvements, railroads frequently contend, with some justification, that the improvements, albeit useful, would not be necessary but for the introduction of passenger rail service. It is possible, but not common, for the railroad to charge a trackage rights fee, for the right to operate each passenger train, above and beyond the initial cost of track and signal upgrades, and the maintenance and dispatch fees discussed below.

No final compensation will be likely agreed upon at the MOU stage, but the railroad may insist that their costs, especially engineering costs to support the negotiations, are the responsibility of the public body. This may be dealt with in the MOU itself, or in a separate “Engineering Support Agreement” where the public body agrees to reimburse the railroad for their costs, perhaps even including reimbursement of a third party engineering firm, of reviewing plans, designs, etc.

## 1.2 Rail Freight Rights

The railroad will retain the right and obligation to serve rail freight customers on the corridor. The right and obligation to provide freight service is regulated by the Surface Transportation Board (STB), formerly the Interstate Commerce Commission (ICC). This retained right is usually styled a “common carrier obligation”, and gives the railroad the contractual and regulatory right and obligation to continue providing rail freight service. It is this rail freight service that, in the view of the railroad, cannot be negatively impacted by the introduction of passenger service.

## 1.3 Level of Passenger Service

The level of planned passenger rail service (number of trains) is normally the determining factor in the track and signal improvements necessary to implement passenger service. The railroad may not be content to surrender the corridor to exclusive passenger service during the peak rush hour period. The planned passenger schedule is therefore combined with the existing level and timing of freight use to test the capacity of the existing infrastructure to handle all the trains, with the peak period obviously being the crucial period. To this initial service, reasonable expansion of both freight and passenger service if further added to determine what additional facilities will be necessary in the foreseeable future. It is this expanded service level and track capacity that railroads insist the Public fund and build at the outset.

These factors compel all parties to devote much time, money, and resources into clearly identifying the level of anticipated passenger and freight service likely or possible on the corridor, and designing improvements to handle that level of service. Railroad capacity modeling is a technique frequently used by the Public and the railroads to help determine the appropriate track and signal improvements. There also are typically provisions for a joint operating committee, or some other process to manage future schedule changes. Future passenger service increases, if allowed, may require another series of negotiations. The level of Passenger service, together with the capacity improvements necessary to support the service, is the battleground of most capacity right access negotiations.

Typically this issue will not be resolved at the time the MOU is signed, but provisions are made for continued discussion on this issue, with the railroad making clear that absent agreement, the railroad is not bound.

## 1.4 Capacity Improvements

This issue is closely linked to the previous issue. Based on the level of passenger and freight use, track, signal, and other improvements are negotiated and agreed upon. The capacity improvements the railroad requires in a rights agreement are critical because the rail line may have significant use already or anticipated future use, and the improvements necessary to operate the trains are therefore of utmost importance.

The railroad expects the public to fund 100 percent of the cost of the capacity improvements. Moreover, because the railroad still owns the line, most capacity improvements will be designed and constructed by the railroad. In most instances, existing railroad labor agreements require that railroad employees actually construct the improvements. Both of these items may be included in the MOU.

Just as with the Level of Service mentioned above, this issue is even more likely not be resolved at the time the MOU is signed. Therefore, provisions are also made for continued discussion on this issue, with the railroad again making clear that absent agreement, they are not bound.

## 1.5 Labor Agreements

Railroads usually insist that the access agreement not impact the existing railroad labor agreements, and if there is any impact, the public bear 100 percent of the cost to the railroad for any labor agreement impacts.

## 1.6 Environmental Conditions

Public should not take on all the risk of the environmental condition of the property. The railroads usually insist; however, that any environmental clean-up required as part of the construction of the capacity improvements be the financial responsibility of the Public. Again, the railroad position is that 'but for' the passenger project, the clean-up would not be undertaken because the construction is only occurring because of the necessary capacity improvements.

The Public must typically also obtain any environmental clearance (Federal NEPA, and/or state approvals) for the capacity improvements necessary for the additional passenger service.

## 1.7 Maintenance and Dispatch

If the Public obtains capacity rights, then the railroad will continue to maintain and dispatch the rail line, and the MOU will likely briefly state this. The standard of maintenance required for the speed and ride quality necessary for good passenger rail service is higher, often much higher, than that required for existing freight service. Accordingly, the MOU may state the standard of maintenance required (often expressed as FRA Class III or IV) and establish the method, or formula for allocating ongoing maintenance costs.

## 1.8 Train Operation

The Public may elect to contract with the railroad to provide train and engine crews for operation of the passenger rail service. The railroad may insist that its crews operate any passenger trains that move on the railroad. If the railroad is going to provide crews, the MOU may address this issue in broad detail, with the basis for compensation. If a third party is to provide crews, then the railroad often retains an approval right for the third party operator, to insure that only dependable, safe, and reliable third party operators are operating on the rail line.

## 1.9 Equipment

Today for most commuter systems, the railroad insists on an affirmative statement that only FRA compliant equipment will be used on the corridor.

The Project Team evaluated Locomotive Hauled Coaches (LHC) and Diesel Multiple Unit (DMU) technologies to determine which type of commuter rail vehicles would be most appropriate for the MAG commuter rail system. An "off-the-shelf" FRA-compliant DMU was not widely available in 2010. However, US Railcar (formerly Colorado Railcar), Nippon Sharyo, and Stadler Rail Group now manufacture FRA-compliant DMUs for the US market. US Railcar supplied vehicles to TriMet for its Westside Express Service (WES) in Portland; Nippon Sharyo supplied vehicles for Sonoma-Marin Area Rail Transit (SMART) commuter rail corridor between the Sonoma County Airport and San Rafael California; and Stadler Rail Group is supplying vehicles to the Fort Worth Transportation Authority (The T) for its TEX Rail corridor between downtown Fort Worth and DFW Airport. These vehicles now meet structural requirements of the FRA and are able to operate in mixed traffic with freight trains.

Maintenance of the equipment is handled by a third party contractor procured by the Public.

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# MARICOPA ASSOCIATION OF GOVERNMENTS
# REGIONAL COMMUTER RAIL SYSTEM STUDY UPDATE

## Appendix K: Insurance and Indemnity Language

**May 2018**

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# 1.0 TYPICAL INSURANCE LANGUAGE

As referenced in the Study, this is an example of proposed insurance language in a recent railroad agreement. Reference to the parties are “State” and “Railroad”.

**Insurance – During Construction.**

State shall, at its sole cost and expense, procure and maintain during the life of this Agreement (except as otherwise provided in this Agreement) the following insurance coverage as set forth below. The State understands that this insurance obligation is wholly separate and independent of any obligation to indemnify and defend RAILROAD and the Indemnified Parties.

**A.** **Liability insurance.** Commercial general liability (CGL) with a limit of not less than $400,000,000 each occurrence and an aggregate limit of not less than $400,000,000 CGL insurance must be written on ISO occurrence form CG 00 01 12 04 or ISO claims made form CG 00 02 12 04 (or substitute forms providing equivalent coverage). If the State utilizes claims made form to meet this requirement the State warrants that any retroactive date applicable to coverage under the policy precedes the effective date of this contract. The State also agrees to purchase an extended reporting period if the retroactive date is advanced or if the policy is canceled or not renewed and not replaced by another claims-made policy with the same (or an earlier) retroactive date during the term of the agreement. The policy must also contain the following endorsement, which must be stated on the certificate of insurance: “Contractual Liability Railroads” ISO form CG 24 17 10 01 (or a substitute form providing equivalent coverage) showing “Railroad Company Property” as the Designated Job Site, and “Designated Construction Project(s) General Aggregate Limit” ISO Form CG 25 03 03 97 (or substitute form providing equivalent coverage) showing the project location as described in the agreement on the form schedule.

**B.** **Automobile insurance.** Business auto coverage written on ISO form CA 00 01 10 01 (or substitute form providing equivalent liability coverage) with a limit not less $25,000,000 for each accident. Such insurance shall cover liability arising out of any auto (including owned, hired, and non-owned autos). The policy must contain the following endorsements, which must be stated on the certificate of insurance: Coverage For Certain Operations In Connection With Railroads” ISO form CA 20 70 10 01 (or substitute form providing equivalent coverage) showing “Railroad Property” as the Designated Job Site, and Motor Carrier Act Endorsement - Hazardous materials clean Railroad (MCS-90) if required by law.

**C.** **Workers Compensation and Employers Liability Insurance.** Coverage must include but not be limited to: State’s statutory liability under the workers' compensation laws of the State, Employers' Liability (Part B) with limits of at least $1,500,000 each accident, $1,500,000, employee for disease and $1,500,000, policy limit for disease, and Alternate Employer endorsement ISO form WC 00 03 01 A (or substitute form providing equivalent coverage) showing RAILROAD in the schedule as the alternate employer (or substitute form providing equivalent coverage). If the State is self-insured, evidence of state approval and excess workers compensation coverage must be provided. Coverage must include liability arising out of the U.S. Longshoremen's and Harbor Workers' Act, the Jones Act, and the Outer Continental Shelf Land Act, if applicable.

D. **Railroad Protective Liability Insurance.** The State must maintain "Railroad Protective Liability" insurance written on ISO occurrence form CG 00 35 12 04 (or substitute form providing equivalent coverage) on behalf of RAILROAD and Indemnified Parties, as Named Insureds, with a limit of not less than $25,000,000 per occurrence and an aggregate of $25,000,000. A Binder of Insurance stating the policy is in place must be submitted to RAILROAD before work may be commenced and until the original policy is received by RAILROAD. It is understood that the State may utilize a single policy to cover Railroad Protective Liability risks and exposures for all projects undertaken pursuant to the Agreement and MUO; and it is understood that if a single policy is used the policy's definition of "JOB LOCATION" and "WORK" on the declaration page of the single policy shall refer to both Agreements and shall describe all WORK or OPERATIONS performed under both agreements."

E. **Umbrella or Excess insurance.** If the State utilizes umbrella or excess policies, these policies must "follow form" and afford no less coverage than the primary policy.

F. **Pollution Liability insurance.** Pollution Liability coverage must be included when any "hazardous" material is used, disposed of, supplied, applied or is in, upon, leaching, present or transversing at any time upon railroad property above or below ground, in the atmosphere or watercourse above or below ground. If required, coverage may be provided by a separate policy or by endorsement to the State's CGL policy. In either form coverage must be equivalent to that provided in ISO form "Pollution Liability Coverage Form Designated Sites" CG 00 39 12 04 with limits of at least $5,000,000 per occurrence and an aggregate limit of $10,000,000. If the scope of work includes the disposal of any hazardous or non-hazardous materials from the job site, the State must furnish railroad evidence of pollution legal liability insurance maintained by the disposal site operator for losses arising from the insured facility accepting the materials, with coverage in minimum amounts of $5,000,000 per loss, and an annual aggregate of $10,000,000.

G. **Self-Funding.** The State may elect to self-fund the first $10,000,000 of the coverage limits required under Sections A, B, C, D and E. If the State so elects it shall secure and maintain an unconditional and irrevocable standby Letter of Credit addressed to RAILROAD equal to the then current self-funded portion of the requirement. The issuer of the Letter of Credit shall be a bank with a long term senior debt rating of not less than "A (2)" by Moody's Investment Service or "A" by Standard & Poor's. In the event the State fails to meet its obligation with respect to claims within the self-funded retention under any insurance policy provided in Article 4, RAILROAD shall have the right, on ten (10) days' notice to the State, to draw on the Letter of Credit to satisfy such claims and seek interest from the State in the amount of 10 percent (%) per annum retrospective to the date of any payment by RAILROAD.

H. **Endorsements. All policy(ies) required above (except worker's compensation and employers liability) must include RAILROAD and Indemnified Parties as an "Additional Insured" using ISO Additional Insured Endorsements CG 20 26, and CA 20 48 (or substitute forms providing equivalent coverage). The coverage provided as additional insured shall, to the extent specifically set forth under the appropriate form of ISO Additional Insured Endorsement CG 20 26 and CA 20 48, provide coverage for RAILROAD's and Indemnified Parties' negligence whether sole or partial, active or passive; and such coverage shall be at least as broad as**

**the coverage afforded to the named insured under the policies; and such coverage shall not be limited by or to the State's liability pursuant to the Indemnity provisions of this Agreement. State understands that the Indemnity and Insurance obligations of this Agreement are wholly separate from each other as set forth herein.**

**I.** **Punitive Damages.** Punitive damages exclusion, if any, must be deleted and such deletion shall be indicated on the certificate of insurance.

**J.** **Waiver.** The State waives all rights against RAILROAD and Indemnified Parties and its agents, officers, directors and employees for recovery of damages to the extent these damages are covered by the workers compensation and employer's liability or commercial umbrella or excess liability insurance obtained by the State required by this Agreement (which must be stated on the certificate of insurance.)

**K.** **Certificate of Insurance.** Prior to commencing the work, the State shall furnish RAILROAD with a certificate(s) of insurance, executed by a duly authorized representative of each insurer, showing compliance with the insurance requirements in this Agreement and naming RAILROAD and Indemnified Parties as additional insureds by specific endorsement.

**L.** **Insurance Company.** All insurance policies must be written by a reputable insurance company acceptable to RAILROAD or with a current Best's Insurance Guide Rating of A- and Class VII or better, and authorized to do business in the state(s) in which the work is to be performed. These insurers may be admitted, non-admitted or alien insurers.

**M.** **Liability.** The fact that insurance is obtained by the State will not be deemed to release or diminish the liability of the State in any way, including, without limitation, liability under the Indemnity provisions of this Agreement, or to the extent such indemnity may be excepted pursuant to the applicable state statute. Damages recoverable by RAILROAD and Indemnified Parties from the State or any third party will not be limited by the amount of the insurance coverage which is set forth as a minimum in this Agreement.

**EXHIBIT C2**

**Insurance – During Operations**

The State shall, at its sole cost and expense, procure and maintain during the life of the project contemplated by this Agreement (except as otherwise provided in this Agreement) the following commercial insurance coverage as set forth below. The State understands that this insurance obligation is wholly separate and independent of any obligation to indemnify and defend RAILROAD and the Indemnified Parties.

**A. Railroad Liability Insurance.** Commercial general liability (CGL) with a limit of not less than $400,000,000 each occurrence and an aggregate limit of not less than $400,000,000. CGL insurance must be written on ISO occurrence form CG 00 01 12 04 or ISO claims made form CG 00 02 12 04 (or substitute forms providing equivalent coverage). If the State utilizes claims made form to meet this requirement the State warrants that any retroactive date applicable to coverage under the policy precedes the effective date of this MOU. The State also agrees to purchase an extended reporting period if the retroactive date is advanced or if the policy is canceled or not renewed and not replaced by another claims-made policy with the same (or an earlier) retroactive date during the term of the MOU. The policy must also contain the following endorsements, which must be stated on the certificate of insurance: "Contractual Liability Railroads" ISO form CG 24 17 10 01 (or a substitute form providing equivalent coverage) showing "Railroad Company Property" as the Designated Job Site, and the policy must be endorsed to provide coverage for RAILROAD's and Indemnified Parties' personal property that may, for any reason, be in the State's care, custody, or control.

**B. Automobile Insurance.** To the extent not covered by other insurance policies required herein, business auto coverage written on ISO form CA 00 01 10 01 (or a substitute form providing equivalent coverage) with a limit not less $25,000,000 for each accident. Such insurance shall cover liability arising out of any auto (including owned, hired, and non-owned autos). The policy must contain the following endorsement (which must be shown on the certificate of insurance): "Coverage For Certain Operations In Connection With Railroads" ISO form CA 20 70 10 01 (or a substitute form providing equivalent coverage) showing "Railroad Company Property" as the Designated Job Site.

