Appendix B - PAG High Capacity Transit Implementation Plan - December 2017

PIMA ASSOCIATION OF GOVERNMENTS HIGH CAPACITY TRANSIT IMPLEMENTATION PLAN

DECEMBER 2017

Pima Association of Governments


Warren Ave / Helen St
Landfill

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INTRODUCTION

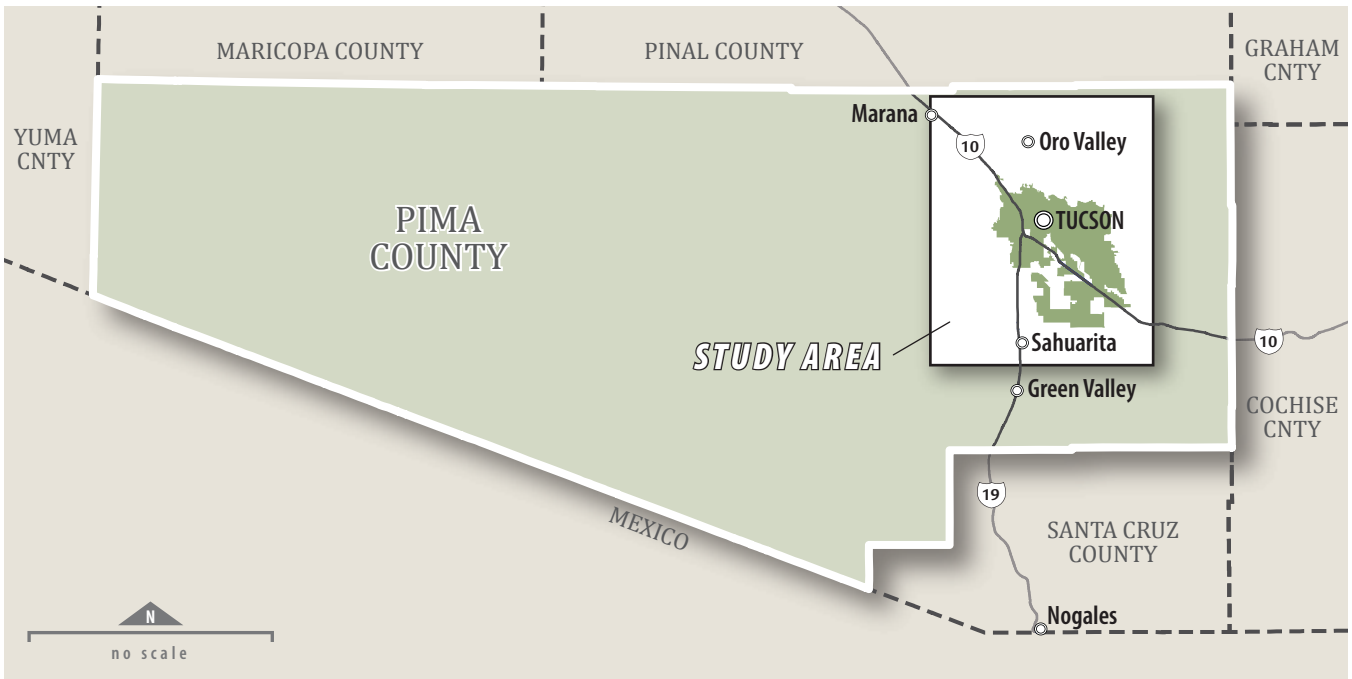
The Pima Association of Governments (PAG) High Capacity Transit Implementation Plan (HCTIP) identifies and prioritizes future high capacity transit (HCT) improvements (corridors and modes) in Pima County and the Tucson metropolitan area (see Figure 1). The HCTIP is a partnership between PAG and the City of Tucson Department of Transportation.

Corridors, Modes, and Travel Markets

The HCTIP develops and evaluates HCT corridors and modes that consolidate transit service into prioritized HCT corridors. These corridors and modes were evaluated based on technical criteria developed collaboratively among project team and agency staff. The goal of the HCTIP is to prioritize these HCT corridors and modes for future inclusion and advancement within the regional transportation network.

The HCTIP considers regional travel markets and connections to existing and planned transit services. It addresses connections to regional transportation nodes (e.g., Downtown Tucson, University of Arizona, Tucson International Airport) and balances the needs for local and regional transit circulation. The HCTIP also responds to potential changes in land use and density in the region with an increased emphasis on making connections to regional transportation nodes.

Figure 1 Project Location

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EXISTING CONDITIONS

Existing conditions reviews and analyzes socioeconomic and demographic information and existing transit conditions.

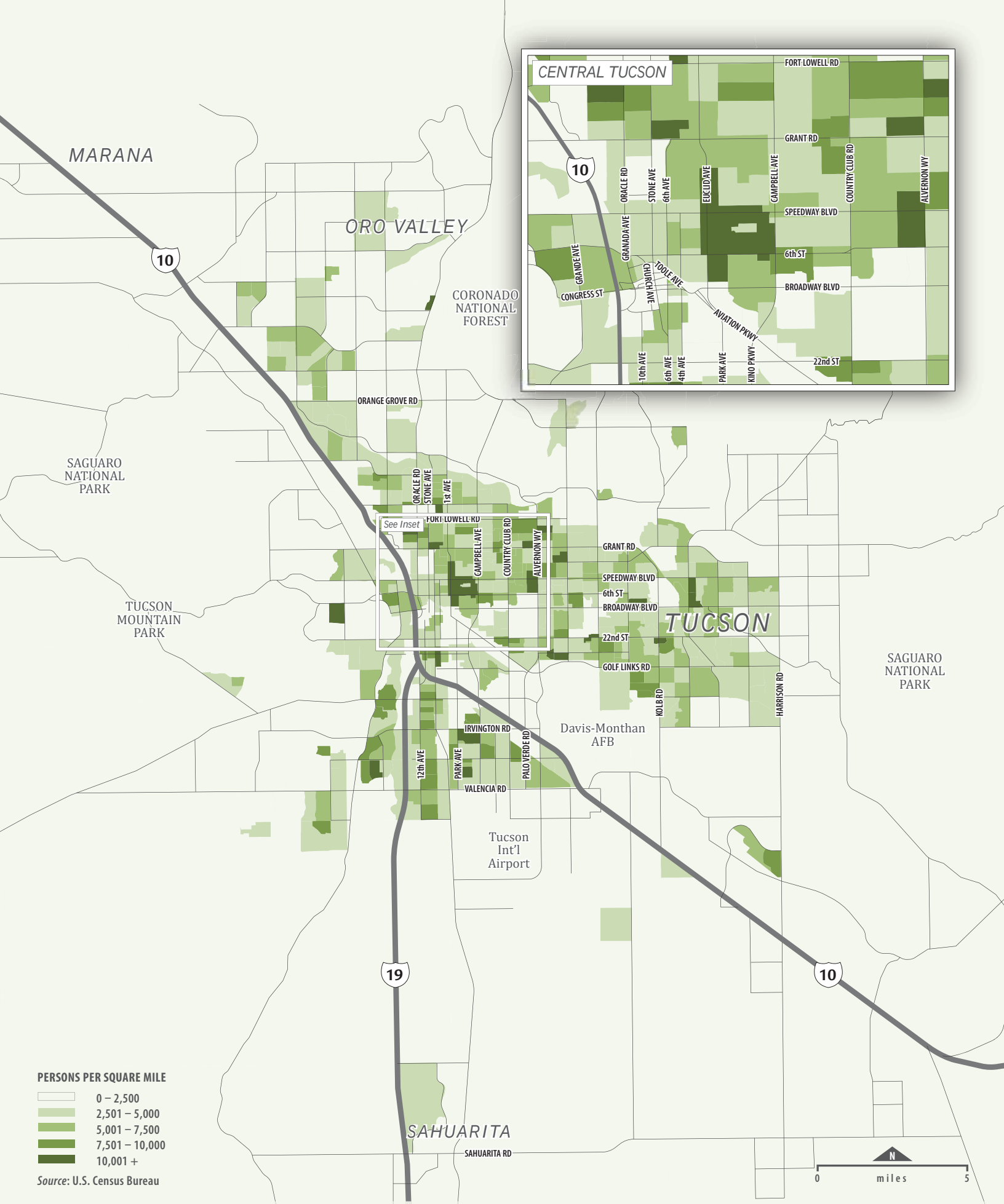
Socioeconomic and Demographic Information

The recent socioeconomic and demographic changes in Pima County are well documented. The Tucson metropolitan area will continue to transform into a more urbanized area with multi-modal transportation connections. The ***PAG 2045 Regional Mobility and Accessibility Plan*** identifies changes in land use and transportation that take on a more urban arrangement and preference.

The study area for the HCTIP includes a similar area evaluated in the ***PAG 2045 Regional Mobility and Accessibility Plan***. Existing socioeconomic and demographic information in Pima County is documented using Census and American Community Survey data. This information is shown using density, which is a better indicator for transportation analysis.

Figures 2 through 10 show current socioeconomic and demographic information for the study area for the following categories:

- Population Density
- Employment Density
- Persons with Disabilities Density
- Minority Population Density
- Youth Population Density
- Elderly Population Density
- Population Below Poverty Density
- Housing Units Density
- Zero-Car Household Density



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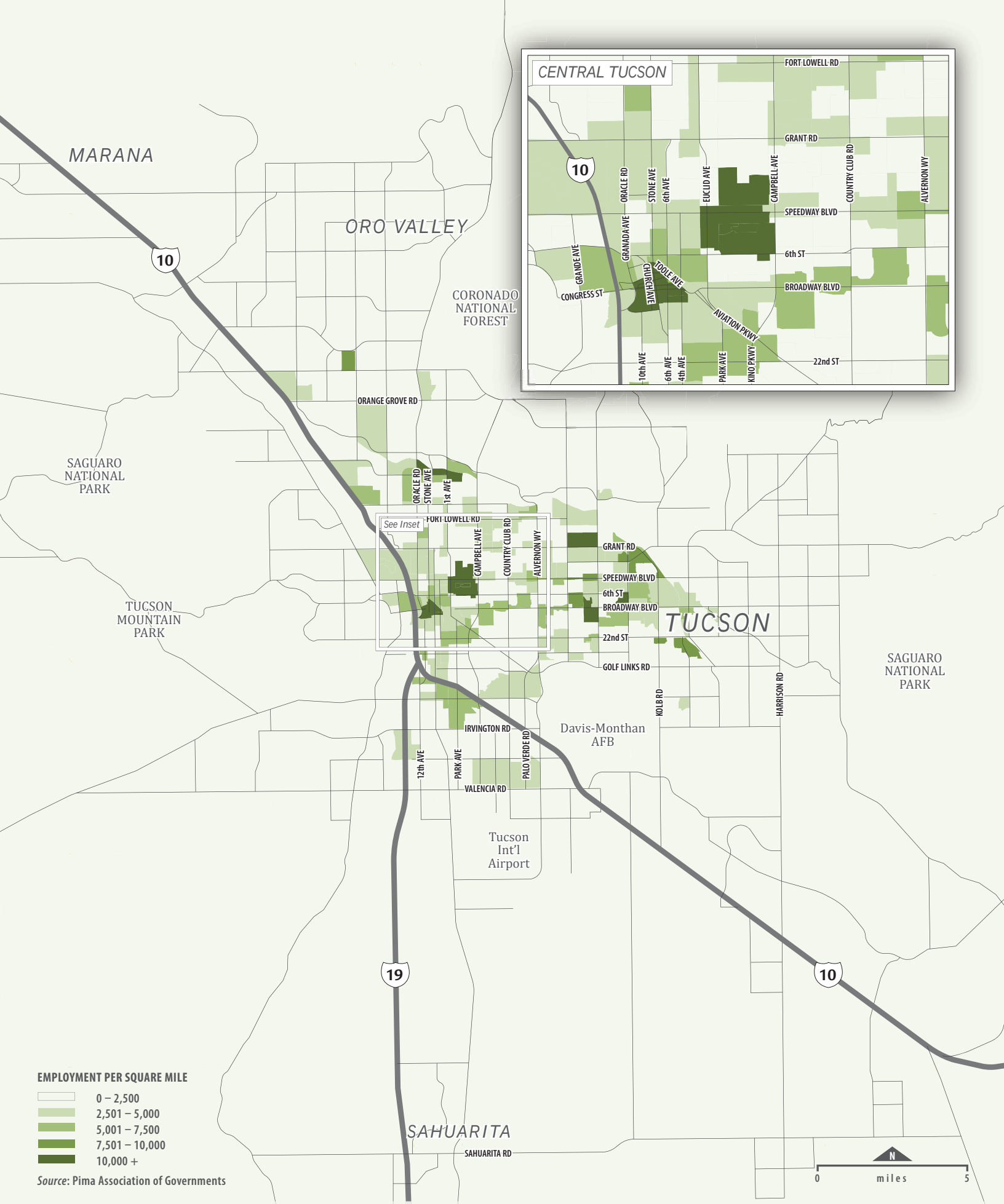
HIGH CAPACITY TRANSIT IMPLEMENTATION PLAN

Population Density by Block Group (2014)

Figure 2



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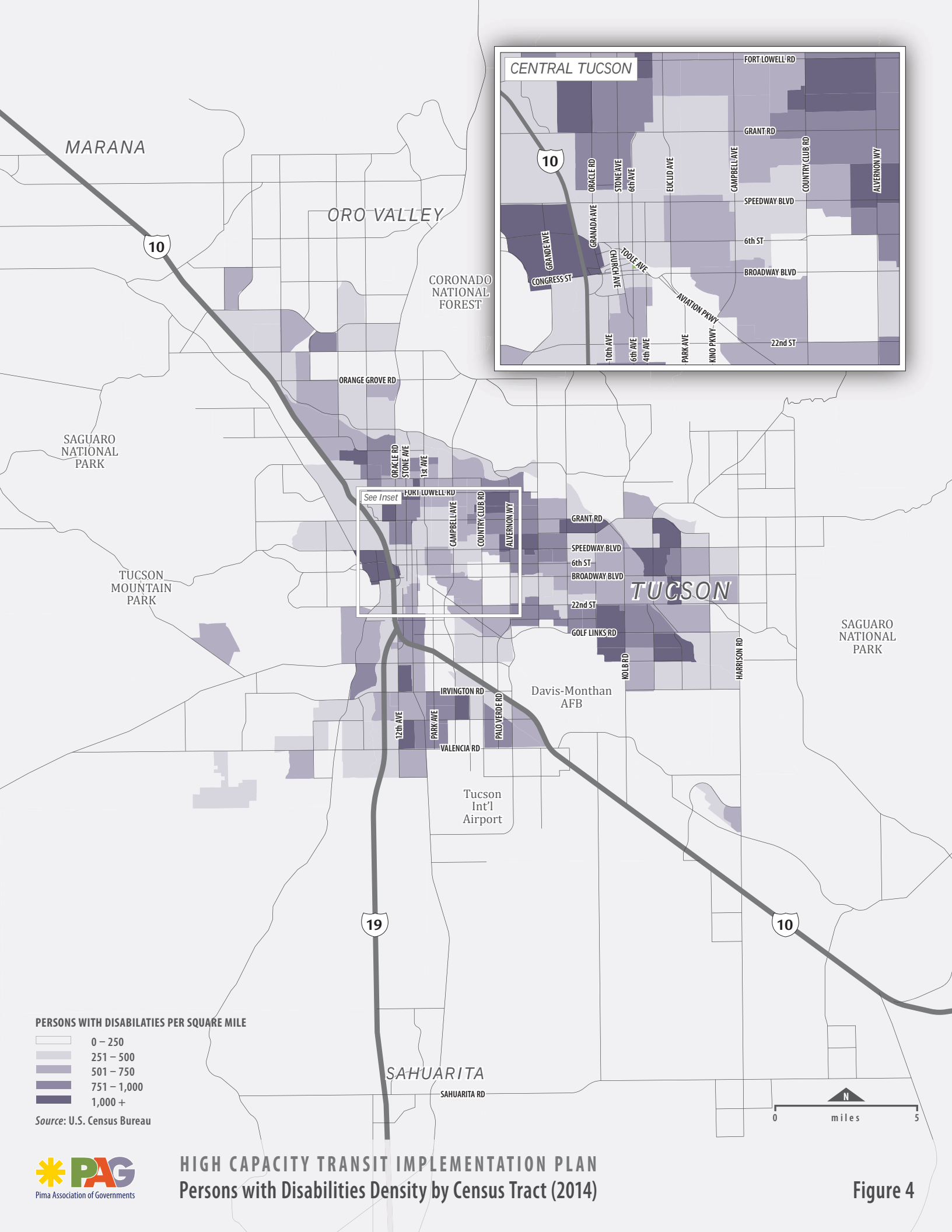
Employment Density by Census Block Group (2014)

Figure 3



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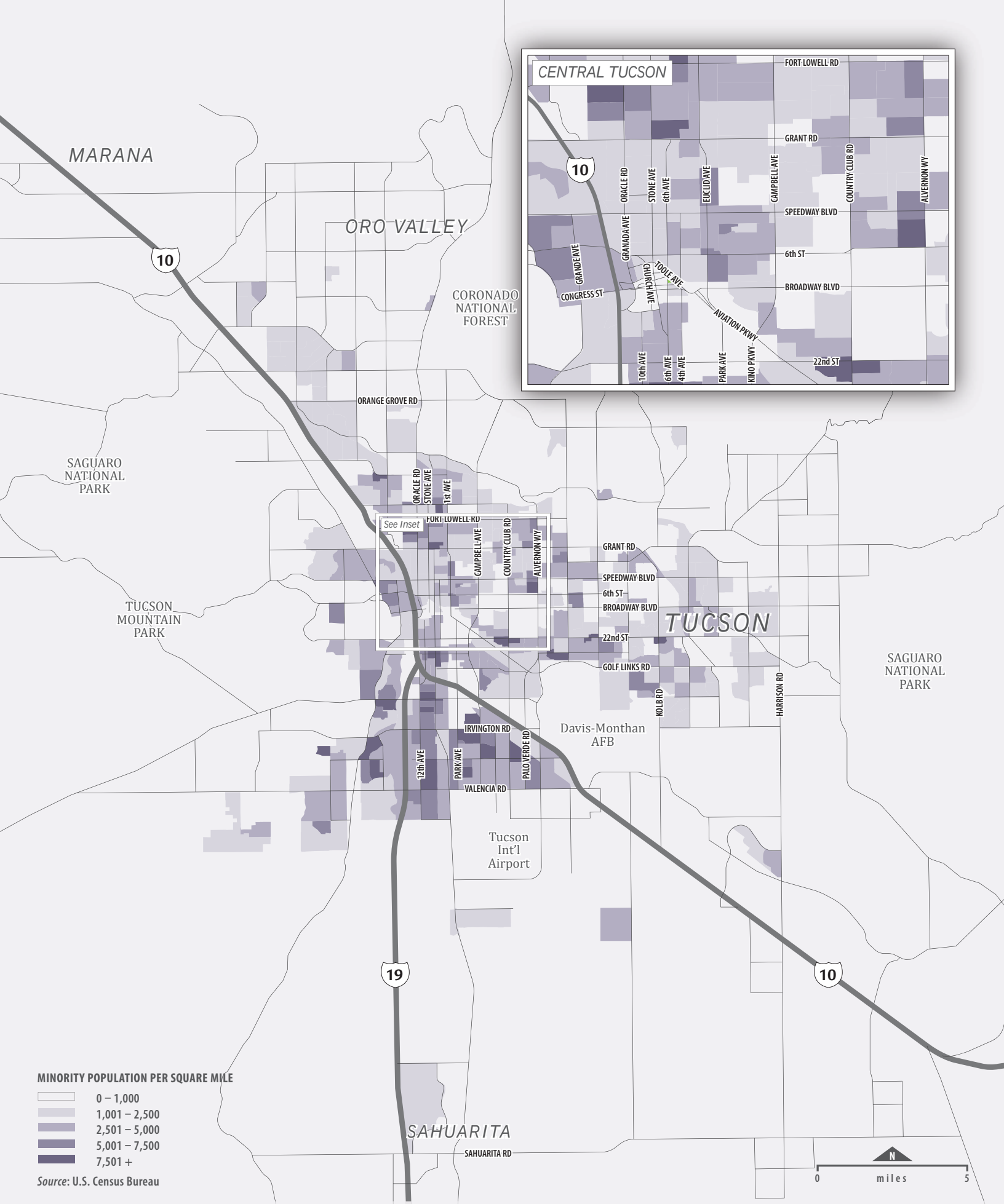
HIGH CAPACITY TRANSIT IMPLEMENTATION PLAN

Persons with Disabilities Density by Census Tract (2014)

