MEMORANDUM

TO: Broadway Boulevard Citizens Task Force
FROM: Broadway Boulevard Project Team
DATE: October 18, 2012
RE: Functionality and Performance Measures in Relation to EPA’s Guide to Sustainable Transportation Measures

OVERVIEW

The definition of “functionality” has become an issue for the Broadway project. RTA has suggested that a roadway configuration that is “functionally equivalent” to that defined in the voter-approved plan may be acceptable. The RTA has also been vague about the definition of functionality, suggesting that they are open for discussion and input in regard to the definition of functionality for the Broadway Boulevard Project. Some stakeholder groups have taken heart in this, suggesting that performance measures beyond simple vehicular level of service (LOS) be considered in the evaluation of alternative corridor development approaches. The planning team has already been undertaking additional analysis, has planned to do more comprehensive analysis of future alternatives, and welcomes this discussion of the functional goals for the project and how performance of the alternatives will be measured.

The document Guide to Sustainable Transportation Performance Measures, U.S. Environmental Protection Agency publication EPA 231-K-10-004; August, 2011 has been referenced as a resource for identifying “out of the box” approaches to be applied in designing the Broadway corridor development; Tucson’s Mayor and Council voted unanimously to direct the Broadway Boulevard CTF to conduct their work under a definition of functionality that allows for consideration of performance measures detailed in the EPA’s “Guide to Sustainable Transportation Performance Measures.” This memorandum summarizes the EPA guide, discusses how it might be applied to Broadway, and suggests potential additional performance measures and metrics that go beyond those recommended in the EPA guide. The majority of the performance measures identified in the EPA guide are focused on transportation function of the improvements, but several of them are focused on non-transportation functions, such as community character, economic development, and physical environmental factors. This memorandum, and the October 18th CTF meeting will focus on transportation performance measures. A later update of this memorandum will add further non-transportation performance measures which are planned to be discussed at a CTF meeting in December.

The EPA guide notes that “many transportation agencies are now being called upon by their stakeholders to plan, build, and operate transportation systems that - in addition to achieving the important goals of mobility and safety for all modes - support a variety of environmental, economic, and social objectives. These include protecting natural resources, improving public health, strengthening energy security, expanding the economy, and providing mobility to disadvantaged people.” (EPA, page 3) In addition, the EPA guide references the growing focus on preservation and enhancement of community character and public health.
Use of Performance Measures at Various Stages of Transportation Planning

EPA's guide describes how sustainable transportation practices and measures can be applied throughout the various stages of planning and implementing a regional transportation system. The stages identified by EPA are shown in Table 1. In some cases these apply at a regional planning level. Land Use Visioning and Long-Range Transportation Plans are examples. Table 1 also indicates "Corridor Studies" as discussed below.

Section 3 -- EPA's Livability-Focused Performance Measures

The EPA guide describes twelve "livability-focused" performance measures that can readily be applied in transportation decision-making, see Table 2. The guide states that this list is not intended to constitute a comprehensive set, nor are each of them necessarily the most appropriate for a particular project or community. However, the list does reflect a range of sustainability issues, and provides a starting point for the Broadway project. The measures can be used to objectively compare project alternatives and ultimately selecting a preferred alternative.

Performance measures used in corridor studies have traditionally focused on congestion reduction and vehicle mobility. While these are clearly important, the EPA guide notes that including measures of environmental, economic, and social equity outcomes can lead to a project that balances the broader needs of a community.

The guide discusses each performance measure including metrics by which it might be measured, relevant analytical methods, and data sources. It also describes how these measures have been previously used by transportation agencies.

Section 4 -- Applicability of Performance Measures to Various Stages of Transportation Planning

The EPA guide does not consider all performance measures to be applicable to all elements of transportation decision-making process. The guide’s applicability of each measure to particular elements of the transportation planning process as summarized in Table 3.
While the EPA Guide identifies three measures as not being applicable to corridor studies, "4 -- Carbon Intensity", "5 -- Mixed Land Uses", and "6 -- Transportation Affordability". The Broadway planning team believes that aspects of the first two of these measures are applicable to the Broadway project, as discussed below.

