Update and Discussion of Future Broadway Corridor High Capacity Transit Improvements

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Purpose of Presentation

To provide more information to the Broadway Citizens Task Force (CTF) for them to consider in determining how to accommodate HCT on Broadway during development of corridor concepts, including:

- Update the CTF on rough initial Bus Rapid Transit (BRT) modeling results
- Provide BRT design concept and best practices information for consideration during this Broadway segment’s planning & design process
Presentation Outline

• Brief Review of Current Bus Transit Services
• Brief Review of PAG’s High Capacity Transit Plan (HCTP) Recommendations
• Overview of Bus Rapid Transit (BRT) and BRT Elements
• Results from Initial BRT Conceptual Analysis
• Considerations for How to Preserve the Opportunity to Implement Future HCT on Broadway
Brief Review of Current Bus Transit Service
Current Transit on Broadway

• Two Routes
  – Route 8
  – Route 108 Express
Current Transit on Broadway

• Route 8
  – Runs Broadway Blvd. & S. 6th Ave. every 15 mins.; Branches at Broadway & Wilmot, every 30 mins.
  – 161 Bus Stops
  – Highest ridership route in Sun Tran system
  • 3,182,789 million boardings, FY11-12
  • About 55% (1,733,666) boardings along Broadway Blvd.
  • About 9% of total Sun Tran ridership
Current Transit on Broadway

- **Route 108 Express**
  - 3 trips in A.M.,
  - 3 trips in P.M.
  - Limited stops, only 22 in each direction
  - 22,596 boardings, FY11-12
  - Performs at average of Sun Express system
  - The only express route with parallel Sun Tran service along entire route
Brief Review of PAG’s 2009 High Capacity Transit Plan Recommendations
2009 High Capacity Transit Plan

Recommendations

• 2009 Plan completed by Pima Association of Governments

• Provides a financially unconstrained menu of options, to be implemented based on funding availability

  • High Capacity Transit (HCT)
    – High volume of passengers
    – Fast and convenient service

  • Types
    – Express Bus
    – Modern Streetcar
    – Bus Rapid Transit
    – Light Rail
    – Commuter Rail
• 2009 High Capacity Transit System Plan performed initial evaluations and identified priority corridors
  – Sixteen Initial Corridors Identified
  – Eight Selected Corridors for Evaluation:
    • Ridership
    • Right of Way Availability
    • Potential Capital and Operating Costs
  – Two Priority Corridors Identified:
    • Broadway Blvd.
    • 6th Avenue/Nogales Highway
2009 High Capacity Transit Plan
Recommendations

• Identified Broadway Corridor for BRT
  – Favorable future ridership projections
    • 3,887 daily riders (~ 120,497 monthly ridership)
    • In 2011-2012 counts, this would be the 4th highest ridership route in the system
  – Existing bus lanes
  – Planned expansion
  – Relative low cost
  – Conducive to Transit-Oriented Development (TOD)
  – Serves transit-dependant populations
2009 High Capacity Transit Plan Recommendations

“There do not appear to be any constraints to implementing BRT service on Broadway Boulevard in the near term. In fact, the existing transit facilities within this corridor, including dedicated transit lanes and the upcoming transit priority signal timing upgrade, make implementation of BRT relatively straightforward.”

This statement is generally true of Broadway to the east of Alvernon, but within this Broadway: Euclid to Country Club project area, there are challenges.
Major Activity Centers Along Broadway

- University of Arizona
- Downtown
- El Con Mall
- Park Mall
- Williams Centre
Broadway HCT Options

