NOTE: We will be recording this meeting to make it available on the project website.

Southeast Texas Hurricane Evacuation Study

Presentation of the Transportation Analysis Evacuation Scenarios

June 4, 2025

NATIONAL HURRICANE PROGRAM

Texas A&M Transportation Institute

HAZARD REDUCTION & RECOVERY CENTER

TEXAS DIVISION OF EMERGENCY MANAGEMENT

TDEM

THE TEXAS A&M UNIVERSITY SYSTEM

Agenda:

- Introductions
  - Team and Participants*
- Transportation Analysis Scenarios
  - Overview
  - Detail discussion of Baseline and Special Scenarios for each area
  - Evacuation regional destinations
  - Input request
  - Questions/comments
- Contacts

Project website:

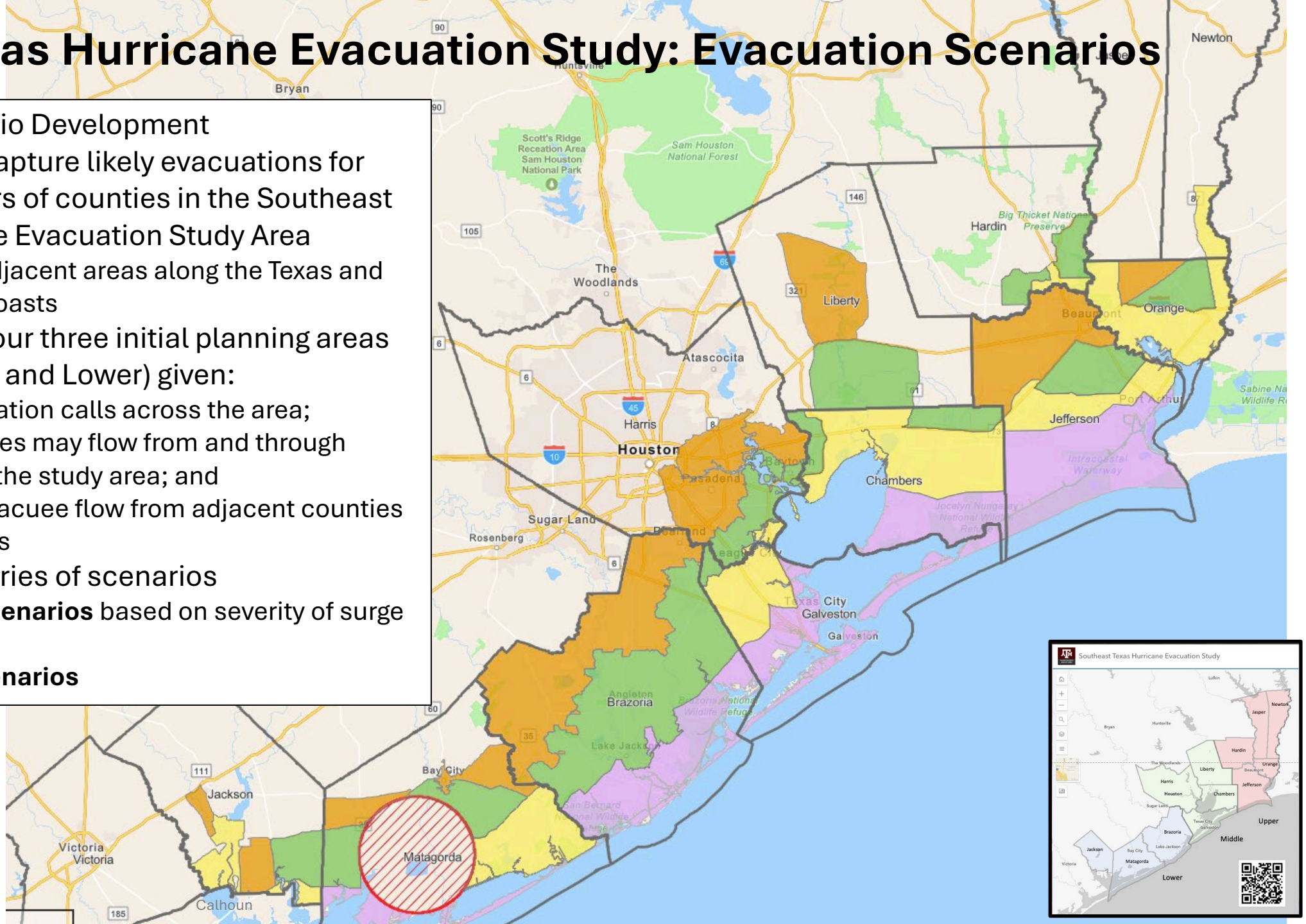
Atlas website:

*** Participants, please put your name, organization, county, and contact information in the chat**

Southeast Texas Hurricane Evacuation Study: Evacuation Scenarios

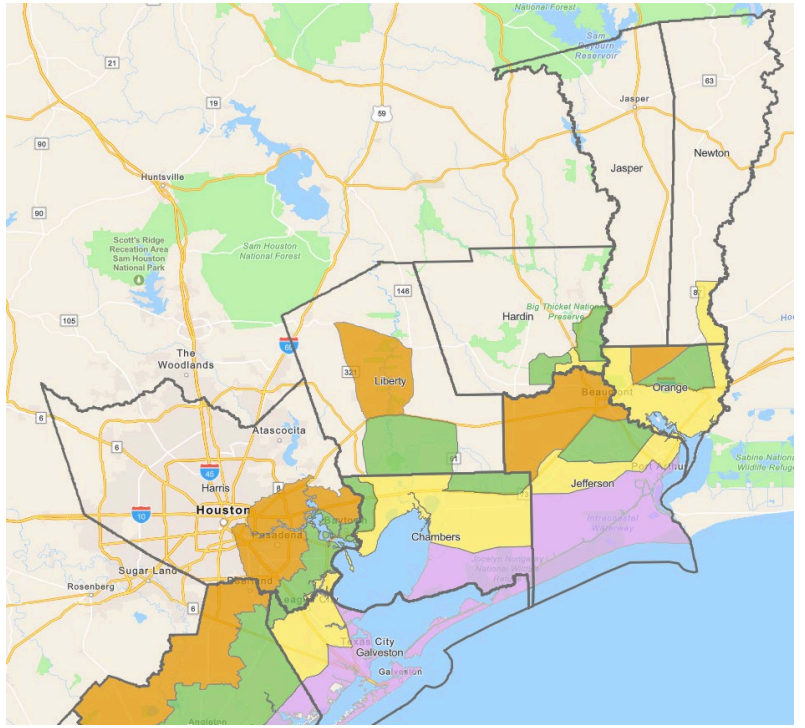
General goal in scenario Development

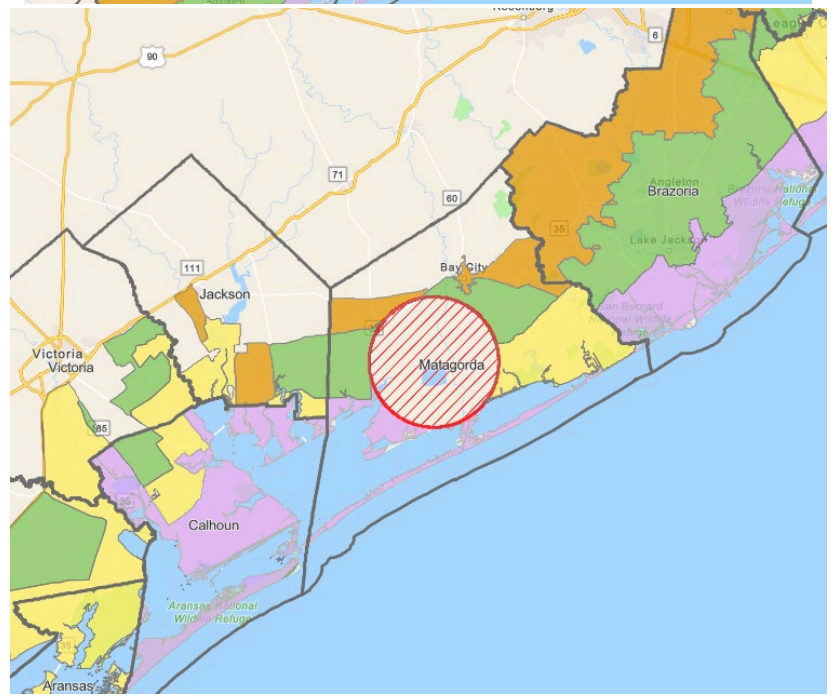
- Attempted to capture likely evacuations for regional clusters of counties in the Southeast Texas Hurricane Evacuation Study Area
  - Including adjacent areas along the Texas and Louisiana coasts
- Deviated from our three initial planning areas (Upper, Middle, and Lower) given:
  - likely evacuation calls across the area;
  - how evacuees may flow from and through counties in the study area; and
  - potential evacuee flow from adjacent counties and parishes
- Developed a series of scenarios
  - **Baseline scenarios** based on severity of surge risk
  - **Special scenarios**