Figure 4



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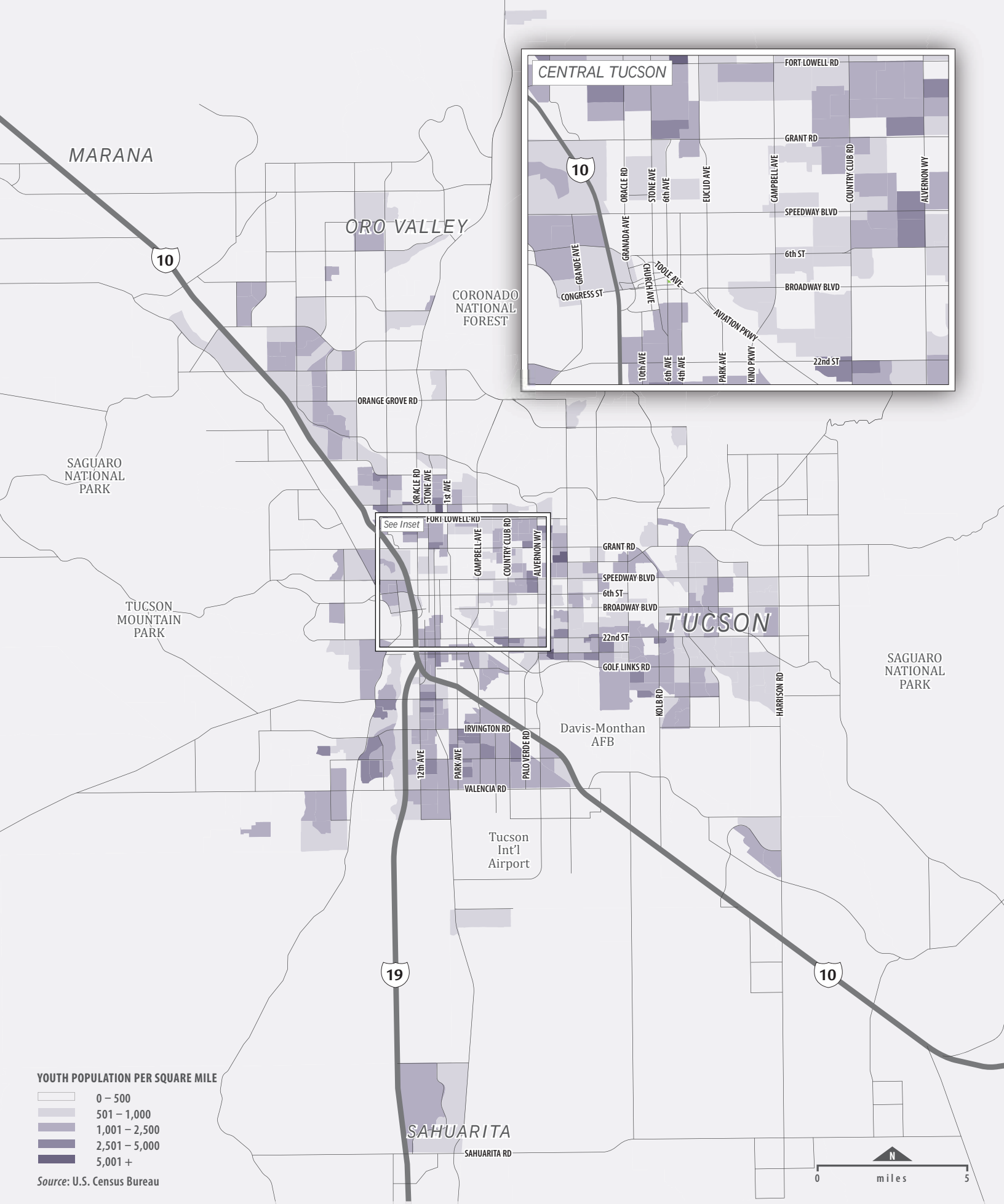
Minority Population by Block Group (2014)

Figure 5



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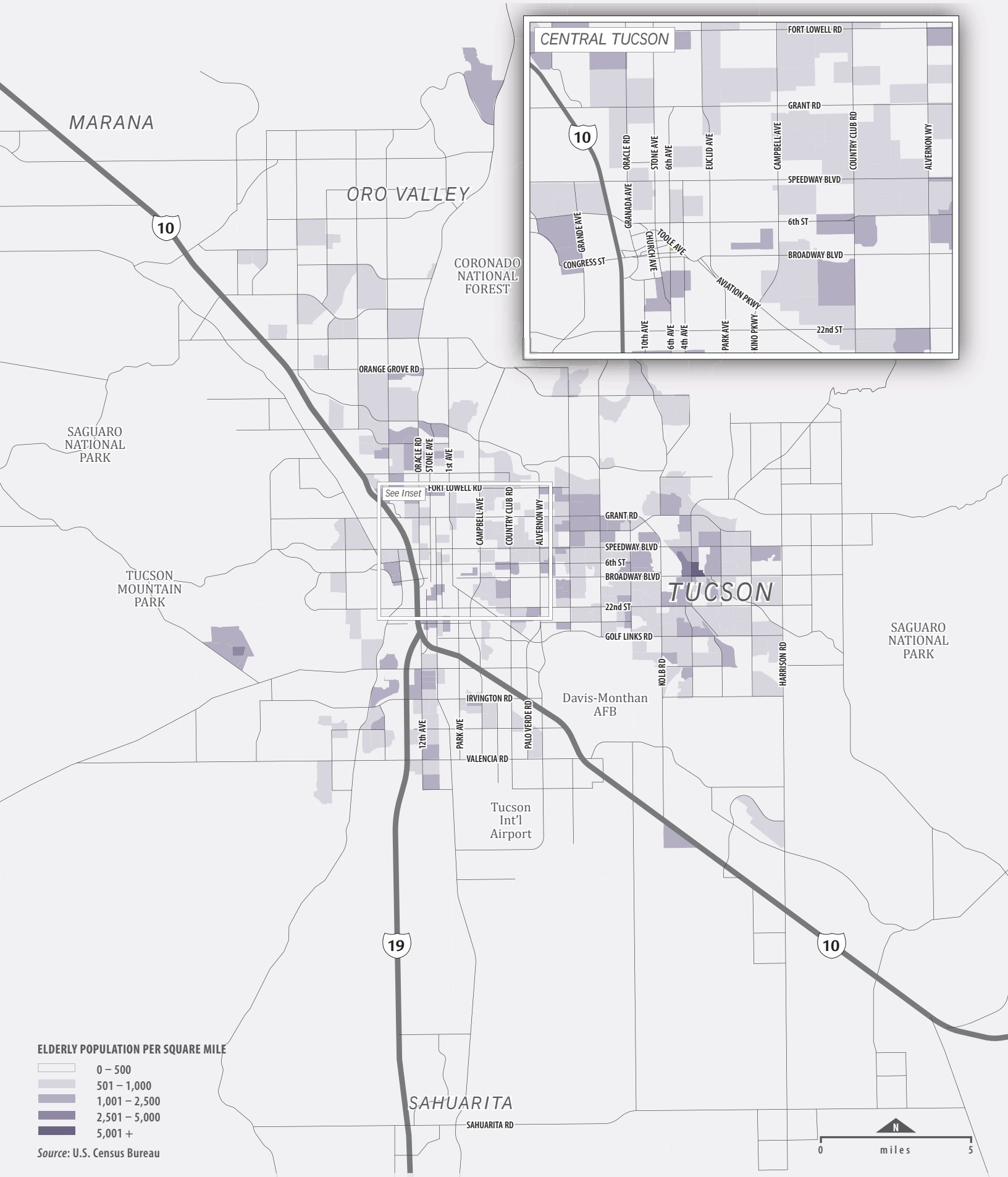
Youth Population by Block Group (2014)

Figure 6



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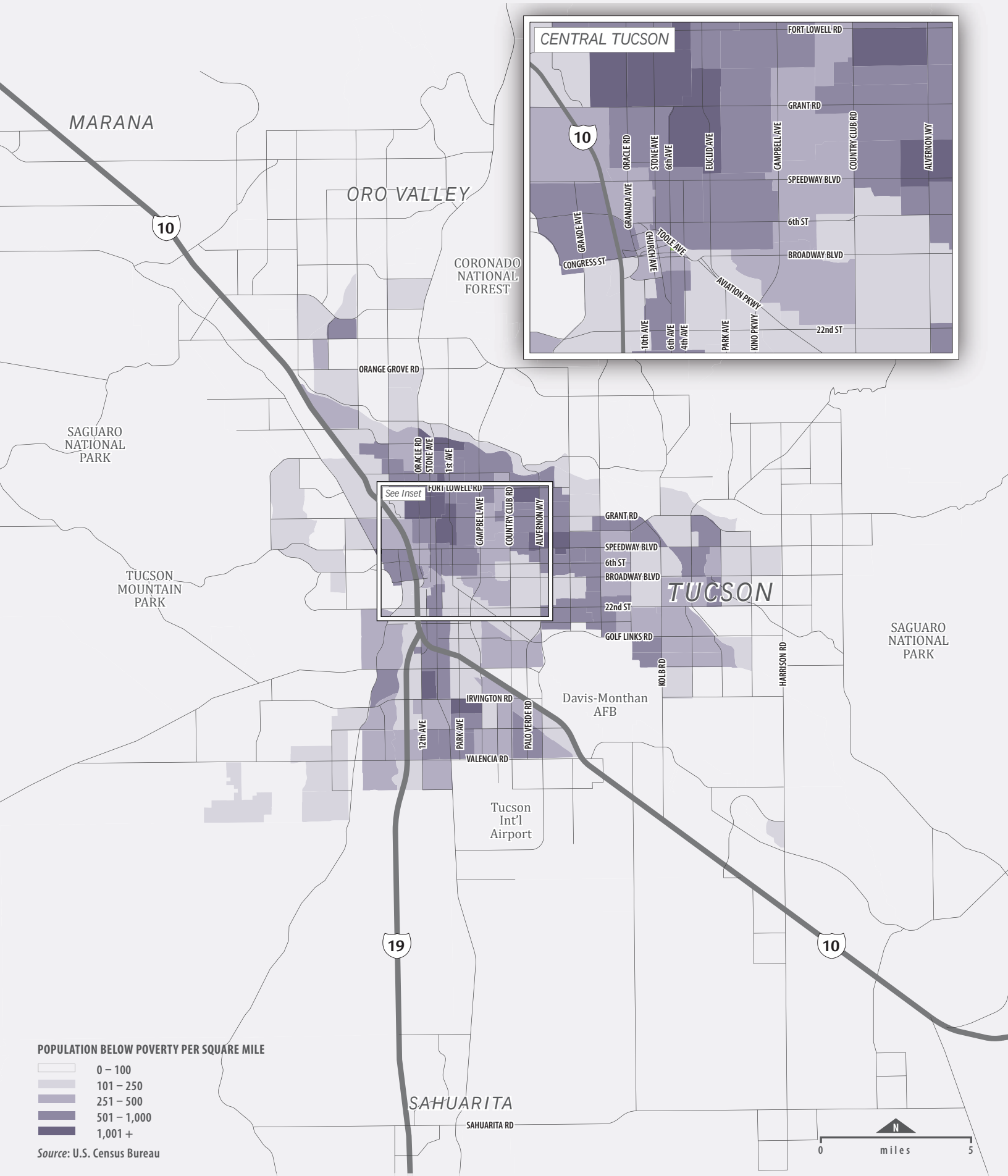
Elderly Population by Block Group (2014)

Figure 7



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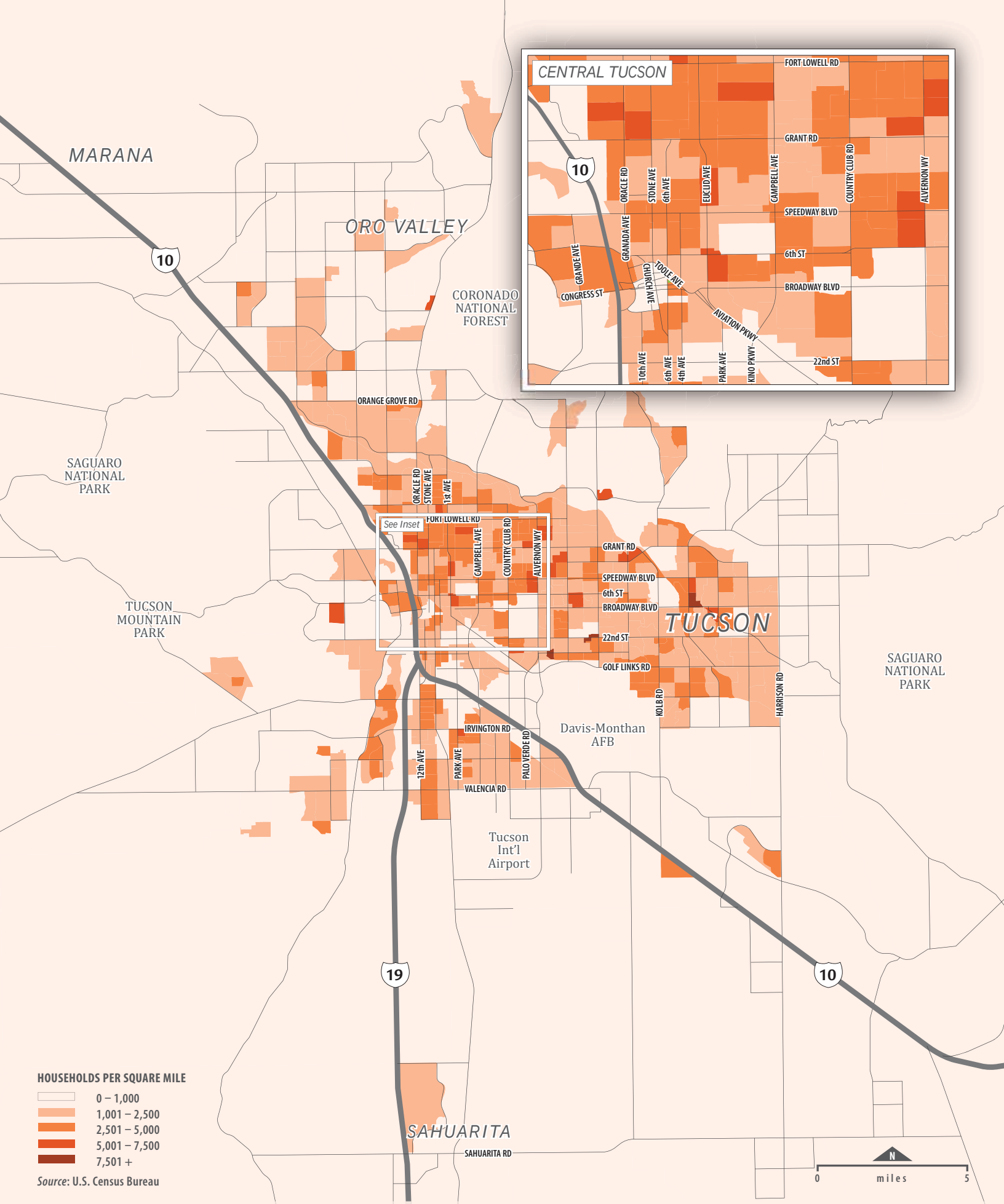
Population Below Poverty by Census Tract (2014)

Figure 8



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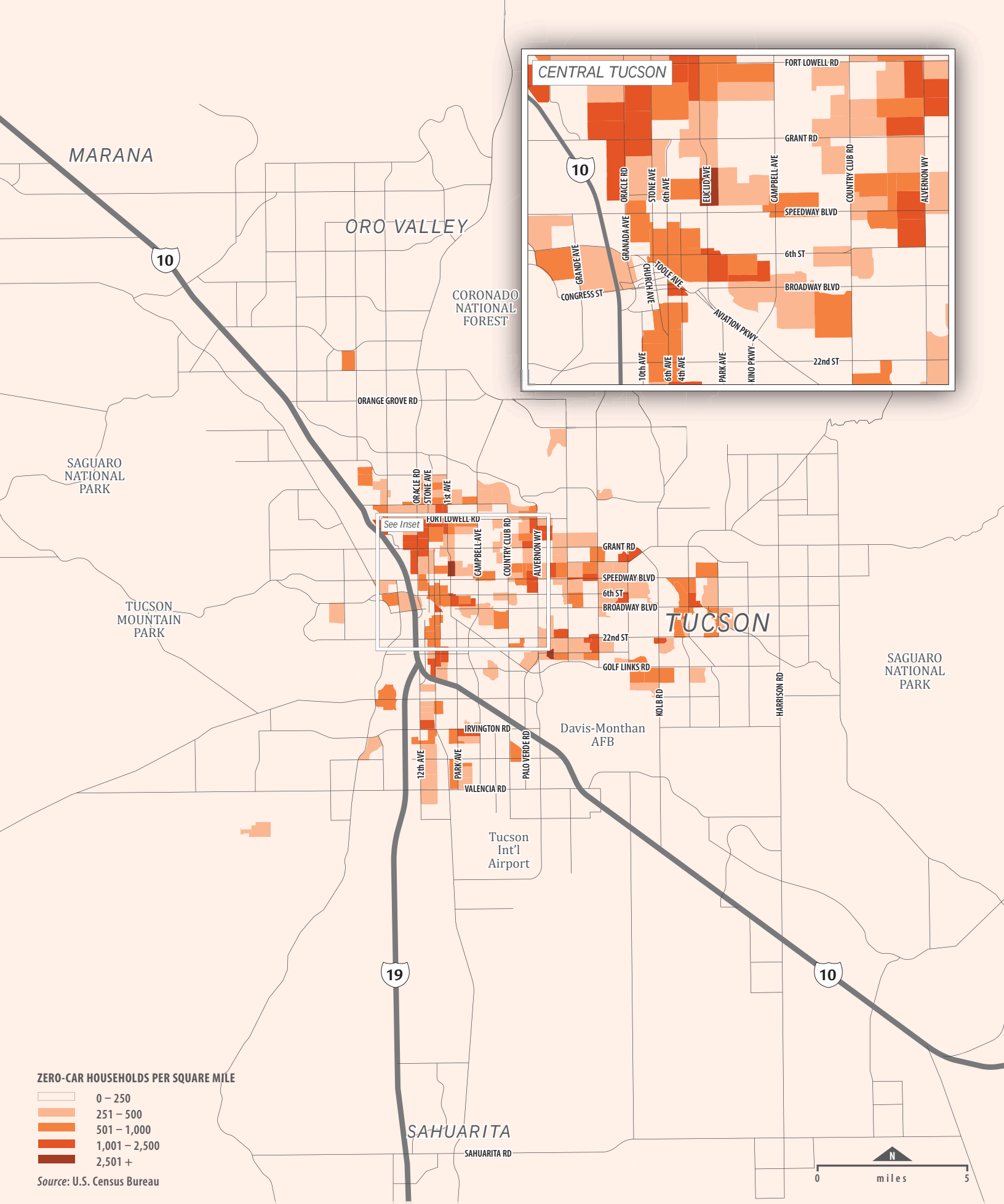
Housing Units by Block Group (2014)

Figure 9



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HIGH CAPACITY TRANSIT IMPLEMENTATION PLAN

Zero-car Households by Block Group (2014)

Figure 10

SOCIOECONOMIC AND DEMOGRAPHIC TRENDS

While densities for many of the socioeconomic and demographic categories are relatively evenly dispersed throughout the study area, certain areas have consistently higher concentrations.

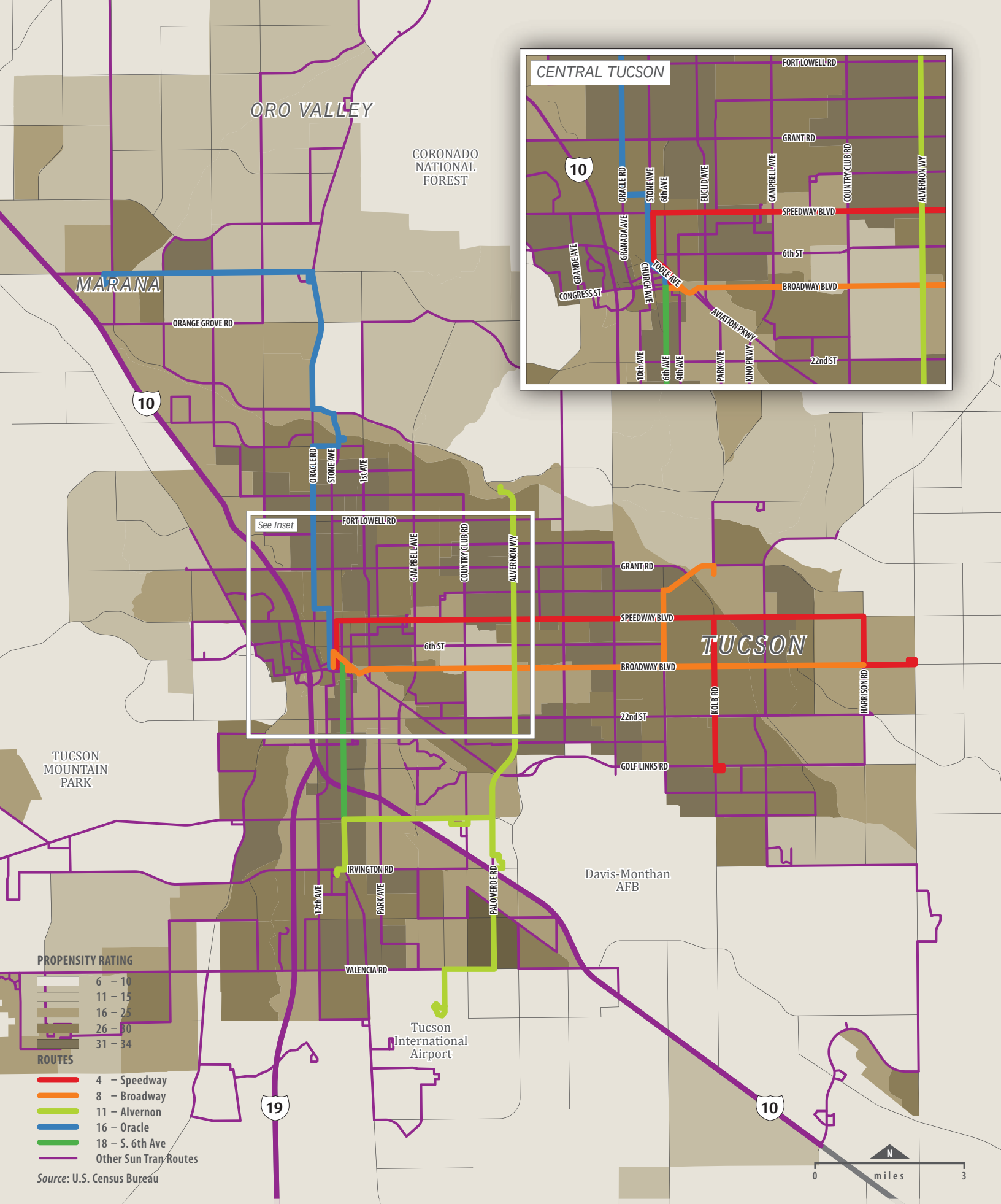
One method to identify socioeconomic and demographic trends is to overlay the categories using a composite analysis for census tracts in Pima County. This analysis is a good indicator of transit propensity for potential HCT corridors.