**C. Workers Compensation and Employers Liability Insurance.** Coverage must include but not be limited to: the State's statutory liability under the workers' compensation laws of the state and Employers' Liability (Part B) with limits of at least $1,500,000 each accident, $1,500,000 each employee by disease and a policy limit $1,500,000 by disease. The policy must also contain the following endorsement (which must be shown on the certificate of insurance): Alternate Employer Endorsement ISO form WC 00 03 01 A (or a substitute form providing equivalent coverage) showing RAILROAD in the schedule as the alternate employer. If the State is self-insured, evidence of state approval and excess workers compensation coverage must be provided. Coverage must include liability arising out of the U. S. Longshoremen's and Harbor Workers' Act, the Jones Act, and the Outer Continental Shelf Land Act, if applicable.

**D. Umbrella or Excess Insurance.** If the State utilizes umbrella or excess policies to comply with limits of coverage required, these policies must "follow form" or as acceptable to RAILROAD and afford no less coverage than the primary policy.

E. **Pollution Liability Insurance.** Pollution Liability coverage must be provided and written on ISO Form "Pollution Liability Coverage Form Designated Sites" CG 00 39 12 04 (or a similar form providing equivalent coverage) with limits of at least $5,000,000 per occurrence and an aggregate limit of $10,000,000. Coverage may be provided by a separate policy or by endorsement to the State's CGL policy. RAILROAD's and Indemnified Parties' must be added to coverage by endorsement as an additional insured as set forth in Section G. below. If the scope of any work includes the disposal of any hazardous or non-hazardous materials from the job site, the State must furnish RAILROAD evidence of pollution legal liability insurance maintained by the disposal site operator for losses arising from the insured facility accepting the materials, with coverage in minimum amounts of $5,000,000 per loss, and an annual aggregate of $10,000,000.

F. **Self-Funding.** The State may elect to self-fund the first $10,000,000 of the coverage limits required under Sections A, B, C, D, and E. If the State so elects, it shall secure and maintain an unconditional and irrevocable standby Letter of Credit addressed to RAILROAD equal to the then current self-funded portion of the requirement. The issuer of the Letter of Credit shall be a bank with a long term senior debt rating of not less than "A (2)" by Moody's Investment Service or "A" by Standard & Poor's. In the event the State fails to meet its obligation with respect to claims within the self-funded retention under any insurance policy, RAILROAD shall have the right, on ten (10) days' notice to the State, to draw on the Letter of Credit to satisfy such claims and seek interest from the State in the amount of ten (10) percent per annum retrospective to the date of any payment by RAILROAD.

G. **Endorsements. All policy(ies) required above (except worker's compensation and employers liability) must include RAILROAD and Indemnified Parties as an "Additional Insured" using ISO Additional Insured Endorsements CG 20 26, and CA 20 48 (or substitute forms providing equivalent coverage). The coverage provided as additional insured shall, to the extent specifically set forth under the appropriate form of ISO Additional Insured Endorsement CG 20 26 and CA 20 48, provide coverage for RAILROAD's and Indemnified Parties' negligence whether sole or partial, active or passive; and such coverage shall be at least as broad as the coverage afforded to the named insured under the policies; and such coverage shall not be limited by or to the State's liability pursuant to the Indemnity provisions of this Agreement. State understands that the Indemnity and Insurance obligations of this Agreement are wholly separate from each other as set forth herein.**

H. **Waiver.** The State waives all rights against RAILROAD and its agents, officers, directors, and employees for recovery of damages, whether by contribution, subrogation, or otherwise, to the extent these damages are covered by the workers compensation and employer's liability or commercial umbrella or excess liability insurance obtained by the State required by this MOU, (which must be stated on the certificate of insurance.)

I. **Certificate of Insurance.** Prior to commencing the work, the State shall furnish RAILROAD with a certificate(s) of insurance, executed by a duly authorized representative of each insurer, showing compliance with the insurance requirements in this Agreement and identifying RAILROAD and Indemnified Parties as additional insured by specific endorsement.

**J.** **Punitive Damages.** Punitive damages exclusion, if any, must be deleted and such deletion shall be indicated on the certificate of insurance.

**K.** **Insurance Company.** All insurance policies must be written by a reputable insurance company acceptable to RAILROAD or with a current Best's Insurance Guide Rating of A- and Class VII or better, and authorized to do business in the state(s) in which the work is to be performed. These insurers may be admitted, non-admitted or alien insurers.

**L.** **Liability.** The fact that insurance is obtained by the State will not be deemed to release or diminish the liability of the State in any way pursuant to this Agreement; including, but without limitations to, liability pursuant to the indemnity portions of this Agreement and any indemnity excepted by state statute. Damages recoverable by RAILROAD and Indemnified Parties from the State and/or any third party as set forth herein shall not be limited by the amount of the insurance coverage which is set forth as a minimum in this Agreement.

# 2.0 TYPICAL INDEMNITY LANGUAGE

**STATE INDEMNITY**
**A. Definitions.**
**1. "Affiliate"** means any person who controls a party or other entity, is controlled by a party or other entity, or is under common control with a party or other entity. For purposes of this Agreement, "control" as to an entity means direct or indirect beneficial ownership of at least 50% of the voting stock or other ownership interest in such entity, or such other relationship which, in fact, would constitute actual control of such entity, so long as such person is an Affiliate as defined in this section.
**2. "Claim"** or **"Claims"** has the meaning set forth in Section B-2.
**3. "Environmental Laws"** collectively means any and all applicable statutes, laws, regulations, rules, enforceable requirements, orders, decrees, and agreements to which State or RAILROAD or any other railroad may be subject; and any and all judgments, fines or injunctions validly issued, promulgated, or entered by any court or governmental agency with jurisdiction, relating to the environment, to preservation or reclamation of natural resources, or to the management, release, or threatened release of Hazardous Substances; and regardless of whether now existing or enacted, promulgated, issued, or entered into in the future.
**4. "Facilities"** collectively means any and all rails, fastenings, switches, switch mechanisms, and frogs with associated materials, ties, ballast, signals and communications devices (and associated equipment), drainage facilities, automatic warning devices, traction power substations, overhead catenary systems, bunters, roadbed, embankments, bridges, trestles, culverts, and any other structures or things necessary for the support thereof, and, if any portion thereof is located in a thoroughfare, the term includes pavement, crossing planks, and other similar materials or facilities used in lieu of pavement or other street surfacing materials at vehicular and pedestrian crossings of tracks, and any and all structures and facilities required by lawful authority in connection with the construction, renewal, maintenance, and operation of any of these features.
**5. "Hazardous Substances"** collectively means any material or substance:
(a) which is present in quantities and in a form which requires investigation, removal, clean-up, transportation, disposal, response or remedial action (as the terms "response" and "remedial action" are defined in Section 101 of the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended, 42 U.S.C. § 9601(23) and (24)) under any Environmental Law; Ex. C-4, p. 1
(b) which is defined as a "hazardous waste," "hazardous substance," "hazardous material," "toxic substance," "toxic material," "flammable material," "waste," "radioactive material," "pollutant," or "contaminant" under any Environmental Law; or
(c) any petroleum, petroleum product, oil, waste oil, asbestos, polychlorinated biphenyls (or byphenyls), or other chemical, material, or substance exposure to which or whose discharge, emission, disposal, or release is prohibited, limited, or regulated under any applicable Environmental Law.
**6. "Indemnified Parties"** shall include RAILROAD and has the meaning set forth in Section B-2.

**7. "Other Railroads"** collectively means Amtrak or any other railroad business using any part of the property described in this Agreement at any time now or in the future.
**8. "Passenger"** collectively means any person (other than an employee or agent of RAILROAD or any Other Railroad when acting in the course and scope of his or her employment or agency) who is:
(a) Riding on or ticketed to ride on a passenger train operated by or on behalf of the State; or
(b) At or adjacent to a passenger station used by or on behalf of the State for the purpose of boarding or detraining from a passenger train, meeting a Passenger train, purchasing a ticket, making a reservation, obtaining information concerning passenger rail service, or otherwise conducting business with State or its Affiliate or agent or others with respect to Passenger service with Passengers riding on a passenger train; or
(c) Providing local transportation to or from or accompanying any person described in the foregoing clause (a) or (b).
**9. "Related Persons"** collectively means the officers, employees, agents, servants, representatives, contractors, subcontractors and Affiliates of the relevant party or entity.
Ex. C-4, p. 2
**B. Indemnification and Insurance.**
**1. Intent of the Parties.** County acknowledges that this transaction and related rights under this agreement are made for the benefit of State; AND IT KNOWS, UNDERSTANDS AND COMPREHENDS THE POTENTIAL RISKS AND LIABILITIES ASSOCIATED WITH THIS TRANSACTION, WITH RAIL PROPERTY AND WITH RAIL OPERATIONS; AND THAT THE GRANT OF SUCH RIGHTS BY RAILROAD IS ENTIRELY VOLUNTARY AND IS NOT REQUIRED BY LAW; AND THAT THIS TRANSACTION AND THE EXERCISE OF THE STATE'S RIGHTS THEREUNDER ARE CONDITIONED UPON INDEMNIFIED PARTIES BEING INDEMNIFIED, RELEASED, DEFENDED AND HELD HARMLESS FROM ANY LIABILITY, FINES, COSTS (INCLUDING BUT NOT LIMITED TO ATTORNEY FEES), DAMAGES AND/OR LOSSES WHICH ARISE OUT OF OR ARE CONNECTED TO THIS TRANSACTION, THE PROPERTY OF RAILROAD AND INDEMNIFIED PARTIES AND/OR PROPERTY DESCRIBED HEREIN, OR THE EXERCISE OF SUCH RIGHTS BY THE STATE. The parties therefore expressly intend, as part of the material consideration to RAILROAD for this agreement, that:
**2. Indemnification.** STATE AGREES TO FULLY INDEMNIFY, RELEASE, HOLD HARMLESS, AND DEFEND EACH AND ALL OF RAILROAD AND ITS RELATED PERSONS AND ANY OTHER RAILROAD AND ITS RELATED PERSONS (COLLECTIVELY "INDEMNIFIED PARTIES") FROM AND AGAINST ANY AND ALL FINES, PENALTIES, JUDGMENTS, SETTLEMENTS, AWARDS, CLAIMS, DEMANDS, DAMAGES, LOSSES, LIABILITIES, OBLIGATIONS, COSTS, AND EXPENSES, INCLUDING BUT NOT LIMITED TO ATTORNEY FEES AND COSTS AND THE FEES AND COSTS OF EXPERTS AND CONSULTANTS (COLLECTIVELY A "CLAIM" OR "CLAIMS"), DIRECTLY OR INDIRECTLY ARISING OUT OF OR RELATING TO OR IN CONNECTION WITH ANY OF THE FOLLOWING:
(a) Any injury or death of any person (including, but not limited to, any Passenger, employee, agent, servant, or representative of RAILROAD, Indemnified Parties, or any Other Railroad, or State or its operator);

(b) Any loss of or damage to or diminution in value of real or personal property belonging to any person or entity, including but not limited to any real or personal property of RAILROAD and Indemnified Parties ;
(c) Any Claim arising out of, relating to or connected with any Environmental Laws;
(d) Any Claim arising out of or related to or connected with the offering, operation, use, repair or maintenance of Passenger train service or any Passenger facilities related to Passenger service;
Ex. C-4, p. 3
(e) Any other entry upon or use of the property of RAILROAD and Indemnified Parties and/or property described in this Agreement by any person or entity or in any manner pursuant to this Agreement;
(f) Any other activities directed by, conducted by, or on behalf of State or any Related Person involving the Passenger train service;
(g) Any other Claim arising out of, related to, or connected with State's activities, including but not limited to any and all contracts, agreements whether oral or written, or other transactions by or on behalf of State with Passengers or other third person or entities;
(h) Any breach or other default or nonperformance by State of or under any provision of this agreement, any other agreement of any kind between the parties or any of their Affiliates, or any other obligation or covenant or duty of State of any kind;
(i) Any violation or breach by State or any of its Related Persons of any law;
(j) Any changes in law following the Effective Date of this agreement that alter the risks of RAILROAD, or alter the terms or obligations of this agreement;
(k) The enforcement by RAILROAD and Indemnified Parties of its rights and remedies under this Agreement and its Exhibits C-1 through C-4;
(1) Any other act or omission of State or any of its Related Persons of any kind or nature; or
(m) All operations, projects, and/or any other acts which arise out of or are connected to this Agreement. State expressly agrees to the Indemnification as set forth above, including but not limited to:
(a) THOSE CLAIMS THAT ARISE OUT OF, RELATE TO OR ARE IN CONNECTION WITH THE SOLE, JOINT, CONCURRENT, DIRECT, ACTIVE, PASSIVE OR CONTRIBUTORY NEGLIGENCE AND/OR FAULT OF RAILROAD AND ANY OTHER INDEMNIFIED PARTY OR ANY OTHER PERSON OR ENTITY;
Ex. C-4, p. 4
(b) THOSE CLAIMS THAT ARISE OUT OF, RELATE TO OR ARE IN CONNECTION WITH THE GROSS NEGLIGENCE, WILLFUL MISCONDUCT OR OTHER FAULT OF RAILROAD OR ANY OTHER INDEMNIFIED PARTY OR OTHERWISE, WHETHER PUNITIVE OR NOT; EXCEPT STATE WILL NOT BE OBLIGATED FOR ACTS OF INTENTIONAL FRAUD CAUSED BY INDEMNIFIED PARTIES;
(c) THOSE CLAIMS THAT ARISE OUT OF, RELATE TO OR ARE IN CONNECTION WITH THE STRICT LIABILITY OF RAILROAD AND/OR ANY INDEMNIFIED PARTY; and
(d) THE OBLIGATIONS AGREED TO HEREIN SHALL OCCUR REGARDLESS OF WHETHER OR NOT THE RELEVANT CLAIM IS ACTUAL OR ALLEGED OR HAS MERIT.

**C. Defense of Claims.**
State shall fully and diligently defend RAILROAD and the Indemnified Parties from and against any and all Claims, providing further that:
**1.** By written notice of such election to State and for each Claim, RAILROAD and Indemnified Parties Will have the right to choose and appoint separate defense counsel at the expense of State, its agents, trustees, insurers and indemnitors to represent RAILROAD and Indemnified Parties; and RAILROAD will further have the unilateral right to govern the defense of any Claim at any time in its sole discretion for itself or any of the Indemnified Parties, at the sole cost and expense of State, its agents, trustees, insurers and indemnitors. Any election by RAILROAD to choose defense counsel or to conduct the defense of any Claim will not affect or limit the obligations of State to fully indemnify, hold harmless, and defend RAILROAD and the other Indemnified Parties from and against all Claims under this agreement or as otherwise required by law.
**2.** To the extent RAILROAD and Indemnified Parties seek to appoint independent counsel for representation separate and apart from 1 above, RAILROAD and Indemnified Parties will have the right to associate and appear on a joint and equal footing in the defense of any Claim or in any lawsuit wherein RAILROAD and/or Indemnified Parties, or any one of them, have been named as a defendant.
**3.** RAILROAD and Indemnified Parties agree to reasonably cooperate with State in the defense of all Claims.
**4.** State, its agents, trustees, insurers and indemnitors agrees to promptly pay or reimburse all fees and costs associated with such defense to RAILROAD and Indemnified Parties when incurred. All such obligations to pay or reimburse such fees and costs will be part of State's defense obligations EXPRESSLY UNDERTAKEN HEREIN.
**5.** State, its agents, insurers and indemnitors expressly agree that it will not consent to any judgment or award or concede or settle or otherwise compromise any Claim without the prior written approval of the RAILROAD and/or Indemnified Party on whose behalf the concession, settlement, or compromise is being made, which approval will not be unreasonably withheld or delayed.
**D. Contractors.**
As a condition of this transaction, and REGARDLESS OF FAULT, LIABILITY OR NEGLIGENCE FOR ANY LOSSES, DAMAGES OR CLAIMS, State shall require each of its contractors and subcontractors (collectively "Contractors") to agree in writing to indemnify, hold harmless and defend RAILROAD and its Related Persons and any Other Railroad and its Related Persons (collectively also "Indemnified Parties") TO THE EXTENT OF, AND IN ACCORDANCE WITH, THE TERMS FOR INDEMNITY AND DEFENSE OF CLAIMS AS SET FORTH ABOVE IN THIS AGREEMENT; AND TO ADD RAILROAD AND INDEMNIFIED PARTIES AS ADDITIONAL INSUREDS BY ENDORSEMENT TO EACH AND EVERY INSURANCE POLICY TO THE EXTENT OF THE COVERAGE AS REQUIRED BY THIS AGREEMENT AND AS SET FORTH IN EXHIBITS C-1 THROUGH C-3. To the extent it may lawfully do so, prior to the commencement of any work to be performed, such Contractor further must waive in writing any and all defenses under any otherwise applicable workers' compensation and industrial insurance acts in order to fully indemnify, hold harmless, and defend RAILROAD and the Indemnified Parties.