<table>
<thead>
<tr>
<th>EPA Performance Measure</th>
<th>Land Use Visioning</th>
<th>Long-Range Transportation Planning</th>
<th>Corridor Studies</th>
<th>Programming</th>
<th>Performance Monitoring</th>
<th>Environmental Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 -- Transit Accessibility</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 -- Bicycle/Pedestrian Mode Share</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 -- VMT per Capita</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 -- Carbon Intensity</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 -- Mixed Land Uses</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 -- Transportation Affordability</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 -- Benefits by Income Group</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 -- Land Consumption</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 -- Bicycle/Pedestrian Activity and Safety</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 -- Bicycle/Pedestrian Level of Service</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 -- Average Vehicle Occupancy</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 -- Transit Productivity</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Section 5 -- Discussion of EPA Performance Measures**

The EPA guide discusses each performance measure, explaining what it entails, identifying metrics by which it might be measured, and how those metrics can be improved. It also identifies relevant analytical methods, and data sources. The following table provides a short description of the measures, lists possible metrics identified in the EPA guide, and then lists some additional metrics that the Broadway planning team has identified for potential use in the project. In addition, the table includes some possible additional performance measures that have been identified by the planning team. The table distinguishes which performance measures are primarily related to transportation function and which are related to non-transportation functions or impacts of potential improvements to Broadway Boulevard; non-transportation related performance measures are highlighted in green. In some cases there is also discussion of data or other limitations that restrict the utility of some performance measures and metrics for Broadway; these are highlighted in grey.
<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>EPA Guide Possible Metric</th>
<th>Planning Team Possible Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Possible EPA Guide Transportation Performance Measures</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 1. **Transit Accessibility** - the ability of people to reach destinations using public transportation in a convenient way. (Transportation Measure) | • Amount of population and jobs within walking distance of transit stops.  
• Amount of jobs or services available within a certain travel time for residents.  
• Amount of housing or services available within a certain travel time for workers. | • Transit frequency and dependability.  
• Transit travel time along the corridor. |
| 2. **Bicycle and Pedestrian Mode Share** - the proportion of trips taken by walking or bicycling. (Transportation Measure) | • Proportion of total trips that are walking or bicycling trips - for all trips or work trips only during peak-period or average daily travel.  
• May also include transit trips, depending if exact modes are identifiable by model or a significant number. | • Data and modeling tools are not available to estimate future pedestrian mode share, but it appears that the bicycle mode share that PAG models could be used for the project.  
• For development along Broadway and in adjacent neighborhoods.  
• For total trips along Broadway. |
| 3. **Vehicle Miles Traveled (VMT) per Capita** - measures the amount of vehicle activity normalized to population. (Transportation Measure) *(Not identified as applicable to corridor projects)* | • VMT per capita.  
• Light-duty VMT per capita.  
• VMT per employee. | • For development along Broadway and in adjacent neighborhoods. |
| 4. **Carbon Intensity** - measures CO₂ emissions normalized to population. (Transportation Measure) *(Not identified as applicable to corridor projects)* | • Total transportation CO₂ emissions per capita. | • Total transportation CO₂ emissions per corridor person trip.  
• Total transportation emission of other pollutants per corridor person trip.  
• Total transportation particulate emissions per corridor person trip. |
<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>EPA Guide Possible Metric</th>
<th>Planning Team Possible Metric</th>
</tr>
</thead>
</table>
| 5. **Mixed Land Uses** - measure of the ratio of jobs to housing. (Non-Transportation Measure) *(not identified as applicable to corridor projects)* | • Ratio of jobs to housing at a regional, city, or neighborhood level. | • While measuring the ratio of jobs to housing is relatively unimportant in terms of performance for a corridor segment, the provision of services within walking distance can be a benefit to local residents and jobs.  
• It is not clear that the Broadway project will establish new land use regulations for the area so this measure is not applicable at this point in the process.  
• See 18 - Mixed Use Accessibility. |
| 6. **Transportation Affordability** - measures the cost of transportation relative to income. (Transportation Measure) | • Annual cost of transportation relative to annual income for overall population adjacent to corridor or for those traveling the corridor segment.  
• Alternatively measure annual cost of transportation relative to annual income for different income groups. | • It is difficult to estimate the cost of future trips along Broadway.  
• Could be measured for residents and workers in the study area, but not clear that changes to Broadway would significantly affect their transit costs with the exception of transit improvements that are evaluated through other performance measures. |
| 7. **Benefits by Income Group** - measures benefits for range of income and minority groups. (Transportation and Non-Transportation Measures) | • Performance measures can be analyzed for different population groups to illustrate how decisions will affect disadvantaged communities compared to others. Performance measures that may be appropriate include:  
   o 1 - Transit Accessibility  
   o 3 - Vehicle Miles Traveled  
   o 6 - Transportation Affordability  
   o 18 - Mixed Use Accessibility | • It is difficult to estimate the proportion of future trips along Broadway that are made by people of different income and racial groups.  
• It is not clear that design alternative would change these characteristics with the exception of transit improvements that are evaluated through other performance measures. |
### Performance Measure | EPA Guide Possible Metric | Planning Team Possible Metric
---|---|---
8. **Land Consumption** - measures amount of land consumed by new transportation infrastructure and/or new development served by the infrastructure. (Non-Transportation Measure)  
• Number of lane miles of roadway.  
• *(Majority of metrics are related to greenfield/suburban development, not an urban project like Broadway.)*

