RESILIENT TRANSPORTATION SYSTEMS FOR PLANNED SPECIAL EVENTS (and natural disasters too)

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Transportation and Resiliency: Current Federal Transportation Law

- Requires agencies to take resiliency into consideration during the transportation planning process.

- States and metropolitan planning organizations (MPOs) must consider and implement projects, strategies, and services that “[i]mprove the resiliency and reliability of the transportation system”.

  -- 23 CFR 450.206(a)(9) and 23 CFR 450.306(b)(9))
Why is this important?

- Historically, transportation professionals (and elected officials) have tended to have an *infrastructure bias*.
- But, for communities facing an immediate risk, exactly the opposite is needed.
- Their priorities are transportation system management, operations, and *services*. 
There are many car-less populations that may need help escaping a hazard

Examples:
- Elderly and disabled populations
- Low-income populations
- Tourists and other visitors who don’t rent cars
- Local residents whose cars have already been lost to the disaster
Case of hurricane evacuation in a three-county area in Texas
How would people in car-less households get out of harm’s way?

- “Only a small percentage of respondents reported lacking a personal vehicle for evacuation and most of them (78%) plan to rely on rides with peers (friends, relatives, neighbors, or coworkers)…”

- “Nonetheless, there will be a significant number of households expecting to take public transportation so emergency managers and transit officials need to address this issue in their hurricane plans.”

  - Study of hurricane response behavior of residents in Cameron, Willacy, and Hidalgo Counties, Texas. (https://hrrc.arch.tamu.edu/publications/research%20reports/ValleyBehavioralStudy.pdf)
## Zero-Vehicle Population in Cameron, Hidalgo and Willacy Counties

<table>
<thead>
<tr>
<th></th>
<th>Population in Households with one or more vehicles</th>
<th>Population in Zero-Vehicle Households</th>
<th>Total Population</th>
<th>Percent in Zero-Vehicle Households</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cameron County</td>
<td>392,956</td>
<td>24,749</td>
<td>417,705</td>
<td>5.9%</td>
</tr>
<tr>
<td>Hidalgo County</td>
<td>784,393</td>
<td>34,981</td>
<td>819,374</td>
<td>4.3%</td>
</tr>
<tr>
<td>Willacy County</td>
<td>21,373</td>
<td>670</td>
<td>22,043</td>
<td>3.0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,198,722</strong></td>
<td><strong>60,400</strong></td>
<td><strong>1,259,122</strong></td>
<td><strong>4.8%</strong></td>
</tr>
</tbody>
</table>

Source: U.S. Census Bureau, 2009-2013 5-Year American Community Survey
How many people would be trapped?

- If 78 percent of car-less people get a ride, then 22 percent do not get a ride.

- But that’s over 13,000 people!
  - \( 60,400 \times 0.22 = 13,288 \)
Would local transit agencies have enough bus capacity to handle the demand?

### Seated Capacity of Transit Vehicles in the Three-County Area

<table>
<thead>
<tr>
<th>Agency</th>
<th>Assumed number of seats per vehicle</th>
<th>Commuter Bus</th>
<th>Transit Bus</th>
<th>Demand Response Bus</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>City of McAllen - McAllen Express Transit</td>
<td>55</td>
<td>0</td>
<td>14</td>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>City of Brownsville - Brownsville Metro</td>
<td>37</td>
<td>8</td>
<td>24</td>
<td>8</td>
<td>40</td>
</tr>
<tr>
<td>Lower Rio Grande Valley Development Council (d/b/a Valley Metro)</td>
<td>15</td>
<td>29</td>
<td>26</td>
<td>7</td>
<td>62</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>37</strong></td>
<td><strong>64</strong></td>
<td><strong>19</strong></td>
<td><strong>120</strong></td>
</tr>
</tbody>
</table>

Source: National Transit Database

### Number of Transit Vehicles Available in the Three-County Area

<table>
<thead>
<tr>
<th>Agency</th>
<th>Number of Vehicles Available for Maximum Service</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Commuter Bus</td>
</tr>
<tr>
<td>City of McAllen - McAllen Express Transit</td>
<td>0</td>
</tr>
<tr>
<td>City of Brownsville - Brownsville Metro</td>
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<tr>
<td>Lower Rio Grande Valley Development Council (d/b/a Valley Metro)</td>
<td>29</td>
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<td><strong>Total</strong></td>
<td><strong>37</strong></td>
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</tbody>
</table>

Source: National Transit Database
Could school buses augment the transit agency supply?