**E. No Indemnification by RAILROAD.**
Notwithstanding any contrary provision in this agreement, RAILROAD AND INDEMNIFIED PARTIES SHALL NOT HAVE ANY OBLIGATION OR DUTY OF EXPRESS, IMPLIED, OR EQUITABLE INDEMNIFICATION OR SUBROGATION OF ANY KIND TO STATE OR ITS RELATED PERSONS, WHETHER UNDER THIS AGREEMENT OR UNDER APPLICABLE LAW OR OTHERWISE. The parties agree that neither State nor its Related Persons will be deemed Related Persons of RAILROAD or Indemnified Parties.
Ex. C-4, p. 6
**F. Regulatory Requirements.**
Without limiting, and in addition to the other obligations of State under this Agreement and its exhibits, the entire cost of compliance with any additional governmental requirements imposed following the Effective Date of this agreement with respect to operations, construction, service or any related activities will be borne solely by State, including without limitation any and all costs and expenses for construction and maintenance of improvements, relocation of facilities and other property, implementation of safety procedures, and the filing of or participation in regulatory proceedings. Both parties will reasonably cooperate to ensure compliance with all such governmental requirements, subject to the obligation of State to pay all such costs of compliance.
**G. FELA and Related Acts.**
The parties agree and acknowledge that any State employees, hires, contractors and sub-contractors retained by State or any Related Person are not and will not be deemed employees of RAILROAD and the Indemnified Parties or any Other Railroad for purposes of the Federal Employers' Liability Act, 45 U.S.C. § 21, *et seq.* ("FELA") or any other applicable law. To the extent it may lawfully do so, State waives any and all defenses under any otherwise applicable workers' compensation and industrial insurance acts, in order to fully indemnify, hold harmless, and defend RAILROAD and all other Indemnified Parties.
**H. Insurance.**
Without limiting the foregoing promises, and as a wholly separate obligation and promise which is expressly undertaken by State in addition to the other provisions of this Agreement:
**1.** State shall purchase and keep in effect at all times during the Term of this agreement and for an additional period of three years thereafter the insurance coverage as required in Exhibits C-1 through C-3, in amounts sufficient to satisfy State's assumed liabilities under this Agreement and its exhibits; but in no event shall the total amount and scope of insurance coverage be **less than** the minimum amounts required in Exhibits C-1 through C-3. These insurance limits are subject to adjustment every five years (in the event of the renewal of this agreement by the parties,) based on the then-equivalent coverage for the insured risks under this Agreement.
**2.** State shall cause its insurance carriers to add and include RAILROAD and any Indemnified Parties as additional insureds by endorsement on all of the insurance policies and certificates of insurance as set forth in Exhibits Cl through C-3.
Ex. C-4, p. 7

**3.** State shall provide RAILROAD with complete copies of all required insurance policies, certificate of insurance, and declaration pages showing proof of insurance no later than 30 days following the Effective Date. On or before the first day of February of each year, State shall deliver by certified mail such documentation of insurance to RAILROAD at the address for notices below; and without limiting its obligations hereunder, shall not permit such insurance to lapse or materially modify such insurance without at least 30 days prior written notice to RAILROAD.
Director of Insurance
Railroad Company
XXXXX
XXXXX
**4.** During any time period in which the insurance coverage set forth in this Section and in Exhibits Cl through C-3 is not in effect, State shall suspend its operations, service and related activities and, upon request by RAILROAD, remove all equipment from the property described in this Agreement. Without limiting the foregoing, State shall not provide Passenger service during any time periods in which all required insurance policies are not in effect. Any failure by State to adhere to the obligations set out in this section and in Exhibits Cl through C-3 for the provision of insurance will not affect State's separate obligations to indemnify, hold harmless, and defend Indemnified Parties as set forth in this agreement.

**I. Contractual Allocation of Claims.**

This agreement constitutes a contractual allocation of financial liability for claims as sanctioned by 49 U.S.C. § 28103.

**J. Survival.**

All of the provisions of this Section 13 will survive the expiration or termination of this Agreement and remain in full force and effect thereafter,
Ex. C-4, p. 8

# MARICOPA ASSOCIATION OF GOVERNMENTS
# REGIONAL COMMUTER RAIL SYSTEM STUDY UPDATE

## Appendix L: Potential Grade Separation Locations

**May 2018**

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1.2 Kyrene Line 1

1.3 Estrella Line 1

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1.5 COMPASS Grand Avenue (Additional Scenarios) 1

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# 1.0 POTENTIAL GRADE SEPARATION LOCATIONS

## 1.1 San Tan Line

- 24th Street / Air Lane (Phoenix – Sky Harbor)
- Rural Road (ASU/Tempe) or a full, depressed trench from 5th Street or University Drive to Rural Road
- Gilbert Road grade separation near Downtown Gilbert

## 1.2 Kyrene Line

- Chandler Boulevard east of 56th Street (Chandler)
- I-10 north of Wild Horse Pass (Gila River Indian Community)

## 1.3 Estrella Line

- 43rd Avenue (West Phoenix – UPRR Campo Yard west leads)
- Cotton Lane at MC 85 (Goodyear)

## 1.4 Grand Line

- COMPASS Grand Avenue
- New Grade Separations with BNSF – planned after 2022

(Improvements are planned considerations regardless of commuter rail implementation)

- McDowell Road @ 19th Avenue/Grand Avenue (north end of Mobest Yard) (east-west grade-separation over BNSF)
- Indian School Road @ 35th Avenue (east-west grade-separation over BNSF)
- 35th Avenue @ Indian School Road (north-south grade-separation over BNSF)
- Bethany Home Road @ 51st Avenue (east-west grade-separation over BNSF)
- 51st Avenue @ Bethany Home Road (north-south grade-separation over BNSF)
- Northern Avenue @ 67th Avenue (east-west grade-separation over BNSF)
- 67th Avenue @ Northern Avenue (north-south grade-separation over BNSF)
- Olive Avenue @ 75th Avenue (east-west grade-separation over BNSF)
- 75th Avenue @ Olive Avenue (north-south grade-separation over BNSF)

## 1.5 COMPASS Grand Avenue (Additional Scenarios)

- Potential closure of four grade crossings in Sun City.
- Conceptual implementation of a ‘trench’ for the BNSF mainline between New River bridge and Agua Fria River bridge.
- This would separate Sun City and BNSF traffic by isolating railway below grade within a 2.5 mile long, 0%-grade, 3-track wide, depressed trench; with required clearances under the following four new roadway bridges.
    - 99th Avenue @ Grand Avenue
    - 103rd Avenue @ Grand Avenue
    - Del Webb Boulevard/107th Avenue @ Grand Avenue
    - 111th Avenue @ Grand Avenue

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# MARICOPA ASSOCIATION OF GOVERNMENTS

# REGIONAL COMMUTER RAIL SYSTEM STUDY UPDATE

## Appendix M: One-on-One Meetings with Participating Jurisdictions

**May 2018**

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# 1.0 AGENCY STAKEHOLDER MEETING NOTES AND OBSERVATIONS

The following sections are general notes from the agency stakeholder meetings held between September and December of 2017.

## 1.1 ADOT

Date: October 2, 2017
Attendees: Carlos Lopez (ADOT), Marc Pearsall (MAG), Tyler Besch (AECOM)

- FTA would align with Commuter Rail.
- FTA would be engaged if process went through Tier 2 analysis.
- Utilize ADOT Service Development Plan for unit costs as a reference.
- Is it possible to fit service in Amtrak umbrella to use Union Pacific Railroad track?
  - With this model, host RR would operate and run service.
- Reference list of capital improvements for grade separations from 2010 study.
- Union Pacific Railroad yard is not able to handle Unit Trains (overlapping trains).
  - Would require long track to be installed in Phoenix Yard to accommodate Unit Trains.
  - Is this a bargaining chip with Union Pacific Railroad if paid for through Commuter Rail Service plan?
  - Implementation of a grade separation at Campo Yard is another possible bargaining chip with Union Pacific Railroad, would help Commuter and Freight operations.

## 1.2 City of Avondale

Date: October 9, 2017

- In the interim, we keep existing Avondale Boulevard at Buckeye Road station.
- In paragraph form describe that Dysart and MC 85 may be a potential station instead of Avondale Boulevard at Buckeye Road.
- City Manager David Fitzhugh has concerns over the viability and market share of commuter rail.
- Does the region have the market and the density to make commuter rail a worthwhile investment for the region?
- What are the operating subsidies?
- What are the effects on local service and it's connectivity to regional commuter rail?
- Perhaps there should be a special taxing district specifically set aside for commuter rail as to ensure a dedicated funding stream beyond that of the sales tax.

## 1.3 City of Buckeye

Date: October 30, 2017

- Supports the concept of commuter rail.
- Asked to ensure that all narrative related to Buckeye now regard it as "City of Buckeye", as it was incorporated as city in 2014.
- Approve of downtown Buckeye station planning area. Located at Miller Rd @ Baseline Road – Union Pacific Railroad.

- Approve of Buckeye East-Liberty station planning area. Located at Jackrabbit Trail @ Union Pacific Railroad. However, this station may need to be adjusted in the future due to opposition from adjacent landowners.
- Staff believes that public opinion and input are important regarding commuter rail planning.
- Staff noted that there is the potential for “Transit Adjacent Development” near potential rail stations.

## 1.4 City of Chandler

Date: September 19, 2017

- *Chandler is OK with its two planning station areas at 56th Street and Chandler Boulevard.
- City of Chandler - East Valley voters need to have the case made that this mode is higher speed rail transit, beyond that of just light rail.
- A question of is there a market for a higher speed train in the Southeast Valley and valley as a whole and do we have the density and population to warrant such an expense.
- Safety and security issues must be addressed, similar to what affects light rail and those who want to use it.
- Commuter rail should have attributes that are attractive to the suburban passenger; specifically comfortable vehicle frequency with Wi-Fi, power, restrooms, cup holders, cleanliness, and the feeling of safety and security.
- Is it worth it and perhaps a hybrid of commuter rail that is a bit more light rail like in vehicle type; (DMU); but with frequency may be more palatable and attractive to Phoenix area voters.
- This type of DMU service may work on Kyrene Line to downtown Phoenix.
- Also there is probably a market for Gateway Airport to Phoenix users on the San Tan Line.

## 1.5 City of El Mirage

Date: September 27, 2017

- Supportive of commuter rail and request that a rail station continue to be modeled at Primrose or Greenway and Grand Avenue (current location).
- There is concern that if City of Surprise were to move its current station planning area from Bell Road to Dysart, then this will squeeze the downtown El Mirage Station.
- Therefore there could be a case for a unified duel city station at Greenway and Grand Avenue in El Mirage.
- Highly interested on commuter rail‘s overall impact on their potential downtown development.
- If BNSF Railway (BNSF) automobile facility moves, then that parcel of land becomes redevelopment candidate for mixed use and service by a central commuter rail station adjacent to Grand Avenue.
- Further the compass Grand Avenue improvements may create a grade separation opportunity so that freight service on the BNSF Ennis Branch no longer blocks Grand Avenue.

## 1.6 Town of Florence and Pinal County

Date: October 13, 2017

- Florence and Pinal County OK with current station locations as identified.
- San Tan Valley station near Central Arizona College (near Bella Vista Road) is also good.
- This service will be shown as illustrative future service dependent upon Pinal County funding.
- Florence location has shifted west slightly. Country Thunder still good.
- MAG will show rail service in paragraph form on the Copper basin railway branch to Florence and country thunder also show Copper basin railway involvement.
- Andy Smith of Pinal county believes the governance is important so does Brent Billingsley of Town of Florence.
- San Tan Valley – had 102,000 population in 2007.

## 1.7 Gila River Indian Community and Wild Horse Pass Development Authority

Date: October 9, 2017

- Support extension of over 3,000 feet of new track within Lone Butte Industrial Park in order to bring the Kyrene Line closer to the Wild Horse Pass campus.
- Fully supports the introduction of commuter rail to the Wild Horse Pass development campus.
- Wanted to know if there was way to accelerate commuter rail on the Kyrene Branch outside of a regional election; MAG responded no.
- Wanted to know what the park-and-ride vehicle and square footage allocation work requirements are for rail station on the west side and east side of Interstate 10.

## 1.8 Town of Gilbert

Date: September 14, 2017
Attendees: Marc Pearsall (MAG), Kristin Myers, Kyle Mieras, Amy Arguilez, Kiana Flores, Rene Guillen, and Leah Hubbard Rhineheimer (Town of Gilbert)

- Supports existing Downtown Gilbert Station and Cooley Station-Gateway Airport link modeling areas.
- Town of Gilbert has submitted a slight alteration for the address of the Cooley Station-Gateway Airport link planning area and Marc has embedded that information in the model.
- Mentioned a Gilbert Road grade separation downtown Gilbert. May be difficult due to proximity of adjacent buildings and streets.
- The region shouldn't close the door on the possibility of commuter rail and inclusion in the next RTP, even if the completion of the study update identifies challenges.
- Gilbert supports MAG being the single-point of contact with Union Pacific Railroad and BSNF.
- Gilbert believes that it is too early to determine the governance structure at this point, but request that the consultant recommend alternative governance structures that may work for the region.

- Gilbert has concerns over governance and perhaps a hybrid option where a Joint Powers Authority is mixed with another option might be the best option.
- Questions and concern over funding strategies for capital and operations. What is the viable threshold for the cost-benefit of the system and how do we analyze this under the Federal Transit Administration in the interim.
- Marc responded that we cannot until voters approve the funding or there is reasonable assumption that voters will approve the funding as the tier 2 analysis clock has a limited shelf life.
- In Tier 2 analysis, the door will be kept open as dialogue with Union Pacific Railroad and the requirements that the region needs. Union Pacific Railroad may need to bend a little bit on their 50 foot offset within the right-of-way and perhaps allow the new trackage to be within 25 feet of the existing main line within the right-of-way. If this can not be done, it would be difficult to implement commuter rail at all. These discussions will be left open through 2022 so that regional leaders may engage Union Pacific Railroad over the next five years so that the railroad may potentially change their corporate philosophy and work with the region to implement commuter rail under the right circumstances.

## 1.9 City of Glendale

Date: October 24, 2017
Attendees: Marc Pearsall (MAG), Kevin Link and Matthew Dudley (City of Glendale)

- Glendale is open to commuter rail as a mode.
- *Downtown Glendale station (BNSF depot area) can continue to be modeled as commuter rail station.
- Even though light rail connection at downtown Glendale may not occur due to City Council decision, perhaps there is another option for connectivity.
- Perhaps another station at 43rd Ave at Camelback Road. – This could serve as a CRT + LRT transfer location; however this would only occur if the West Phoenix-Central Glendale Corridor continues west from GCU to 43rd Ave.
- Glendale is open to event trains on Grand Ave (serving Glendale Glitters at downtown; and via shuttle connection to Westgate for football games and other events).
- Glendale may still be able to be a transit gateway to the Northwest Valley.