For this effort, the following categories were rated using breakpoints for each category:

- Population Density
- Employment Density
- Disability Density
- Minority Population Density
- Youth Population Density
- Elderly Population Density
- Population Below Poverty Density
- Housing Units Density

Overall, the composite analysis shows higher ratings of socioeconomic and demographic categories in many of the north/south and east/west corridors. In particular, higher concentrations occur around Oracle Road north of Speedway Boulevard, Alvernon Way between Broadway Boulevard and Fort Lowell Road, and South 6th Avenue between Broadway Boulevard and Valencia Road.

Figure 11 shows the results of the composite analysis.



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HIGH CAPACITY TRANSIT IMPLEMENTATION PLAN

Transit Propensity by Census Tract

Figure 11

Existing Transit Conditions

This section documents the existing transit services operating in the study area and evaluates their performance based on several common metrics.

TRANSIT SERVICES

Existing transit services include streetcar, local and express bus service, neighborhood circulators, and paratransit. The existing transit routes are depicted in Figure 12. A list of the existing transit routes and their service hours and frequencies is provided in Table 1.

Streetcar

The 3.9-mile Sun Link streetcar line began operations in July 2014. The route connects passengers to destinations in five unique districts: the University of Arizona, Main Gate, 4th Avenue, Downtown Tucson, and Mercado. There are 19 stops along the streetcar line.

Local Bus

There are 30 local bus routes in the study area. Hours of operation vary by route, with some routes beginning service as early as 4:15 am and continuing as late as 12:30 am. Frequencies also vary by route, with weekday peak frequencies ranging from 7 minutes to 30 minutes.

Express Bus

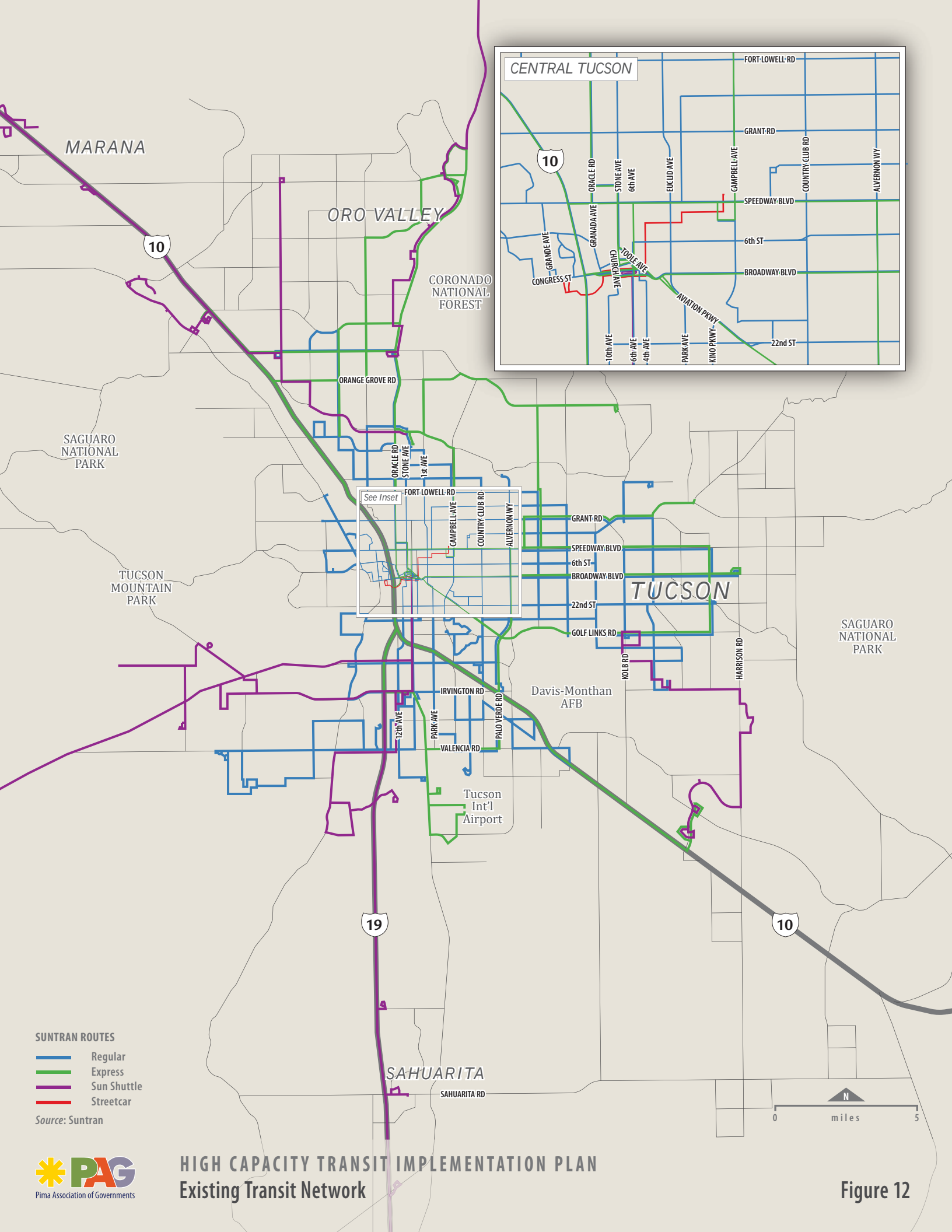
There are 13 express bus routes in the study area. These routes provide peak period trips primarily to Downtown, with some routes serving Aero Park and Oro Valley. The express routes provide between two and six trips during the a.m. and p.m. peak periods on weekdays only.

Neighborhood Circulators

There are ten Sun Shuttle routes that primarily serve destinations outside the City of Tucson and connect passengers to Sun Tran services.

Paratransit Service

Paratransit service is provided by Sun Van and Sun Shuttle Dial-a-Ride. Sun Van service operates primarily within the City of Tucson while Sun Shuttle Dial-a-Ride operates primarily in Oro Valley, Marana, and Pima County. This service is only available to passengers certified as Americans with Disabilities Act (ADA) clients.



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HIGH CAPACITY TRANSIT IMPLEMENTATION PLAN

Existing Transit Network

Figure 12

Table 1 Transit Service Hours and Frequency

Route Name	Weekday			Saturday			Sunday		
	Hours	Peak	Off-Peak	Hours	Peak	Off-Peak	Hours	Peak	Off-Peak
Streetcar									
700–Sun Link	7:00 am–10:00 pm[1]	10/15	15/30	8:00 am–2:00 am	15	30	8:00 am–8:00 pm	20	30
Local									
1 Glenn/Swan	5:30 am–11:00 pm	30	30/60	6:30 am–9:30 pm	60	60	7:30 am–8:30 pm	60	60
2 Pueblo Gardens	5:15 am–11:15 pm	30	30/60	7:00 am–9:00 pm	60	60	8:15 am–7:00 pm	60	60
3 6th St/Wilmot	5:00 am–12:00 am	20	30/60	5:00 am–10:00 pm	60	60	6:45 am–8:15 pm	60	60
4 Speedway	5:00 am–12:30 am	10	15	6:00 am–10:00 pm	30	30	7:00 am–9:00 pm	30	30
5 Pima/W. Speedway	5:45 am–7:30 pm	30	30	5:30 am–7:15 pm	60	60	6:45 am–7:30 pm	60	60
6 Euclid/N. 1st Ave	5:00 am–12:00 am	15	30/60	6:30 am–9:00 pm	30	30	6:45 am–8:15 pm	60	60
7 22nd St	6:00 am–11:30 pm	15	20/60	6:00 am–9:00 pm	60	60	7:00 am–8:00 pm	60	60
8 Broadway	4:15 am–12:15 am	10	15	5:30 am–9:15 pm	15	15	6:30 am–9:15 pm	20	20
9 Grant	4:30 am–11:45 pm	15	30/60	6:00 am–9:00 pm	60	60	7:00 am–8:45 pm	60	60
10 Flowing Wells	5:30 am–11:30 pm	30	30/60	6:30 am–9:30 pm	60	60	7:00 am–8:45 pm	60	60
11 Alvernon	4:45 am–12:15 am	15	15/30	6:00 am–9:30 pm	30	30	6:45 am–8:30 pm	30	30
12 10th/12th Ave	5:00 am–12:30 am	15	15/30	5:30 am–9:15 pm	30	30	5:30 am–8:15 pm	30	30
15 Campbell	5:30 am–11:45 pm	20	30/60	6:30 am–9:15 pm	60	60	7:30 am–8:15 pm	60	60
16 Oracle/Ina	5:00 am–12:00 am	7/10	15/30	6:00 am–9:30 pm	15	30	6:00 am–9:00 pm	20	30
17 Country Club/29th St	5:00 am–11:15 pm	30	30/60	6:00 am–10:00 pm	60	60	7:00 am–9:00 pm	60	60
18 S. 6th Ave	4:45 am–12:30 am	7/10	15/30	5:30 am–9:45 pm	15	15	6:15 am–8:30 pm	20	20
19 Stone	5:45 am–11:00 pm	30	30/60	6:45 am–9:30 pm	30	30	6:45 am–8:45 pm	60	60
20 W. Grant St	6:30 am–6:30 pm	30	30	6:00 am–6:45 pm	60	60	6:30 am–6:45 pm	60	60
21 W. Congress/Silverbell	6:00 am–11:15 pm	30	30/60	6:15 am–9:15 pm	30	30	7:15 am–8:45 pm	30	30
22 Grande	5:30 am–11:15 pm	30	30/60	6:15 am–9:30 pm	60	60	7:00 am–8:30 pm	60	60
23 Mission	5:00 am–11:15 pm	30	30/60	7:00 am–9:30 pm	60	60	7:45 am–8:30 pm	60	60
24 12th Ave	4:30 am–9:30 pm	30	30/60	5:45 am–9:00 pm	60	60	7:30 am–8:00 pm	60	60
25 S. Park Ave	4:15 am–12:00 am	30	30/60	5:45 am–9:15 pm	30	30	6:30 am–9:00 pm	60	60
26 Benson Highway	5:15 am–11:15 pm	30	30/60	6:45 am–9:15 pm	60	60	6:45 am–7:15 pm	60	60
27 Midvale Park	5:45 am–11:15 pm	15	30/60	7:00 am–9:45 pm	60	60	6:00 am–7:45 pm	60	60
29 Valencia	5:45 am–11:30 pm	30	30/60	6:15 am–10:00 pm	60	60	7:15 am–9:00 pm	60	60
34 Craycroft/Ft. Lowell	6:00 am–11:30 pm	20	30/60	6:15 am–9:30 pm	60	60	7:30 am–8:30 pm	60	60
37 Pantano	5:30 am–7:45 pm	30	30	6:30 am–8:30 pm	60	60	7:00 am–8:00 pm	60	60
50 Ajo Way	5:15 am–9:30 pm	30	30/60	6:30 am–8:00 pm	60	60	8:00 am–6:00 pm	60	60
61 La Cholla	5:45 am–8:00 pm	30	30	6:00 am–7:00 pm	60	60	6:00 am–7:00 pm	60	60
Express									
101X Golf Links-Downtown	3 trips AM, 3 trips PM			No Service			No Service		
102X Northwest-UA	3 trips AM, 3 trips PM			No Service			No Service		
103X Northwest-Downtown	4 trips AM, 4 trips PM			No Service			No Service		
104X Marana-Downtown	3 trips AM, 3 trips PM			No Service			No Service		
105X Foothills-Downtown	3 trips AM, 3 trips PM			No Service			No Service		
107X Oro Valley-Downtown	3 trips AM, 3 trips PM			No Service			No Service		
108X Broadway-Downtown	3 trips AM, 3 trips PM			No Service			No Service		
109X Catalina Hwy-Downtown	3 trips AM, 3 trips PM			No Service			No Service		
110X Rita Ranch-Downtown	6 trips AM, 6 trips PM			No Service			No Service		
201X Eastside-Aero Park	2 trips AM, 2 trips PM			No Service			No Service		
202X Northwest-Aero Park	3 trips AM, 3 trips PM			No Service			No Service		
203X Oro Valley-Aero Park	3 trips AM, 3 trips PM			No Service			No Service		
312X Oro Valley-Tohono	6 trips AM, 6 trips PM			No Service			No Service		
Circulators									
401 N. Oracle/Catalina	5:45 am–6:30 pm	60	60	8:45 am–2:30 pm	60	60	No Service		
410 Anway/Trico	5:30 am–7:30 pm	120	120	9:00 am–3:00 pm	120	120	No Service		
411 Cortaro/Silverbell	5:30 am–6:30 pm	60	60	9:00 am–3:00 pm	45	45	No Service		
412 Thornydale/River	5:30 am–6:45 pm	90	90	9:00 am–2:30 pm	80	80	No Service		
413 Marana/I-10	6:30 am–7:15 pm	60	60	9:30 am–3:30 pm	60	60	No Service		
421 Green Valley/Sahuarita	5:15 am–8:00 pm	varies	varies	9:00 am–4:30 pm	varies	varies	No Service		
430 Tucson Estates	6:15 am–7:15 pm	90	90	6:15 am–7:15 pm	90	90	No Service		
440 San Xavier	6:30 am–7:30 pm	70	70	7:15 am–6:1 5pm	60	60	No Service		
450 SE Tucson/Rita Ranch	5:30 am–7:00 pm	varies	varies	5:30 am–7:00 pm	varies	varies	No Service		
Ajo/Tucson	1 Inbound trip, 1 outbound trip			No Service			No Service		

Source: Sun Link and Sun Tran websites, September 2016

[1] Sun Link service operates until 12:00 am on Thursdays and 2:00 am on Fridays

TRANSIT PERFORMANCE

Ridership data for existing transit service in the study area is provided by Sun Tran and Sun Link. For the purpose of evaluating transit performance, ridership from April 2016 is being used because it best represents system-wide ridership conditions. Average weekday boardings, total monthly boardings, boardings per revenue mile, and boardings per revenue hour are common transit performance metrics and summarized by route in Table 2.

The top performing routes based on these transit performance metrics were identified. They include routes with over 4,000 average daily boardings, routes with over 2.5 boardings per revenue mile, and routes with over 31 boardings per revenue hour.

The transit routes that are included in one or more of these transit performance categories are:

- Route 4 (Speedway)
- Route 8 (Broadway)
- Route 11 (Alvernon)
- Route 16 (Oracle/Ina)
- Route 18 (S. 6th Avenue)
- Route 19 (Stone)
- Route 700 (Sun Link Streetcar)

The transit performance metrics are shown in bar chart format in Figure 13 and in maps in Figure 14, Figure 15, and Figure 16.

These transit routes:

Route 4	*Speedway*
Route 8	*Broadway*
Route 11	*Alvernon*
Route 16	*Oracle/Ina*
Route 18	*S. 6th Avenue*
Route 19	*Stone*
Route 700	*Sun Link Streetcar*

are the top performers in the following performance categories:

over **4k** **average daily** boardings

over **2.5** boardings per **revenue mile**

over **31** boardings per **revenue hour**

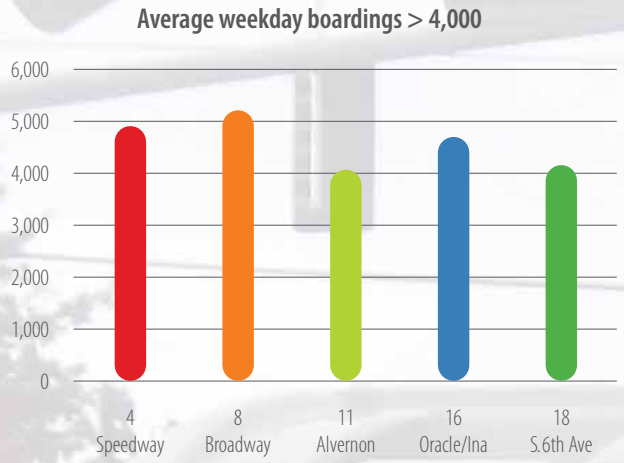
Table 2 Transit Performance

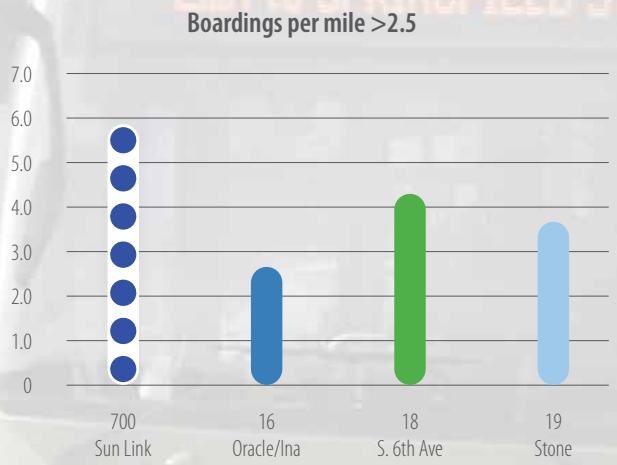
Route Name	Average Weekday	Total Monthly Boardings	Boardings per Revenue Mile[1]	Boardings per Revenue Hour[2]
Streetcar				
700–Sun Link	3,432	92,657	5.86	45.7
Local				
1 Glenn/Swan	1,674	40,899	2.09	26.2
2 Pueblo Gardens	1,092	26,166	1.27	17.5
3 6th St/Wilmot	3,076	71,360	1.65	23.1
4 Speedway	4,910	122,151	2.23	28.2
5 Pima/W. Speedway	1,005	23,550	1.26	16.6
6 Euclid/N. 1st Ave	2,025	51,127	2.41	26.3
7 22nd St	2,816	65,552	2.00	28.2
8 Broadway	5,210	131,862	2.44	31.2
9 Grant	2,389	57,357	2.34	27.3
10 Flowing Wells	1,261	31,620	2.15	26.8
11 Alvernon	4,073	101,844	2.27	28.7
12 10th/12th Ave	1,865	46,569	2.40	28.6
15 Campbell	1,302	31,112	0.97	13.3
16 Oracle/Ina	4,690	119,257	2.66	30.4
17 Country Club/29th St	3,271	82,111	2.10	29.5
18 S. 6th Ave	4,164	105,352	4.30	42.3
19 Stone	1,470	36,122	3.68	34.7
20 W. Grant St	366	9,017	1.15	14.6
21 W. Congress/Silverbell	578	15,095	1.46	17.4
22 Grande	572	13,606	1.33	17.1
23 Mission	1,398	34,140	1.72	20.7
24 12th Ave	630	16,073	2.19	26.7
25 S. Park Ave	1,738	43,176	1.95	24.4
26 Benson Highway	880	21,655	1.30	21.7
27 Midvale Park	1,249	30,325	0.98	15.5
29 Valencia	1,348	34,809	1.68	21.9
34 Craycroft/Ft. Lowell	2,155	53,056	2.28	26.4
37 Pantano	695	17,055	0.97	15.3
50 Ajo Way	395	9,600	1.59	14.6
61 La Cholla	448	11,344	0.98	14.1
Express				
101X Golf Links-Downtown	91	1,916	0.51	22.8
102X Northwest-UA	68	1,436	0.37	15.2
103X Northwest-Downtown	65	1,369	0.27	11.4
104X Marana-Downtown	61	1,276	0.40	10.9
105X Foothills-Downtown	69	1,447	0.35	7.6
107X Oro Valley-Downtown	74	1,552	0.31	11.5
108X Broadway-Downtown	53	1,116	0.28	12.3
109X Catalina Hwy-Downtown	53	1,106	0.26	8.9
110X Rita Ranch-Downtown	67	1,398	0.26	8.8
201X Eastside-Aero Park	39	819	0.20	11.1
202X Northwest-Aero Park	74	1,559	0.26	3.3
203X Oro Valley-Aero Park	52	1,101	0.13	18.6
312X Oro Valley-Tohono	35	727	0.17	8.7

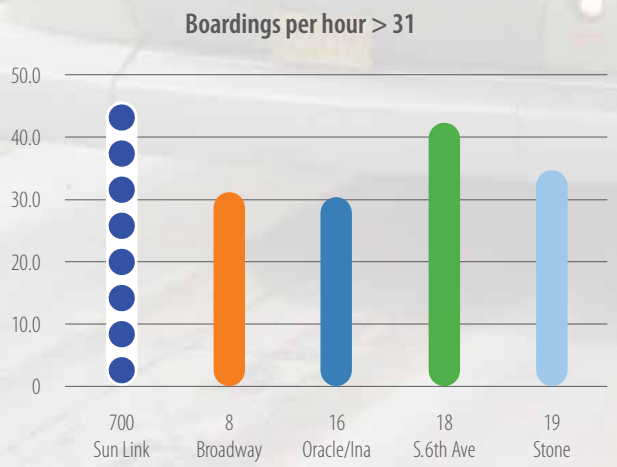
Source: Sun Link and Sun Tran websites, September 2016