| • Square feet or acres of new right-of-way.  
| • Square feet or acres of new paved right-of-way.  
| • Square feet of private land acquired for new right-of-way.  
| • Additional metrics, such as businesses and residences lost will be identified in later memo.

9. **Bicycle and Pedestrian Activity and Safety** - measures bicycle and pedestrian activity and safety in specific locations. (Transportation Measure)  
• Bicycles per day.  
• Pedestrians per day.  
• Bicycle crashes per 1,000 cyclists.  
• Pedestrian crashes per 1,000 pedestrians.  
• *(Difficulty in modeling bicycle and pedestrian trips, no modeling of crashes, and no information is available regarding historic pedestrian and bicycle accidents in this section of Broadway.)*

| • Level of Bicycle and Pedestrian Activity is difficult to model in relationship to benefits of physical infrastructure.  
| • See Measure 10 - Bicycle and Pedestrian Level of Service for potential metrics related to bicycle and pedestrian infrastructure.  
| • Frequency of protected crossings of Broadway.  
| • Travel time across Broadway, considering distance and average delay waiting for signal.

10. **Bicycle and Pedestrian Level of Service** - measures quality of service from the perspective of a bicyclist or pedestrian. (Transportation Measure)  
• Bicycle LOS - safety and comfort from an adult cyclist perspective combined measure of roadway width, bike lane widths and striping combinations, traffic volume, pavement surface conditions, motor vehicle speed and type, and on-street parking.  
• Pedestrian LOS - similar to bicycle LOS, a combined measure of roadway/street width and striping combinations, presence of a sidewalk, presence and spacing of street trees, traffic volumes, motor vehicles speed, and on-street parking.

| • *(Bicycle and Pedestrian LOS combine measurement of physical improvements, traffic conditions and other metrics that are not actually direct trade-offs).*  
| • Measure the individual metrics rather than combine them into one “score” of LOS.  
| • Also see, 18 - Mixed Use Accessibility.

**KEY:**  
- **Non-highlighted** = transportation performance measures recommended for CTF consideration.  
- **Grey** = transportation measures not recommended for CTF consideration, for various reasons.  
- **Green** = Non-transportation performance measures to be discussed at future CTF meetings.
### Performance Measure