## 1.10 City of Goodyear

Date: September 18, 2017

- City of Goodyear supports its two rail station modeling areas.
- Progress with Union Pacific is required as next steps so that the region may begin dialogue on how to fulfill the transit needs of the upcoming RTP at MAG.
- MAG should employ a special group or consultant in order to take charge of the RTP assemblage and campaign, one that is a separate group from MAG that can engage the public communities and member agencies.
- This group would have dedicated meetings that would regionally assemble the RTO language and then at a later date market this proposition to the general public.
- Commuter rail may be a part of that particular package and Goodyear would support it.

## 1.11 City of Mesa and Mesa Aviation Gateway

Date: October 10, 2017

- Mesa supports their downtown station modeling area.
- For modeling purposes, remove the McQueen Junction/Baseline Road station and see if ridership increases at downtown Mesa station.
- Commuter rail is at the bottom of the list of priorities for the city; however, it is good long-term regional planning.
- She said in some circumstances a commuter rail station may warrant a new connecting bus service because the commuter rail station really doesn't connect to anything else.
- This would impact local funding obligations for connecting bus service. This creates a downstream effect on local bus service and the need to fund local feeder service.
- Perhaps these adjacent bus services costs should be embedded in the price of commuter rail funding.
- Potential connector bus service between downtown Mesa and the fiesta district.
- From Mesa's perspective what is the net benefit for Mesa residents?
- Mesa does not want to be just a pass-through community, but does also want to be served by commuter rail passengers.

## 1.12 City of Peoria

Date: September 27, 2017

- Commuter rail and the station planning area will fit into their overall redevelopment of their downtown.
- Supportive of commuter rail and its place in their revised downtown general plan which links both east and west sides of the community.
- A grade separation on Grand Avenue will link both sides of the new downtown.

## 1.13 Phoenix Transit Team – Sky Harbor

Date: Sept 8, 2017 – Sept 15, 2017
Attendees: Marc Pearsall (MAG), Megan Neil, Maria Hyatt, Joe Bowar, Ken Kessler, Mike James, Lars.

- Phoenix is open to the existing station areas for modeling purposes.
- Staff wondered if there were too many downtown stations, specifically the State Capitol.
- MAG noted that the State Capitol station was a vital, one-seat ride link for travelers, but that the Arena/Ballpark station may be "event only".
- Primary concern is to fulfill the Transit 2050 obligation and their need to provide the light rail and high-capacity transit that they promised to their voters in 2015.
- They wanted to know how CRT operations may be paid for. By the regional or local? Capital or Operating?
- Is there an assumption the capital is paid for regionally; with a rudimentary station that is paid for by the region, and anything beyond that is local?
- Are the operations costs paid for by the participating cities?
- Another concern is that Phoenix would not like to see the suburban communities spend all their money on commuter rail and yet not have any money left for fundamental bus service and local service.

- These cities should not sacrifice local bus service for the sake of commuter rail.
- Another question about our study assumptions for a fare structure. Will it be zone based?
- What does the analysis say about the breakdown and details about how the fare system would work? Were peer cities used to analyze?
- The importance of cost per passenger mile was noted.
- Discussion on the minimal transit oriented development (TOD) opportunities associated with commuter rail and that MAG must remind the region of that industry-mode fact.

## 1.14 Phoenix Aviation Team Section

Date: September 14, 2017
Attendees: Marc Pearsall (MAG), Molly Monserud and Jordan D. Feld, CM, AICP (City of Phoenix Aviation Department)

- Phoenix Sky Harbor station interface between Sky Train, Metro light rail and conceptual commuter rail/intercity rail shall be modeling in the vicinity of 44th Street and Washington Street (not 38th Street).
- The current Union Pacific Railroad mainline may potentially be shifted northward about one block between 44th Street and 24th Street to accommodate future aviation industry growth.
- This would occur if Sky Harbor/Phoenix Aviation redevelops and redesigns Air Lane.
- Phoenix Aviation Department is about to kick off an update for the PHX master plan and will be re-evaluating all land use concepts on the Northside of PHX (including existing and planned rail corridor, stations and related TOD).
- MAG will participate in this planning process, along with ADOT and Union Pacific Railroad.
- A potential grade separation at 24th St at Air Lane may be a candidate for future consideration as this would greatly benefit auto and truck traffic at the intersection.
- There will not be a 4th runway as there is sufficient capacity through the long-term with the current airfield layout.

## 1.15 Phoenix Light Rail Team

Date: September 28, 2017
Attendees: Marc Pearsall (MAG), Tyler Besch (AECOM), Carla Khan and Mike James (Phoenix Rail/BRT Team)

- Connections to light rail are important especially in the downtown.
- Phoenix Union Station is a good hub that is a few blocks from light rail.
- Concern over cost and who pays both operationally and construction as well as governance.
- Cannot be a detriment to the T 2050 initiative.
- Commuter rail is a regional service and Phoenix must see local benefit as well being the hub of such system.

## 1.16 Town of Queen Creek

Date: September 26, 2017

- Queen creek is supportive of commuter rail and its current downtown modeled station.

- Queen Creek Schnepf Farm station will be added to the model and system as an (event/seasonal only) station.
- Emphasize the importance of local input and local control over decision-making when it comes to commuter rail station placing and bus service connections to commuter rail.
- Local input and control over Queen Creek's portion of capital and operating funding is also very important.

## 1.17 City of Surprise

Date: September 26, 2017

- Supports their current modeled station near Bell Road/Grand Ave Park & Ride, but this location may shift in the future.
- Surprise has asked that their Loop 303 station be moved slightly to the northwest to align with a grade crossing and signal at US 60.
- Surprise staff does not prefer Valley Metro as an operator nor would they want MAG as a governing authority.
- They prefer a Joint Powers Authority that will make a decision later on a contractor.
- Only members of the commuter rail authority (i.e. those paying into the system with operating and trackage) should be allowed to be voting members of that authority.
- Please note that Bell Road park-and-ride station may be a candidate to move south east towards Dysart. However, of caution this may create problems for downtown El Mirage station which wouldn't at that point be less than 1 mile away. The El Mirage station cannot move therefore if surprise does not want to stay with their Bell Road station then there may be a regional case for a dual surprise El Mirage station at Greenway and Grand Avenue.

## 1.18 City of Tempe

Date: October 18, 2017

- Keep all station planning areas.
- Keep both San Tan alignments through Tempe (both hatched-dotted lines); as the Tempe bypass was approved by Council.
- The 101-202 alignment was selected by Council to minimize traffic-blockage, noise, and property takes.
- Decide funding scenarios first and then Governance structure will be determined.
- Kyrene Line could be a 20 mile line to downtown Phoenix or an isolated interurban line to Downtown Tempe if the Union Pacific Railroad does not permit shared usage of their Tempe-Phoenix mainline.

## 1.19 City of Tolleson

No meeting requested by the community staff.

## 1.20 Valley Metro

Date: October 3, 2017
Attendees: Abhishek Dayal (Valley Metro), John Farry (Valley Metro), Marc Pearsall (MAG), Tyler Besch (AECOM)

- What is the relationship between commuter rail service and intercity passenger service?
- Focus on interconnections between proposed commuter rail service and existing high capacity transit service. How do these connections happen, and where are the opportunities for them to happen?
- Is there a viable option to create a pedestrian walkway between Union Station and Cityscape?
- Summary of governance options that would require legislation vs. those that don't will be helpful for the region to make a decision on the best possible approach. JPA worked well for Valley Metro Rail, Inc. because legislation wasn't required.

## 1.21 Town of Youngtown (Sun City)

Date: October 3, 2017

- Town of Youngtown interested in the need of regional governments and perhaps a Joint Powers Authority so that all can pay into commuter rail service.
- Town of Youngtown believes the need for the region to listen well to member agencies and local concerns must be taken into consideration as they blend in with regional needs.
- Regional Joint Powers Authority or a regional commuter rail authority would be better than a standalone system.

**RCRSSU Governance Workshop**
**AGENDA**

**Project:** **FY 17 MAG Commuter Rail System Study Update**
**Date:** **8/29/17**
**Time:** **10:00 AM – 12:00 PM**
**Location:** **MAG office – Saguaro Conference Room**

**I. Introductions**

**II. Purpose and objective**

**III. Commuter rail mode overview**

**IV. What is governance**

**V. Governance models**

A. Advantages and disadvantages

**VI. Facilitated discussion**

**VII. Summary/wrap-up**

**VIII. Next Steps**

**Notes:**

# Summary – Governance Workshop

**August 29, 2017**

**In Attendance:**

Marc Pearsall, MAG
Audra Koester Thomas, MAG
Tyler Besch, AECOM
Joe Racosky, AECOM
Jennifer Pyne, AECOM
Lonnie Blaydes, Blaydes Consulting
Christine McMurdy, Goodyear
Edward Jones, Mesa
Ken Kessler, Phoenix
Mohamed Youssef, Maricopa
Robert Yabes, Tempe
John Farry, Valley Metro
Abhishek Dayal, Valley Metro
Carlos Lopez, ADOT
Kristin Taylor, Avondale
Jason Crampton, Chandler
Matthew Dudley, Glendale
Grant Anderson, Youngtown
Martin Lucero, Surprise
Jose Macias, El Mirage
Kevin Link, Glendale
David Kohlbeck, Surprise
Kristen Myers, Gilbert
Kyle Mieras, Gilbert
Nathan Pryor, MAG
Jamie Bennett, Queen Creek
Rene Guillen, Gilbert
Kiara Flores, Gilbert
Reed Kempton, MCDOT
Tim Oliver, GRIC DOT
Stephanie Stearns, Glendale
Stuart Kent, Peoria
Ryan Lee, Glendale
Albert Santana, Phoenix
David Maestas, Maricopa
Jill Dusenberry, ADOT
Jeff Martin, Mesa/Chandler
Jodi Sorrell, Mesa
Sean Banda, Buckeye

Materials Distributed:

- Meeting Agenda
- Governance Summary Sheets

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**Introductions**

Marc Pearsall opened the meeting and introduced key project management team members in attendance. He asked everyone in attendance to introduce themselves and who they were representing.

**Purpose and Objective**

Marc Pearsall explained the basic goals of the study: update data and information from the 2010 Commuter Rail System Study including costs and ridership. He noted that a specific difference from 2010 would be the focus on indemnification and liability with respect to the railroad as well as a more focused evaluation of potential governance options. He added that the results of this update would feed directly into the Regional Transit Framework Study update that is being done concurrently to our study.

**Commuter Rail Overview**

Marc reviewed some information on the Commuter Rail mode in general to refresh the group on the type of service. He mentioned service characteristics including peak period/peak direction service, right of way needs, station spacing, and coordination with the Federal Railroad Administration, speed limits, and capital costs averages. Marc continued by reviewing the commuter rail implementation timeline and where this study falls. Marc noted that he will update this information for future use to show the Identification of funding, Regional governance, and Railroad agreements to occur concurrently not in a specific order.

Marc continued by reviewing where in the country Commuter Rail systems are in operation or under planning/design and briefly reviewed the 2010 study results as well as the ADOT Passenger Rail Study that looked at intercity service between Phoenix and Tucson.

**Governance**

Marc introduced Lonnie Blaydes to review what governance is and the options summarized:

- Regional Transit Authority (Multi-Purpose)
- Regional Transit Authority (Single-Purpose)
- Joint Powers Authority
- Division of State DOT
- Division of MPO

Lonnie reviewed each option and provided examples of where they are in practice throughout the country. Questions were asked and answered throughout the discussion:

Kristen Sexton (Avondale) – Per the information summarized, in a JPA each individual community would have control over stations, is that governed by the district in an RTA setup?

*In general, a JPA has more control at a city level. An RTA has more control at by the agency.*

Stuart Kent (Peoria) – Relative to each other, is one option more successful in competing for federal funds?

*Typically, Commuter Rail Systems don't compete in New Starts for federal funds. Those programs are more geared towards Light Rail Systems.*

Kristen Taylor (Avondale) – Since we don't really have a local champion right now, how do we know what will work uniquely for our region?

*Grant Anderson (Youngtown) suggested that we won't know the answer to that for a while and that in our one on one meetings with MAG we can get into some of those specific details*

Kristen Taylor (Avondale) – Private entities are becoming partners in large projects around the region, is that an option for commuter rail?

*There are not a lot of Commuter Rail examples. Denver is a recent example but the revenue is not as available as a source of the pay back for commuter rail. Marc Pearsall (MAG) noted that the Florida Brightline is an example of private rail.*

Kristen Taylor (Avondale) – Does the indemnification/liability change depending on the governance model we move forward with?

*No, these are separate. The indemnification and liability discussion centers around what the railroad requires. It does not make a difference how the operation is governed.*

Martin Lucero (Surprise) – Finance and governance are related. What is the financial system that will work well in Arizona?

*That is one of the things we are trying to determine through these conversations. We may not know the answer to that for a while; we are still in education mode.*

Ken Kessler (Phoenix) – As we move forward we need to remain flexible so we don't lock ourselves into one model. We need to be able to shift in the future if needed. We need to keep the planning process going until the funding is determined.

John Farry (Valley Metro) – Until funding is understood, governance can't be locked down. We need to determine who the players are, where money is coming from, and when. He noted that financing affects the governance type, whether it is regional or local.

Matt Dudley (Glendale) – Have you seen models evolve and adapt to changes in the region?

*New Mexico is a good example of this; it started under the jurisdiction of the MPO and has evolved into a Regional Transit Authority. This is one of the challenges, allowing your region to change and evolve over time for what's best for the system.*

Christine McMurdy (Goodyear) – Has UP evolved in their position since 2010?

*UP has mentioned the possibility of the sale of the Kyrene and Estrella lines in the future. This study will allow them to better understand our regional position and how we are preparing for the possibility of commuter rail.*

Kristen Taylor (Avondale) – The timeline seems off if we need to get a tax passed (Prop 500) but the railroad won't cooperate now?

*Marc noted that the timeline graphic should be updated to show Railroad Agreements, Governance, and Funding all happening concurrently rather than in a linear fashion.*

Abhishek Dayal (Valley Metro) – Are there any examples of the Railroads not being involved if the alignment was fully separated from their right-of-way?

*No, there are no examples of fully separate systems.*

Abhishek Dayal (Valley Metro) – How will potential commuter rail service work in Pinal County?

*Portions of Pinal County are within the MAG region. However, the funding for operations within Pinal County would need to be covered through a separate Pinal County funding stream.*

John Farry (Valley Metro) – When Valley Metro Rail, Inc. was formed it was very political. As a region we need to engage our city leaders and intergovs in these conversations.

Christine McMurdy (Goodyear) – When having one on one meetings it will be important to understand the state of transit in each jurisdiction. The appetite for commuter rail is different in different parts of the valley.

**Next Steps**

The project team will take information gathered from this discussion and individual one on one meetings with cities and document a path forward. It may not result in a recommendation, but will summarize where the region is now and what decisions need to be made in the future.

Within the Governance Models chart, add a column for applicable funding sources.