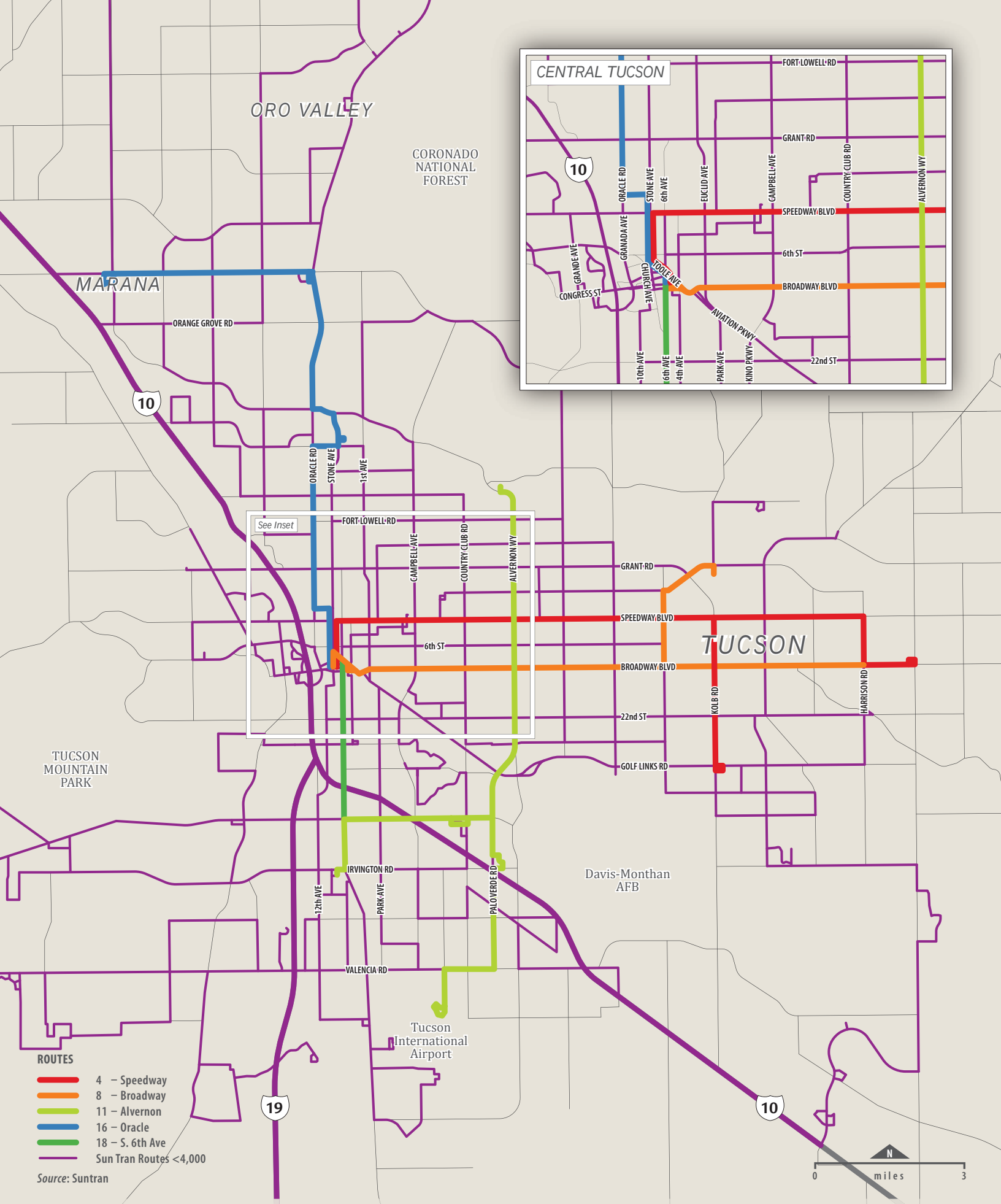
[1] Sun Link service operates until 12:00 am on Thursdays and 2:00 am on Fridays

Figure 13 Transit Performance









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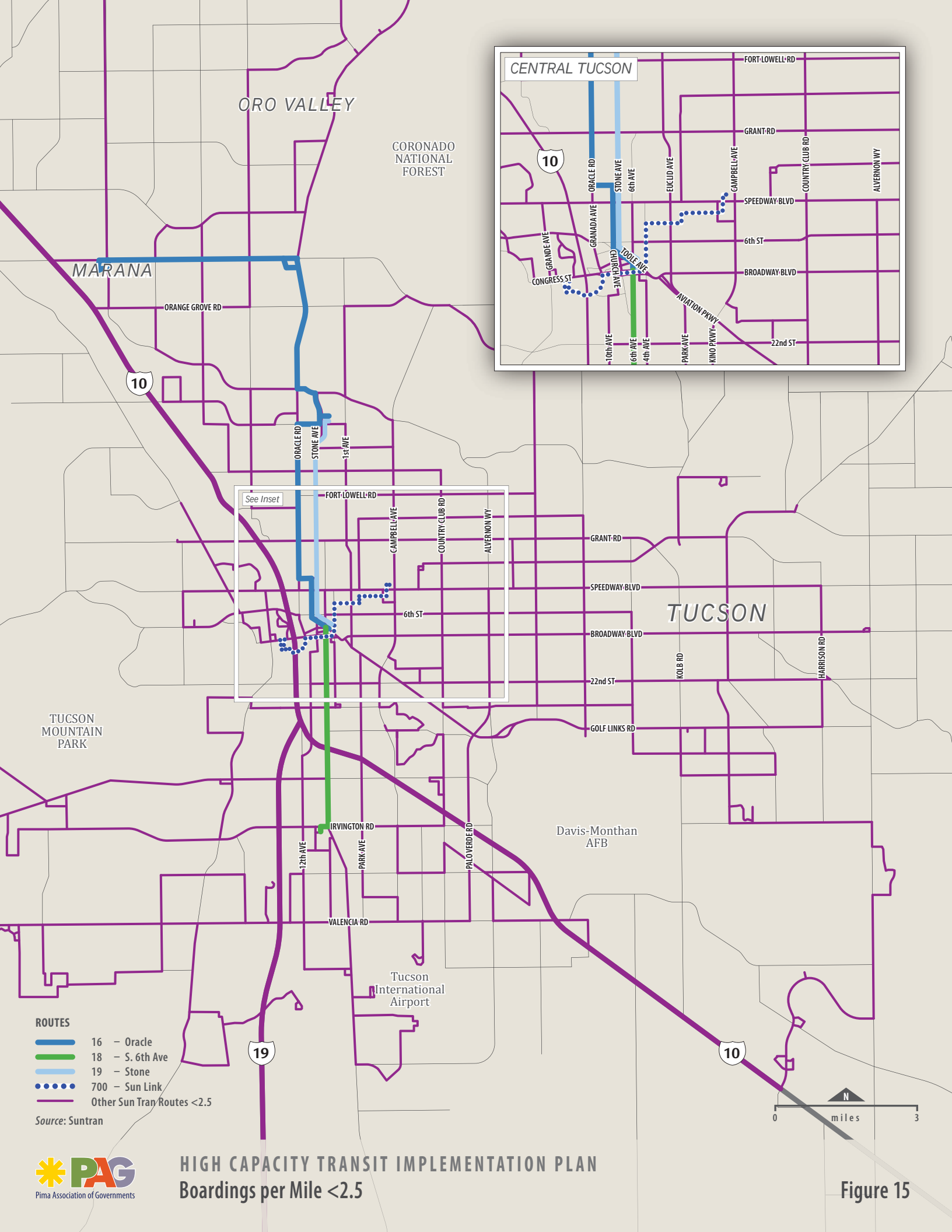
HIGH CAPACITY TRANSIT IMPLEMENTATION PLAN

Average Weekday Boardings <4,000

Figure 14



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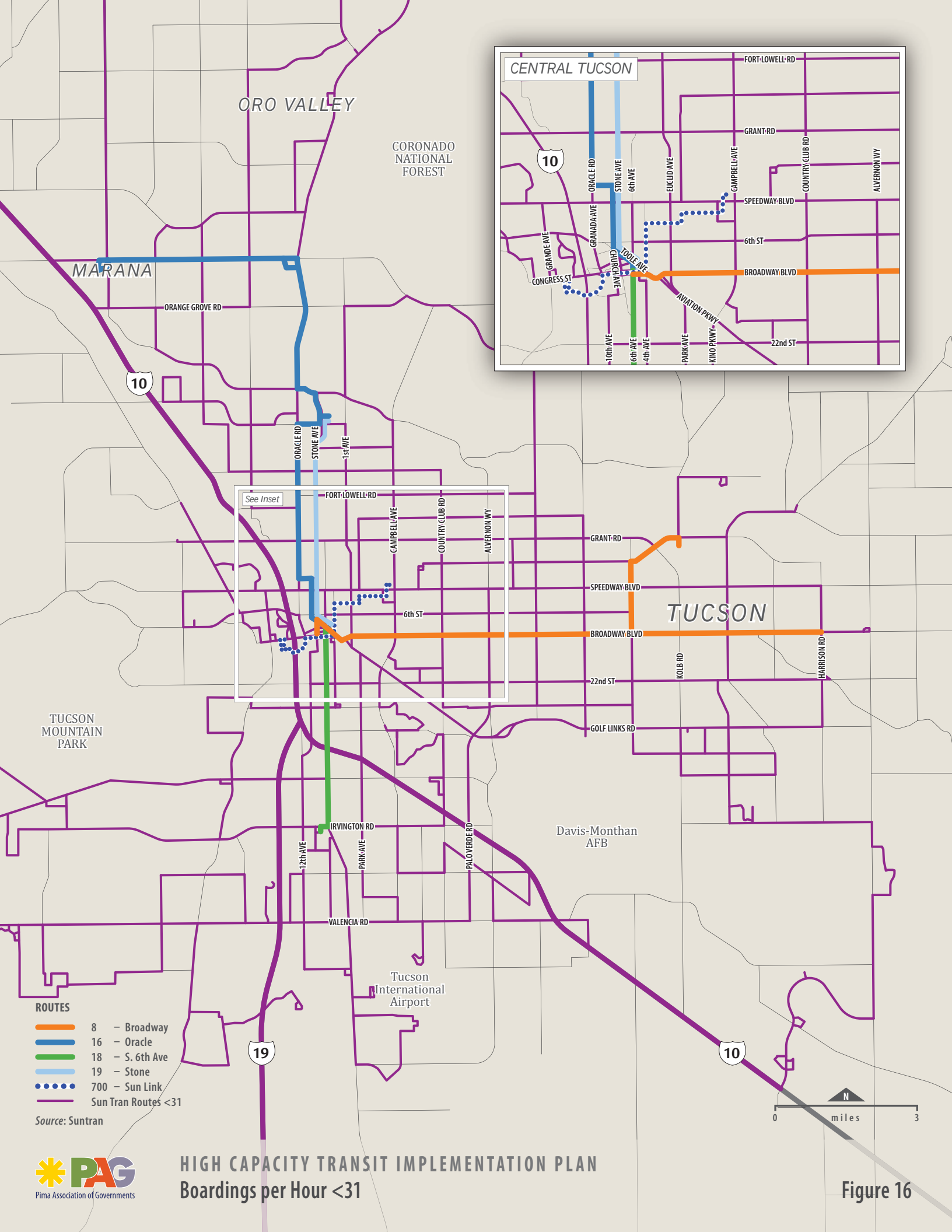
HIGH CAPACITY TRANSIT IMPLEMENTATION PLAN

Boardings per Mile <2.5

Figure 15



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HIGH CAPACITY TRANSIT IMPLEMENTATION PLAN

Boardings per Hour <31

Figure 16


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101

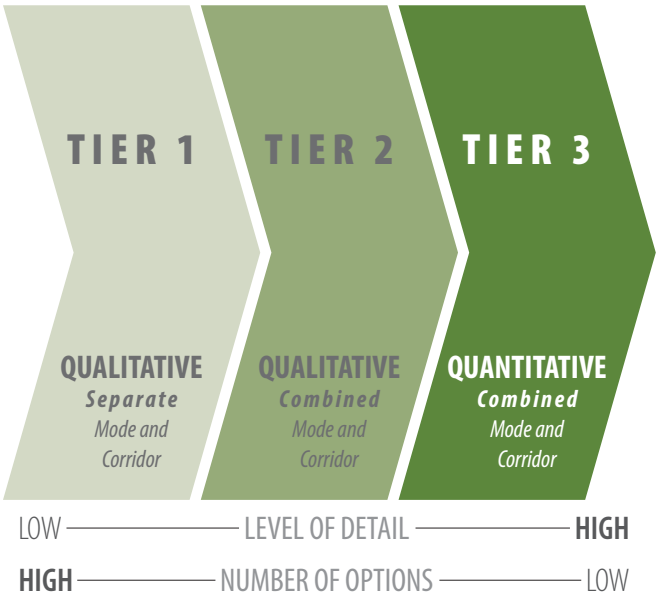
EVALUATION AND IMPLEMENTATION METHODOLOGY

The HCTIP alternatives include modes and corridors. Modes are the potential transit technologies for HCT; corridors are the potential routes for HCT and include both alignment and cross-section considerations.

Evaluation Process

The evaluation process used a three-step evaluation to screen the alternatives. Figure 17 shows the evaluation process.

Figure 17 Tier Evaluation Process



Tier 1 screened the modes and corridors separately using qualitative evaluation criteria and measurements. This was a high-level analysis that allowed the number of modes and corridors being considered to be screened to a manageable number that could be advanced into alternatives that combined modes and corridors.

Tier 2 screened the modes and corridors together using qualitative evaluation criteria and measurements. Examples of qualitative evaluation criteria are order of magnitude capital and operating cost estimates from peer systems. This allowed the number of combined mode and corridor alternatives being considered to be screened to a manageable number that could be advanced to more detailed analysis.

Tier 3 screened the remaining combined mode and corridor alternatives using quantitative evaluation criteria and measurements. Examples of quantitative evaluation are detailed capital and operating cost estimates for each alternative. The result of the Tier 3 screening analysis are the recommended alternatives for the HCTIP.

The evaluation and criteria measurements that were used to evaluate the alternatives in Tier 1, 2, and 3 were rated using symbols for indicating optimal performance, indicating moderate performance, and indicating substandard performance.

EXPRESS BUS	BUS RAPID TRANSIT	RAPID STREETCAR
Peak hour or all-day service	All-day frequent service	All-day frequent service
Commuter type service	High capacity transit service	Urban circulator or high capacity transit service
Operates in mixed traffic or high occupancy vehicle lanes	Operates in mixed traffic or exclusive lanes	Operates in mixed traffic or exclusive lanes
Limited stop spacing	1/2 to 1 mile stop spacing	1/4 to 1 mile stop spacing
High speed	Moderate or high speed	Moderate or high speed
40-60 foot bus	40-60 foot bus	65-90 foot rail vehicle; single car train
40-80 passengers per bus	60-80 passengers per bus	150-225 passengers per rail vehicle
Low floor, 1 or 2 doors	Low floor , multiple doors	Low floor, multiple doors
Diesel, compressed natural gas, or hybrid electric	Diesel, compressed natural gas, hybrid electric, or battery power	Overhead wire or battery power
		Steel wheel on rails (fixed-guideway)

Example: Sun Tran Express (Tucson)

Example: King County Metro RapidRide (Seattle)

Example: Sun Link Streetcar (Tucson)

LIGHT RAIL TRANSIT	COMMUTER RAIL
All-day frequent service	Peak hour or all-day service
High capacity transit service	Commuter type service
Operates in exclusive lanes or separate right-of-way	Operates in separate right-of-way
1/2 to 1 mile stop spacing	Limited stop spacing
Moderate or high speed	High speed
90-120 foot rail vehicle; multiple car train	90 foot bi-level rail vehicle, multiple car train
200-225 passengers per rail vehicle	360 passengers per rail vehicle
Low floor, multiple doors	High floor, multiple doors
Overhead wire or battery power	Diesel or overhead wire
Steel wheel on rails (fixed-guideway)	Steel wheel on rails (fixed-guideway)

Example: Valley Metro Light Rail (Phoenix)

Example: Rio Metro Rail Runner (Albuquerque)

King County Metro RapidRide (Seattle)

TIER 1 EVALUATION

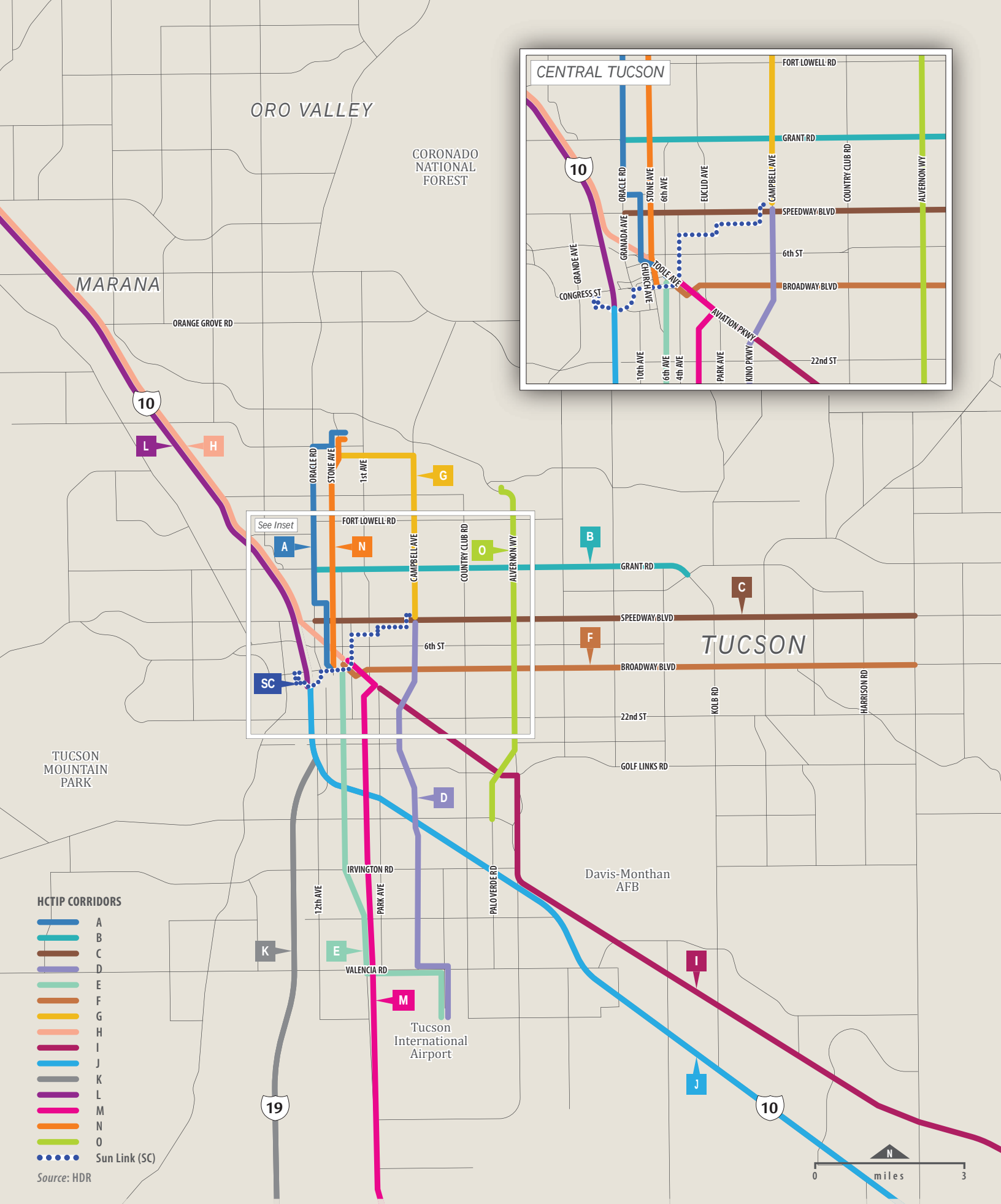
This section includes an overview of the Tier 1 evaluation. Tier 1 screens the modes and corridors separately using qualitative evaluation criteria and measurements.

The Tier 1 evaluation includes four modes.

- Express Bus
- Bus Rapid Transit (BRT)
- Rapid Streetcar/Light Rail Transit (LRT)
- Commuter Rail

The Tier 1 evaluation also includes fifteen corridors (see Figure 18):

- A Oracle
- B Grant
- C Speedway
- D Campbell South
- E 6th Avenue
- F Broadway
- G Campbell North
- H Railroad Northwest
- I Railroad Southeast
- J I-10 Southeast
- K I-19
- L I-10 Northwest
- M Railroad South
- N Stone
- O Alvernon



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HIGH CAPACITY TRANSIT IMPLEMENTATION PLAN

Tier 1 Alternatives (Corridor)

Figure 18

Tier 1 Evaluation Matrix

The Tier 1 evaluation studied modes and corridors separately. The evaluation matrix includes the evaluation criteria and measurements used and the rating for each alternative. It also includes a summary of the assumptions and a description of the rating.

The Tier 1 alternatives were evaluated relative to each other. For example, the capital costs of each mode were compared. If the order of magnitude capital cost for one alternative was substantially higher than another, then that alternative received a higher rating. Alternatives that had similar characteristics were given the same rating. The same evaluation methodology was applied to all of the evaluation criteria and measurements.

The Tier 1 evaluation matrix is shown in Table 3.

King County Metro RapidRide (Seattle)

Table 3 Tier 1 Evaluation Matrix

	Mode ▶	Express Bus	BRT	Streetcar/LRT	Commuter Rail
Evaluation Criteria	**Measure**	**Rating**	**Rating**	**Rating**	**Rating**
Capacity	Passengers per vehicle	⌄⌄	—	—	⌃
Capital Cost	Order of magnitude	⌃	—	—	⌄⌄
Operating Cost	Order of magnitude	—	⌃	⌃	⌄⌄
Ridership	Order of magnitude	⌄⌄	⌃	⌃	—
Right-of-way	Right-of-way required	—	—	—	⌄⌄
	DETERMINATION	**Eliminate**	**Advance**	**Advance**	**Eliminate**

	Corridor ▶	A Oracle	B Grant	C Speedway	D Campbell	E 6th Ave	F Broadway	G Campbell N	H RR NW	I RR SE	J I-10 SE	K 1-19	L I-10 NW	M RR S	N Stone	O Alvernon
Evaluation Criteria	**Measure**	**Rating**	**Rating**	**Rating**	**Rating**	**Rating**	**Rating**	**Rating**	**Rating**	**Rating**	**Rating**	**Rating**	**Rating**	**Rating**	**Rating**	**Rating**
Destinations	Destinations served	⌃	⌄⌄	—	—	⌃	⌃	—	⌄⌄	⌄⌄	⌄⌄	⌄⌄	⌄⌄	⌄⌄	—	—
Capital Cost	Order of magnitude	⌃	⌃	⌃	⌃	⌃	⌃	⌃	⌄⌄	⌄⌄	⌃	⌃	⌃	⌄⌄	⌃	⌃
Operating Cost	Order of magnitude	⌃	—	⌃	—	⌃	⌃	—	⌄⌄	⌄⌄	—	—	—	⌄⌄	⌃	⌃
Ridership	Order of magnitude	⌃	⌄⌄	⌃	⌄⌄	⌃	⌃	⌄⌄	⌄⌄	⌄⌄	⌄⌄	⌄⌄	⌄⌄	⌄⌄	⌃	⌃
Right-of-way	Right-of-way required	—	⌃	—	—	—	⌃	—	⌄⌄	⌄⌄	—	—	—	⌄⌄	—	—
	DETERMINATION	**Advance**	**Advance**	**Advance**	**Advance**	**Advance**	**Advance**	**Advance**	**Eliminate**	**Eliminate**	**Eliminate**	**Eliminate**	**Eliminate**	**Eliminate**	**Advance**	**Advance**

Tier 1 Summary

This section provides a summary of the Tier 1 evaluation results for each evaluation criteria.