MANAGEMENT

School Buses Rescue Residents in Hurricane

Amid the devastation and heartache of Hurricane Harvey, one of the signs of hope and heroism was the yellow school bus.

In the Houston area and elsewhere, as schools were shut down in late August and early September, school buses and drivers served in storm relief efforts. In some cases, they plowed through floodwaters to rescue residents, and they transported food and supplies to storm shelters.

One of the southeastern Texas school bus operations that pitched in to help was New Caney Independent School District (ISD). The district’s buses and staff evacuated more than 1,000 adults and children, along with their pets.

Josh Rice, director of transportation and fleet services for New Caney ISD, said that many of the evacuees had physical disabilities and were in wheelchairs. That included residents of a local nursing home.

“With a shortage of wheelchair buses, we were transferring people from their wheelchair to a bus seat in order to get them out of flooded areas,” Rice told us.

New Caney ISD also assisted in evacuations in nearby Humble (shown above) when Humble ISD buses couldn’t access much of the northern part of their district. Still, Humble ISD buses and staff covered other ground, transporting evacuees and donations to local shelters.

A photo posted by Humble ISD on Twitter shows two of the district’s drivers, Tiffany Aston and Daniel
What do we know about moving large numbers of people quickly using transit buses and school buses?

Lessons from large Planned Special Events
Albuquerque International Balloon Fiesta
The largest planned special event in New Mexico
Albuquerque International Balloon Fiesta
Park-and-Ride Bus Routes
Unexpectedly high ticket sales wreaked havoc on opening day of the 2018 Fiesta
### First Saturday Morning (2018)

<table>
<thead>
<tr>
<th>Location</th>
<th>Tickets</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coronado</td>
<td>6,203</td>
<td>32%</td>
</tr>
<tr>
<td>Hoffmantown</td>
<td>4,822</td>
<td>25%</td>
</tr>
<tr>
<td>Cottonwood</td>
<td>4,189</td>
<td>22%</td>
</tr>
<tr>
<td>Intel</td>
<td>4,019</td>
<td>21%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>19,233</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Source: Albuquerque International Balloon Fiesta
What could Balloon Fiesta have done differently?
Question: How is it possible to move 6,000 people using school buses in the shortest possible time span?

Answer: Three factors are especially critical for ensuring success
Factor #1: A well-designed and well-managed queueing and boarding process

Queueing and Boarding Scheme "A"

Entry → Queue #1 → → → → → Bus 1.A
← ← ← ←
→ → → → → → → → → Bus 1.B
→ Queue #2 → → → → → → → Bus 2.A
← ← ← ←
Entry ... and Boarding Scheme "B"
Queue #3 
Boarding 
Corral
Queue #4 
Boarding 
Corral
Boarding 
Corral
Boarding 
Corral

Queueing and Boarding Scheme "B"

Entry → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → → →
Factor #2: Police assisted bus movements
Factor #3: Training and preparation

Focus on three areas:

- Bus / Traffic Real-Time Surveillance and Operations Control
- Queueing and Boarding
- On-the-ground traffic management / bus movement priority
Hypothetical Arrival of 6,000 People at a Bus Boarding Area
Essence of the problem: How do you load 6,000 people into buses quickly?
The supply of buses is finite / each bus must make three trips to serve the demand

Cumulative Arrivals v. Cumulative Departures
at the bus boarding area
(Assumptions: 6,000 people, 50 school buses, 40 passengers per bus, 6-min boarding cycles, 48-min cycle time)
Thank you!