Southeast Texas Hurricane Evacuation Study: Evacuation Scenarios

1) Run a series of **Baseline** and **Special Scenarios** using RtePM that will provide you a range of likely clearance times given potential evacuation events
    - **Baseline:** provide range of evacuation times given different surge events (limited, moderate, significant, & major)
    - **Special:** provide potential evacuation times bases on special situations/additions.
2) Variable assumptions:
    - **Response times**
        - 8-hour
        - 2-day -- *70% day 1 and 30% day 2*
            - We can tweak start time (sun-up to sun-down)
    - **Varying participation rates by zones**
        - evacuation zones called
        - shadow evacuation area (zones or outside)
3) Constant assumptions:
    - No early or special calls for **mobile home residents**
    - **Seasonal populations** included as part of residential populations (i.e., without early calls)
    - No adjustments to **background traffic** or **traffic incidents**
4) Total of 85+ scenario runs.



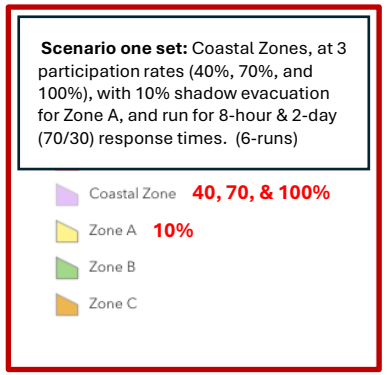


Baseline Scenarios will provide a range of clearance times for ***four*** different surge events with **varying participation rates**, and **varying participation rates.**

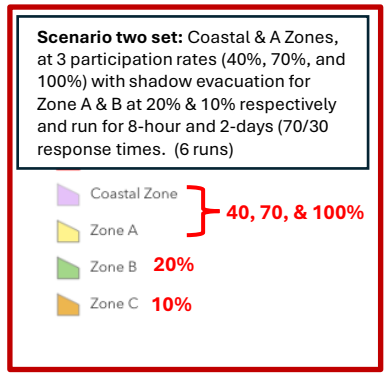
- **Surge Event Baseline Scenario sets (4):**
  - *Limited:* Coastal Zone
  - *Moderate:* Coastal and Zone A
  - *Significant:* Coastal and Zones A & B
  - *Major:* Coastal and Zones A, B, & C
- **Varying participation rates**
  - *Limited – Significant*: 40%, 70%, & 100%
  - *Major:* 70% & 100%
  - *Shadow evacuation* rates increase with surge events
    - Areas: adjacent zones to areas outside zones
    - Participation rates 10% - 30%
- **Response times:**
  - 8-hour and 2-day -- *70% day 1 and 30% day 2*
- **Minimum of 22 baseline scenarios for each sub-region**
  - Providing a range of clearance times for each
    - Surge event evacuation call
    - Given different participation rates
    - Response times
- **Sub-regions:** Three (3) sub-regions
- **Special Scenarios**
  - Upper/middle region with LA parishes (10)
  - Full Southeastern Regional evacuation call (5)
  - Potential Evaculanes/Contra-flow, middle region (2)
  - Brazoria Beach population (1-2)

Baseline Evacuation Scenarios

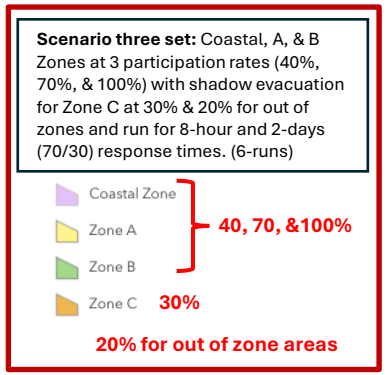
Scenario set one (*limited* surge event)



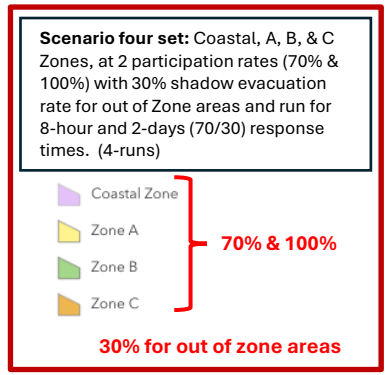
Scenario set two (*moderate* surge event)



Scenario set three (*significant* surge event)



Scenario set four (*major* surge event)



Each **scenario set** will be run at two response times

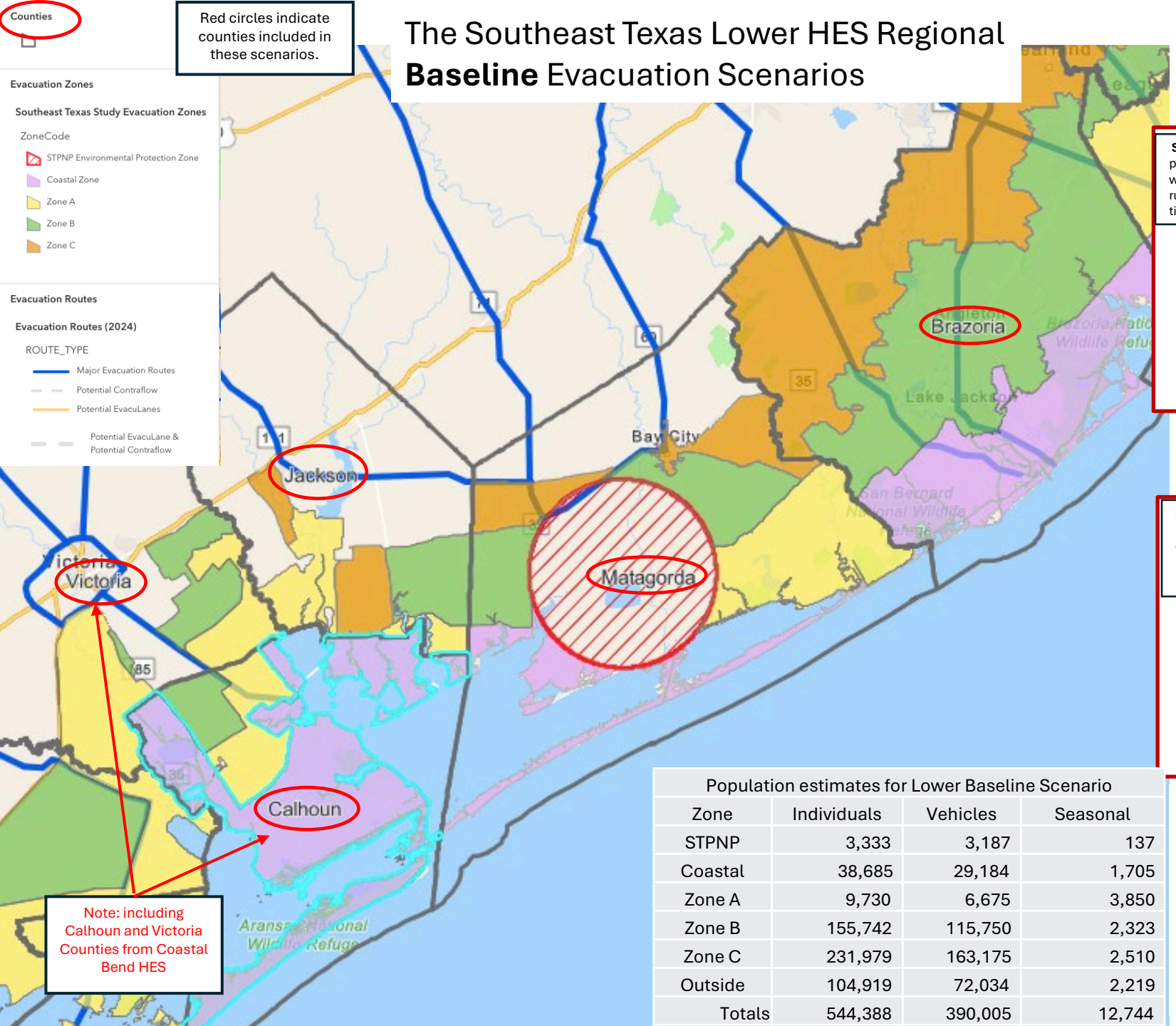
- - 8-hour Response time
- - 2-day response time (70% day 1 & 30% day 2)

All Scenarios will assume

- - Seasonal population included at full occupancy for each zone
- - No special calls for mobile home residents.
- - Background traffic and traffic incidents not adjusted

The Southeast Texas Lower HES Regional **Baseline** Evacuation Scenarios

Red circles indicate counties included in these scenarios.