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>EPA Guide Possible Metric</th>
<th>Planning Team Possible Metric</th>
</tr>
</thead>
</table>
| **11. Average Vehicle Occupancy** - measures the average number of people per vehicle. (Transportation Measure) | • Average number of occupants per vehicle.  
• Average number of occupants per private vehicle.  
• Can be measured as daily average or as peak-hour average. | • The PAG model’s projection of vehicle occupancy is not sensitive to variations at the scale of the Broadway Boulevard alternatives.  
• See also, 19 - Person Travel Time. |
| **12. Transit Productivity** - measures the average number of people per transit vehicle. (Transportation Measure) | • Average weekday transit boardings per vehicle revenue hour.  
• Average transit boardings per vehicle revenue mile  
• Average annual transit boardings per route mile.  
• Passenger miles traveled per vehicle revenue mile. | • Average number of transit riders per vehicle weekday average.  
• Average number of transit riders per vehicle weekday peak hour average.  
• See also Possible Additional Measure 15 - Transit Level of Service. |

### Possible Additional Measures

<table>
<thead>
<tr>
<th>Possible Additional Measures</th>
<th>Planning Team Possible Metric</th>
</tr>
</thead>
</table>
| **13. Vehicular Intersection Level of Service** - measures average time that vehicles wait at an intersection. (Transportation Measure) | • Intersection LOS is typically measured for the peak traffic level for one hour in the morning and one hour in the afternoon/evening.  
• Alternative Metrics:  
  o Average number of minutes a motorist waits at intersection during the 8 am to 8 pm time period; and during morning and afternoon/evening peak hour.  
  o Average number of minutes a pedestrian waits at an intersection, assuming arrive halfway through signal cycle and including crossing time.  
  o Average number of minutes a bicyclist waits at an intersection, assuming arrive halfway through signal cycle and including crossing time.  
  o Average number of minutes a bus waits at intersection during the 8 am to 8 pm time period; and during morning and afternoon/evening peak hour. |
| **14. Vehicular Corridor Level of Service** - measures average speed of a motorist over a roadway segment. (Transportation Measure) | • Corridor LOS is typically measured for the peak traffic level for one hour in the morning and one hour in the afternoon/evening.  
• Alternative Metrics (note - the following can also be expressed at the ratio of the actual travel time to the free flow travel time):  
  o Average number of minutes it takes a motorist to travel the length of the corridor during the 8 am to 8 pm time period; and during morning and afternoon/evening peak hour.  
  o Average number of minutes it takes a cyclist to travel the length of the corridor during the 8 am to 8 pm time period; and during morning and afternoon/evening peak hour.  
  o Average number of minutes it takes a transit rider to travel the length of the corridor during the 8 am to 8 pm time period; and during morning and afternoon/evening peak hour. |
## Possible Additional Measures

<table>
<thead>
<tr>
<th>Possible Additional Measures</th>
<th>Planning Team Possible Metric</th>
</tr>
</thead>
</table>
| **15. Transit Level of Service** - measures quality of transit service more than roadway design factors. *(Transportation Measure)* | • Transit LOS is typically measured at peak hours or on average for a weekday service period, and includes factors such as: transit vehicles per hour (headway), hours of service per day, vehicle area per passenger and passengers per seat, on-time percentage, headway dependability or adherence, etc.  
• Alternative Metrics:  
  o Report the individual metrics that go into the Transit LOS measure that are most related to roadway design rather than transit service levels (because service levels cannot be directly influenced by the Broadway study), such as: on-time percentage and headway dependability or adherence. |
| **16. Suitability for Future High Capacity Transit** - ability of the street design to accommodate future HCT. *(Transportation Measure)* | • Likely focus on the ability of the street design to accommodate improvements that are being defined through the PAG Broadway BRT Study, such as dedicated lanes and stations, without further right-of-way acquisition. |
| **17. Access Management Improvement** - reduction in the amount of Broadway access points from properties. *(Transportation Measure)* | • Total number of curb cuts on each side of Broadway.  
• Average curb cut spacing on each side of Broadway. |
| **18. Mixed Use Accessibility** - mix of uses within walking, bicycle, or transit accessible distance. *(Transportation Measure)* | • Retail/service use within 10 minute walking, bicycling, or transit distance of a residence along the corridor or within adjacent neighborhoods.  
• Retail/service use within 10 minute walking, bicycling, or transit distance of an employment use along the corridor or within adjacent neighborhoods. |
| **19. Person Travel Time** - measures multimodal travel time. *(Transportation Measure)* | • Average corridor travel time per person for all modes. |