- Bus Rapid Transit in Near Term, 0-10 years
- Streetcar between Downtown and El Con Mall in Mid Term, 10 to 20 Years
- Light Rail in Long Term > 20 years
Overview of Bus Rapid Transit (BRT) and BRT Elements
* Likely overestimates Broadway’s full cost, since much of the Right-of-Way on the corridor is already available.
<table>
<thead>
<tr>
<th>BRT Attribute</th>
<th>Basic Implementation</th>
<th>Intermediate Implementation</th>
<th>Full Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right-of-Way</td>
<td>Mixed Traffic</td>
<td>Designated/HOV/Barrier-Separated Lanes</td>
<td>Exclusive/Grade Separation</td>
</tr>
<tr>
<td>Stations</td>
<td>Improved Passenger Amenities</td>
<td>Enhanced Passenger Information &amp; Fare Collection</td>
<td>Enhanced Loading</td>
</tr>
<tr>
<td>Service</td>
<td>Improved Service Frequency</td>
<td>Skip Stop &amp; Express Service Options</td>
<td>Convenient Transfers</td>
</tr>
<tr>
<td>Route Structure</td>
<td>Single Route with Transfers, Color Coding</td>
<td>Multiple Route Operations with Transfer Facilities Integration with Regional Transit</td>
<td>One Seat Rides Transfer Reduction</td>
</tr>
<tr>
<td>Intelligent Transportation System</td>
<td>Signal Priority</td>
<td>Automated Passenger Information</td>
<td>Vehicle Location and System Surveillance</td>
</tr>
</tbody>
</table>
“Bus Rapid Transit can best be described as a combination of facility, systems, and vehicle investments that convert conventional bus services into a fixed-facility transit service, greatly increasing their efficiency and effectiveness to the end user.”

## BRT Benefits to Passengers

### User Experience
- Reduced transit travel time
- Increased trip reliability
- Improved transit connections and more direct service
- Decreased station stop dwell times and waiting times
- Enhanced system identity
- Increased travel comfort
- Enhanced safety and security

### Broad Benefits
- Capital Cost Effectiveness
- Operating Cost Efficiency
- Transit-supportive land development
- Environmental Quality
BRT Systems

- Started in Curitiba, Brazil in 1974
- Applied worldwide in major urban areas
- 20 systems in the U.S., 1 system rated as silver and 4 bronze by the Institute of Transportation and Development Policy

**U.S. Silver Rated Systems**
- Cleveland, OH

**U.S. Bronze Rated Systems**
- Eugene, OR
- Los Angeles, CA
- Pittsburg, PA
- Las Vegas, NV
BRT Elements

- Running ways
- Stations
- Vehicles
- Fare Collection
- Intelligent Transportation Systems (ITS)
- Service Structure & Relationship to Existing Bus Transit
- Branding
Running Way

• Defines BRT travel parameters
• Most critical component in determining system performance
• Important to public perception and identity
• Characteristics of running ways
  – Running way type
  – Running way markings
  – Running way guidance
Running Way Types

- Grade-Separated
- At-Grade Transitway
- On-Street Bus Lanes
- Mixed Flow

Degree of Segregation vs. Performance
Running Way – Mixed Flow
Running Way – On Street Bus Lane
Running Way – At Grade Separated
Running Way – Grade Separated
Stations

• Level boarding
• Real-time information
  – Arrival time
  – Route maps
  – Schedule
• Enhanced amenities
  – Increased comfort: shade, fare vending, other vending
  – Enhanced safety: lighting, emergency telephones, video cameras
Vehicles

Conventional Standard

Stylized Standard

Conventional Articulated

Stylized Articulated (partial low floor)

Specialized BRT Vehicle (full low floor)
Fare Collection

- On-Board, Driver-Validated System
- On-Board, Conductor-Validated System
- Off-Board Barrier System
- Off-Board, Barrier-Free, or Proof-of-Payment (POP) System
- Fare Medium
  - Cash
  - Magnetic Card
  - Smartcard
Intelligent Transportation Systems (ITS)

• Transit Vehicle Prioritization
• Intelligent Vehicle Systems
• Operations Management Systems
• Passenger Information Systems
• Safety and and Security Systems
Service Structure & Relationship to Existing Bus Transit

- Route Length
- Route Structure
- Service Span
- Service Frequency
- Station Spacing
- Methods of Schedule Control
Branding

• Provides system identity
• Creates impression of high quality
• Helps boost ridership
Results from Initial BRT Conceptual Analysis
PAG Initial BRT Alternatives Analysis

• “Sketch level” analysis provides very rough information; helps to guide focus of next level of analysis