Scenario one (*limited* surge event)

Scenario one set: Coastal Zones, at 3 participation rates (40%, 70%, and 100%), with 10% shadow evacuation for Zone A, and run for 8-hour & 2-day (70/30) response times. (6-runs)

- STPNP Environmental Protection Zone 100%
- Coastal Zone 40, 70, & 100%
- Zone A 10%
- Zone B
- Zone C

Scenario two (*moderate* surge event)

Scenario two set: Coastal & A Zones, at 3 participation rates (40%, 70%, and 100%) with shadow evacuation for Zone A & B at 20% & 10% respectively and run for 8-hour and 2-days (70/30 response times. (6 runs)

- STPNP Environmental Protection Zone 100%
- Coastal Zone, Zone A: 40, 70, & 100%
- Zone B 20%
- Zone C 10%

Scenario three (*significant* surge event)

Scenario three set: Coastal, A, & B Zones at 40%, 70%, & 100% participation rates with shadow evacuation for Zone C at 30% & 20% for out of zones and run for 8-hour and 2-days (70/30) response times. (6-runs)

- STPNP Environmental Protection Zone 100%
- Coastal Zone, Zone A, Zone B: 40, 70, & 100%
- Zone C 30%

20% for out of zone areas

Scenario four (*major* surge event)

Scenario four set: Coastal, A, B, & C Zones, at 2 participation rates (70% & 100%) with 30% shadow evacuation rate for out of Zone areas and run for 8-hour and 2-days (70/30) response times. (4-runs)

- STPNP Environmental Protection Zone 100%
- Coastal Zone, Zone A, Zone B, Zone C: 70% & 100%

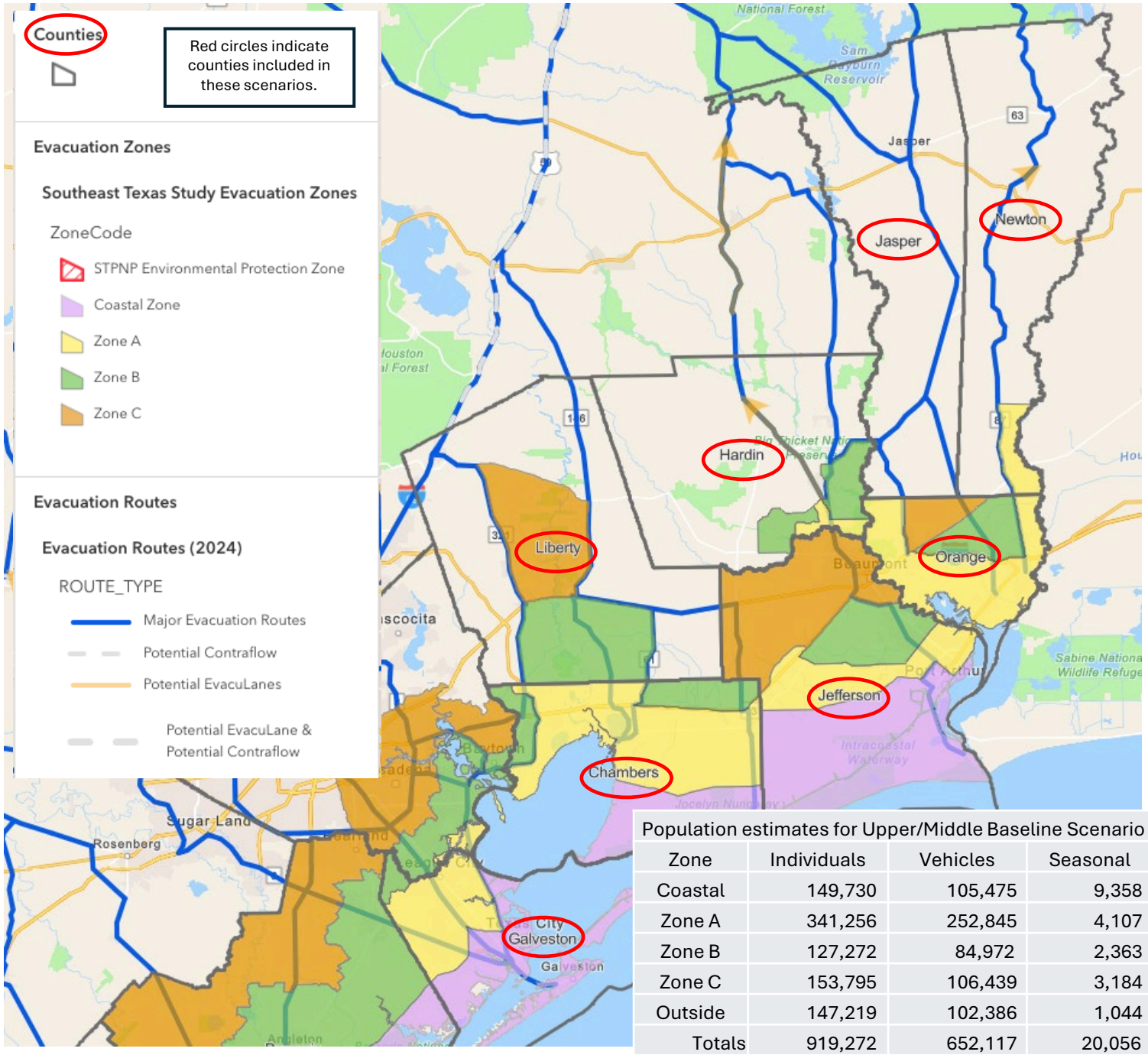
30% for out of zone areas

Population estimates for Lower Baseline Scenario

Zone	Individuals	Vehicles	Seasonal
STPNP	3,333	3,187	137
Coastal	38,685	29,184	1,705
Zone A	9,730	6,675	3,850
Zone B	155,742	115,750	2,323
Zone C	231,979	163,175	2,510
Outside	104,919	72,034	2,219
Totals	544,388	390,005	12,744

1. Each scenario will be run for two response times
   - 8-hour Response time
   - 2-day response time (70% day 1 & 30% day 2)
2. All Scenarios will assume
   - 100% participation for STPNP
   - Seasonal population at full occupancy for each zone (+ 2-3 extra assuming additional seasonal populations in Brazoria, scenarios to be determined.)
   - Background traffic and traffic incidents not adjusted
3. A total of 24 baseline scenarios for the Lower Regional

The Southeast Texas Upper/Middle Regional **Baseline** Evacuation Scenarios



Population estimates for Upper/Middle Baseline Scenario			
Zone	Individuals	Vehicles	Seasonal
Coastal	149,730	105,475	9,358
Zone A	341,256	252,845	4,107
Zone B	127,272	84,972	2,363
Zone C	153,795	106,439	3,184
Outside	147,219	102,386	1,044
Totals	919,272	652,117	20,056

Scenario one (*limited* surge event)

Scenario one set: Coastal Zones, at 3 participation rates (40%, 70%, and 100%), with 10% shadow evacuation for Zone A, and run for 8-hour & 2-day (70/30) response times. (6-runs)

- Coastal Zone **40, 70, & 100%**
- Zone A **10%**
- Zone B
- Zone C

Scenario two (*moderate* surge event)

Scenario two set: Coastal & A Zones, at 3 participation rates (40%, 70%, and 100%) with shadow evacuation for Zone A & B at 20% & 10% respectively and run for 8-hour and 2-days (70/30 response times. (6 runs)