**Adjourn**

# MAG Commuter Rail Governance Workshop

## SIGN IN SHEET - ATTENDANCE

MAG Saguaro Room

August 29, 2017 10:00 a.m. (MAG Saguaro Room)

| Name | Agency | E-mail | Phone |
|---|---|---|---|
| Tyler Besch | AECOM | tyler.besch@aecom.com | 480.326.0709 |
| Jose A. Macias | El Mirage | jmacias@elmirageaz.gov | 623-876.2996 |
| Christine McMurdy | Goodyear | christine.McMurdy@goodyeraz.gov | 623 882 7806 |
| Kristen Taylor | Avondale | | |
| Kevin Link | Glendale | Klink@glendaleaz.com | 623-930-3509 |
| Martin Lucero | Surprise | martin.lucero@surpriseaz.gov | |
| David Kohlbeck | Surprise | | 623-222-6025 |
| Kristin Myers | Gilbert | | |
| Kyle Mieras | Gilbert | | |
| Nathan Pryor | MAG | | |
| Carlos Lopez | ADOT | CLOPEZ@azdot.gov | 602-712-4786 |
| Jamie Bennett | Queen Creek | | |
| AUDRA KOESTER THOMAS | MAG | akthomas@ | |
| René Guillen | Gilbert | rene.guillen@gilbertaz.gov | |
| Kiara Flores | Gilbert | | |

# MAG Commuter Rail Governance Workshop

## SIGN IN SHEET - ATTENDANCE

MAG Saguaro Room

August 29, 2017 10:00 a.m. (MAG Saguaro Room)

| Name | Agency | E-mail | Phone |
|---|---|---|---|
| Reed Kempton | MCDOT | reedkempton@mail.maricopa.gov | |
| Ken Kessler | Phoenix | | |
| Tim Olive | GRTC-DO | | |
| Stephanie Stearns | Glendale | sstearns@glendaleaz.com | 623-930-2036 |
| STUART KENT | Peoria | SKENT@peoriaaz.gov | 623 773-7502 |
| Abhi Dayal | Valley Metro | adayal@valleymetro.org | 602-744-5572 |
| Robert Yabes | CITY of Tempe | robert_yabes@tempe.gov | 480-350-8274 |
| Jason Crampton | Chandler | jason.crampton@chandleraz.gov | ~~520-~~ 480-782-3402 |
| RYAN LEE | GLENDALE | INTERGOV | 623-930-2081 |
| Ed Jones | MESA | Edward.Jones@mesaaz.gov | 480-644-2307 |
| Jennifer Pyne | AECOM | | |
| Lonnie Blanks | LB / AECOM | | |
| Joe Lecosky | AECOM | | |
| Marc Pearsall | MAG | | |
| Matthew Dudley | Glendale | | |

# MAG Commuter Rail Governance Workshop

## SIGN IN SHEET - ATTENDANCE

MAG Saguaro Room

August 29, 2017 10:00 a.m. (MAG Saguaro Room)

| Name | Agency | E-mail | Phone |
|---|---|---|---|
| ~~Jason Crampton~~ | ~~Chandler~~ | | |
| Albert Santana | Phoenix | | |
| David Maestas | Maricopa | | |
| Jill Ossenberg | ADOT | | |
| Jake Martin | Mesa / CHANDLER | | |
| Jodi Sorrell | MESA | | |
| Grant Anderson | Youngtown | | |
| Sean Banda | Buckeye | | |
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# Regional Transit Authority/District (Multi-Modal)

- Usually characterized by appointed boards, with representation aligned with area political subdivisions.
- Have the authority to impose voter-approved taxes to balance financial resources with service demands.
- In mature systems throughout the country, a regional transit authority manages and operates several types of transit services, such as light rail, commuter rail, bus, streetcar, etc.
- Valley Metro is the existing Regional Public Transportation Authority (RPTA) for the Phoenix region; however, they currently do not operate commuter rail service.

### How it might work for commuter rail in Arizona:

- Should the Phoenix region consider this model for the implementation of commuter rail, changes to the current RPTA may be needed, which was authorized in 1985 by the State Legislature.

| | |
|---|---|
| **Current Example** | **Sound Transit District, Washington** – Sounder between Seattle and Everett and Seattle and Tacoma.<br>**Startup Details**<br>• In 1993, the Central Puget Sound Regional Transit Authority (RTA) was created as Snohomish, Pierce, and King county councils vote to participate in the Regional Transit Plan and create the Regional Transit Authority to move it forward. In November 1996, voters approved ballot measure to fund bus, light rail and commuter rail services.<br>**Tri-County Metropolitan District (TriMet), Oregon** – Westside Express Service (WES) between Wilsonville, Tualatin, Tigard and Beaverton<br>**Startup Details**<br>• The Oregon Legislature passed House Bill 1808 allowing the creation of transit districts and providing them with the power to raise revenue through a payroll tax. The district replaced five private bus companies that operated in the three counties; Multnomah, Washington, and Clackamas.<br>• Washington County led the early and preliminary planning and design efforts for Westside Express commuter rail before turning over to TriMet. |
| **Pros** | • Fewer transit service providers would create greater efficiencies and coordination between all transit modes to help ensure integrated regional system. |
| **Cons** | • May lack focus; if any agency is expanded to include commuter rail, it may/could take away from focus on existing services.<br>• May be a cumbersome political process to expand taxing authority to outlying areas (could create an issue of taxing equity).<br>• Would present a learning curve for any agency that does not currently operate a commuter rail program. |

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# Regional Rail Authority/District (Single-Purpose)

- A new regional transit authority or district could conceptually be a single provider of commuter rail service with its own board and all or some of the following functions: planning, design, construction, operations and maintenance.
- A new regional authority can be formed in one of two ways:
  - (1) by a legislative statute at the state level that defines and grants authority to a district; or
  - (2) by a direct popular vote of the electorate in which voters opt-in to form a regional transit district.
- A single-purpose regional rail authority is also usually characterized by an appointed board with representation aligned with area political subdivisions
- Ideally has the authority to impose voter-approved taxes.

### How it might work for commuter rail in Arizona:

- A newly formed single-purpose regional rail authority would involve membership by Maricopa County and potentially other counties if service is expanded in the future (or if intercity rail would be included as part of the commuter rail program).
- The more expansive a commuter rail network, the more a Regional Rail Authority/District makes sense (as funding larger system could be spread over a greater number of residents).
- Because commuter rail is the only transit mode regulated by FRA a clear benefit of one single-purpose entity would be the ability of this entity to the focus on one, FRA regulated service.

| | |
|---|---|
| **Current Example** | **Sonoma-Marin Area Rail Transit (SMART), California** – Planned commuter rail between Cloverdale in Sonoma County and the San Francisco-bound ferry terminal in Larkspur, Marin County (initial phase opened in June 2017 with future extensions to open in 2019 and beyond)<br>**Startup Details**<br>• SMART is a special-purpose district consisting of Sonoma and Marin Counties and was established by state legislation in 2002. The district is funded by federal, state, regional and local allocations (including bridge tolls), dedicated sales tax revenues, and fares. |
| **Pros** | • Single focus on commuter rail and FRA, rather than competition for resources being distributed among transit modes, may help ensure success.<br>• With creation of new taxing district, all funding partners would be equally represented from the outset. |
| **Cons** | • Would require close coordination with Valley Metro to ensure integrated regional transit system.<br>• Adds another service provider to the region.<br>• If formed by popular vote jurisdiction by jurisdiction, it would be unable to serve jurisdictions which do not vote to join, leaving possible gaps in representation/service.<br>• Cost and start-up time to form new authority may be greater. |

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# Joint Powers Authority

- A JPA is a common governance model for commuter rail transit operations.
- A JPA is an institution permitted under state law (Arizona Revised Statute 11-952) whereby two or more public entities can operate collectively.
- A JPA has a separate operating board of directors that can be given powers in participating agencies.
- A JPA relies on funding through its constituent members.
- Can have legal standing at the state level or can be a partnership entered into between its constituent members via intergovernmental agreements.

## How it might work for commuter rail in Arizona:

- In Phoenix region, a JPA would be formed by aggregating authorities from two or more cities, towns, Indian tribes, counties, councils of governments, metropolitan planning organizations, metropolitan public transit authorities or regional public transportation authorities, similar to how Valley Metro Rail, Inc. was formed.
- The mission of an existing agency could be expanded, building upon the existing staff resources.
- Individual jurisdictions may tax their constituents or rely on annual appropriations.
- This governance model is the most flexible, as it can be formed to fit whatever combined structure makes the most sense locally.
- The board of directors of the JPA would be composed of persons appointed by the governing bodies of the authorities that are members of the authority.

| | |
|---|---|
| **Current Example** | **Peninsula Corridor Joint Powers Board (PCJPB), California** – Caltrain between San Francisco, San Jose, and Gilroy.<br>**Startup Details**<br>• In 1992 PCJPB took over Caltrain operations from Caltrans. The PCJPB consists of agencies from the three counties served by Caltrain: San Francisco, San Mateo and Santa Clara.<br>**South Florida Regional Transportation Authority (SFRTA), Florida** – Tri-Rail between Miami, Fort Lauderdale, and West Palm Beach.<br>**Startup Details**<br>• The SFRTA started as a tri-county public transit authority serving Miami-Dade, Broward and Palm Beach counties. The organization became an independent agency in 2003 by the Florida Legislature and enacted by the Florida DOT. Tri-Rail is solely owned by Florida DOT and managed by SFRTA.<br>**Virginia Railway Express (VRE), Virginia** – VRE operates two lines connecting Washington, D.C. to Manassas and Fredericksburg.<br>**Startup Details**<br>• The VRE is a joint project of the Northern Virginia Transportation Commission (NVTC) and the Potomac and Rappahannock Transportation Commission (PRTC). Service began in 1992 and the agency is overseen by an Operations Board, consisting of members from each jurisdiction that supports VRE, which supervises all operating aspects of the VRE. |
| **Pros** | • Would provide maximum flexibility in formation and responsibilities of a governing body.<br>• Does not require legislative authority.<br>• If an agency's mission is expanded, JPA may benefit from existing experiences. |
| **Cons** | • May result in potential overlapping responsibilities among representative entities.<br>• Each participating entity would be required to secure its own funding source through annual appropriations or voter-approved taxes, potentially resulting in less-stable funding.<br>• Would present a learning curve as light rail and commuter rail have different regulatory environments, operating characteristics and institutional arrangements.<br>• Would require "unwinding provisions" if one or more forming entities desire to withdraw. |

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# Division of the Arizona Department of Transportation

- The provision of regional transportation services by state agencies is more common in states with one dominant metropolitan area.

### How it might work for commuter rail in Arizona:

- While primarily found in states with a single major metropolitan area, may have application in the Phoenix region in conjunction with a state-sponsored intercity rail connection between Tucson and Phoenix (or other statewide rail planning).
- ADOT developed a Statewide Rail Framework Study in which it considered the establishment of a state rail organization that would be empowered to negotiate with railroads for a unified statewide passenger rail system.
    - Determining the responsible agency for regional or statewide rail operation, governance, and oversight would need to be addressed.
    - There can be equity issues associated with statewide funding or governance discussions.

| | |
|---|---|
| **Current Example** | **Maryland Transit Administration (MTA), Maryland** – Maryland Area Regional Commuter (MARC) between Maryland and Union Station in Washington, D.C., operating three commuter rail lines.<br>**Startup Details**<br>• The MTA is state-operated as part of the Maryland Department of Transportation. The MTA took over the operations of the old Baltimore Transit Company in 1970. |
| **Pros** | • A state agency could apply for funding from federal programs that a local entity may not be able to obtain.<br>• Could empower single railroad negotiator and greater coordination for unified statewide passenger rail service. |
| **Cons** | • Typically State Departments of Transportations are focused on Highway projects and issues. As such, ADOT has not traditionally been an operator of transit systems.<br>• May rely primarily on state legislative appropriations.<br>• With the focus on the Phoenix metropolitan area, may bring into question of equity between regions of the state.<br>• Increases state influence over local/regional decisions. |

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# Division of a Metropolitan Planning Organization

- While Metropolitan Planning Organizations (MPOs) generally play a significant role in the planning for regional commuter rail service, they are usually not the responsible for the governance and administration of commuter rail service.
- Within the Phoenix region, MAG has initiated the preliminary planning of commuter rail service.

### How it might work for commuter rail in Arizona:

- This would require expanding the charter of MAG to include the operation of commuter rail, which is currently not described in the charter.
- Expansion would require a clarification in state law and the creation of an operational division of MAG.
- Commuter rail service area would all operate within the MAG region, but intercity rail would extend beyond MAG region (if included as part of commuter rail program).

| | |
|---|---|
| **Current Example** | **Initially, New Mexico Mid-Region Council of Governments (MRCOG), New Mexico** – Rail Runner Express between Albuquerque, Santa Fe, and Belen.<br>**Startup Details**<br>• Funding came from New Mexico DOT Bonds and the state purchased the rail corridor, but MRCOG lead implementation efforts and early operations. Regional Transit District later formed (Rio Metro) to fund and operate, but still is affiliated with MRCOG. |
| **Pros** | • MAG could continue its role as lead implementation agency and pass-through funding entity. |
| **Cons** | • Could require continued/greater collaboration and coordination among existing transit authorities.<br>• Would require expansion of MAG charter.<br>• MPOs typically don't have an operations mindset. Would require establishment of new operational division within MAG. |

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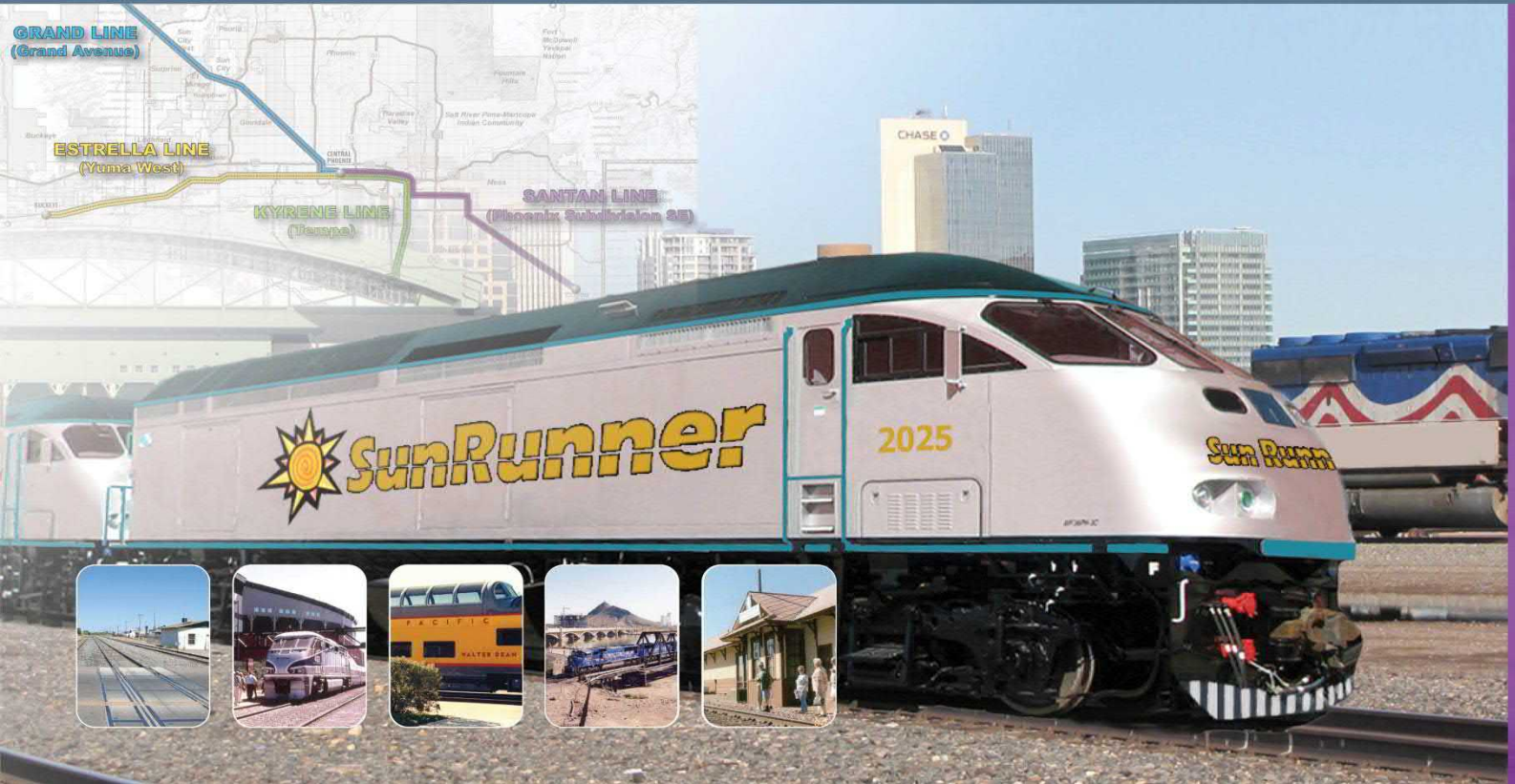
Regional Commuter Rail System Study Update