MODES

Capacity

Ratings for this criterion were based on passenger capacity per vehicle for each mode. Commuter Rail had an optimal rating because it had the highest passenger capacity per vehicle and assumed bi-level cars (as is standard for commuter rail operations). BRT and Rapid Streetcar/LRT had the next highest passenger capacity per vehicle as they assumed articulated buses and trains. Express Bus had the lowest passenger capacity per vehicle as it assumed a standard 40-foot bus.

Capital Cost

Ratings for this criterion were based on order of magnitude capital cost estimates for each mode using industry standards. Express Bus had an optimal rating because it had the lowest capital cost, while Commuter Rail had a substandard rating since it had the highest capital cost. BRT and Rapid Streetcar/LRT had moderate costs, and the most flexibility to scale the projects accordingly.

Operating Cost

Ratings for this criterion were based on order of magnitude operating cost estimates for each mode using industry standards. BRT and Rapid Streetcar/LRT had optimal ratings because they have the lowest capital cost per passenger. The larger passenger capacity per vehicle is a major advantage for these modes. Express Bus had a moderate rating as it is constrained by the passenger capacity per vehicle and therefore would require additional frequency to carry the same number of people. Commuter Rail rated the lowest as it had the highest operating cost of all the modes.

Ridership

Ratings for this criterion were based on order of magnitude ridership potential for each mode using industry standards. BRT and Rapid Streetcar/LRT had optimal ratings as they have the most potential to meet travel demand in HCT corridors. This includes the ability to carry large numbers of passengers per trip and the ability to operate frequent transit service. Commuter Rail and Express Bus both rated lower as they are traditionally peak hour commuter service and serve a different travel market than HCT corridors.

Right-Of-Way

Ratings for this criterion were based on the potential right-of-way required for each mode. All of the modes require right-of-way in some form, whether it is a dedicated transit lane or right-of-way needed for a stop location. Express Bus, BRT, and Rapid Streetcar/LRT had moderate ratings as each requires some form of right-of-way, but typically offer flexibility in design. Commuter Rail rated the lowest as it requires dedicated right-of-way that is often controlled by existing railroads.

CORRIDORS

Destinations

Ratings for this criterion were based on destinations served for each corridor. Most of the arterial roadway corridors (A, C, D, E, F, G, N, and O) had optimal ratings as they provide direct access to key regional destinations. Most of the remaining corridors had substandard ratings as many of the freeways and railroads miss key regional destinations or require substantial deviations.

Capital Cost

Ratings for this criterion were based on order of magnitude capital costs for each corridor. All of the arterial and freeway corridors (A, B, C, D, E, F, G, J, K, L, N, and O) had optimal ratings because the capital cost estimates are comparable to industry standards for HCT projects. All of the railroad corridors had substandard ratings as the capital cost required to provide HCT service in an existing active railroad corridor is substantial.

Operating Cost

Ratings for this criterion were based on order of magnitude operating costs for each corridor. All of the arterial and freeway corridors (A, B, C, D, E, F, G, J, K, L, N, and O) had optimal or moderate ratings because the operating cost estimates are comparable to industry standards for HCT projects. Similar to capital cost, all of the railroad corridors had substandard ratings as the operating cost required to provide HCT service in an existing active railroad corridor is substantial.

Ridership

Ratings for this criterion were based on order of magnitude ridership potential for each corridor. Several corridors (A, C, E, F, N, and O) received optimal ratings based on a review of existing transit performance and their potential to meet travel demand using HCT modes. This includes corridors that are part of the frequent transit network.

Right-Of-Way

Ratings for this criterion were based on the potential right-of-way required for each corridor. All of the arterial and freeway corridors (A, B, C, D, E, F, G, J, K, L, N, and O) had optimal or moderate ratings because there is available right-of-way to provide HCT service. All of the railroad corridors had substandard ratings since the right-of-way is controlled by an existing active railroad.

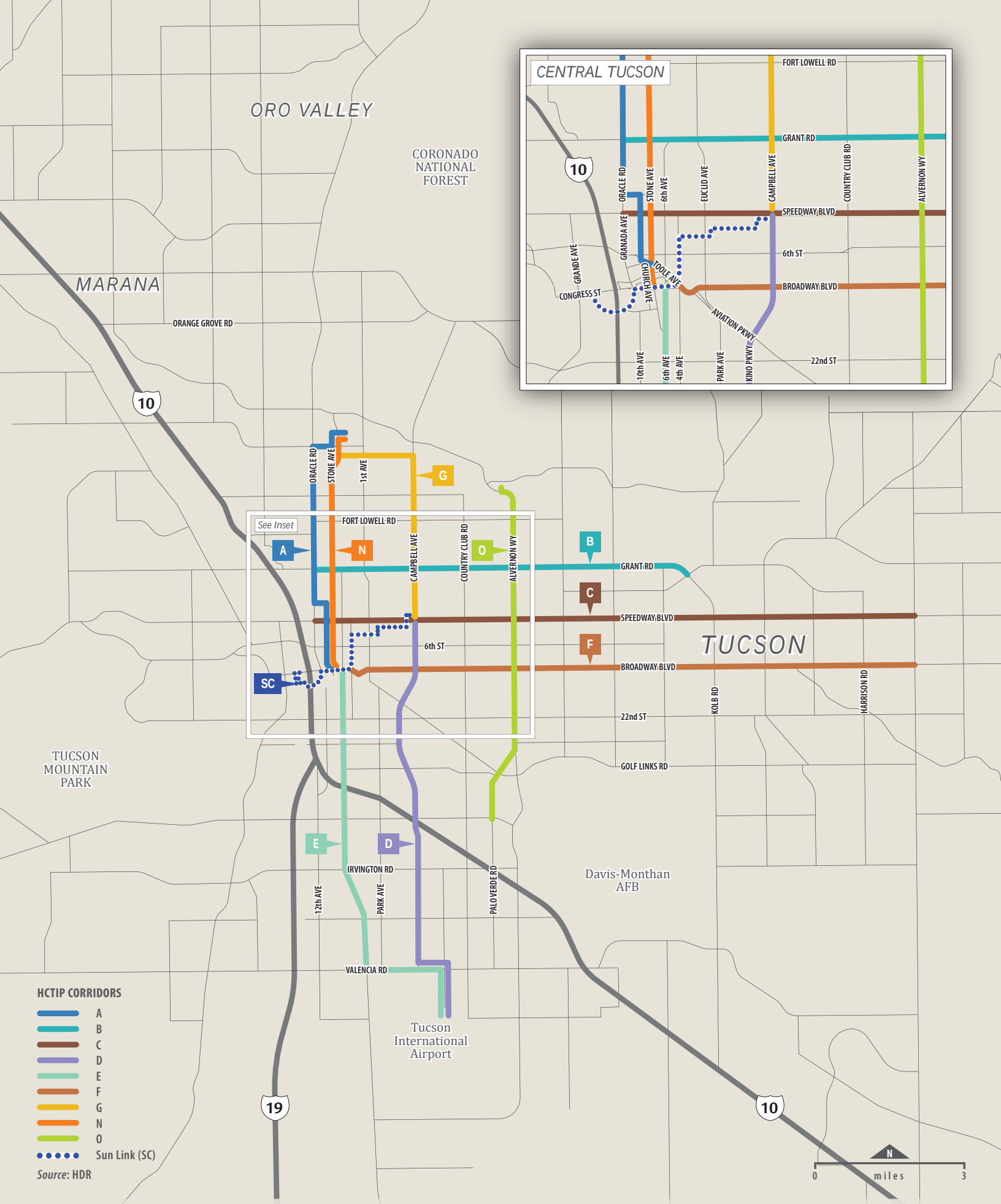
Tier 1 Evaluation Results

The following modes were advanced to Tier 2:

- BRT
- Rapid Streetcar/LRT

The following corridors were advanced to Tier 2 (see Figure 19):

- A Oracle
- B Grant
- C Speedway
- D Campbell South
- E 6th Avenue
- F Broadway
- G Campbell North
- N Stone
- O Alvernon



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HIGH CAPACITY TRANSIT IMPLEMENTATION PLAN

Tier 1 Evaluation Results (Corridor)

Figure 19

TIER 2 EVALUATION

This section includes an overview of the Tier 2 evaluation. Tier 2 screens the modes and corridors together using qualitative evaluation criteria and measurements.

The modes and corridors that advanced from Tier 1 were refined into combined mode and corridor alternatives. The combined alternatives were renumbered as some corridors include multiple alternatives.

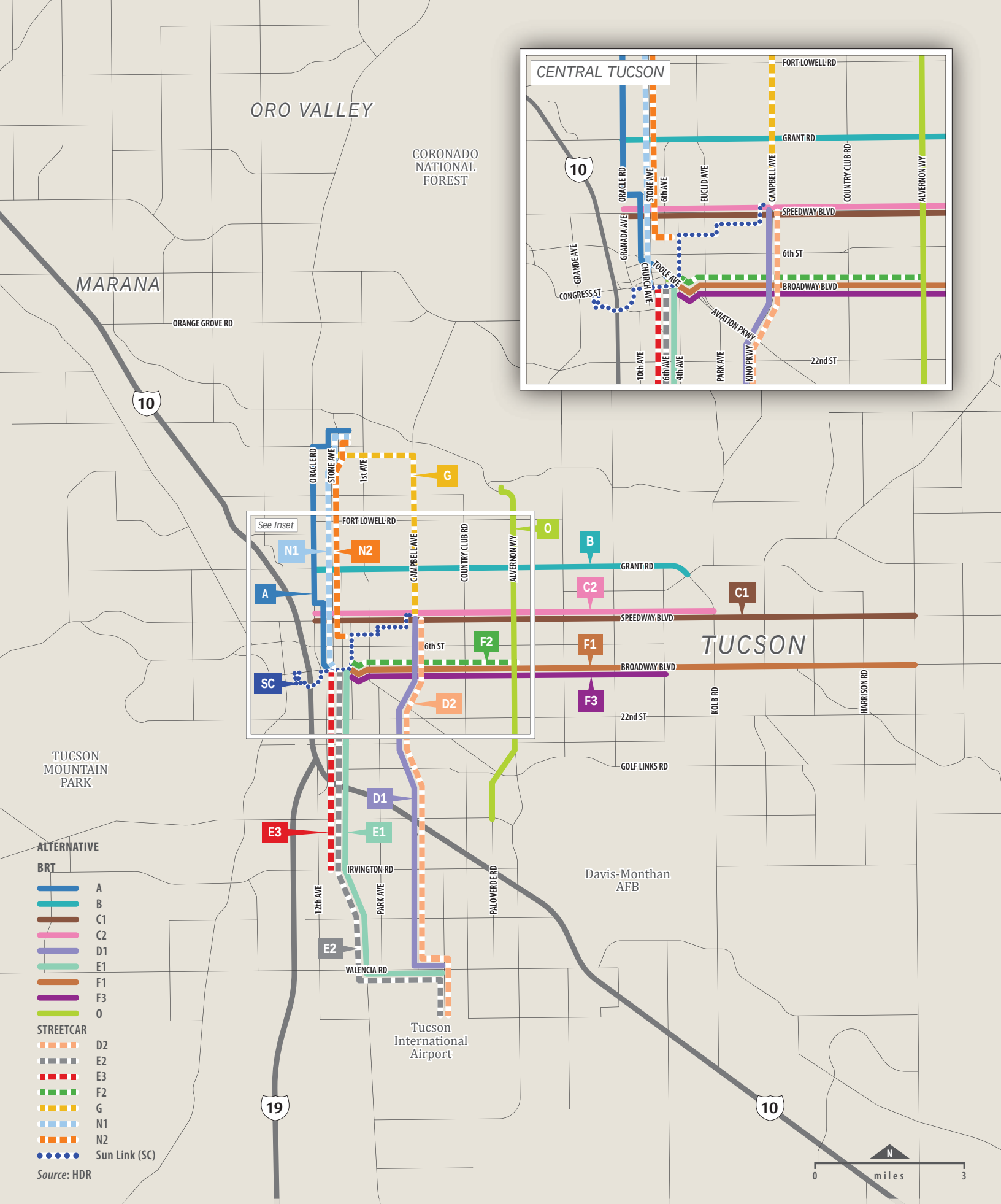
The Tier 2 evaluation includes fourteen alternatives (see Figure 20).

BRT

- » A Oracle
- » B Grant
- » C Speedway
- » D1 Campbell South
- » E1 6th Ave to Airport
- » F1 Broadway to Houghton
- » F3 Broadway to Wilmot
- » O Alvernon

RAPID STREETCAR/LRT

- » D2 Campbell South
- » E2 6th Ave to Airport
- » E3 6th Ave to Irvington
- » F2 Broadway to Alvernon
- » G Campbell North
- » N Stone



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HIGH CAPACITY TRANSIT IMPLEMENTATION PLAN

Tier 2 Alternatives (Combined Mode and Corridor)

Figure 20

Tier 2 Evaluation Matrix

The Tier 2 evaluation studied modes and corridors together. The evaluation matrix includes the evaluation criteria and measurements used and the rating for each alternative. It also includes a summary of the assumptions and a description of the rating.

The Tier 2 alternatives were evaluated relative to each other, first against the combined alternatives with the same mode, then against the combined alternatives that had a different mode. For example, the capital cost of each mode was compared. The capital cost for BRT alternatives was first compared to the other BRT alternatives, then to the Rapid Streetcar/LRT alternatives. Likewise, the capital cost for Rapid Streetcar/LRT alternatives was first compared to the other Rapid Streetcar/LRT alternatives, then to the BRT alternatives. This two stage comparison was done since the unit cost differs substantially for BRT and Rapid Streetcar/LRT. The same evaluation methodology was applied to all of the evaluation criteria and measurements.

The Tier 2 evaluation matrix is shown in Table 4.

Table 4 Tier 2 Evaluation Matrix

Evaluation Criteria	Measure	Assumptions: BRT	Assumptions: Streetcar/LRT	A		B		C1		C2		D1		D2		E1		E2		E3		F1		F2		F3		G		N1		N2		O	
			Mode ▶	BRT		BRT		BRT		BRT		BRT		Streetcar/BRT		BRT		Streetcar/LRT		Streetcar/LRT		BRT		Streetcar/LRT		BRT		Streetcar/LRT		Streetcar/LRT		Streetcar/LRT		BRT	
			Corridor ▶	Oracle		Grant		Speedway to Houghton		Speedway to Kolb		Campbell to Airport		Campbell to Airport		6th Ave to Airport		6th Ave to Airport		6th Ave to Irvington		Broadway to Houghton		Broadway to Alvernon		Broadway to Wilmot		Campbell N		Stone		Stone to 4th Ave		Alvernon	
				5.52 miles		7.58 miles		11.98 miles		7.98 miles		8.53 miles		8.53 miles		8.70 miles		8.70 miles		4.05 miles		11.52 miles		3.50 miles		6.60 miles		5.06 miles		4.95 miles		4.64 miles		7.08 miles	
				Rating	Detail	Rating	Detail	Rating	Detail	Rating	Detail	Rating	Detail	Rating	Detail	Rating	Detail	Rating	Detail	Rating	Detail	Rating	Detail	Rating	Detail	Rating	Detail	Rating	Detail	Rating	Detail	Rating	Detail	Rating	Detail
Transit Speed and Reliability	Transit speed and reliability	Obvious speed and reliability impediments		⊖	Driveways, access control	⊖	Linear distance	⊖	Linear distance	⊖	Linear distance	⊖	Linear distance	⊖	Linear distance	⊖	Linear distance	⊖	Linear distance	⌃	Consistent travel time	⊖	Linear distance	⌃	Broadway widening	⌃	Bus lane between Columbus/ Wilmot	⊖	Driveways, access control	⌃	Consistent travel time	⌃	Consistent travel time	⊖	Linear distance
Capacity	Passengers per hour			⊖	480	⊖	480	⊖	480	⊖	480	⊖	480	⌃	960	⊖	480	⌃	960	⌃	960	⊖	480	⌃	960	⊖	480	⌃	960	⌃	960	⌃	960	⊖	480
	passengers per vehicle	*80*	*160*																																
Destinations	Key destinations served	Downtown, Schools, Malls, Medical, Airport		⌃	Downtown, Tucson Mall	⌄	None	⌃	UA, PCC, UMC	⌃	UA, PCC, UMC	⊖	UA, Airport	⊖	UA, Airport	⌃	Downtown, VA, Airport	⌃	Downtown, VA, Airport	⌃	Downtown, VA	⌃	Downtown, El Con, Park Place	⌃	Downtown, El Con	⌃	Downtown, El Con, Park Place	⊖	UA, UMC	⊖	Downtown, Tucson Mall	⊖	Tucson Mall	⊖	El Con
Capital Cost	Total capital cost			⌃	$138.00 M	⌃	$189.50 M	⊖	$299.50 M	⌃	$199.50 M	⌃	$213.25 M	⌄	$639.75 M	⌃	$217.50 M	⌄	$652.50 M	⌃	$303.75 M	⌃	$288.00 M	⌃	$262.50 M	⌃	$165.00 M	⊖	$379.50 M	⊖	$371.25 M	⊖	$348.00 M	⌃	$177.00 M
	per mile	*$25.0 M*	*$75.0 M*																																
Operating Cost	Annual operating cost			⌃	$1,589,760	⌃	$2,183,040	⊖	$3,450,240	⌃	$2,298,240	⌃	$2,456,640	⌄	$5,527,440	⌃	$2,505,600	⌄	$5,637,600	⌃	$2,624,400	⌃	$3,317,760	⌃	$2,268,000	⌃	$1,900,800	⊖	$3,278,880	⊖	$3,207,600	⊖	$3,006,720	⌃	$2,039,040
	cost per mile	*$8*	*$18*																																
	trips	*120*	*120*																																
	days	*300*	*300*																																
Ridership	Boardings per mile	Does not distinguish between mode		⌃	2.6	⌃	2.6	⊖	1.9	⊖	2.4	⌄	1.4	⌄	1.4	⊖	1.8	⊖	1.8	⌃	2.3	⌄	1.4	⌃	2.2	⊖	1.7	⊖	1.7	⌃	2.4	⌃	2.6	⊖	1.9
Right-of-Way	Right-of-way required	Obvious right-of-way needs (excludes dedicated transit lanes which are applicable to all corridors)		⌃	Stations, queue jumps	⌃	Stations, queue jumps	⌃	Stations, queue jumps	⌃	Stations, queue jumps	⊖	Airport, stations, queue jumps	⊖	Airport, stations, queue jumps, substations, maintenance facility	⊖	Airport, stations, queue jumps	⊖	Airport, stations, queue jumps, substations, maintenance facility	⊖	Airport, stations, queue jumps, substations, maintenance facility	⌃	Stations, queue jumps	⊖	Airport, stations, queue jumps, substations, maintenance facility	⌃	Stations, queue jumps	⊖	Airport, stations, queue jumps, substations, maintenance facility	⊖	Airport, stations, queue jumps, substations, maintenance facility	⊖	Airport, stations, queue jumps, substations, maintenance facility	⌃	Stations, queue jumps
Physical Constraints	Potential conflict with bridges, underpasses, etc.	Obvious physical constraints		⊖	Stone Ave underpass, Downtown Links	⌃	None	⌃	None	⌃	None	⊖	Airport access	⌄	Airport access, bridge structures over Aviation Parkway, 22nd St, and Ajo	⊖	Airport access	⊖	Airport access, I-10 bridge structure	⊖	I-10 bridge structure	⌃	Downtown Links	⌃	Downtown Links	⌃	Downtown Links	⌃	None	⊖	Stone Ave underpass, Downtown Links	⌃	None	⌃	None
Transit Integration	Integration with existing and future transit	Transit centers, Sun Tran routes >4,000 boardings, Sun Link		⌃	RTC, TTTC, 4 Sun Tran routes >4,000 boardings, Sun Link	⊖	1 Sun Tran route >4,000 boardings	⊖	3 Sun Tran routes >4,000 boardings, Sun Link	⊖	3 Sun Tran routes >4,000 boardings, Sun Link	⌄	3 Sun Tran routes >4,000 boardings	⌄	3 Sun Tran routes >4,000 boardings	⌃	RTC, RLTC, 5 Sun Tran routes >4,000 boardings, Sun Link	⌃	RTC, RLTC, 5 Sun Tran routes >4,000 boardings, Sun Link	⌃	RTC, RLTC, 5 Sun Tran routes >4,000 boardings, Sun Link	⌃	RTC, 5 Sun Tran routes >4,000 boardings, Sun Link	⌃	RTC, 5 Sun Tran routes >4,000 boardings, Sun Link	⌃	RTC, 5 Sun Tran routes >4,000 boardings, Sun Link	⊖	TTTC, 2 Sun Tran routes >4,000, Sun Link	⌃	RTC, TTTC, 4 Sun Tran routes >4,000 boardings, Sun Link	⊖	TTTC, 4 Sun Tran routes >4,000 boardings, Sun Link	⊖	2 Sun Tran routes >4,000 boardings
Non-Motorized Access	Ease of bicycle/ pedestrian access	Bicycle boulevards, shared used paths, bikeways		⌃	3rd/Univ bicycle blvd, The Loop, and good bikeway network in Central Tucson	⌃	4th/Fontana bicycle blvd, The Loop, and good bikeway network in Central Tucson	⌃	4th/Fontana bicycle blvd, 3rd/Univ bicycle blvd, The Loop, and good bikeway network in Central Tucson	⌃	4th/Fontana bicycle blvd, 3rd/Univ bicycle blvd, The Loop, and good bikeway network in Central Tucson	⊖	3rd/Univ bicycle blvd, Aviation Path, The Loop, but fewer bike routes south of Aviation Pkwy	⊖	3rd/Univ bicycle blvd, Aviation Path, The Loop, but fewer bike routes south of Aviation Pkwy	⊖	3rd/Univ bicycle blvd, The Loop, but fewer bike routes south of I-10	⊖	3rd/Univ bicycle blvd, The Loop, but fewer bike routes south of I-10	⌃	3rd/Univ bicycle blvd, The Loop, and good bikeway network in Central Tucson	⊖	3rd/Univ bicycle blvd, The Loop, and good bikeway network in Central Tucson, but fewer bike routes east of Wilmot	⌃	3rd/Univ bicycle blvd, and good bikeway network in Central Tucson	⌃	3rd/Univ bicycle blvd, The Loop, and good bikeway network in Central Tucson	⌃	3rd/Univ bicycle blvd, The Loop, and good bikeway network in Central Tucson	⌃	3rd/Univ bicycle blvd, The Loop, and good bikeway network in Central Tucson	⌃	3rd/Univ bicycle blvd, The Loop, and good bikeway network in Central Tucson	⌃	3rd/Univ bicycle blvd, The Loop, and good bikeway network in Central Tucson
Scalable	Ability to be expanded or contracted	Obvious or functional termini locations		⊖	Grant	⌄	None	⊖	Kolb	⊖	Alvernon	⌄	None	⌄	None	⊖	Ajo, Irvington	⊖	Ajo, Irvington	⊖	Airport	⊖	Wilmot	⊖	Wilmot Houghton	⊖	Alvernon	⊖	Grant, Fort Lowell	⊖	Grant	⊖	Grant	⊖	Airport
Roadway Impacts	Vehicular capacity	Traffic congestion (volume over capacity ratio)		⌃	Low V/C ratio	⊖	Medium V/C ratio	⊖	Low/Medium V/C ratio	⊖	Low/Medium V/C ratio	⊖	Low/Medium V/C ratio	⊖	Low/Medium V/C ratio	⌃	Low V/C ratio	⌃	Low V/C ratio	⌃	Low V/C ratio	⊖	Low/Medium V/C ratio	⊖	Low/Medium V/C ratio	⊖	Low/Medium V/C ratio	⊖	Medium V/C ratio	⌃	Low V/C ratio	⌃	Low V/C ratio	⊖	Low/Medium V/C ratio
Land Use/Economic Development	Land use/economic development potential	Streetcar (percentage of frontage developable); BRT (potential number of nodes)		⊖	3-4 nodes	⊖	3-4 nodes	⌄	2 nodes	⌄	2 nodes	⊖	3-4 nodes	⊖	10-20% frontage	⌄	2 nodes	⊖	10-20% frontage	⊖	10-20% frontage	⊖	3-4 nodes	⌃	>20% frontage	⊖	3-4 nodes	⊖	10-20% frontage	⌃	>20% frontage	⌃	>20% frontage	⌄	2 nodes
Environmental Issues	Potential environmental issues	FTA environmental checklist category		⌃	Traffic, resources	⌃	Traffic	⌃	Traffic, resources	⌃	Traffic, resources	⊖	Property acquisition	⊖	Noise and vibration, property acquisition	⊖	Resources, property acquisition	⊖	Noise and vibration, resources, property acquisition	⌄	Noise and vibration, resources, property acquisition	⊖	Traffic, resources	⊖	Traffic, noise and vibration, resources, property acquisition	⊖	Traffic, resources	⊖	Noise and vibration, property acquisition	⊖	Noise and vibration, property acquisition	⊖	Noise and vibration, property acquisition	⊖	Traffic
Funding	Funding potential	Assumes cost and ridership potential are primary factors		⌃	Low cost and high ridership	⌃	Low cost and high ridership	⊖	Medium cost and medium ridership	⌃	Medium cost and high ridership	⊖	Low cost and low ridership	⌄	High capital cost and low ridership	⌃	Low cost and high ridership	⌄	High cost and medium ridership	⌃	Low cost and high ridership	⊖	Low cost and low ridership	⌃	Low cost and high ridership	⊖	Low cost and medium ridership	⌄	High cost and low ridership	⊖	Medium cost and high ridership	⊖	Medium cost and high ridership	⊖	Low capital cost and medium ridership
			DETERMINATION		**Advance**		**Advance**		**Defer**		**Advance**		**Defer**		**Defer**		**Defer**		**Defer**		**Advance**		**Defer**		**Advance**		**Advance**		**Defer**		**Defer**		**Advance**		**Defer**