• Coordinated by Pima Association of Governments (PAG) staff, in conjunction with the PAG Transit Working Group

• Performed as part of a partnership between PAG and University of Arizona

• To evaluate potential time savings of BRT and impact on existing traffic
BRT Study Area

11-mile corridor
BRT Initial Alternatives Analysis Modeling

• Model Inputs
  – Overall lane configuration:
    • Indirect left turns assumed at every intersection
    • Hybrid & Outside-running lane model:
      – Includes center-running lane in project area (Euclid-C. Club)
      – Reintegrate with outside-running traffic lanes from C. Club to Columbus
      – Diamond Lanes between Columbus and Camino Seco
      – Back to mixed traffic between Camino Seco and Houghton
BRT Initial Alternatives Analysis Modeling

• Model Inputs
  – 12 stops in each direction (approx. every 1 - 1½ miles)
    • 2 stops in project area: Euclid and Campbell; next stop El Con Mall
  – Interaction with other traffic
    • Center-running only interact with traffic at intersections (possible conflicts if traffic backs up in indirect cue lane as buses would need to wait until vehicles clear)
    • No bus pullouts
  – Bus operation frequency
PAG Initial BRT Alternatives Analysis

Alternatives Reviewed

1: Center Running Dedicated Lanes
   • Buses given signal priority and vehicle left-turns limited to major intersections

2: Outside Lane Mixed Traffic
   • Vehicles operate in diamond lanes or mixed traffic
   • Some use of BRT elements

3: Hybrid Center Lane and Outside Lane/Mixed Traffic
   • Dedicated median running way along Broadway Euclid to Country Club expansion
   • After Country Club, reintegrate with traffic and travel in diamond lanes to Columbus, travel in diamond lanes from Columbus to Camino Seco, then back to mixed to Houghton
PAG Initial BRT Alternatives Analysis

Alternative 1

Center Running Dedicated Lanes
Buses given signal priority and vehicle left-turns limited to major intersections

Image credit: San Francisco County Transportation Authority
Outside Lane Mixed Traffic
Vehicles operate in diamond lanes or mixed traffic; Some use of BRT elements
Hybrid Center Lane and Outside Lane/Mixed Traffic

- Dedicated median running way along Broadway Euclid to Country Club expansion
- After Country Club, reintegrate with traffic and travel in diamond lanes to Columbus, travel in diamond lanes from Columbus to Camino Seco, then back to mixed to Houghton
# PAG Initial BRT Alternatives Analysis

## BRT Alternatives Descriptions

<table>
<thead>
<tr>
<th>BRT Element</th>
<th>Alternative 1 Dedicated Center</th>
<th>Alternative 2 Outside Busway</th>
<th>Alternative 3 Mixed Center/Outside</th>
</tr>
</thead>
<tbody>
<tr>
<td>Running Way</td>
<td>Dedicated Center</td>
<td>On-street Bus/Shared Turning</td>
<td>Mix Alt 1/Alt 2</td>
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<tr>
<td>Stations</td>
<td>Level Boarding/Real Time Info</td>
<td>Unique Bus Shelter</td>
<td>Mix Alt 1/Alt 2</td>
</tr>
<tr>
<td>Vehicles</td>
<td>Specialized BRT</td>
<td>Specialized Articulated</td>
<td>Specialized BRT</td>
</tr>
<tr>
<td>Fare Collection</td>
<td>Off-Board, Smart Card</td>
<td>On-Board, Smart Card</td>
<td>Mix Alt 1/Alt2</td>
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<tr>
<td>Intelligent Transportation System (ITS)</td>
<td>Transit Priority/Cue Jump</td>
<td>None</td>
<td>Transit Priority/Cue Jump</td>
</tr>
<tr>
<td>Branding</td>
<td>Unique Branding</td>
<td>Unique Branding</td>
<td>Unique Branding</td>
</tr>
</tbody>
</table>
PAG Initial BRT Alternatives Analysis

Travel Time Comparison

• Modeling assumed one-way trips between Ronstadt TC and Harrison
• Estimated total travel time based on departure time
• Travel times compared between alternatives and against current Route 8
• Route 8 trip times represent Ronstadt to/from Harrison only, no S. 6th or Wilmot legs
## PAG Initial BRT Alternatives Analysis
### 2017 Travel Time Results