- Coastal Zone, Zone A **40, 70, & 100%**
- Zone B **20%**
- Zone C **10%**

Scenario three (*significant* surge event)

Scenario three set: Coastal, A, & B Zones at 3 participation rates (40%, 70%, & 100%) with shadow evacuation for Zone C at 30% & 20% for out of zones and run for 8-hour and 2-days (70/30) response times. (6-runs)

- Coastal Zone, Zone A, Zone B **40, 70, &100%**
- Zone C **30%**

20% for out of zone areas

Scenario four (*major* surge event)

Scenario four set: Coastal, A, B, & C Zones, at 2 participation rates (70% & 100%) with 30% shadow evacuation rate for out of Zone areas and run for 8-hour and 2-days (70/30) response times. (4-runs)

- Coastal Zone, Zone A, Zone B, Zone C **70% & 100%**

30% for out of zone areas

Each scenario set will be run for two response times

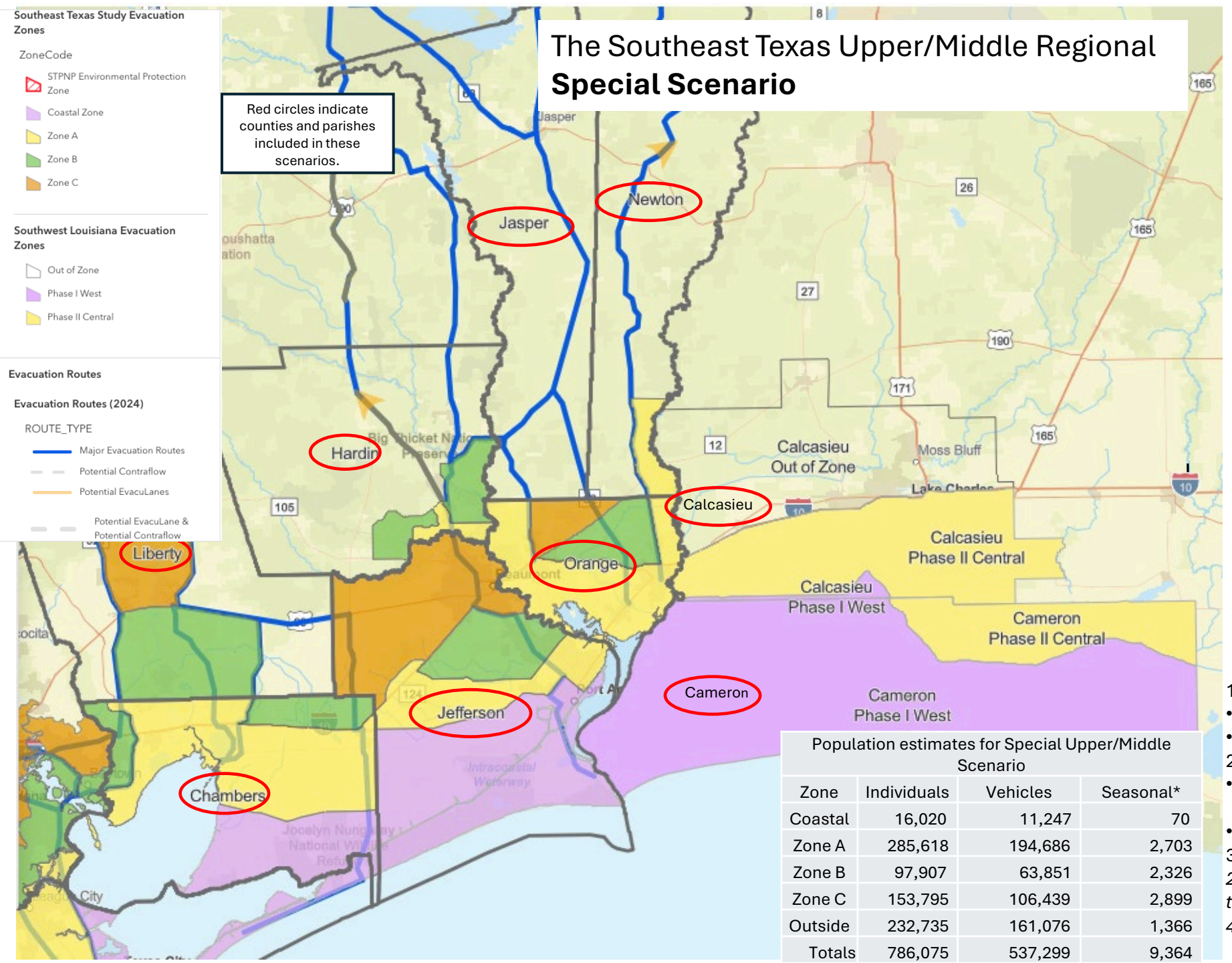
- - 8-hour Response time
- - 2-day response time (70% day 1 & 30% day 2)

All Scenarios will assume

- - Seasonal population included at full occupancy for each zone
- - Background traffic and traffic incidents not adjusted

A total of **22** baseline scenarios for the Upper/middle Region

The Southeast Texas Upper/Middle Regional **Special Scenario**



Population estimates for Special Upper/Middle Scenario

Zone	Individuals	Vehicles	Seasonal*
Coastal	16,020	11,247	70
Zone A	285,618	194,686	2,703
Zone B	97,907	63,851	2,326
Zone C	153,795	106,439	2,899
Outside	232,735	161,076	1,366
Totals	786,075	537,299	9,364

1. *Significant* surge event

Significant Surge sett: Coastal, A, & B Zones (40%, 70%, & 100%);shadow evac. for Zone C at 30% & 20% for outside zones; & 8-hour and 2-days (70/30) response times. (6-runs)

25% for assumed participation rates for LA zones, moving west into Texas

Coastal Zone
Zone A
Zone B
40, 70, & 100%
Zone C **30%**

20% for out of zone areas

2. *Major* surge event

Major Surge Scenario: Coastal, A, B, & C Zones at 70% & 100% with 30% shadow evacuation rate outside zones; 8-hour and 2-days (70/30) response times. (4-runs)

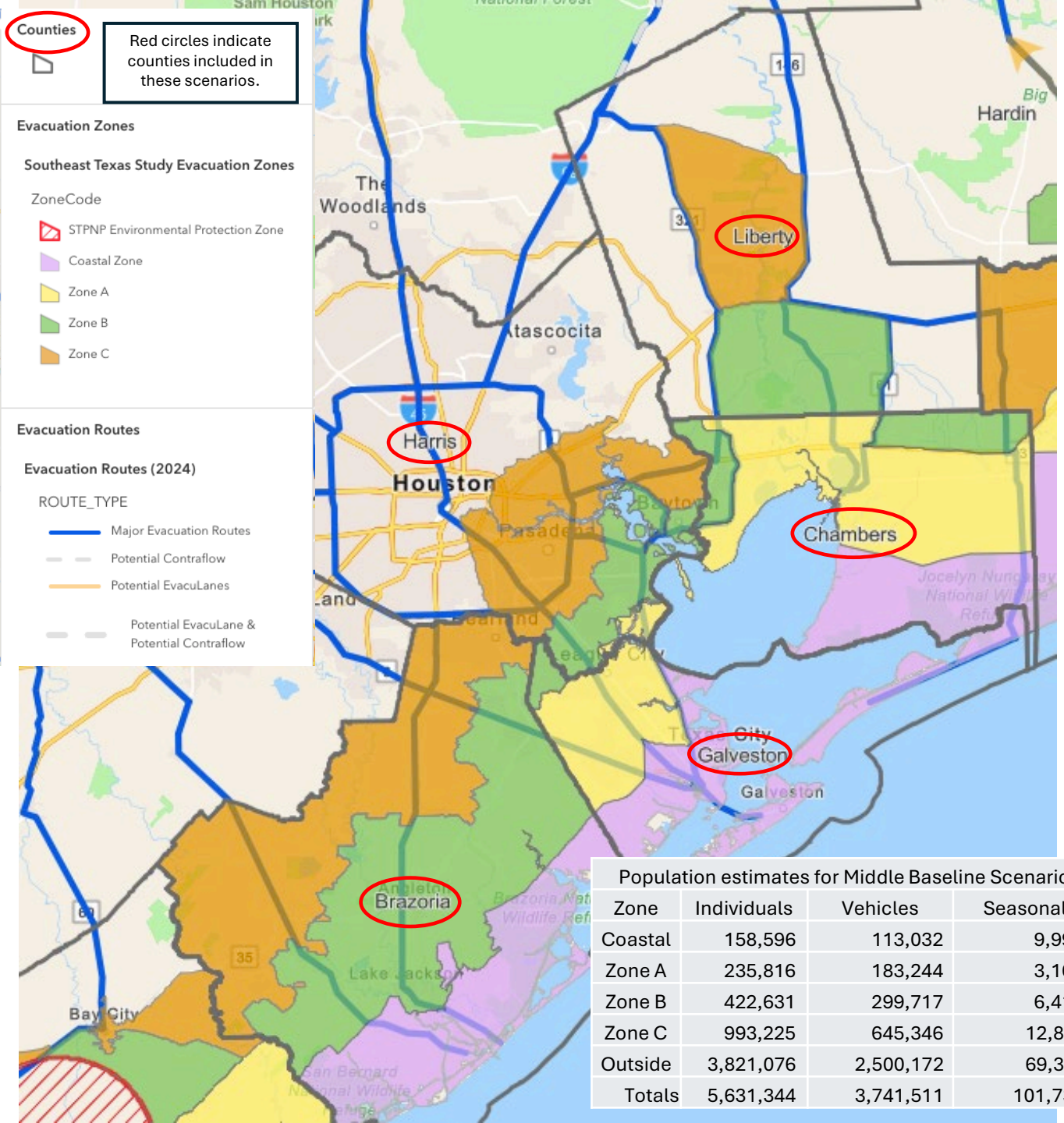
25% of assumed participation rates LA zones, all moving west into Texas