Tier 2 Summary

This section provides a summary of the Tier 2 evaluation results for each evaluation criteria.

Transit Speed And Reliability

Ratings for this criterion were based on the presence of any obvious transit speed and reliability impediments in project corridors. Corridors with consistent travel time earned optimal ratings while those with impediments such as frequent driveways were assigned moderate or substandard ratings. Among the BRT alternatives, F3 earned an optimal rating due to the existing bus lanes on Broadway Boulevard between Columbus Boulevard and Wilmot Road. Rapid Streetcar/LRT alternatives E3, F2, and N2 earned optimal ratings owing to the consistent travel time in these corridors.

Capacity

Ratings for this criterion were based on the total passengers that could potentially be carried per hour. For the purposes of this evaluation, assumed passenger capacity was 80 for BRT vehicles and 160 for Rapid Streetcar/LRT vehicles. These capacity figures were then applied to the number of trips per hour to determine the total potential passengers per hour. As all of the alternatives assumed the same operating plan (10-minute peak frequency/20-minute off-peak frequency), all Rapid Streetcar/LRT alternatives received optimal ratings because of their greater vehicle capacity and all BRT alternatives earned moderate ratings.

Destinations

Ratings for this criterion were based on the number of key destinations served by each alternative. For the purposes of this evaluation, key destinations included Downtown Tucson, schools, malls, medical facilities, and Tucson International Airport. Among the BRT alternatives, A, C, E1, F1, and F3 served the greatest number of key destinations and thus earned optimal ratings. For the Rapid Streetcar/LRT alternatives, E2, E3, and F2 earned optimal ratings.

Capital Cost

Ratings for this criterion were based on the projected capital cost for each option. Capital cost estimates were developed by applying order-of-magnitude costs per mile to the route length for each option. For BRT alternatives, a cost per mile of $25 million was assumed. For Rapid Streetcar/LRT alternatives, a cost per mile of $75 million was assumed. Although capital costs vary among streetcar and LRT projects, this figure is an approximate average for recently developed systems in North America. Because of the substantially lower cost per mile, most BRT alternatives received optimal ratings. They were A, B, D1, E1, F1, F3 and O. For the Rapid Streetcar/LRT alternatives, E3 and F2 earned optimal ratings.

Operating Cost

Ratings for this criterion were based on the projected operating cost for each option. Operating cost estimates were developed by applying an assumed cost per mile ($8 for BRT alternatives and $18 for Rapid Streetcar/LRT) to the total annual revenue miles for each option. The following base-level operating plan was assumed for each option:

- Service span: 16 hours (4 hour peak/12 hour off-peak)
- Frequency: 10-minute peak, 20-minute off-peak
- Daily trips: 120
- Annual multiplier: 300

Because of the lower operating cost per mile, most BRT alternatives earned optimal ratings. However, Rapid Streetcar/LRT alternatives E3 and F2 also earned optimal ratings, primarily as a product of their relatively short route length.

Ridership

Ratings for this criterion were based on the ridership potential for each alternative. Ridership estimates

were developed using a methodology that uses the demographic characteristics of a corridor to predict potential performance. Essentially, this methodology evaluates the relationship between ridership and certain demographic variables along each existing local bus route in the system, develops system-wide coefficients for each variable, and then applies them to demographic corridor totals for each new service option to develop a daily ridership estimate. Using the assumed operating plan for the new service, an estimated boardings per revenue mile figure is then generated. As this methodology is based entirely on demographic variables, it does not distinguish between modes.

Among the BRT alternatives, A and B were projected to have the highest ridership performance and thus earned optimal ratings. Rapid Streetcar/LRT alternatives E3, F2, and N2 received optimal ratings based on their projected ridership performance.

Right-Of-Way

Ratings for this criterion were based on the obvious right-of-way need for each alternative excluding dedicated transit lanes, which would be applicable to all alternatives. BRT alternatives were generally assumed to require less right-of-way than Rapid Streetcar/LRT alternatives that would require traction power substations and a new maintenance and storage facility. As such, nearly all BRT alternatives received optimal ratings. The exceptions were D1 and E1 which provide service to the airport where right-of-way acquisition may be limited. Because of the greater right-of-way requirements, all Rapid Streetcar/LRT alternatives received moderate ratings.

Physical Constraints

Ratings for this criterion were based on the presence of obvious physical constraints in project corridors such as bridges and underpasses or access to the airport. Most BRT alternatives earned optimal ratings. They were B, C, F1, F3, and O. Among the Rapid Streetcar/LRT alternatives, only F2 and G lacked obvious physical constraints and thus earned optimal ratings.

Transit Integration

Ratings for this criterion were based on the ability of each option to integrate with the existing and future transit network. Alternatives that connected with existing transit centers, high ridership Sun Tran routes (over 4,000 average daily boardings), and Sun Link streetcar earned more favorable ratings than those that provided few connections. Alternatives in the Oracle (A), 6th Avenue (E1, E2, E3), Broadway (F1, F2, F3), and Stone (N) corridors earned optimal ratings for their connections to at least four high ridership Sun Tran routes, Sun Link, and the Ronstadt Transit Center, Tohono Tadai Transit Center, and/or Roy Laos Transit Center.

Non-Motorized Access

Ratings for this criterion were based on the ease of bicycle and pedestrian access and connections to such facilities as bicycle boulevards, shared-use paths, and bikeways. Alternatives that received optimal ratings were BRT alternatives A, B, C, F3, and O, and Rapid Streetcar/LRT alternatives E3, F2, G, and N2. They were given priority for connecting to such facilities as the 3rd Street/University bicycle boulevard, the Loop, and the strong bicycle network in central Tucson.

Scalable

Ratings for this criterion were based on the ability of alternatives to be expanded or contracted to obvious or functional termini locations. Nearly all alternatives received moderate ratings for this criterion, with alternatives in the Grant (B) and Campbell (D1, D2) corridors earning substandard ratings for having no other functional termini locations.

Roadway Impacts

Ratings for this criterion were based on the vehicular capacity of project roadways. Those corridors with low Volume over Capacity (V/C) ratios were awarded higher ratings than those that had higher V/C ratios. Alternatives in the Oracle (A), 6th Avenue (E1, E2, E3), and Stone (N) corridors received optimal ratings for having low V/C ratios and thus fewer anticipated traffic impacts.

Land Use/Economic Development

Ratings for this criterion were based on the land use/economic development potential in project corridors. BRT alternatives were evaluated based on the potential number of activity nodes, while Rapid Streetcar/LRT alternatives were evaluated based on the percentage of frontage that was developable. Rapid Streetcar/LRT alternatives F2 and N2 received optimal ratings for having greater than 20 percentage of developable frontage. All other alternatives earned moderate or substandard ratings.

Environmental Issues

Ratings for this criterion were based on the potential environmental issues in project corridors. Alternatives were evaluated to determine potential issues related to the Federal Transit Administration (FTA) environmental checklist categories. This was only a high-level screening and did not include an environmental impact assessment. BRT alternatives earned optimal ratings for having the fewest issues related to traffic and resources. Streetcar alternatives were anticipated to have impacts related to property acquisition, noise, vibration, traffic, and resources.

Funding

Ratings for this criterion were based on funding potential, assumed cost, and ridership potential. Essentially, alternatives with low cost and high ridership potential earned optimal ratings while those with high cost and low ridership potential earned lower ratings. BRT alternatives A, B, and E1 and Rapid Streetcar/LRT alternatives E3 and F2 earned optimal ratings for having relatively low cost and high ridership potential.

Tier 2 Evaluation Results

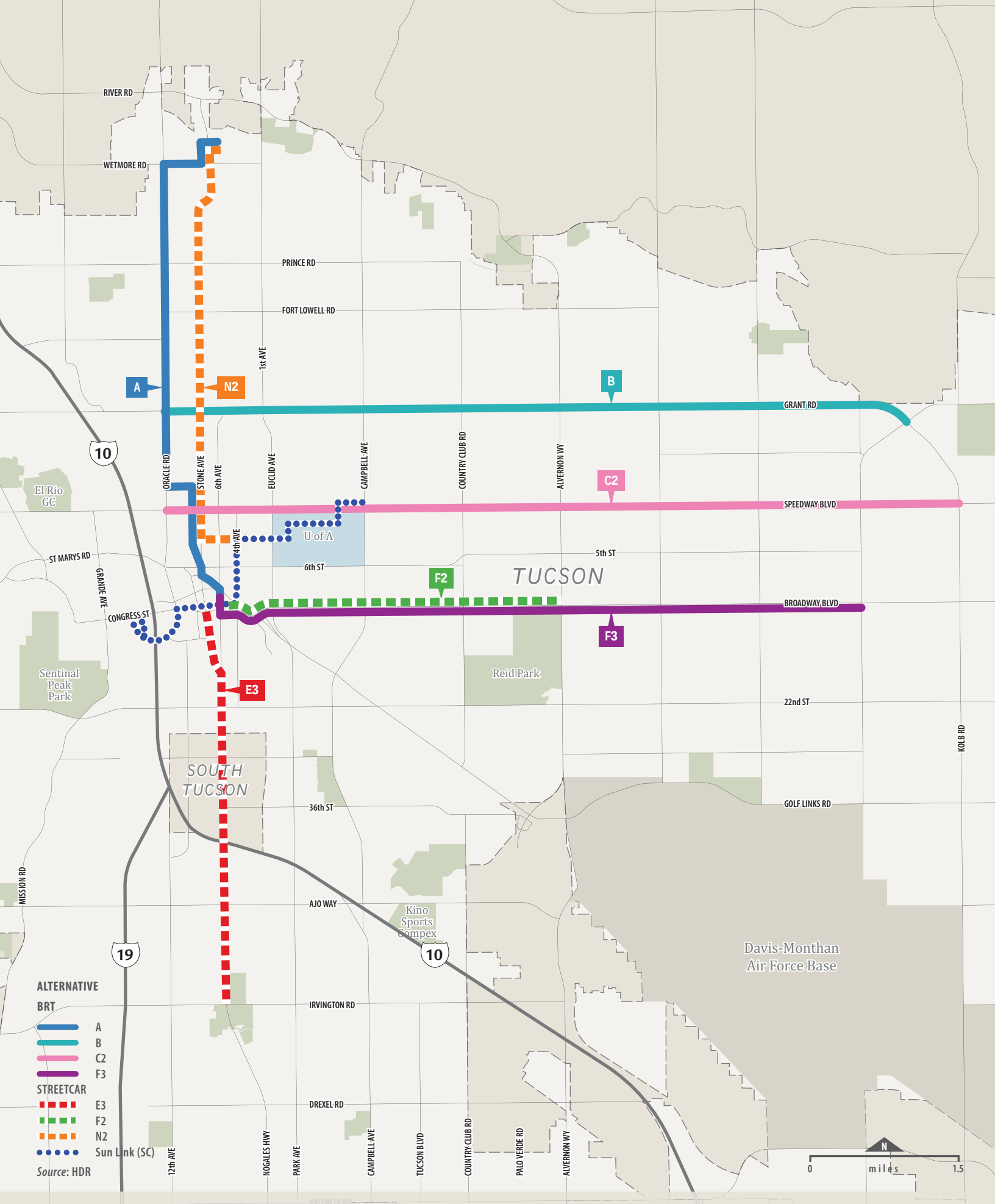
Based on the results of the Tier 2 evaluation, the following alternatives are recommended for advancement to Tier 3 (see Figure 21):

BRT

- A Oracle
- B Grant
- C2 Speedway to Kolb
- F3 Broadway to Wilmot

Rapid Streetcar/LRT

- E3 6th Ave to Irvington
- F2 Broadway to Alvernon
- N2 Stone to 4th Ave



Source: HDR

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HIGH CAPACITY TRANSIT IMPLEMENTATION PLAN

Tier 2 Evaluation Results (Combined Mode and Corridor)

Figure 21

TIER 3 EVALUATION

This section includes an overview of the Tier 3 evaluation which screened the modes and corridors together. The Tier 3 screening was split into two separate analyses: Tier 3A, which applied weighted values to the evaluation criteria to screen the alternatives considered to a manageable number, and Tier 3B, which used quantitative evaluation criteria and weighted values to identify the final recommended alternatives. Each of these analyses are discussed in greater detail in the following sections.

The Tier 3A evaluation included the following seven alternatives advanced from the Tier 2 screening (see Figure 21):

BRT:

- » A Oracle
- » B Grant
- » C2 Speedway to Kolb
- » F3 Broadway to Wilmot

Rapid Streetcar/LRT

- » E3 6th Ave to Irvington
- » F2 Broadway to Alvernon
- » N2 Stone to 4th Ave

Tier 3A Evaluation Matrix

The Tier 3A evaluation used the same evaluation criteria as Tier 2 but applied a weighting system, developed in collaboration with the project team, to prioritize certain criteria over others. For example, ridership potential (weight = 5) was weighted higher than roadway impacts (weight = 2). The weighting system allowed the alternatives considered to be screened to a manageable number.

The Tier 3A evaluation matrix (Table 5) includes the evaluation criteria and measurements, and the weighted score for each alternative. It also includes a summary of the assumptions and a description of the rating.

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Table 5 Tier 3A Evaluation Matrix