# Governance Workshop

**Maricopa Association of Governments**

August 29, 2017




MARICOPA ASSOCIATION of GOVERNMENTS

# Agenda

- Introductions
- Purpose and objectives
- Commuter rail overview
- Governance
- Discussion
- Summary
- Next Steps

# Project Team

- Marc Pearsall – MAG Project Manager
- Audra Koester Thomas - MAG
- Tyler Besch – AECOM Project Manager
- Lonnie Blaydes – Governance Advisor
- Joe Racosky – AECOM
- Jennifer Pyne - AECOM

# Purpose and Objective

- Update to 2010 Commuter Rail System Study
- Update ridership and cost estimates
- Understand legal issues
- **Begin conversation about governance**
- Prep for potential Proposition 400 extension
  - Feed into Regional Transit Framework Study

# What is Commuter Rail?

- Peak period, peak direction service
- Can share right-of-way with freight railroads
- Typically 3-7 mile station spacing
- FRA compliant
- Max speeds of ~80mph
- Capital cost per mile ~$25-$35M

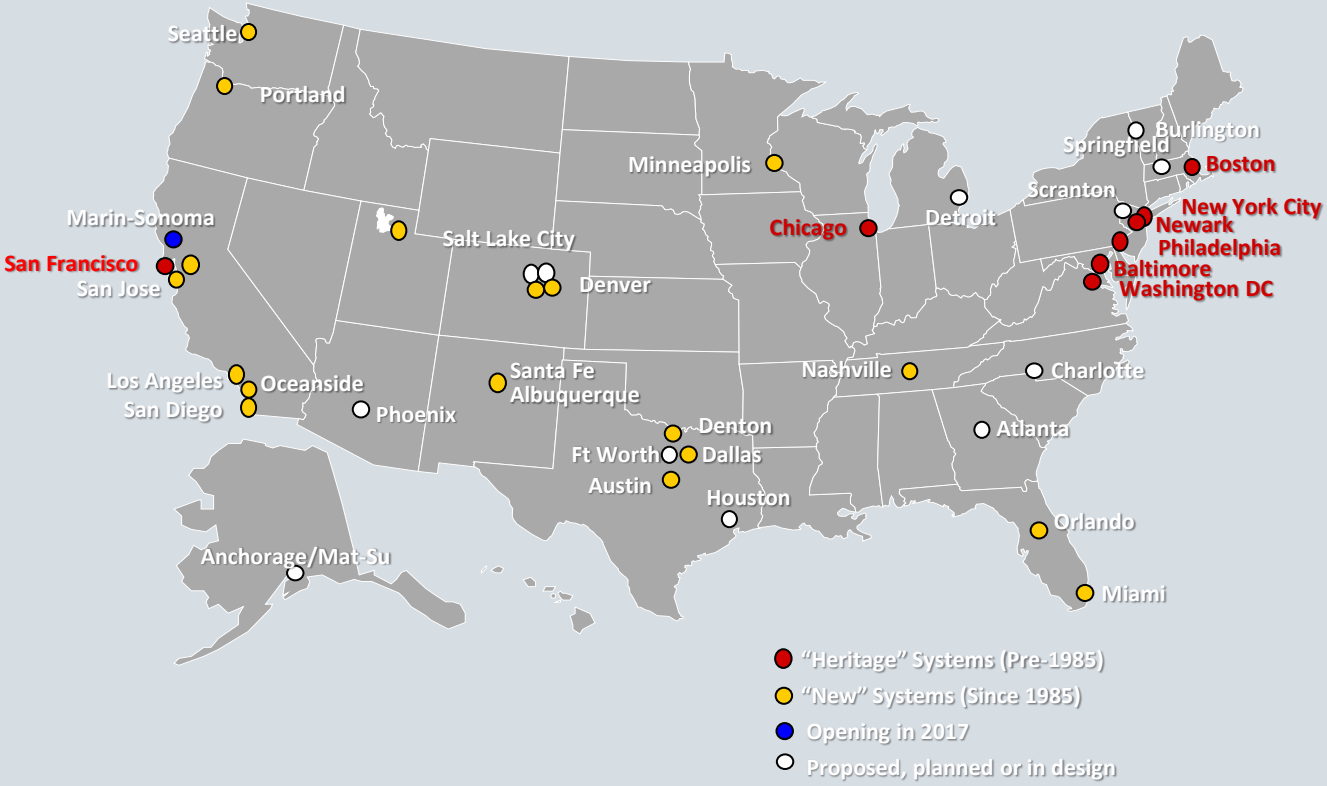
# Commuter Rail Implementation Timeline

1. Continue coordination with ADOT and railroads
2. Determine liability/indemnification statutes *(2016 – 2020)*
3. MAG Regional Commuter Rail System Study Update *(fall 2017)*
4. MAG Regional Transit Framework Study Update *(summer 2018)*
5. Identify local-regional funding (2020+>)
6. Develop and implement regional governance plan
7. Railroad agreements (inc. Indemnity/Liability) (BNSF/UPRR)
8. FTA process: EA, Design, PE and construction
9. Testing / Operations

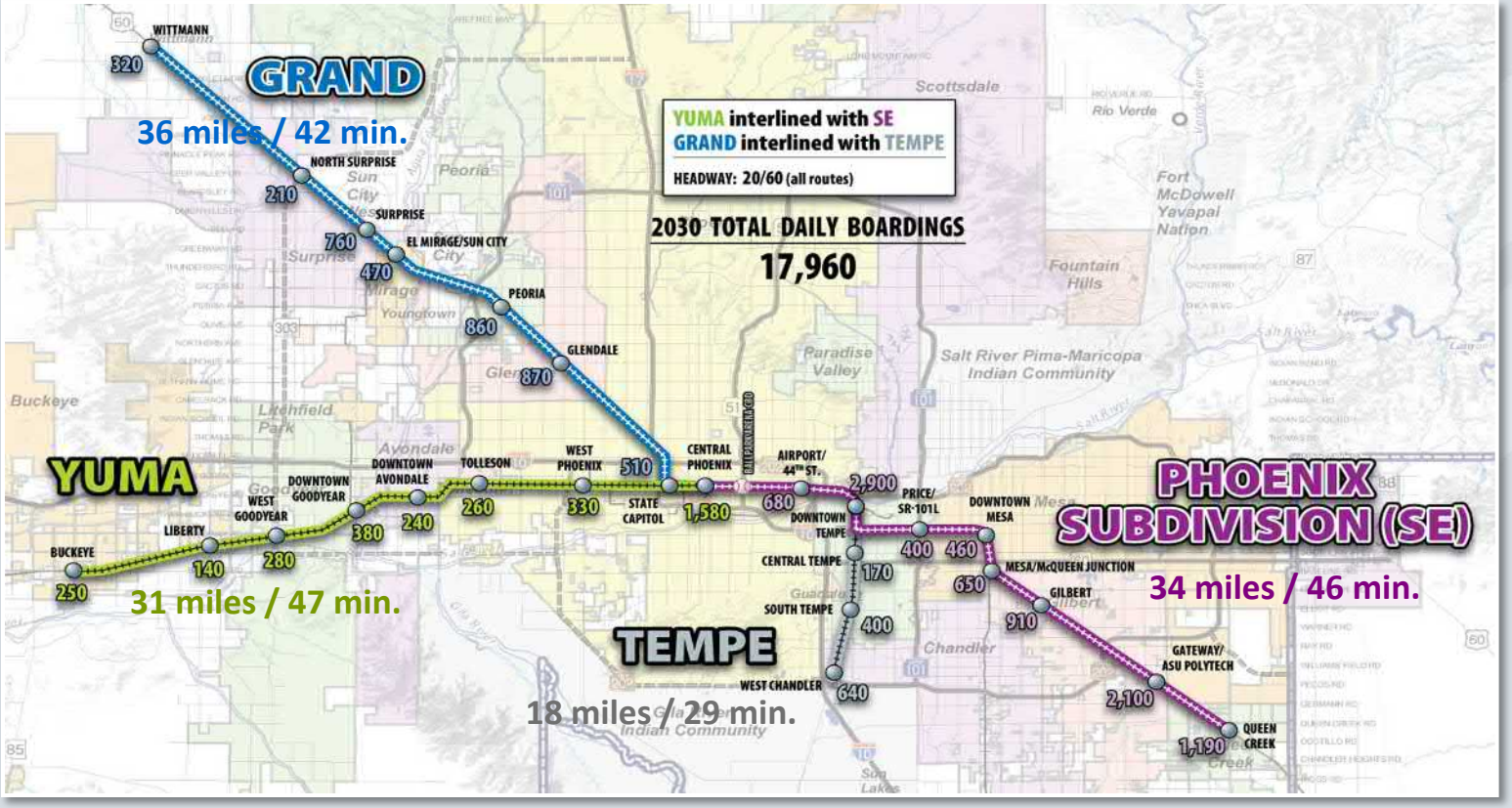
# High Capacity Rail Transit Modes

| SYSTEM (Example) | Mode Type | Cost per mile (2017 avg.) | Speed Range (avg.) |
|---|---|---|---|
| | **LRT**<br>(Light Rail Transit – at grade) | $70-100 million | 35-60mph |
| | **Elevated LRT**<br>(Light Rail Transit) | $150-350 million | 50-60mph |
| | **HRT / Elevated HRT (ART)**<br>(Heavy Rail Transit / + Automated RT) | $150-350 million | 50-60mph |
| | **Monorail** (Elevated Transit) | $150-350 million | 50-60mph |
| | **Subway**<br>(Subterranean/Underground Rail Transit) | $400-700 million | 50-60mph |
| | **CRT** (Commuter Rail Transit)<br>**IRT** (Intercity Rail Service)*(limited stops)* | $20-40 million | 50-79mph (CRT)<br>79-90mph (Intercity) |
| | **HSR** (High Speed Rail) *(limited stops)*<br>**HrSR** (Higher Speed Rail) | $40-150 million | 120-357mph (HSR)<br>90-110mph (HrSR) |
| | **Maglev** (Magnetic Levitation)<br>*(limited stops)* | $100-500 million | 140-375mph |

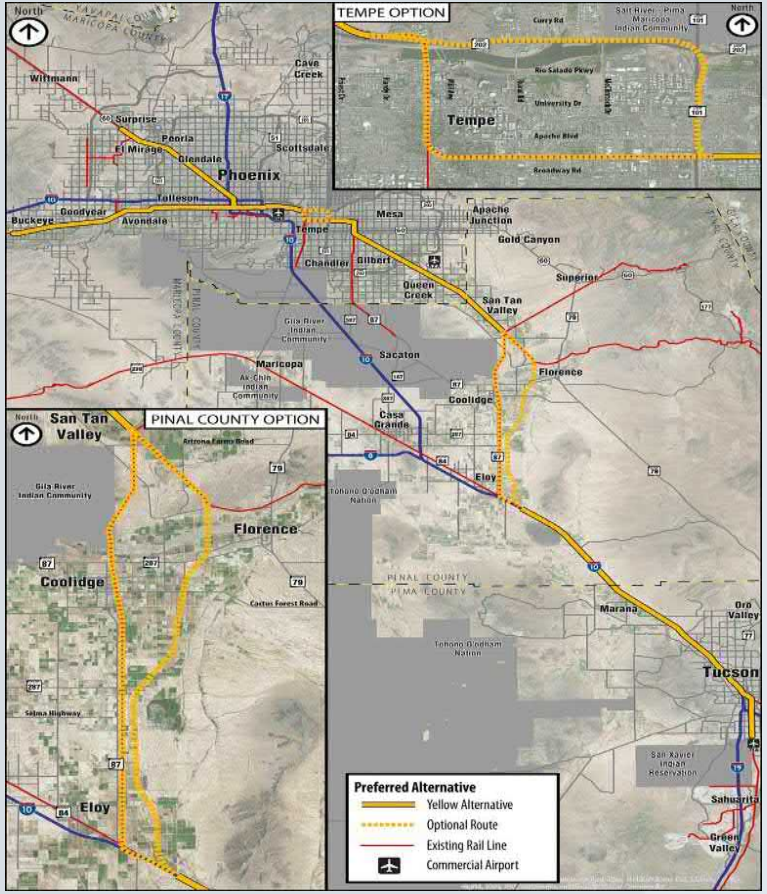
# USA Commuter Rail Systems



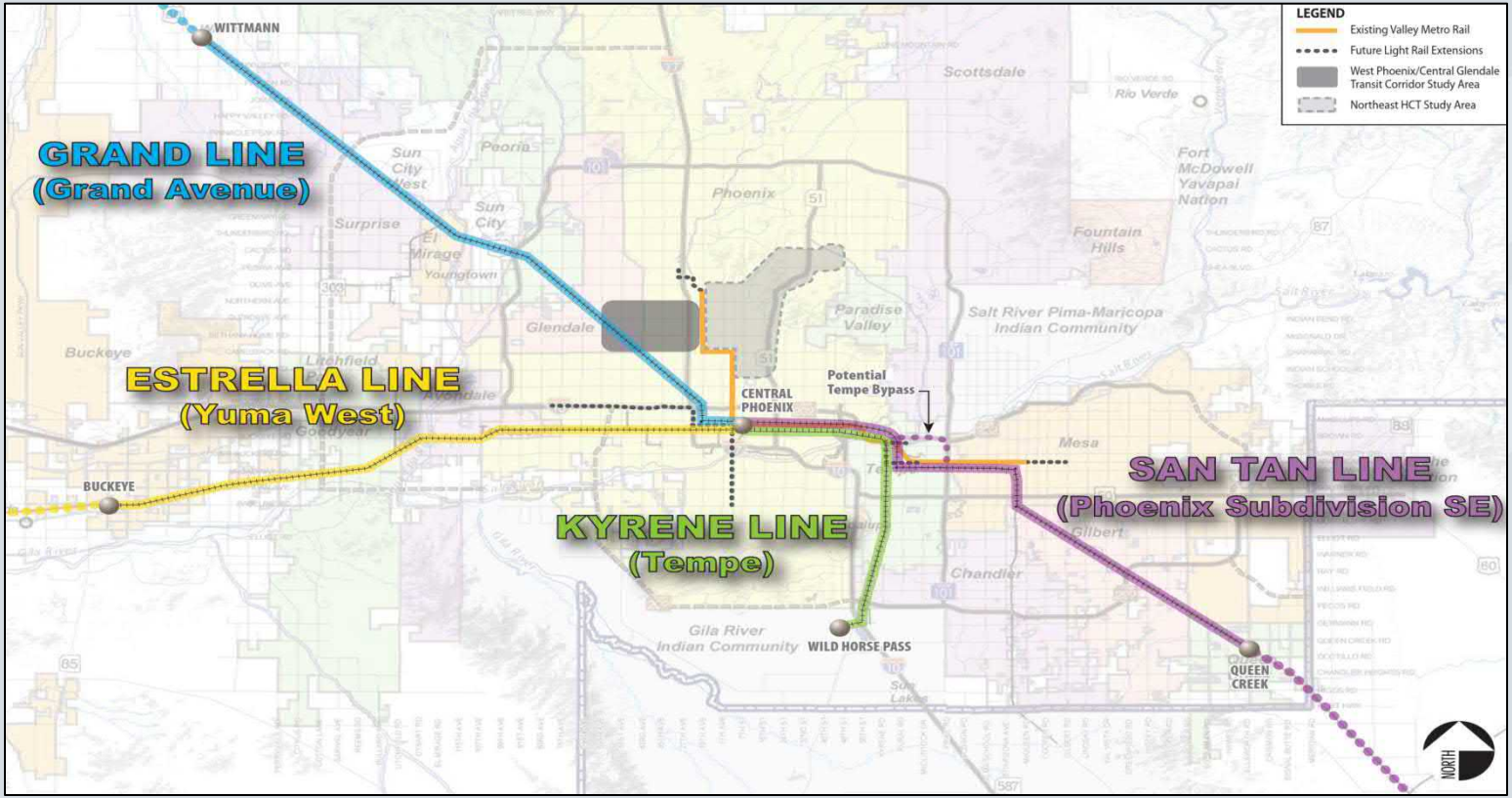
# 2010 Commuter Rail System Study Network



# ADOT Passenger Rail Study



# 2017 Commuter Rail System Study Update



# What is Governance?

- Overall service responsibility
  - Management
  - Design
  - Construction
  - Operation
- Federal Railroad Administration coordination
- Freight railroad coordination (UPRR/BNSF)

| Governance Model | Characteristics | Examples Agencies |
|---|---|---|
| **Regional Transit Authority (Multi-Purpose)** | • Appointed boards<br>• Impose voter approved taxes<br>• Manages and operates several modes | • Sound Transit, WA<br>• Tri-County Metropolitan, OR |
| **Regional Transit Authority (Single-Purpose)** | • Solely responsible for commuter rail<br>• Separate board or directors<br>• Can be formed via legislature or vote | • Sonoma-Marin Area Rail Transit, CA |
| **Joint Powers Authority** | • Two or more governmental entities<br>• Separate board of directors<br>• Relies on funding from constituents | • Peninsula Corridor Joint Powers Board, CA<br>• South Florida RTA, Florida |
| **Division of State DOT** | • More common in states with one dominant metropolitan area<br>• Can be equity issues with statewide funding | • Maryland Transit Administration, Maryland |
| **Division of MPO** | • Would require operating division<br>• Expansion beyond MPO boundary could be an issue | • New Mexico Mid-Region Council of Governments |

# Discussion

# Discussion

- What are regional priorities for governance of commuter rail service?
- What has worked or not worked with existing multi-jurisdictional arrangements in the region?
- How should representation be determined?
- What is the relationship with funding?