<table>
<thead>
<tr>
<th></th>
<th>Alternative 1</th>
<th>Alternative 2</th>
<th>Alternative 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eastbound Total</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation Time</td>
<td>40.9 hours</td>
<td>42 hours</td>
<td>41.1 hours</td>
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<tr>
<td><strong>Annual Cost</strong></td>
<td>$1,200,442</td>
<td>$1,231,736</td>
<td>$1,206,799</td>
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<tr>
<td><strong>Westbound Total</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation Time</td>
<td>43.1 hours</td>
<td>44.6 hours</td>
<td>44 hours</td>
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<tr>
<td><strong>Annual Cost</strong></td>
<td>$1,265,476</td>
<td>$1,308,995</td>
<td>$1,289,925</td>
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<tr>
<td><strong>Total</strong></td>
<td>84.1 hours</td>
<td>86.6 hours</td>
<td>85.1 hours</td>
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<td><strong>Total Annual Cost</strong></td>
<td>$2,465,918</td>
<td>$2,540,731</td>
<td>$2,496,723</td>
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</tbody>
</table>

- Difference between alt 1 and 2 is enough to save 1-2 trips each way, saving a vehicle.
- Westbound travel time is affected by back-up in Michigan left turn (indirect left) cue lanes.
BRT Alternative Lanes Vehicle Travel Times vs. Route 8

Eastbound Travel Times

Minutes

Westbound Travel Times

Minutes
# BRT vs. Rt. 8 Travel Time Comparison

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Route 8 corridor trip</td>
<td>45 minutes</td>
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<tr>
<td>BRT corridor trip</td>
<td>31 minutes</td>
</tr>
<tr>
<td>BRT savings over Rt. 8</td>
<td>14 minutes</td>
</tr>
<tr>
<td>BRT savings per mile</td>
<td>1.2 minutes per mile</td>
</tr>
</tbody>
</table>

*All calculations represent average trip times over total 11-mile corridor length*
Summary of Results

• Broadway continues to lead the region with highest ridership counts
• 2009 projected ridership for Broadway HCT would make Broadway BRT the 4th highest ridership, if compared to 2011-2012 system ridership counts
• Initial analysis focused on travel time to try to identify the type of running way that would work best on Broadway
  – Modeling indicates that separated/dedicated running ways provide the most significant savings
  – Hybrid model is an improvement over outside-running only lanes
Considerations for How to Preserve the Opportunity to Implement Future HCT on Broadway
Realities of Implementing HCT on Broadway

• Additional planning and analysis required to select a preferred service system (costs money; takes time)

• Funding source(s) need to be identified and committed before HCT can be implemented
  – Federal funds require local match
  – Local funding requires finding funding streams

• Commitment to Operations and Maintenance Costs and responsibilities is needed
Realities of Implementing HCT on Broadway

• Schedule/timing of implementation is uncertain until key decisions made and funding identified

• Current activities are conducive to continued, accelerated BRT planning efforts:
  – Downtown development (and related construction, population, and jobs which has created congestion)
  – Convenient circulation once passengers are downtown, particularly once Streetcar is built
  – Additional population and jobs in other centers along Broadway
  – New Park-N-Ride built at Broadway/Houghton
Design Considerations for Broadway Planning & Design

• Broadway Roadway Project funding does not include money to implement BRT service, but can support facility construction that works today and could accommodate BRT in the future
  – Potential to use as cost match for Federal funding in the future

• RTA Plan includes funding for transit enhancements on Broadway, but not BRT
  – Supports incremental improvements of existing bus service, and potential future BRT
Design Considerations for Broadway Planning & Design

**Bottom Line:**
Allow enough Right-of-Way in improved roadway to accommodate future HCT ("preserve the opportunity")
Design Considerations for Broadway Planning & Design