				Mode ▶	BRT	BRT	BRT	BRT	BRT	Streetcar/BRT	BRT	Streetcar/LRT	Streetcar/LRT	BRT	Streetcar/LRT	BRT	Streetcar/LRT	Streetcar/LRT	BRT
					A	B	C1	C2	D1	D2	E1	E2	E3	F1	F2	F3	N1	N2	O
				Corridor ▶	Oracle	Grant	Speedway to Houghton	Speedway to Kolb	Campbell to Airport	Campbell to Airport	6th Ave to Airport	6th Ave to Airport	6th Ave to Irvington	Broadway to Houghton	Broadway to Alvernon	Broadway to Wilmot	Stone	Stone to 4th Ave	Alvernon
		Assumptions			5.52 miles	7.58 miles	11.98 miles	7.98 miles	8.53 miles	8.53 miles	8.70 miles	8.70 miles	4.05 miles	11.52 miles	3.50 miles	6.60 miles	4.95 miles	4.64 miles	7.08 miles
Evaluation Criteria	Measure	BRT	Streetcar/ LRT		Rating / Detail	Rating / Detail	Rating / Detail	Rating / Detail	Rating / Detail	Rating / Detail	Rating / Detail	Rating / Detail	Rating / Detail	Rating / Detail	Rating / Detail	Rating / Detail	Rating / Detail	Rating / Detail	Rating / Detail
Transit Speed and Reliability	Transit speed and reliability	Obvious speed and reliability impediments			Driveways, access control	Linear distance	Linear distance	Linear distance	Linear distance	Linear distance	Linear distance	Linear distance	Consistent travel time	Linear distance	Broadway widening	Bus lane between Columbus/ Wilmot	Consistent travel time	Consistent travel time	Linear distance
Capacity	Passengers per hour				480	480	480	480	480	960	480	960	960	480	960	480	960	960	480
	passengers per vehicle	*80*	*160*																
Destinations	Key destinations served	Downtown, Schools, Malls, Medical, Airport			Downtown, Tucson Mall	None	UA, PCC, UMC	UA, PCC, UMC	UA, Airport	UA, Airport	Downtown, VA, Airport	Downtown, VA, Airport	Downtown, VA	Downtown, El Con, Park Place	Downtown, El Con	Downtown, El Con, Park Place	Downtown, Tucson Mall	Tucson Mall	El Con
Capital Cost	Total capital cost				$138.00 M	$189.50 M	$299.50 M	$199.50 M	$213.25 M	$639.75 M	$217.50 M	$652.50 M	$303.75 M	$288.00 M	$262.50 M	$165.00 M	$371.25 M	$348.00 M	$177.00 M
	per mile	*$25.0 M*	*$75.0 M*																
Operating Cost	Annual operating cost				$1,589,760	$2,183,040	$3,450,240	$2,298,240	$2,456,640	$5,527,440	$2,505,600	$5,637,600	$2,624,400	$3,317,760	$2,268,000	$1,900,800	$3,207,600	$3,006,720	$2,039,040
	cost per mile	*$8*	*$18*																
	trips	*120*	*120*																
	days	*300*	*300*																
Ridership	Boardings per mile	Does not distinguish between mode			2.6	2.6	1.9	2.4	1.4	1.4	1.8	1.8	2.3	1.4	2.2	1.7	2.4	2.6	1.9
Right-of-Way	Right-of-way required	Obvious right-of-way needs (excludes dedicated transit lanes which are applicable to all corridors)			Stations, queue jumps	Stations, queue jumps	Stations, queue jumps	Stations, queue jumps	Airport, stations, queue jumps	Airport, stations, queue jumps, substations, maintenance facility	Airport, stations, queue jumps	Airport, stations, queue jumps, substations, maintenance facility	Airport, stations, queue jumps, substations, maintenance facility	Stations, queue jumps	Airport, stations, queue jumps, substations, maintenance facility	Stations, queue jumps	Airport, stations, queue jumps, substations, maintenance facility	Airport, stations, queue jumps, substations, maintenance facility	Stations, queue jumps
Physical Constraints	Potential conflict with bridges, underpasses, etc.	Obvious physical constraints			Stone Ave underpass, Downtown Links	None	None	None	Airport access	Airport access, bridge structures over Aviation Parkway, 22nd St, and Ajo	Airport access	Airport access, I-10 bridge structure	I-10 bridge structure	Downtown Links	Downtown Links	Downtown Links	Stone Ave underpass, Downtown Links	None	None
Transit Integration	Integration with existing and future transit	Transit centers, Sun Tran routes >4,000 boardings, Sun Link			RTC, TTTC, 4 Sun Tran routes >4,000 boardings, Sun Link	1 Sun Tran route >4,000 boardings	3 Sun Tran routes >4,000 boardings, Sun Link	3 Sun Tran routes >4,000 boardings, Sun Link	3 Sun Tran routes >4,000 boardings	3 Sun Tran routes >4,000 boardings	RTC, RLTC, 5 Sun Tran routes >4,000 boardings, Sun Link	RTC, RLTC, 5 Sun Tran routes >4,000 boardings, Sun Link	RTC, RLTC, 5 Sun Tran routes >4,000 boardings, Sun Link	RTC, 5 Sun Tran routes >4,000 boardings, Sun Link	RTC, 5 Sun Tran routes >4,000 boardings, Sun Link	RTC, 5 Sun Tran routes >4,000 boardings, Sun Link	RTC, TTTC, 4 Sun Tran routes >4,000 boardings, Sun Link	TTTC, 4 Sun Tran routes >4,000 boardings, Sun Link	2 Sun Tran routes >4,000 boardings
Non-Motorized Access	Ease of bicycle/ pedestrian access	Bicycle boulevards, shared used paths, bikeways			3rd/Univ bicycle blvd, The Loop, and good bikeway network in Central Tucson	4th/Fontana bicycle blvd, The Loop, and good bikeway network in Central Tucson	4th/Fontana bicycle blvd, 3rd/Univ bicycle blvd, The Loop, and good bikeway network in Central Tucson	4th/Fontana bicycle blvd, 3rd/Univ bicycle blvd, The Loop, and good bikeway network in Central Tucson	3rd/Univ bicycle blvd, Aviation Path, The Loop, but fewer bike routes south of Aviation Pkwy	3rd/Univ bicycle blvd, Aviation Path, The Loop, but fewer bike routes south of Aviation Pkwy	3rd/Univ bicycle blvd, The Loop, but fewer bike routes south of I-10	3rd/Univ bicycle blvd, The Loop, but fewer bike routes south of I-10	3rd/Univ bicycle blvd, The Loop, and good bikeway network in Central Tucson	3rd/Univ bicycle blvd, The Loop, but fewer bike routes east of Wilmot	3rd/Univ bicycle blvd, and good bikeway network in Central Tucson	3rd/Univ bicycle blvd, The Loop, and good bikeway network in Central Tucson	3rd/Univ bicycle blvd, The Loop, and good bikeway network in Central Tucson	3rd/Univ bicycle blvd, The Loop, and good bikeway network in Central Tucson	3rd/Univ bicycle blvd, The Loop, and good bikeway network in Central Tucson
Scalable	Ability to be expanded or contracted	Obvious or functional termini locations			Grant	None	Kolb	Alvernon	None	None	Ajo, Irvington	Ajo, Irvington	Airport	Wilmot	Wilmot Houghton	Alvernon	Grant	Grant	Airport
Roadway Impacts	Vehicular capacity	Traffic congestion (volume over capacity ratio)			Low V/C ratio	Medium V/C ratio	Low/Medium V/C ratio	Low/Medium V/C ratio	Low/Medium V/C ratio	Low/Medium V/C ratio	Low V/C ratio	Low V/C ratio	Low V/C ratio	Low/Medium V/C ratio	Low/Medium V/C ratio	Low/Medium V/C ratio	Low V/C ratio	Low V/C ratio	Low/Medium V/C ratio
Land Use/Economic Development	Land use/economic development potential	Streetcar (percentage of frontage developable); BRT (potential number of nodes)			3-4 nodes	3-4 nodes	2 nodes	2 nodes	3-4 nodes	10-20% frontage	2 nodes	10-20% frontage	10-20% frontage	3-4 nodes	>20% frontage	3-4 nodes	>20% frontage	>20% frontage	2 nodes
Environmental Issues	Potential environmental issues	FTA environmental checklist category			Traffic, resources	Traffic	Traffic, resources	Traffic, resources	Property acquisition	Noise and vibration, property acquisition	Resources, property acquisition	Noise and vibration, resources, property acquisition	Noise and vibration, resources, property acquisition	Traffic, resources	Traffic, noise and vibration, resources, property acquisition	Traffic, resources	Noise and vibration, property acquisition	Noise and vibration, property acquisition	Traffic
Funding	Funding potential	Assumes cost and ridership potential are primary factors			Low cost and high ridership	Low cost and high ridership	Medium cost and medium ridership	Medium cost and high ridership	Low cost and low ridership	High capital cost and low ridership	Low cost and high ridership	High cost and medium ridership	Low cost and high ridership	Low cost and low ridership	Low cost and high ridership	Low cost and medium ridership	Medium cost and high ridership	Medium cost and high ridership	Low capital cost and medium ridership
				DETERMINATION	Advance	Defer	Defer	Advance	Defer	Defer	Defer	Defer	Advance	Defer	Advance	Advance	Defer	Advance	Defer

Tier 3A Summary

Based on the results of the Tier 3A evaluation, one additional alternative was eliminated from further consideration. BRT Alternative B (Grant) was screened out primarily for its moderate or substandard performance on higher-weighted criteria. For example, BRT Alternative B earned a substandard rating for key destinations served, which was a high-weighted criteria. Similarly, it received a moderate rating for transit integration, a criteria that had a weight of 4. As a result, BRT Alternative B's overall weighted score excluded it from further consideration.

Tier 3A Evaluation Results

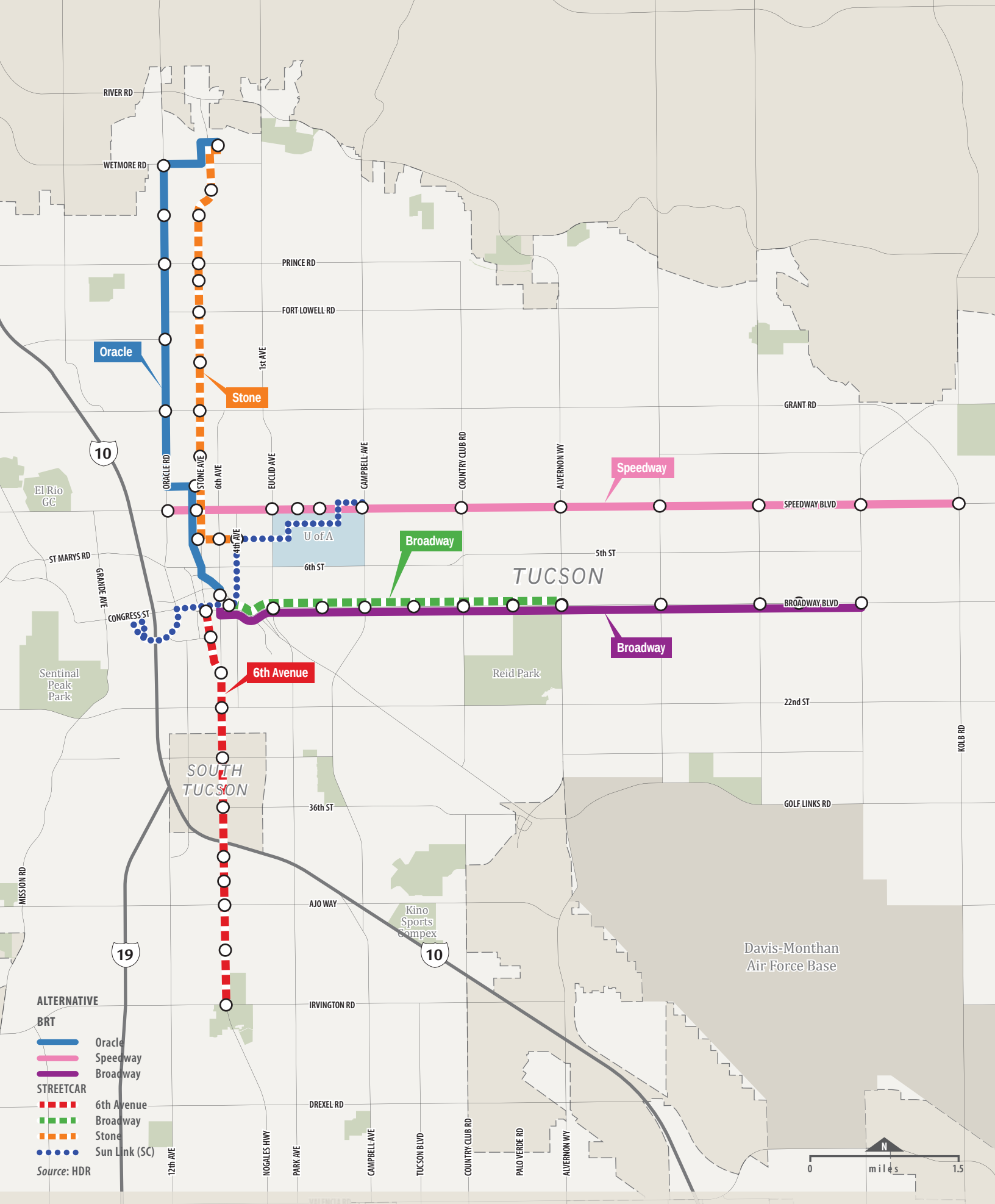
Based on the results of the Tier 3A evaluation, the following alternatives are recommended for advancement to Tier 3B (see Figure 22):

BRT

- » A Oracle
- » C2 Speedway to Kolb
- » F3 Broadway to Wilmot

RAPID STREETCAR/LRT

- » E3 6th Ave to Irvington
- » F2 Broadway to Alvernon
- » N2 Stone to 4th Ave



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HIGH CAPACITY TRANSIT IMPLEMENTATION PLAN

Tier 3B Alternatives (Combined Mode and Corridor)

Figure 22

Tier 3B Evaluation Matrix

The Tier 3B evaluation matrix includes the evaluation criteria and measurements and the rating for each alternative. It also includes a summary of the assumptions and a description of the rating. While the criteria is essentially the same from the previous analyses, the Tier 3B evaluation used more quantitative data and assumptions than in previous evaluations.

For example, the capital cost criterion was based on cost estimates that were generated using the FTA's Standard Cost Categories (SCC) (see category descriptions in box below), whereas previously simplified cost per mile estimates were used for each mode. In addition, the Rapid Streetcar/LRT alternatives were refined to be Streetcar only. This allowed for a more detailed analysis of the costs and technical specifications associated with the fixed-guideway rail alternatives. As in the Tier 3A evaluation, a weighting system was used to prioritize certain criteria over others.

The Tier 3B evaluation matrix is shown in Table 6.

FTA's Standard Cost Categories

SCC 10 – Guideway
This category includes costs associated with the civil and structural costs directly associated with construction of the guideway structures, roadbed, and pavement or track.

SCC 20 – Stations
This category includes costs associated with station platforms, ramps, platform fixtures, canopies, and passenger amenities as well as costs for vertical circulation (elevators and stairs) to the platform, where necessary.

SCC 30 – Support Facilities
Support facilities include the capital cost of operations, maintenance, and storage facilities for the corridor.

SCC 40 – Sitework and Special Conditions
Sitework and special conditions include estimated costs for all other construction activities that are not accounted for in the guideway, stations, support facilities, or systems categories.

SCC 50 – Systems
This category includes capital costs for elements including train control signals, communication systems, central control hardware and software, traction power substations, overhead catenary systems, underground duct banks, automated fare collection, grade crossing protection, and roadway traffic signal systems.

SCC 60 – Right-of-Way
Right-of-way includes costs for acquisition of right-of-way needed for construction and operation of the project.

SCC 70 – Vehicles
Vehicles includes the cost for single LRT vehicles and low-floor, 60-foot articulated BRT buses. Vehicle quantities include a 20 percent spare ratio and were updated based on the most current operating and ridership information. This category also includes an allowance for other service vehicles to support operations and maintenance.

Table 6 Tier 3B Evaluation Matrix

			Mode ▶	BRT		BRT		Streetcar		Streetcar		BRT		Streetcar	
			Corridor ▶	Oracle		Speedway		6th Ave		Broadway		Broadway		Stone	
		Assumptions		6.09 miles		8.02 miles		4.05 miles		3.75 miles		7.12 miles		4.38 miles	
Evaluation Criteria	Measure	BRT	Streetcar/ LRT	Rating	Detail	Rating	Detail	Rating	Detail	Rating	Detail	Rating	Detail	Rating	Detail
Transit Speed and Reliability	Transit speed and reliability	Obvious speed and reliability improvements		⊖	Driveways, access control	⊖	Linear distance	⌃	Consistent travel time	⌃	Broadway widening	⌃	Bus lane between Columbus/Wilmot	⌃	Consistent travel time
Travel Time	Travel time	One-way (minutes)		⌃	22	⌄	32	⌃	16	⊖	14	⊖	26	⌃	19
Capacity	Passengers per hour	*80*	*160*	⊖	480	⊖	480	⌃	960	⌃	960	⊖	480	⌃	960
Destinations	Key destinations served	Downtown, schools, malls, medical, airport		⌃	Downtown, Tucson Mall	⌃	UA, PCC, UMC	⌃	Downtown, VA	⌃	Downtown, El Con	⌃	Downtown, El Con, Park Place	⊖	Tucson Mall
Capital Cost	Total capital cost	FTA Standard Cost Categories (SCC)		⌃	$30.4M	⌃	$39.2M	⊖	$167.4M	⊖	$152.2M	⌃	$34.3M	⌄	$188.4M
Operating Cost	Annual operating cost (per mile)	*$8*	*$18*	⌃	$2.5M	⌃	$3.4M	⊖	$3.7M	⌃	$3.4M	⌃	$2.9M	⊖	$4.0M
Ridership	STOPS ridership estimate	Weekday boardings		⊖	1,149	⊖	1,406	⌃	3,734	⊖	1,554	⊖	1,175	⌃	2,430
Cost/Benefit	(Annualized Capital + Annual Operating)/Ridership	Cost per user		⌃	$3.59	⌃	$3.83	⌃	$3.44	⌄	$7.55	⌃	$4.04	⊖	$5.87
Right-of-Way	Right-of-way required	Specify locations		⌃	Stops	⌃	Stops	⊖	Stops, MSF TPSS	⊖	Stops, MSF TPSS	⌃	Stops	⊖	Stops, MSF TPSS
Physical Constraints	Potential conflict with bridges, underpasses, etc.	Specify locations		⊖	Stone Ave underpass, Downtown Links	⌃	None	⊖	I-10 bridge structure	⊖	Downtown Links	⊖	Downtown Links	⌃	None
Transit Integration	Integration with existing and future transit	Specify locations		⌃	RTC, TTTC, 4 Sun Tran routes >4,000 boardings, Sun Link	⊖	3 Sun Tran routes >4,000 boardings, Sun Link	⌃	RTC, RLTC, 5 Sun Tran routes >4,000 boardings, Sun Link	⌃	RTC, 5 Sun Tran routes >4,000 boardings, Sun Link	⌃	RTC, 5 Sun Tran routes >4,000 boardings, Sun Link	⊖	TTTC, 4 Sun Tran routes >4,000 boardings, Sun Link
Non-Motorized Access	Ease of bicycle/ pedestrian access	Specify locations		⌃	3rd/Univ bicycle blvd, The Loop	⌃	4th/Fontana bicycle blvd, 3rd/ Univ bicycle blvd, The Loop	⌃	3rd/Univ bicycle blvd, The Loop	⌃	3rd/Univ bicycle blvd	⌃	3rd/Univ bicycle blvd, The Loop	⌃	3rd/Univ bicycle blvd, The Loop
Roadway Impacts	Adverse impacts to auto travel	Level of service (LOS)		⌃	Minimal roadway impact	⌄	Segments over capacity	⌃	Minimal roadway impact	⊖	Moderate roadway impact	⊖	Moderate roadway impact	⌃	Minimal roadway impact
Land Use/Economic Development	Land use/economic development potential	Job and household density, proximity to regional housing/ employment centers		⊖	Low density, two regional housing/employment centers	⌄	Low density, one regional housing/employment center	⌄	Low density, one regional housing/employment center	⌄	Low density, one regional housing/employment center	⊖	Low density, four regional housing/employment centers	⌄	Low density, one regional housing/employment center
Environmental Issues	Potential environmental issues	FTA environmental checklist category		⌃	Traffic, resources	⌃	Traffic, resources	⊖	Noise and vibration, resources, property acquisition	⊖	Traffic, noise and vibration, resources, property acquisition	⌃	Traffic, resources	⊖	Noise and vibration, resources, property acquisition
Funding	Funding potential	Overall capital cost and cost/benefit		⌃	Low cost, high cost/benefit	⌃	Low cost, high cost/benefit	⊖	High cost, high cost/benefit	⌄	High cost, high cost/benefit	⌃	Low cost, high cost/benefit	⌄	High cost, low cost/benefit
			DETERMINATION		Advance		Advance		Advance		Advance		Advance		Advance

Operating Plan
10 min peak
20 min off-peak
4 hour peak
12 hour off-peak
300 annual multiplier
120 trips (both directions)

Tier 3B Summary

This section summarizes the Tier 3B evaluation results for each evaluation criteria.

Transit Speed and Reliability

No changes were made to the ratings for this criterion for the remaining alternatives from Tier 2 and Tier 3A. Ratings for this criterion were based on the presence of any obvious transit speed and reliability impediments in project corridors. Corridors with consistent travel time earned optimal ratings while those with impediments such as frequent driveways were assigned moderate or substandard ratings. Among the BRT alternatives, Broadway earned an optimal rating due to the existing bus lanes on Broadway Boulevard between Columbus Boulevard and Wilmot Road. Streetcar alternatives 6th Avenue, Broadway, and Stone earned optimal ratings owing to the consistent travel time in these corridors.

Travel Time

Ratings for this criterion were based on the one-way travel time in minutes for each alternative. The travel time generated for each alternative was also an input into the fleet estimate and ridership analysis. The travel time was typically a function of the linear distance, number of traffic signals, and vehicular delay. Among the BRT and Streetcar alternatives, Oracle, 6th Avenue, and Stone earned optimal ratings.

Capacity

No changes were made to the ratings for this criterion for the remaining alternatives from Tier 2 and Tier 3A. Ratings for this criterion were based on the total passengers that could potentially be transported per hour. For the purposes of this evaluation, assumed passenger capacity was 80 for BRT vehicles and 160 for Streetcar vehicles. These capacity figures were then applied to the number of trips per hour to determine the total potential passengers per hour. As all of the alternatives assumed the same operating plan (10-minute peak frequency/20-minute off-peak frequency), all Streetcar alternatives received optimal ratings because of their greater vehicle capacity and all BRT alternatives earned moderate ratings.

Destinations

No changes were made to the ratings for this criterion for the remaining alternatives from Tier 2 and Tier 3A. Ratings for this criterion were based on the number of key destinations served by each alternative. For the purposes of this evaluation, key destinations included Downtown Tucson, schools, malls, medical facilities, and the Tucson International Airport. Most alternatives (Oracle, Speedway, 6th Avenue, Broadway BRT, and Broadway Streetcar) earned optimal ratings for serving multiple destinations, while alternative Stone received a moderate performance rating for only serving one destination.

Capital Cost

Ratings for this criterion were based on the projected capital cost for each alternative. Capital cost estimates were developed using the FTA's SCC. The capital cost estimate was prepared in current year (2017) dollars. The cost categories include unit costs which vary between BRT and Streetcar. The capital cost estimate also includes contingencies and professional services consistent with SCC format. As capital costs are lower for BRT than Streetcar, all BRT alternatives (Oracle, Speedway, and Broadway) received optimal ratings. However, Streetcar alternative Broadway also earned an optimal rating primarily as a result of its short route length.

Operating Cost

No major changes were made to the ratings for this criterion for the remaining alternatives from Tier 2 and Tier 3A. The linear distance was modified slightly for each alternative based on alignment refinement

with the project team. Ratings for this criterion were based on the projected operating cost for each alternative. Operating cost estimates were developed by applying an assumed cost per mile ($8 for BRT alternatives and $18 for streetcar) to the total annual revenue miles for each alternative. The following base-level operating plan was assumed for each alternative:

- Service span: 16 hours (12 hour peak/4 hour off-peak)
- Frequency: 10-minute peak, 20-minute off-peak
- Daily trips: 168
- Annual multiplier: 300

Because of the lower operating cost per mile, all BRT alternatives earned optimal ratings. However, Streetcar alternative Broadway also earned optimal ratings, primarily as a result of its relatively short route length. Streetcar alternatives 6th Avenue and Stone earned moderate performance ratings.

Ridership

Ratings for this criterion were based on the projected ridership for each alternative. Average daily ridership estimates were generated using the Simplified Trips-on-Project Software (STOPS) model. Developed by FTA, STOPS is a simplified travel model that can be used by project sponsors of New Starts and Small Starts projects to support their grant applications. The results indicate that Streetcar alternative 6th Avenue is projected to have the highest daily ridership and thus it earned an optimal rating. Stone, with the second highest ridership, also earned an optimal rating. The remaining alternatives had substantially lower ridership estimates and received moderate performance ratings.

Cost/Benefit

This criterion was based on the projected cost per user for each alternative. This was determined by adding the annualized capital cost and the annual operating cost and dividing by the average daily ridership estimate. A substantial variance in any of the three inputs (capital cost, operating cost, and/or ridership) can have a large impact on the cost/benefit. Alternative 6th Avenue had the lowest cost per user and thus earned an optimal rating. Alternatives Oracle, Speedway, and Broadway also had relatively low costs per user and earned optimal ratings. The remaining alternatives earned moderate or substandard ratings.

Right-of-Way

No changes were made to the ratings for this criterion for the remaining alternatives from Tier 2 and Tier 3A. Ratings for this criterion were based on the obvious right-of-way need for each alternative excluding dedicated transit lanes, which would be applicable to all alternatives. BRT alternatives were generally assumed to require less right-of-way than Streetcar alternatives that would require traction power substations and a new maintenance and storage facility. As such, all BRT alternatives received optimal ratings while the Streetcar alternatives earned moderating ratings.