# Questions?

# Next Steps

- Document feedback for final report
- Indemnification/Liability analysis
- Update ridership and cost estimates
- Final report by end of 2017
- Incorporate results into RTFS (2018)

# MARICOPA ASSOCIATION OF GOVERNMENTS
# REGIONAL COMMUTER RAIL SYSTEM STUDY UPDATE

## Appendix N: BNSF Coordination

## October 2018

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# 1.0 BNSF COORDINATION

Subsequent to the completion of the System Study Update, BNSF evaluated the proposed commuter rail operations plan and provided capital requirements for the operation of passenger rail service within the existing BNSF freight railroad right-of-way. The findings are included herein.

There do not appear to be any fatal flaws in terms of operating passenger rail service within the BNSF freight rail right-of-way at this time. Infrastructure needs, costs, and passenger rail operations (including travel times) will continue to be revisited at each subsequent stage in this planning process. Coordination with BSNF will also in subsequent stage of the planning process.

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# Attachment 1

## Background and Current Operations:

Maricopa County Association of Governments (MAG) completed a ridership and marketing study in 2010 for passenger service in the Phoenix area. The proposal included a line segment on BNSF named the "Grand Line" from Wittmann, AZ (MP 155.95) to Phoenix, AZ (MP 193.4). In early 2016, BNSF was approached to determine the projects that would be necessary projects to accommodate the proposed passenger service and BNSF 2030 freight traffic.

Currently, the Phoenix Subdivision is single main track with sidings from Williams Jct. to downtown Phoenix. It operates under track warrant control. Train volumes average 7-9 trains per day. For the passenger study, traffic on the entire Phoenix Subdivision was incorporated to reflect the overall impact of this proposed service.

| WESTWARD ↓ | Length of Siding (Feet) | Station Nos. | Mile Post | Phoenix Subdivision MAIN LINE STATIONS | Rule 4.3 | Type of Oper. | Line Segment | Miles to Next Stn. | ↑ EASTWARD |
|---|---|---|---|---|---|---|---|---|---|
| Adjoining Sub: Seligman<br>End Phoenix Sub MT, MP 375.2 / Adjoins Seligman Sub MT at West Williams Jct. at MP 375.2<br>Information for West Williams Jct is found in the Seligman Sub Timetable. | | | | | | | | | |
| | | 20125 | 375.2 | WEST WILLIAMS JCT | JX | TWC | 7206 | 4.0 | |
| | 5,600 | 20150 | 379.2 | WILLIAMS | | | | 5.0 | |
| | | 20180 | 384.2X | SERENO | | | 7207 | 17.0 | |
| | 5,650 | 20200 | 401.2 | ASH FORK | P | | 7208 | 22.0 | |
| | | 20210 | 21.2 | DRAKE<br>Adj. RR: AZCR, MP 21.1 | JT | | | 7.2 | |
| | 6,188 | 20240 | 28.4 | ABRA | | | | 17.8 | |
| | 6,262 | 20275 | 46.2 | TUCKER | | | | 34.3 | |
| | | 20280 | 80.5 | EAST SKULL VALLEY | | DT TWC | | 1.2 | |
| | | | 81.7 | WEST SKULL VALLEY | | TWC | | 19.8 | |
| | 8,200 | 20297 | 101.5 | HILLSIDE | | | | 8.2 | |
| | 6,252 | 20305 | 109.7 | DATE | | | | 25.3 | |
| | | 19550 | 135.0 | MATTHIE<br>Adj. RR: AZCR, MP 134.9 | JT | | | 15.3 | |
| | 7,100 | 19558 | 150.3 | CASTLE HOT SPRINGS | | | | 18.5 | |
| | | 19566 | 168.8 | EAST BEARDSLEY | | DT TWC | | 1.3 | |
| | | | 170.1 | WEST BEARDSLEY | | | | 3.5 | |
| | | 19578 | 173.6 | ENNIS | | TWC | | 0.6 | |
| | | | 174.2 | EL MIRAGE | | | | 5.6 | |
| | | 19654 | 179.9 | PEORIA | | RL | | 3.8 | |
| | | 19690 | 183.7 | GLENDALE | R | | | 4.6 | |
| | | 19694 | 188.3 | ALHAMBRA | TR | | | 3.3 | |
| | | 19700 | 191.6 | MOBEST | BCTR | | | 2.1 | |
| | | 19700 | 193.4 | PHOENIX | TR | | | 220.7 | |
| End of Phoenix Sub MT, MP 193.4 | | | | | | | | | |

Fig. 1 Phoenix Subdivision Timetable

**PRIVILEGED AND CONFIDENTIAL**

**RTC Modeling**:

Three RTC Cases were created.

1. **2017/2030 Base Cases** – A Base Case was created using the July 2017 BNSF network extending from Williams Jct. to Phoenix. BNSF trains were built into the network to replicate one full week of historical train starts.

   An alternate Base Case for passenger comparison was then developed with the anticipated 2030 freight volumes. This case incorporated 2% per year BNSF freight train growth, anticipated projects in the BNSF capital expansion schedule, and relevant projects from the county. On the Phoenix Subdivision, this included the extension of Ash Fork siding (MP 401.2) to 10,000 feet with upgrade to CTC. It also included the planned grade separation projects from the MAG Grand Avenue Project (Figure 2), an approved civil project planned for the downtown Phoenix area. The network was then simulated 30 times using randomized freight train departures. The weekly runtimes by train type were averaged and considered as the baseline service for testing. The output data for this case can be found in Table 3 in the appendix.

| Train Counts by Type (7-Day) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | B | H | M | Q | R | U | V | Z1/7 | Z8/9 |
| 2017 | 5 | 11 | 9 | 2 | 6 | 3 | 11 | 9 | 6 |
| 2030 | 7 | 14 | 11 | 3 | 7 | 5 | 11 | 12 | 8 |

Table 1. Train Counts by year in RTC simulation.

**COMPASS Grand Avenue**
**New Grade Separations with BNSF - planned after 2022**
*(These improvements are planned to occur regardless of commuter rail implementation.)*

- McDowell Road @ 19th Avenue/Grand Avenue
- Indian School Road @ 35th Avenue
- 35th Avenue @ Indian School Road
- Bethany Home Road @ 51st Avenue
- 51st Avenue @ Bethany Home Road
- Northern Avenue @ 67th Avenue
- 67th Avenue @ Northern Avenue
- Olive Avenue @ 75th Avenue
- 75th Avenue @ Olive Avenue
- 99th – 111th from potential Sun City trench; 3 track wide trench 2.5 miles

Source: MAG Compass Avenue Correspondence

Fig 2. Planned grade separations for Maricopa Country on BNSF

2. **Test Case One: Passenger Schedule Evaluation** – Utilizing the 2030 network, a case with *only* the proposed passenger trains was simulated to assist in calculating the base for on-time performance evaluation. On-time performance is set in RTC simulation in this case as arrival to final destination ≤ 1 minute of its scheduled arrival. (The goal was to add time needed without excess.) Some improvements were determined by the Maricopa County and initially added for testing. This included:

   - 2MT North Surprise (~MP 167.35) to Phoenix (MP 193.4)
   - CTC signalization and speed increases in Table 2 from Wittmann (MP 155.95) to Phoenix (MP 193.4)
   - Construction of the connecting track between the Phoenix Sub and the Ennis Spur (MP 173.9)
   - One (1) Passenger Platform at the proposed stations: North Surprise, Surprise, El Mirage, Peoria, Glendale, and State Capital
   - Layover locations (additional track in simulation) as end points of train route at Wittmann and Phoenix

| Station | Milepost | Current Speed | | Proposed Speed | |
|---|---|---|---|---|---|
| | | PSG | FRT | PSG | FRT |
| Wittmann | 155.95 | ** | 49 | 79 | 70 |
| North Surprise/Sun City | 167.35 | ** | 49 | 79 | 70 |
| Surprise | 172.41 | ** | 49 | 79 | 70 |
| El Mirage/Sun City/Youngtown | 174.86 | ** | 40 | 70 | 60 |
| Peoria | 179.00 | ** | 49* (HER) | 70 | 60 |
| Glendale | 186.42 | ** | 20-30* (HER) | 60 | 60 |
| State Capitol | 192.00 | ** | 20 | 40 | 40 |
| Phoenix | 193.4 | ** | 10 | 40 | 40 |

*Miscellaneous speed restrictions and head-end restrictions limiting speed to 20-30mph, max 49 otherwise

Table 2. Proposed Speed changes for passenger implementation

Necessary changes to the proposed schedule as well as additional infrastructure were identified to ensure on time performance of the passenger trains. These changes are identified in the results section of this document. The updates

(schedule named the "altered" schedule) were used to continue testing in Test Case Two.

3. **Test Case Two: 2030 Case Freight w/ Passenger** – The second test case used a network identical to the Test Case One solution with the altered schedule as a base network. BNSF 2030 freight train counts were added to the case. The case was simulated with a batch of 30 randomized freight train departures and the runtimes tabulated. The passenger schedule was not randomized. Run times for freight trains were compared to the 2017 Base Case.

   Additional infrastructure and operational changes were then incorporated iteratively until the optimal solution achieved run times for freight trains matching the 2017 Base Case and a 95% on time goal for passenger trains. Each iteration was run 30 times with their average runtimes tabulated. The identified projects to achieve the goal were then documented. The comparison of those tests can be seen in Table 3 in the appendix.

**RTC Test Results:**

Data for train performance was measured from Wittmann (MP 155.95) to Phoenix (MP 193.4).

**Test Case One – Passenger Schedule Evaluation**

A non-randomized simulation was run and the RTC performance and report files pulled for analysis of the schedule. The initial proposed schedule from MAG was not able to exceed 0% on-time performance. In addition, the initial list of proposed infrastructure from MAG to achieve this schedule was not adequate to achieve base case freight train run times.

**Proposed infrastructure from MAG**

- 2MT North Surprise (~MP 167.35) to Phoenix (MP 193.4)
- CTC signalization and speed increases in Table 2 from Wittmann (MP 155.95) to Phoenix (MP 193.4)
- Construction of the connecting track between the Phoenix Sub and the Ennis Spur (MP 173.9)
- Passenger Platforms at each of the proposed stations: North Surprise, Surprise, El Mirage, Peoria, Glendale, and State Capital
- Layover locations (additional track in simulation) as end points of train route at Wittmann and Phoenix

**Additional projects developed from RTC modelling**

- 2nd Platforms at all stations

- 13 No. 24 crossovers.

The initial proposed schedule from MAG was modelled and determined to be unachievable. Recovery time was added to the proposed schedule to accurately account for run times between stations and topography. This solution is referred to as the "altered passenger schedule" in this report. The altered schedule timetable and comparison to the proposal can be found at the end of the document in Tables 4 and 5 in the appendix.

**Test Case Two – 2030 Passenger and Freight**

RTC test results indicate that BNSF and MAG will need the following projects in-place to achieve Base Case 2017 performance at 2030 growth with the proposed passenger service. These projects are *in addition to* the projects listed above in test one.

**Additional projects identified by the RTC modeling**

- Extend 2MT from North Surprise (~MP 167.35) to Wittmann (~MP 155.95), total 11.4 miles
- Extend El Mirage Facility lead track ~6000'
- Operations currently located at Mobest Yard will be migrated to a new facility at Wittmann

To fully accommodate passenger and freight operations in 2030, the following operational changes were modelled.

**Operational changes needed to accommodate passenger and freight growth**

- Westbound/Eastbound manifest traffic (M & H symbols) terminating/originating at Mobest were modelled to terminate/originate at Wittmann in order to reduce train counts in the Wittmann to Phoenix corridor
- Adjustment to unscheduled return local traffic (RSWE35) to outside rush hour passenger traffic

In Tables 6 and 7 in the appendix, the specific trains and their adjustments can be found. These solutions yielded a 95%-100% on-time performance for passenger trains in simulation and achieved 2017 Base Case run times for freight trains.

**Additional Suggested Grade Separation Projects**

Although not included in the RTC modeling, the following grade separations are recommended for the following tactical benefits.

- Greenway Ave (El Mirage Yard): This grade separation would allow the lead to be utilized without occupying an intersection.
- Camelback Ave and 43rd Ave: This grade separation will facilitate fluid movement between the intermodal strip tracks and support yard at the Glendale Intermodal Facility.

**Summary:**

RTC results indicate that BNSF can implement the Proposed Plan and maintain Base Case 2017 freight run time performance at 2030 freight train volume levels. In order to successfully implement the proposed passenger schedule, the following projects will be required at a minimum:

- 2MT Wittmann (MP 155.95) to Phoenix (MP 193.4) with CTC signalization and associated speed increases found in table 2.
- Two (2) Passenger Platforms at all proposed stations: North Surprise, Surprise, El Mirage, Peoria, Glendale, and State Capital
- Mobest Yard operations re-located to Wittmann
- Operational change for westbound/eastbound manifest traffic (H & M trains) to utilize Wittmann rather than Mobest Yard
- Adjustment to unscheduled return local traffic (RSWE35) to outside rush hour passenger traffic
- Extension of the El Mirage facility lead track ~6,000'
- Construction of the connecting track between the Phoenix Sub and the Ennis Spur (MP 173.9)

If you have any questions about this analysis, please contact Paul Duncan at 817-352-3464.