Coastal Zone
Zone A
Zone B
Zone C
70% & 100%

30% for out of zone areas

1. Each scenario set will be run for two response times
   - - 8-hour Response time
   - - 2-day response time (70% day 1 & 30% day 2)
2. All Scenarios will assume
   - - Seasonal population included at full occupancy for each zone
   - - Background traffic and traffic incidents not adjusted
3. *Evacuation from Louisianna will be constrained to 25% of assumed participation rates moving west from the two zones and shadow.*
4. *Total of **10** runs*

The Southeast Texas **Middle Regional Baseline** Evacuation Scenarios



Population estimates for Middle Baseline Scenario			
Zone	Individuals	Vehicles	Seasonal
Coastal	158,596	113,032	9,995
Zone A	235,816	183,244	3,167
Zone B	422,631	299,717	6,410
Zone C	993,225	645,346	12,825
Outside	3,821,076	2,500,172	69,342
Totals	5,631,344	3,741,511	101,739

Scenario one (*limited* surge event)

Scenario one set: Coastal Zones, at 3 participation rates (40%, 70%, and 100%), with 10% shadow evacuation for Zone A, and run for 8-hour & 2-day (70/30) response times. (6-runs)

- Coastal Zone — 40, 70, & 100%
- Zone A — 10%
- Zone B
- Zone C

Scenario two (*moderate* surge event)

Scenario two set: Coastal & A Zones, at 3 participation rates (40%, 70%, and 100%) with shadow evacuation for Zone A & B at 20% & 10% respectively and run for 8-hour and 2-days (70/30 response times. (6 runs)

- Coastal Zone, Zone A — 40, 70,& 100%
- Zone B — 20%
- Zone C — 10%

Third scenario (*significant* surge event)

Scenario three set: Coastal, A, & B Zones at 3 participation rates (40%, 70%, & 100%) with shadow evacuation for Zone C at 30% & 20% for out of zones and run for 8-hour and 2-days (70/30) response times. (6-runs)

- Coastal Zone, Zone A, Zone B — 40, 70, & 100%
- Zone C — 30%

20% for out of zone areas

Fourth scenario (*major* surge event)

Scenario four set: Coastal, A, B, & C Zones, at 2 participation rates (70% & 100%) with 30% shadow evacuation rate for out of Zone areas and run for 8-hour and 2-days (70/30) response times. (4-runs)

- Coastal Zone, Zone A, Zone B, Zone C — 70% & 100%

30% for out of zone areas

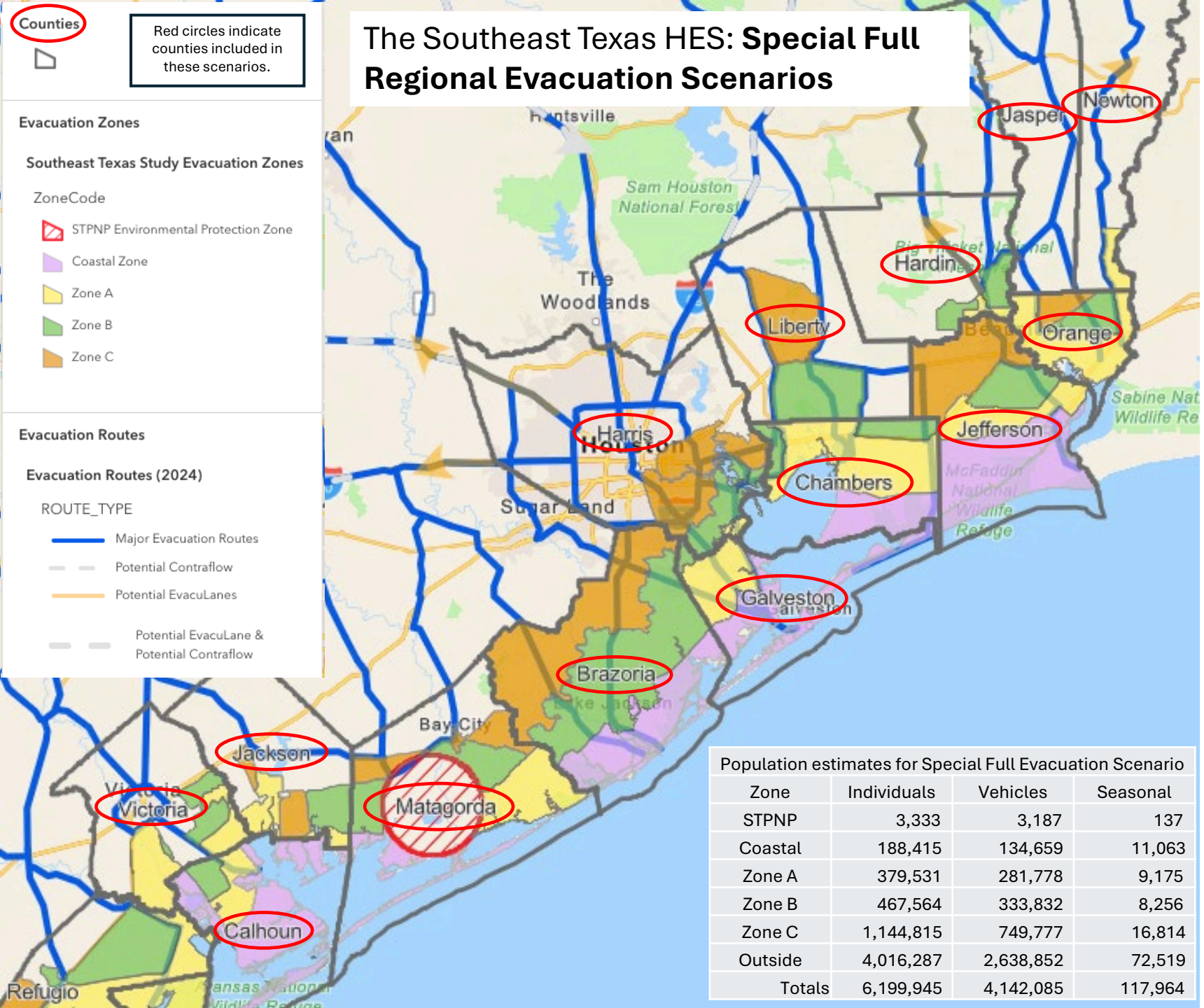
1. Each scenario will be run for two response times
   - - 8-hour Response time
   - - 2-day response time (70% day 1 & 30% day 2)
2. Scenario 4 will also be run with evaculanes and contra flow (only 2-day)

All Scenarios will assume

- - Seasonal population at full occupancy for each zone
- - Background traffic and traffic incidents not adjusted