Physical Constraints

No changes were made to the ratings for this criterion for the remaining alternatives from Tier 2 and Tier 3A. Ratings for this criterion were based on the presence of any obvious physical constraints in

project corridors such as bridges and underpasses. BRT alternative Speedway and Streetcar alternative Stone were the only alternatives that earned optimal ratings for having no or minimal physical constraints, with the remaining alternatives earning moderate ratings.

Transit Integration

No changes were made to the ratings for this criterion for the remaining alternatives from Tier 2 and Tier 3A. Ratings for this criterion were based on the ability of each alternative to integrate with the existing and future transit network. Alternatives that connected with existing transit centers, high ridership Sun Tran routes (over 4,000 average daily boardings), and Sun Link streetcar earned more favorable ratings than those that provided few connections. Most alternatives (Oracle, 6th Avenue, Broadway BRT, and Broadway Streetcar) earned optimal ratings for having numerous connections to high performing transit routes and transit facilities. However, BRT alternative Speedway and Streetcar alternative Stone earned moderate ratings for connecting to slightly fewer transit routes and facilities.

Non-Motorized Access

No changes were made to the ratings for this criterion for the remaining alternatives from Tier 2 and Tier 3A. Ratings for this criterion were based on the ease of bicycle and pedestrian access and connections to such facilities as bicycle boulevards, shared-use paths, and bikeways. All the alternatives earned optimal ratings for connecting to the 3rd Street/University bicycle boulevard, 4th Street/Fontana bicycle boulevard, the Loop, and to the strong bicycle network in central Tucson.

Roadway Impacts

Ratings for this criterion were based on a Level of Service (LOS) analysis to determine if there are adverse impacts to auto traffic. The corridors were divided into segments based on posted speed, number of through lanes, and median type (divided or undivided). The analysis applies to daily traffic volumes, not peak hour conditions. BRT alternative Oracle and Streetcar alternatives 6th Avenue and Stone earned optimal performance because they had the fewest roadway impacts. However, it should be noted that an ideal segment for HCT is one that operates with some congestion, especially if a dedicated transit lane is provided, as a means to attract ridership.

Land Use/Economic Development

Ratings for this criterion were based on the land use/economic development potential in project corridors. This was based on job and household density as well as proximity to regional housing/employment centers. BRT alternatives Oracle and Broadway earned moderate ratings while the remaining alternatives earned low ratings. It should be noted that this methodology was based on existing and planned land use, and does not include potential changes to land use in the corridors that might support transit. Further analysis is required to determine how each alternative would perform if the corridors were "optimized" for transit in terms of land use.

FTA's STOPS Modeling Platform

What is STOPS?

The Federal Transit Administration (FTA) developed the Simplified Trips-on-Project Software (STOPS) as a tool for project sponsors to develop transit ridership forecasts. It is typically used for FTA New Starts and Small Starts projects but can also be used in transit system planning studies such as the PAG HCTIP. STOPS considers travel markets and uses a mode-choice model to predict transit travel patterns and assigns transit trips predicted to use the transit projects in the overall regional transit network.

STOPS uses existing socioeconomic data from the Pima Association of Governments model and adjusts the data as necessary to reflect anticipated development along a corridor. STOPS replaces the traditional coded transit network with standard transit-services data in the General Transit Feed Specification (GTFS) format and the GTFS data can be edited to reflect future changes to the transit network.

According to FTA, "the detailed representation of the transit network along with the mode-choice analysis for individual zone-to-zone travel markets makes STOPS at least as sensitive to alternative lengths, alignments, and combinations of fixed-guideway facilities as the typical regional travel model."

Environmental Issues

No changes were made to the ratings for this criterion for the remaining alternatives from Tier 2 and Tier 3A. Ratings for this criterion were based on the potential environmental issues in the project corridors. Alternatives were evaluated to determine potential issues related to the FTA environmental checklist categories. This was a high level screening only and did not include an environmental impact assessment. BRT alternatives Oracle, Speedway, and Broadway earned optimal ratings for having the fewest issues related to traffic and resources. Streetcar alternatives 6th Avenue, Broadway, and Stone were anticipated to have potential issues related to property acquisition, noise, vibration, traffic, and resources.

Funding

Ratings for this criterion were based on funding potential, assumed capital cost, and cost/benefit. Essentially, alternatives with low cost and high cost/benefit earned optimal ratings while those with high costs and low cost/benefit earned lower ratings. BRT alternatives Oracle, Speedway, and Broadway earned optimal ratings for having relatively low cost and high cost/benefit.

Tier 3B Evaluation Results

Based on the results of the Tier 3B evaluation, all six of the BRT (Oracle, Speedway, and Broadway) and Streetcar (6th Avenue, Broadway, and Stone) alternatives are viable HCT projects. Each of these corridors and modes have different opportunities and constraints, but all have the potential to become prioritized HCT corridors within the regional transportation network.

IMPLEMENTATION APPROACH

The High Capacity Transit Implementation Plan identifies six viable HCT projects. These projects are the result of a tiered evaluation process that refined transit modes and corridors based on evaluation criteria such as socioeconomic data, transit performance, and cost. The HCT corridors include three BRT projects and three Streetcar projects:

Bus Rapid Transit

- Oracle Road: Downtown (Ronstadt Transit Center) to Tucson Mall (Tohono Tadai Transit Center)
- Speedway Boulevard: Main Avenue (Pima Community College) to Kolb Road
- Broadway Boulevard: Downtown (Ronstadt Transit Center) to Wilmot Road

Streetcar

- 6th Avenue: Downtown (Ronstadt Transit Center) to Irvington (Roy Laos Transit Center)
- Broadway Boulevard: Downtown (Ronstadt Transit Center) to Alvernon Road (El Con/ Reid Park)
- Stone Avenue: Fourth Avenue (at University) to Tucson Mall (Tohono Tadai Transit Center)

Each of these BRT and Streetcar projects present unique opportunities and challenges to expand the region's transit options and will require further development and refinement. These projects are not mutually exclusive and can be complementary with each other and to existing transit service.

Further study will be required to develop detailed capital and operating plans, create efficiencies with existing transit service, conduct a thorough analysis of capital and operating costs, develop transit supportive land use, assess development potential, cultivate funding opportunities, and most importantly, support community involvement and participation.

This continued study will make each BRT and Streetcar project more competitive in attracting additional funding partners (local, federal, and private) and provide a road map to guide future transit investment for the Tucson region.

Bus Rapid Transit

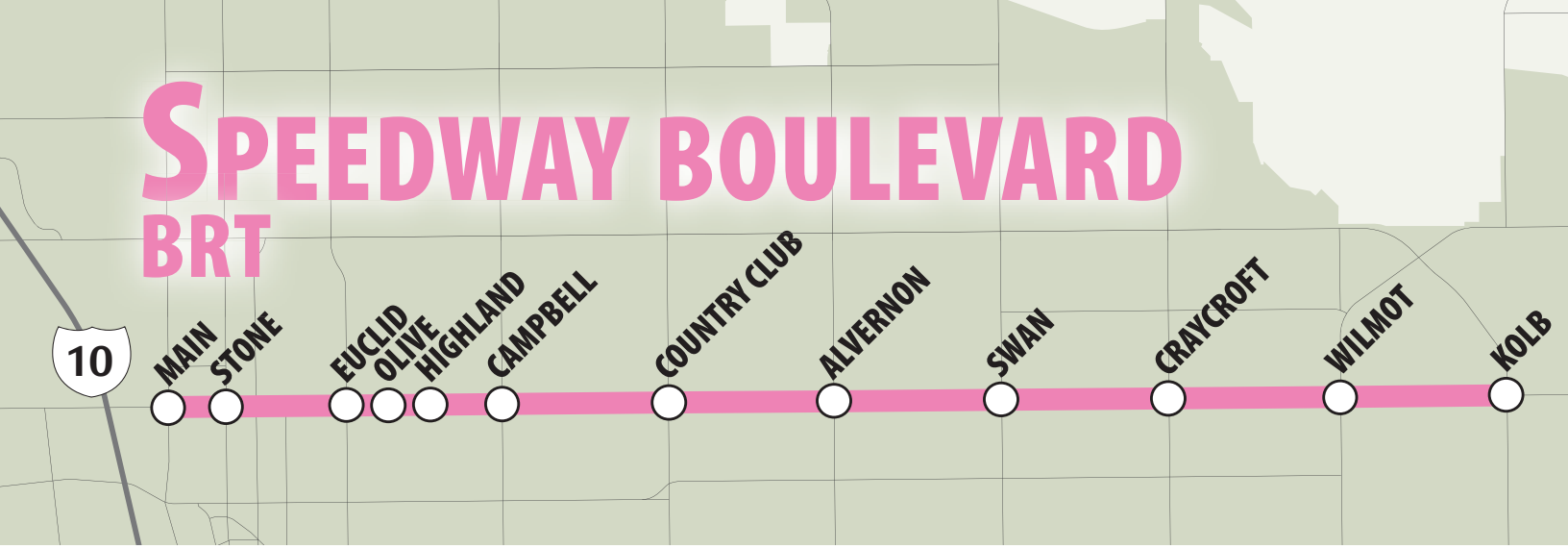
King County Metro RapidRide (Seattle)

ORACLE ROAD
BRT

6.09	miles in length
9	Stops
10/20	Frequency
22	Travel time one way (minutes)
8	Fleet (vehicles)
480	Passengers per hour
$30.4	Capital Cost (millions)
$2.5	Operating Cost (millions per mile)
1,149	Ridership (daily)
$3.59	Cost/Benefit
Stone Ave underpass; Downtown Links	Physical Constraints
LD/2	Land Use/Economic Development*

* LD/# = Low density/number of regional housing/employment centers

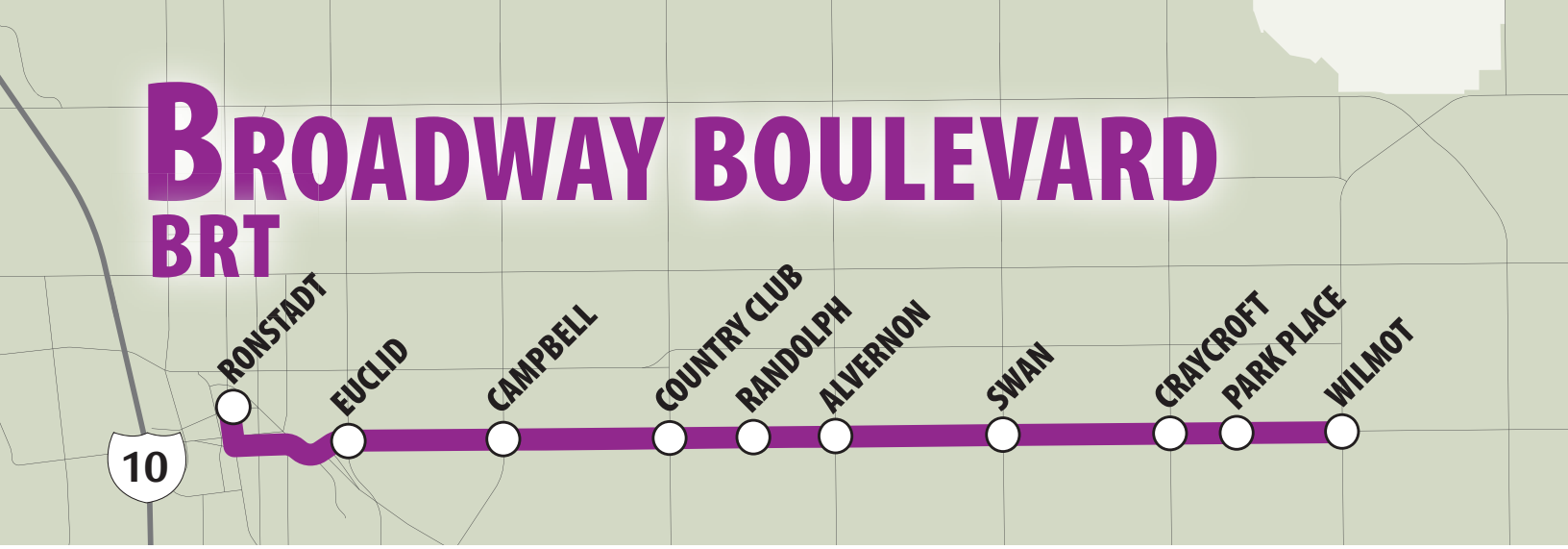
SPEEDWAY BOULEVARD BRT



8.02	miles in length
12	Stops
10/20	Frequency
32	Travel time one way (minutes)
10	Fleet (vehicles)
480	Passengers per hour
$39.2	Capital Cost (millions)
$3.4	Operating Cost (millions per mile)
1,406	Ridership (daily)
$3.83	Cost/Benefit
None	Physical Constraints
LD/2	Land Use/Economic Development*

* LD/# = Low density/number of regional housing/employment centers

BROADWAY BOULEVARD BRT

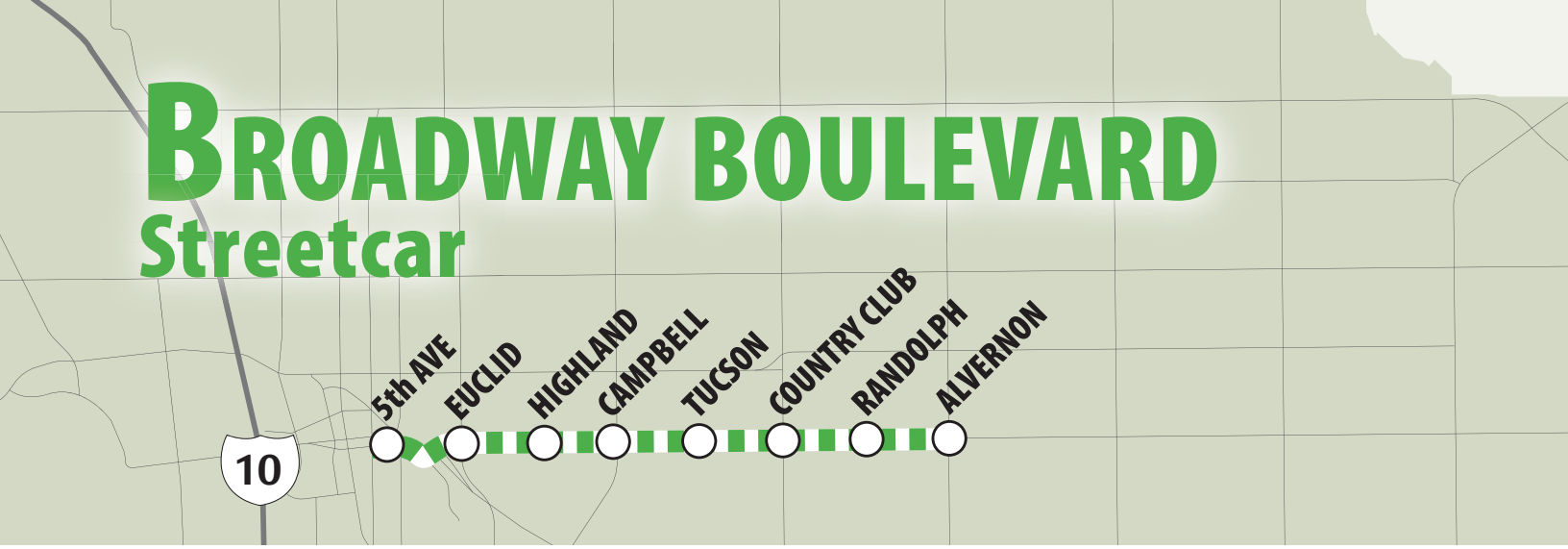


7.12	miles in length
10	Stops
10/20	Frequency
26	Travel time one way (minutes)
9	Fleet (vehicles)
480	Passengers per hour
$34.3	Capital Cost (millions)
$2.9	Operating Cost (millions per mile)
1,175	Ridership (daily)
$4.04	Cost/Benefit
Downtown Links	Physical Constraints
LD/4	Land Use/Economic Development*

* LD/# = Low density/number of regional housing/employment centers

Streetcar

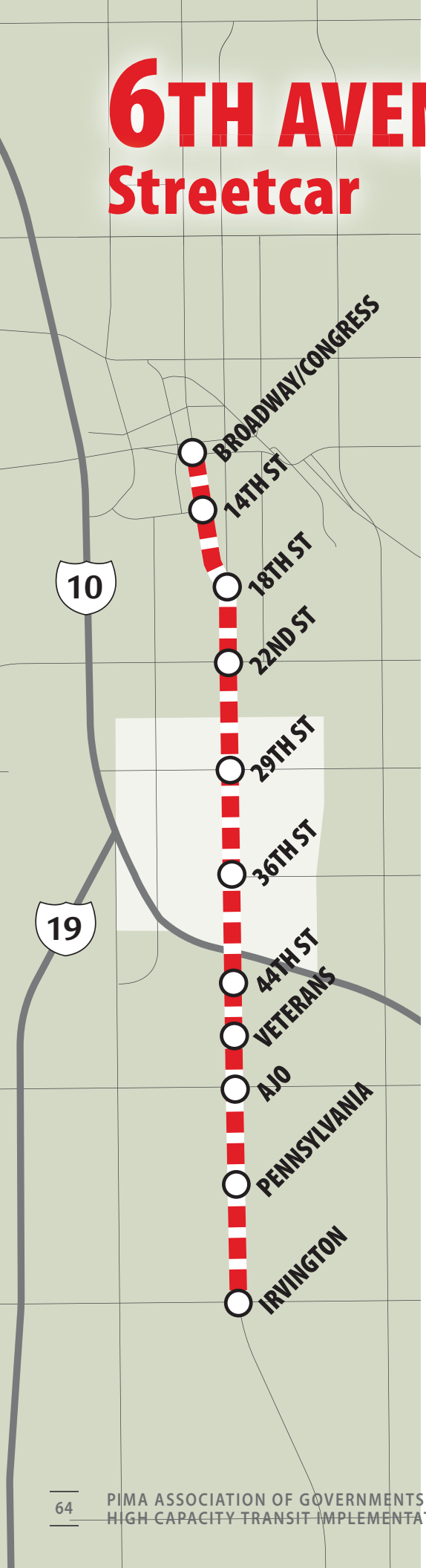
BROADWAY BOULEVARD
Streetcar



3.75	miles in length
8	Stops
10/20	Frequency
14	Travel time one way (minutes)
5	Fleet (vehicles)
960	Passengers per hour
$152.2	Capital Cost (millions)
$3.4	Operating Cost (millions per mile)
1,554	Ridership (daily)
$7.55	Cost/Benefit
Downtown Links	Physical Constraints
LD/1	Land Use/Economic Development*

* LD/# = Low density/number of regional housing/employment centers

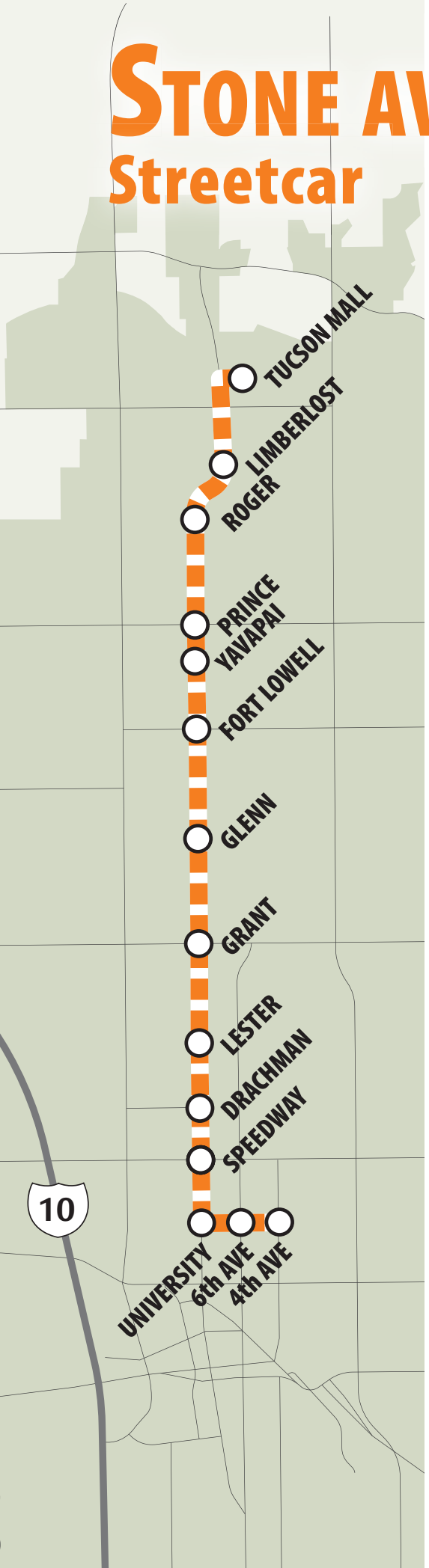
6TH AVENUE Streetcar



4.05	miles in length
11	Stops
10/20	Frequency
16	Travel time one way (minutes)
5	Fleet (vehicles)
960	Passengers per hour
$167.4	Capital Cost (millions)
$3.7	Operating Cost (millions per mile)
3,734	Ridership (daily)
$3.44	Cost/Benefit
I-10 bridge	Physical Constraints
LD/1	Land Use/Economic Development*

* LD/# = Low density/number of regional housing/employment centers

STONE AVENUE
Streetcar



4.38	miles in length
14	Stops
10/20	Frequency
19	Travel time one way (minutes)
6	Fleet (vehicles)
960	Passengers per hour
$188.4	Capital Cost (millions)
$4.0	Operating Cost (millions per mile)
2,430	Ridership (daily)
$5.87	Cost/Benefit
None	Physical Constraints
LD/1	Land Use/Economic Development*

* LD/# = Low density/number of regional housing/employment centers

PIMA ASSOCIATION OF GOVERNMENTS
HIGH CAPACITY TRANSIT IMPLEMENTATION PLAN

Pima Association of Governments