• Relationship to Existing Local Bus Service
  – BRT would operate at higher frequencies (for example, every 10-15 mins.)
  – Local bus could be reduced in frequency (for example, from every 10-15 mins. to every 30 mins.)
  – With pullouts for local bus service and reduced frequency of local bus service, vehicular flow can continue to move quickly
Design Considerations for Broadway Planning & Design

• Dedicated lanes
  – Center-running performed the best in the initial modeling (with 30% time-savings)
  – Center-running lanes assumed for project area for Hybrid model
  – Removal of traffic lanes in the future could be very challenging
  – Access to roadway’s adjacent properties
    • Center-running limits left turns
    • Outside-running limits right turns into adjacent properties
  – Interaction with traffic mainly occurs at intersections
Design Considerations for Broadway Planning & Design

- Intersection design
  - Indirect left was assumed at all major intersections
  - Center-running lanes
    - No left turns permitted on any section
    - Transit stations built in center median, on far side of intersection
DESIGN INNOVATIONS —
Indirect Left Turn
FASTER • SAFER • GAS SAVING

HOW THE INDIRECT LEFT TURN BENEFITS YOU …

A Shorter Wait at Light
- Reduces the amount of time vehicles are stopped at the intersection by 42%.

More Fuel Savings
- Reduces fuel consumption by approximately 9% for all vehicles using the intersection.

Safer
- Reduces total crashes at intersections by 16% and injury crashes by 30%.

Smaller Intersections
- Smaller intersection means less right-of-way needed, lower costs, and possibility of preserving existing businesses and reduces the distance pedestrians have to cross by 20 feet.

A traffic signal located 600-700 feet east and west of the intersection will stop approaching traffic to allow U-turns into a designated right-turn lane. Drivers then return to the intersection to complete their turn.

These traffic signals are timed with the intersection to limit through traffic to one stop only.

Pedestrians cross safely here. Bicycles use a ‘box turn’ at the intersection.

The ‘bulb out’ allows large vehicles to easily make the U-turn.

The Indirect Left will dramatically increase east-west mobility for vehicles and buses.

The ‘bulb out’ allows U-turns for larger vehicles such as buses and semi-trucks.
Improving East-West Travel

The Indirect Left Turn Intersection Design allows significantly more time to be given to traffic moving east-west along Grant Road.

### Indirect Left Turn Traffic Signal Timing
- North/South Through Traffic: 33%
- North/South Left Turns: 17%
- East/West Through Traffic: 50%

### Traditional Traffic Signal Timing
- North/South Through Traffic: 33%
- North/South Left Turns: 17%
- East/West Left Turns: 17%
- East/West Through Traffic: 33%

The Indirect Left Turn is recommended for seven major intersections along Grant Road:
- Swan Road
- Campbell Avenue
- Oracle Road
- Alvernon Way
- 1st Avenue
- Country Club Road
- Stone Avenue
Design Considerations for Broadway Planning & Design

• Station design
  • Bus pullouts are better for vehicular flow, NOT transit
  • Relationship to existing bus transit stops
  • Platforms
  • Bike lanes
LA Metro Rapid: Incremental BRT

• Simple route layout: easy to find/use
• Frequent: 3-10 minutes during peak
• Fewer stops: ¾ mile apart
• Level boarding (LB buses speed-up dwell times)
• Enhanced stations: maps, lighting, canopies, “Next Bus” displays
• Same fare
• Minimal investment:
  – Signal priority
  – Passenger information
  – Strong branding (buses, stations etc.)

Results after demonstration:
• 23-29% reduction in travel times
• 38-42% increase in riders/weekday
• 1/3 of total choice riders, Same cost

*Cliff Henke, PB TR&S, Inc.*
Next Steps for PAG and COT for Transit Improvements/Enhancements

• Utilize results from Comprehensive Operational Analysis currently underway to identify opportunities for existing enhancements and/or BRT system funding
  – Incremental system enhancements for bus transit overall
  – Potential local funding of incremental BRT implementation

• Pursue initiating an application for the Federal Small Starts Program funding program
  – Alternatives analysis (would look at BRT, Streetcar extension, and Light Rail Transit)
  – Efforts to commence sometime after SunLinks (Streetcar) is operational
Thank you

Questions?