3. A total of **24** baseline scenarios for the Upper/middle Region

The Southeast Texas HES: **Special Full Regional Evacuation Scenarios**



Population estimates for Special Full Evacuation Scenario			
Zone	Individuals	Vehicles	Seasonal
STPNP	3,333	3,187	137
Coastal	188,415	134,659	11,063
Zone A	379,531	281,778	9,175
Zone B	467,564	333,832	8,256
Zone C	1,144,815	749,777	16,814
Outside	4,016,287	2,638,852	72,519
Totals	6,199,945	4,142,085	117,964

Significant Surge Scenario

Evacuation Zones

Significant Surge Scenario set: Coastal, A, & B Zones at 40%, 70%, & 100% participation rates with shadow evacuation for Zone C at 30% & 20% for out of zones and run for 8-hour and 2-days (70/30) response times. (3runs)

- STPNP Environmental Protection Zone **100%**
- Coastal Zone
- Zone A
- Zone B

40, 70, & 100%

- Zone C **30%**

20% for out of zone areas

Major surge Scenario

Evacuation Zones

Major Surge Scenario set: Coastal, A, B, & C Zones, at 2 participation rates (70% & 100%) with 30% shadow evacuation rate for out of Zone areas and run for 8-hour and 2-days (70/30) response times. (2-runs)

- STPNP Environmental Protection Zone **100%**
- Coastal Zone
- Zone A
- Zone B

70% & 100%

- Zone C

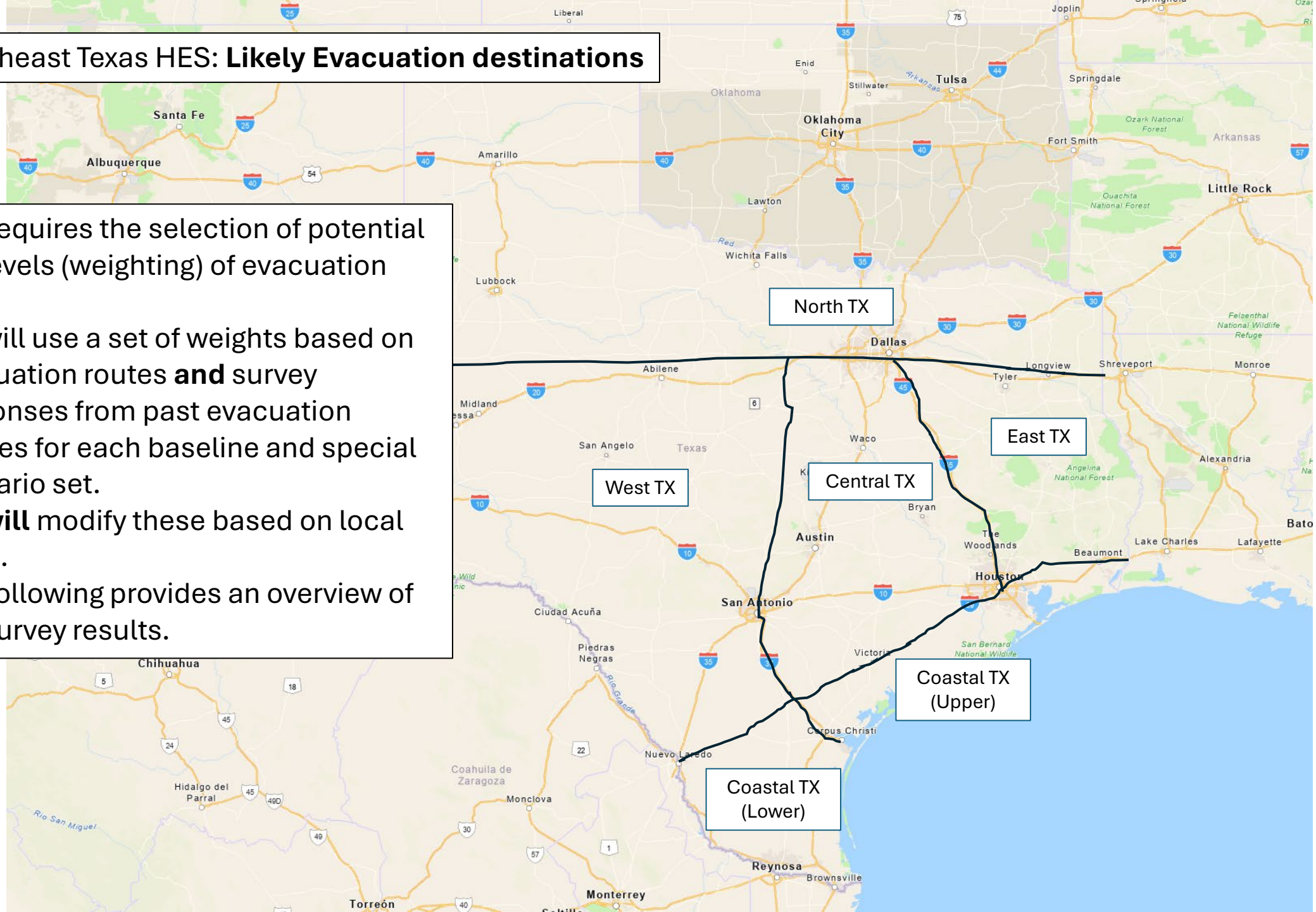
30% for out of zone areas

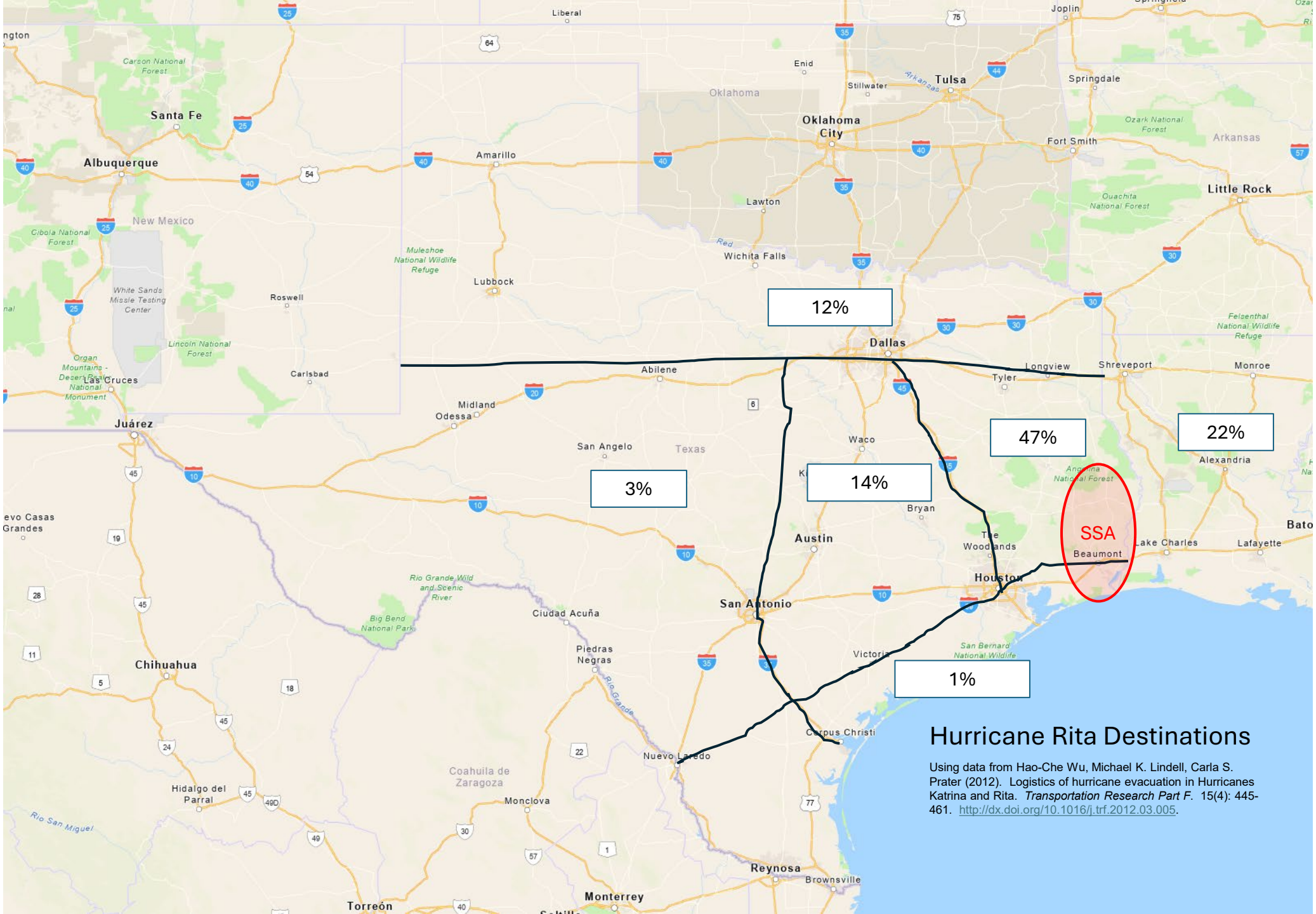
1. Scenario will be run assuming 2-day response time
   - (70% day 1 & 30% day 2)
2. All Scenarios will assume
   - - 100% participation for STPNP
   - - Seasonal population at full occupancy for each
   - - Background traffic and traffic incidents not adjusted
   - - Evaculane and contra flow active
3. A total of 5 full regional scenarios will be run.