## Total Train Delay to Network by Train Type (hrs.) - 7 Day Total

### Base 2030 Volumes - Freight Only - Grand Line Measure

| Sum-Hrs | B | H | M | Q | R | U | V | Z1/7 | Z8/9 |
|---|---|---|---|---|---|---|---|---|---|
| 162.5 | 14.7 | 30.6 | 26.5 | 4.0 | 24.9 | 15.8 | 15.9 | 16.8 | 10.4 |

### 2030 Volumes - Freight w/ Passenger Service

**El Mirage Lead - Manifest to Wittmann - DT to Wittmann - RSWE35 Adjust**

This solution includes all mentioned below and movement of local moves to outside of rush hour passenger traffic.

| Sum-Hrs | A | OTP %* | B-Bare | H-Hi Pr | M-Merch | Q-Guara | R-Road | U-Unit | V-Vehic | Z-Guara | Z-UPS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 298.4 | 179.8 | 98.2%-100.0% | 10.8 | 26.7 | 21.1 | 3.5 | 16.1 | 7.9 | 12.3 | 11.8 | 8.5 |

**El Mirage Lead - Manifest to Wittmann - DT Surprise to Wittmann**

This solution includes all mentioned below and construction of 2MT from North Surprise to Wittmann.

| Sum-Hrs | A | OTP % | B | H | M | Q | R | U | V | Z1/7 | Z8/9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 300.6 | 179.9 | 97.3%-100.0% | 10.9 | 26.6 | 21.3 | 4.5 | 17.2 | 7.7 | 12.2 | 11.9 | 8.4 |
| | | | | | | -0.5 | | | | | |

**El Mirage Lead - Daytime Manifest to Wittmann (Wittmann tracks)**

This solution includes all mentioned below and movement of Manifest-type train traffic to terminate at Wittmann, creating respective local traffic to Mobest outside rush hour passenger traffic.

| Sum-Hrs | A | OTP % | B | H | M | Q | R | U | V | Z1/7 | Z8/9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 311.2 | 181.8 | 90.2%-97.3% | 12.8 | 26.6 | 21.9 | 4.8 | 16.2 | 10.0 | 12.7 | 12.5 | 9.0 |
| | | | | | | -0.8 | | | | | |

**El Mirage Lead**

This solution includes all mentioned below and an extension of the El Mirage east lead.

| Sum-Hrs | A | OTP % | B | H | M | Q | R | U | V | Z1/7 | Z8/9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 303.0 | 181.5 | 91.1%-97.8% | 13.6 | 21.7 | 19.4 | 5.2 | 17.7 | 9.9 | 12.7 | 12.5 | 8.8 |
| | | | | | | -1.2 | | | | | |

**Base Case w/ Freight Added**

This solution includes all initial proposed projects and additional mitigations identified for passenger performance. (ie. 2nd platforms, and crossovers.)

| Sum-Hrs | A | OTP % | B | H | M | Q | R | U | V | Z1/7 | Z8/9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 304.1 | 181.6 | 87.9%-96.9% | 13.6 | 21.6 | 19.4 | 5.3 | 17.7 | 9.9 | 13.8 | 12.5 | 8.8 |
| | | | | | | -1.3 | | | | | |

***Amtrak Unimpeded Schedule Run: 179.4 hrs; OTP range comes from individual Summary files of simulations.**

Table 3. Runtime data for iterative solution testing of Test Case 2 – BNSF Passenger w/ Freight.

## Comparison of Passenger Schedules - Northbound

PRIVILEGED AND CONFIDENTIAL

**NORTHBOUND - Grand/Kyrene Line (Locomotive Hauled Coach)**

| Station | Segment Trip Time | Train Number | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 101 | 103 | 105 | 107 | 109 | 111 | 113 | 115 | 117 | 119 | 121 | 123 | 125 | 127 | 129 | 131 |
| Leave Phoenix | | 602 | 632 | 702 | 732 | 802 | 1032 | 1232 | 1432 | 1602 | 1632 | 1702 | 1732 | 1802 | 1832 | 1902 | 2032 |
| | 2 | | | | | | | | | | | | | | | | |
| State Capitol | | 604 | 634 | 704 | 734 | 804 | 1034 | 1234 | 1434 | 1604 | 1634 | 1704 | 1734 | 1804 | 1834 | 1904 | 2034 |
| | 11 | | | | | | | | | | | | | | | | |
| Glendale | | 615 | 645 | 715 | 745 | 815 | 1045 | 1245 | 1445 | 1615 | 1645 | 1715 | 1745 | 1815 | 1845 | 1915 | 2045 |
| | 5 | | | | | | | | | | | | | | | | |
| Peoria | | 620 | 650 | 720 | 750 | 820 | 1050 | 1250 | 1450 | 1620 | 1650 | 1720 | 1750 | 1820 | 1850 | 1920 | 2050 |
| | 6 | | | | | | | | | | | | | | | | |
| El Mirage/Sun City/Youngtown | | 626 | 656 | 726 | 756 | 826 | 1056 | 1256 | 1456 | 1626 | 1656 | 1726 | 1756 | 1826 | 1856 | 1926 | 2056 |
| | 3 | | | | | | | | | | | | | | | | |
| Surprise | | 629 | 659 | 729 | 759 | 829 | 1059 | 1259 | 1459 | 1629 | 1659 | 1729 | 1759 | 1829 | 1859 | 1929 | 2059 |
| | 5 | | | | | | | | | | | | | | | | |
| North Surprise/Sun City West | | 634 | 704 | 734 | 804 | 834 | 1104 | 1304 | 1504 | 1634 | 1704 | 1734 | 1804 | 1834 | 1904 | 1934 | 2104 |
| | 9 | | | | | | | | | | | | | | | | |
| Wittmann | | 643 | 713 | 743 | 813 | 843 | 1113 | 1313 | 1513 | 1643 | 1713 | 1743 | 1813 | 1843 | 1913 | 1943 | 2113 |
| | 41 | | | | | | | | | | | | | | | | |

**Proposed Schedule**
**Overall Trip Time: 41min**
**OTP % (RTC): 0%**

**NORTHBOUND - GRAND LINE/KYRENE LINE**

| Station | Segment Trip Time | Train Number | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 101 L/MF | 103 L/MF | 105 L/MF | 107 | 109 | 111 | 113 | 115 | 117 | 119 | 121 | 123 | 125 | 127 | 129 | 131 |
| Leave Phoenix | | 602 | 632 | 702 | 732 | 802 | 1032 | 1232 | 1432 | 1602 | 1632 | 1702 | 1732 | 1802 | 1832 | 1902 | 2032 |
| | 2 | | | | | | | | | | | | | | | | |
| State Capitol | | 604 | 634 | 704 | 734 | 804 | 1034 | 1234 | 1434 | 1604 | 1634 | 1704 | 1734 | 1804 | 1834 | 1904 | 2034 |
| | 11 | | | | | | | | | | | | | | | | |
| Glendale | | 615 | 645 | 715 | 745 | 815 | 1045 | 1245 | 1445 | 1615 | 1645 | 1715 | 1745 | 1815 | 1845 | 1915 | 2045 |
| | 5 | | | | | | | | | | | | | | | | |
| Peoria | | 620 | 650 | 720 | 750 | 820 | 1050 | 1250 | 1450 | 1620 | 1650 | 1720 | 1750 | 1820 | 1850 | 1920 | 2050 |
| | 8 | | | | | | | | | | | | | | | | |
| El Mirage/Sun City/Youngtown | | 628 | 658 | 728 | 758 | 828 | 1158 | 1358 | 1558 | 1628 | 1658 | 1728 | 1758 | 1828 | 1858 | 1928 | 2058 |
| | 4 | | | | | | | | | | | | | | | | |
| Surprise | | 632 | 702 | 732 | 802 | 832 | 1102 | 1302 | 1502 | 1632 | 1702 | 1732 | 1802 | 1832 | 1902 | 1932 | 2131 |
| | 6 | | | | | | | | | | | | | | | | |
| North Surprise/Sun City West | | 638 | 708 | 738 | 808 | 838 | 1108 | 1308 | 1508 | 1638 | 1708 | 1738 | 1808 | 1838 | 1908 | 1938 | 2138 |
| | 13 | | | | | | | | | | | | | | | | |
| Wittmann | | 651 | 721 | 751 | 821 | 851 | 1121 | 1321 | 1521 | 1651 | 1721 | 1751 | 1821 | 1851 | 1921 | 1951 | 2151 |
| | 49 | | | | | | | | | | | | | | | | |

L/MF = Trains moving to or from Layover or Maintenance Facility.

**Altered Schedule**
**Overall Trip Time: 49min**
**OTP % (RTC): 100%***

*Also includes projects and additional platforms mentioned.

Table 4. Schedule changes made in test case one for on-time performance – northbound (eastbound) trains.

## Comparison of Passenger Schedules - Southbound

PRIVILEGED AND CONFIDENTIAL

**SOUTHBOUND - Grand/Kyrene Line (Locomotive Hauled Coach)**

| Station | Segment Trip Time | Train Number | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 102 | 104 | 106 | 108 | 110 | 112 | 114 | 116 | 118 | 120 | 122 | 124 | 126 | 128 | 130 | 132 |
| Wittmann | | 530 | 600 | 630 | 700 | 730 | 1000 | 1200 | 1400 | 1530 | 1600 | 1630 | 1700 | 1730 | 1800 | 1830 | 2000 |
| | 9 | | | | | | | | | | | | | | | | |
| North Surprise/Sun City West | | 539 | 609 | 639 | 709 | 739 | 1009 | 1209 | 1409 | 1539 | 1609 | 1639 | 1709 | 1739 | 1809 | 1839 | 2009 |
| | 5 | | | | | | | | | | | | | | | | |
| Surprise | | 544 | 614 | 644 | 714 | 744 | 1014 | 1214 | 1414 | 1544 | 1614 | 1644 | 1714 | 1744 | 1814 | 1844 | 2014 |
| | 3 | | | | | | | | | | | | | | | | |
| El Mirage/Sun City/Youngtown | | 547 | 617 | 647 | 717 | 747 | 1017 | 1217 | 1417 | 1547 | 1617 | 1647 | 1717 | 1747 | 1817 | 1847 | 2017 |
| | 6 | | | | | | | | | | | | | | | | |
| Peoria | | 553 | 623 | 653 | 723 | 753 | 1023 | 1223 | 1423 | 1553 | 1623 | 1653 | 1723 | 1753 | 1823 | 1853 | 2023 |
| | 5 | | | | | | | | | | | | | | | | |
| Glendale | | 558 | 628 | 658 | 728 | 758 | 1028 | 1228 | 1428 | 1558 | 1628 | 1658 | 1728 | 1758 | 1828 | 1858 | 2028 |
| | 11 | | | | | | | | | | | | | | | | |
| State Capitol | | 609 | 639 | 709 | 739 | 809 | 1039 | 1239 | 1439 | 1609 | 1639 | 1709 | 1739 | 1809 | 1839 | 1909 | 2039 |
| | 2 | | | | | | | | | | | | | | | | |
| **Arrive Phoenix** | | **611** | **641** | **711** | **741** | **811** | **1041** | **1241** | **1441** | **1611** | **1641** | **1711** | **1741** | **1811** | **1841** | **1911** | **2041** |
| | 41 | | | | | | | | | | | | | | | | |

**SOUTHBOUND - GRAND LINE/KYRENE LINE**

| Station | Segment Trip Time | Train Number | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 102 | 104 | 106 | 108 | 110 | 112 | 114 | 116 | 118 | 120 | 122 | 124 | 126 | 128 | 130 | 132 |
| Wittmann | | 530 | 600 | 630 | 700 | 730 | 1000 | 1200 | 1400 | 1530 | 1600 | 1630 | 1700 | 1730 | 1800 | 1830 | 2000 |
| | 11 | | | | | | | | | | | | | | | | |
| North Surprise/Sun City West | | 541 | 611 | 641 | 711 | 741 | 1011 | 1211 | 1411 | 1541 | 1611 | 1641 | 1711 | 1741 | 1811 | 1841 | 2011 |
| | 5 | | | | | | | | | | | | | | | | |
| Surprise | | 546 | 616 | 646 | 716 | 746 | 1016 | 1216 | 1416 | 1546 | 1616 | 1646 | 1716 | 1746 | 1816 | 1846 | 2016 |
| | 4 | | | | | | | | | | | | | | | | |
| El Mirage/Sun City/Youngtown | | 550 | 620 | 650 | 720 | 750 | 1020 | 1220 | 1420 | 1550 | 1620 | 1650 | 1720 | 1750 | 1820 | 1850 | 2020 |
| | 7 | | | | | | | | | | | | | | | | |
| Peoria | | 557 | 627 | 657 | 727 | 757 | 1027 | 1227 | 1427 | 1557 | 1627 | 1657 | 1727 | 1757 | 1827 | 1857 | 2027 |
| | 6 | | | | | | | | | | | | | | | | |
| Glendale | | 603 | 633 | 703 | 733 | 803 | 1033 | 1233 | 1433 | 1603 | 1633 | 1703 | 1733 | 1803 | 1833 | 1903 | 2033 |
| | 11 | | | | | | | | | | | | | | | | |
| State Capital | | 614 | 644 | 714 | 744 | 814 | 1044 | 1244 | 1444 | 1614 | 1644 | 1714 | 1744 | 1814 | 1844 | 1914 | 2044 |
| | 2 | | | | | | | | | | | | | | | | |
| **Arrive Phoenix** | | **616** | **646** | **716** | **746** | **816** | **1046** | **1246** | **1446** | **1616** | **1646** | **1716** | **1746** | **1816** | **1846** | **1916** | **2046** |
| | 46 | | | | | | | | | | | | | | | | |

L/MF = Trains moving to or from Layover or Maintenance Facility.

**Proposed Schedule**
**Overall Trip Time: 41min**
**OTP % (RTC): 0%**

**Altered Schedule**
**Overall Trip Time: 46min**
**OTP % (RTC): 100%***

*Also includes projects and additional platforms mentioned.

Table 5. Schedule changes made in test case one for on-time performance – southbound (westbound) trains.

| Test Case - Operational Changes to Manifest traffic in RTC | | | |
|---|---|---|---|
| Trains | Time passing Wittmann/New Arrival time to Yard | New Departure outside Passenger Window | Time spent at Wittmann Yard |
| HBELPHX101 | 20:00 | 21:00 | **1:00** |
| HBELPHX103 | 12:14 | 15:49 | **3:35** |
| HBELPHX104 | 5:00 | 12:00 | **7:00** |
| HBELPHX105 | 7:00 | 11:30 | **4:30** |
| HBELPHX106 | 17:54 | 22:54 | **5:00** |
| HBELPHX304 | 17:43 | 21:43 | **4:00** |
| HBELPHX302 | 16:32 | 21:32 | **5:00** |
| HBELPHX330 | 19:00 | 23:00 | **4:00** |
| | | | |
| MMATPHX102 | 0:47 | *No change | |
| MMATPHX103 | 7:52 | 8:52 | **1:00** |
| MMATPHX1-4 | 6:00 | 9:00 | **3:00** |
| MMATPHX105 | 5:00 | 9:00 | **4:00** |
| MMATPHX106 | 6:15 | 9:15 | **3:00** |
| MMATPHX1-7 | 6:15 | 9:15 | **3:00** |
| *Time is in HH:MM. | | | |

Table 6: Adjustments to manifest trains in RTC in Test Case 2.

| Test Case - Operational Changes to unscheduled RSWE traffic in RTC | | | |
|---|---|---|---|
| Trains | Current Scheduled time to Ennis | New Schedule time to Ennis | Difference (earlier) |
| RSWE35-8 | 17:30 | 14:30 | **3:00** |
| RSWE3502 | 16:16 | 12:16 | **4:00** |
| RSWE3503 | 16:16 | 12:16 | **4:00** |
| RSWE3504 | 0:39 | *No change | |
| RSWE3505 | 16:15 | 12:15 | **4:00** |
| RSWE3506 | 16:03 | 12:03 | **4:00** |
| RSWE3507 | 17:30 | 13:30 | **4:00** |
| *Time is in HH:MM. | | | |

Table 7. Adjustments to unscheduled return traffic Ennis-Mobest traffic in RTC in Test Case 2 to accommodate rush hour.