The Southeast Texas HES: **Likely Evacuation destinations**

RtePM requires the selection of potential usage levels (weighting) of evacuation routes.

- We will use a set of weights based on evacuation routes **and** survey responses from past evacuation studies for each baseline and special scenario set.
- We **will** modify these based on local input.
- The following provides an overview of the survey results.

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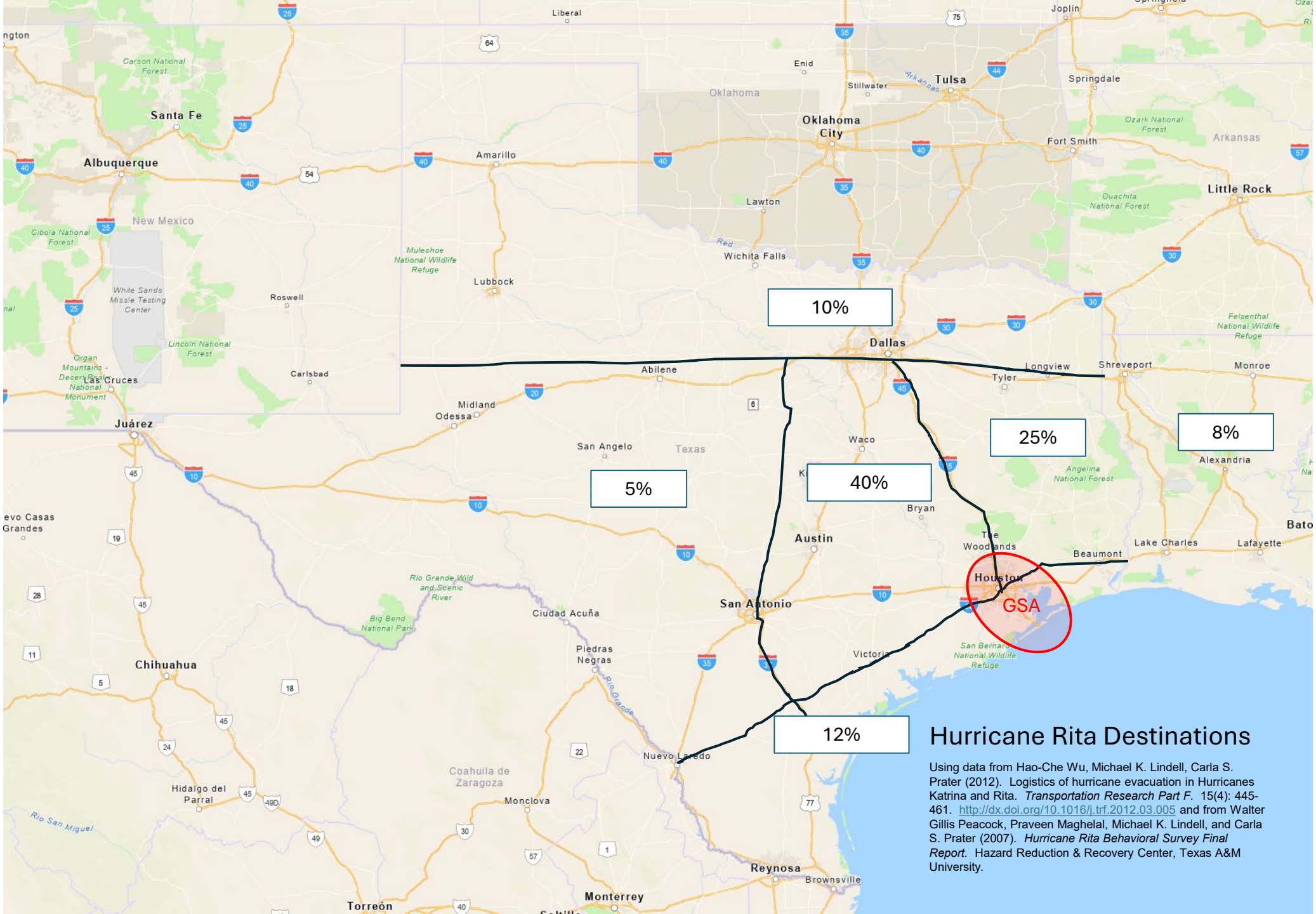
Hurricane Rita Destinations
Using data from Hao-Che Wu, Michael K. Lindell, Carla S. Prater (2012). Logistics of hurricane evacuation in Hurricanes Katrina and Rita. *Transportation Research Part F*. 15(4): 445-461. http://dx.doi.org/10.1016/j.trf.2012.03.005.
Liberal
Santa Fe
Albuquerque
Amarillo
Oklahoma City
Tulsa
Enid
Stillwater
Springdale
Fort Smith
Little Rock
Lawton
Wichita Falls
Lubbock
Roswell
Carlsbad
Las Cruces
Juárez
Abilene
Midland
Odessa
San Angelo
Waco
Dallas
Tyler
Longview
Shreveport
Monroe
Alexandria
Bryan
Austin
The Woodlands
Houston
Beaumont
Lake Charles
Lafayette
San Antonio
Victoria
Corpus Christi
Nuevo Laredo
Reynosa
Brownsville
Monterrey
Torreón
Chihuahua
Ciudad Acuña
Piedras Negras
Coahuila de Zaragoza
Monclova
Hidalgo del Parral
Rio Grande
Rio Grande Wild and Scenic River
Big Bend National Park
Rio San Miguel
Carson National Forest
Cibola National Forest
White Sands Missile Testing Center
Lincoln National Forest
Organ Mountains - Desert Peaks National Monument
Muleshoe National Wildlife Refuge
Ozark National Forest
Ouachita National Forest
Felsenthal National Wildlife Refuge
San Bernard National Wildlife
New Mexico
Oklahoma
Texas
Arkansas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Hurricane Rita Destinations
Using data from Hao-Che Wu, Michael K. Lindell, Carla S. Prater (2012). Logistics of hurricane evacuation in Hurricanes Katrina and Rita. *Transportation Research Part F*. 15(4): 445-461. http://dx.doi.org/10.1016/j.trf.2012.03.005 and from Walter Gillis Peacock, Praveen Maghelal, Michael K. Lindell, and Carla S. Prater (2007). *Hurricane Rita Behavioral Survey Final Report*. Hazard Reduction & Recovery Center, Texas A&M University.
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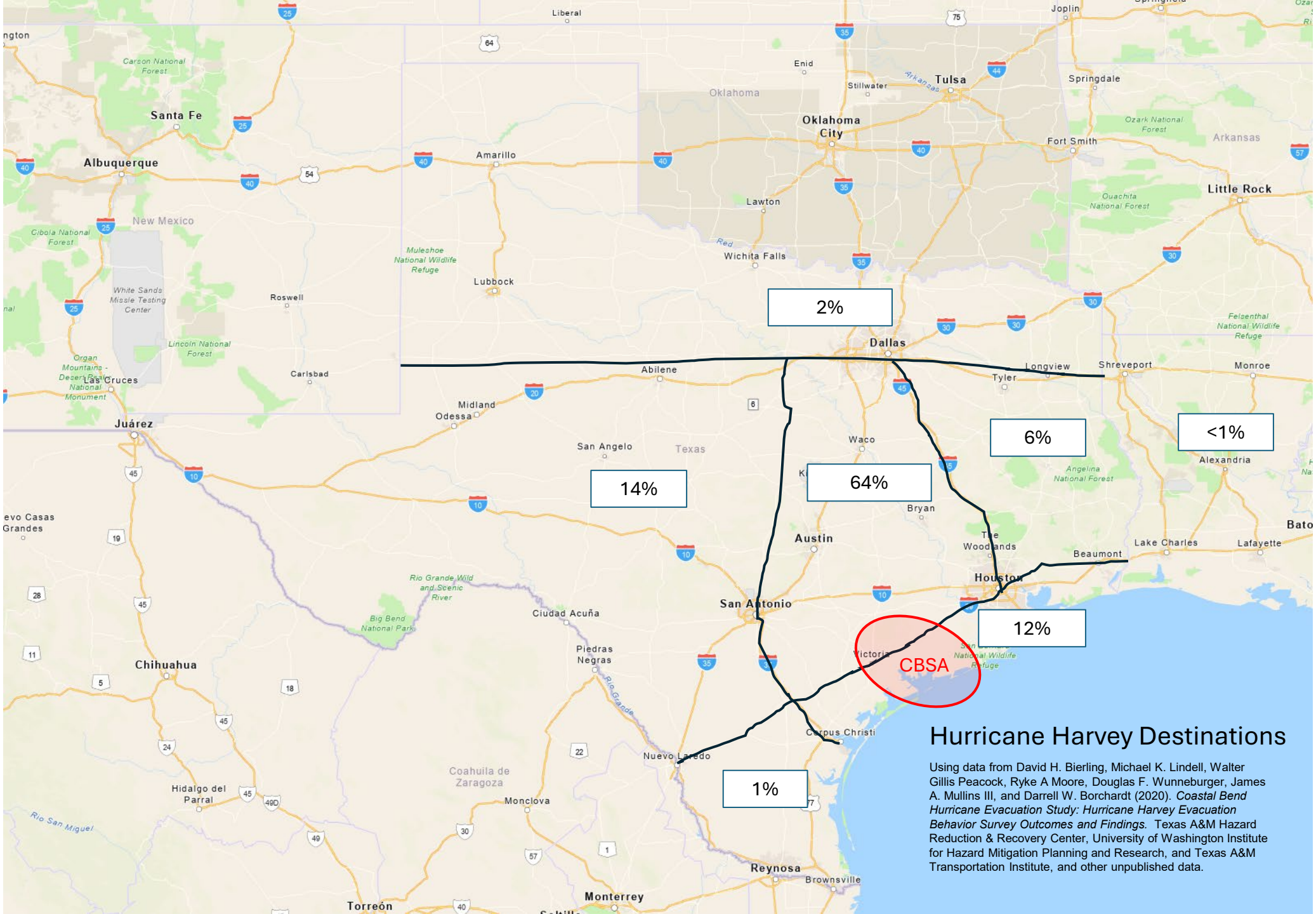
Ouachita National Forest
Felsenthal National Wildlife Refuge
Angelina National Forest
San Bernard National Wildlife Refuge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CBSA
Hurricane Harvey Destinations
Using data from David H. Bierling, Michael K. Lindell, Walter Gillis Peacock, Ryke A Moore, Douglas F. Wunneburger, James A. Mullins III, and Darrell W. Borchardt (2020). *Coastal Bend Hurricane Evacuation Study: Hurricane Harvey Evacuation Behavior Survey Outcomes and Findings.* Texas A&M Hazard Reduction & Recovery Center, University of Washington Institute for Hazard Mitigation Planning and Research, and Texas A&M Transportation Institute, and other unpublished data.
Liberal
Santa Fe
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Carlsbad
Abilene
Dallas
Longview
Tyler
Shreveport
Monroe
Midland
Odessa
San Angelo
Waco
Alexandria
Bryan
Austin
The Woodlands
Beaumont
Lake Charles
Lafayette
Houston
San Antonio
Ciudad Acuña
Piedras Negras
Chihuahua
Juárez
Las Cruces
Victoria
Corpus Christi
Nuevo Laredo
Hidalgo del Parral
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Monterrey
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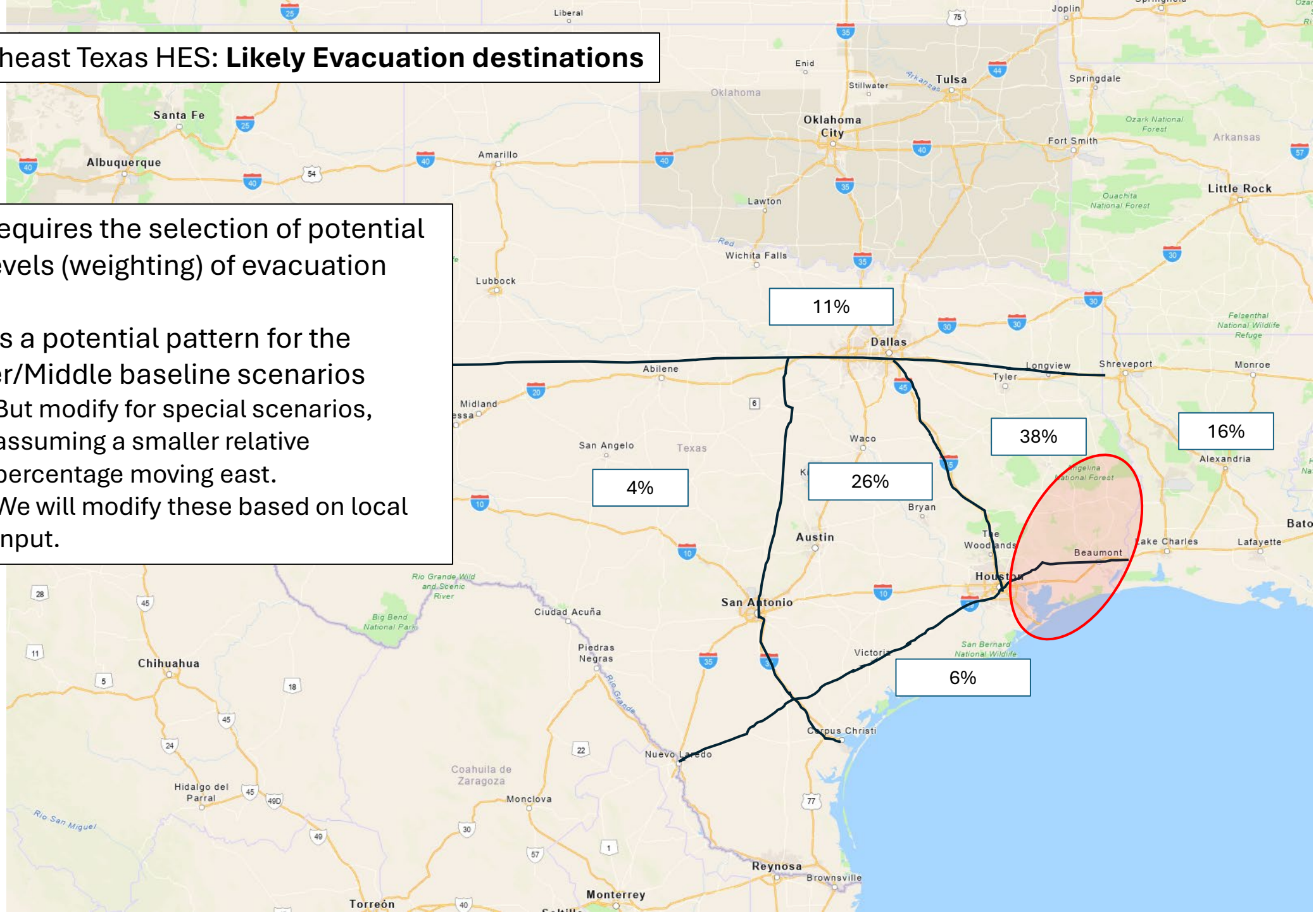
Oklahoma
Texas
Arkansas
Carson National Forest
Cibola National Forest
Lincoln National Forest
White Sands Missile Testing Center
Muleshoe National Wildlife Refuge
Ozark National Forest
Ouachita National Forest
Angelina National Forest
Felsenthal National Wildlife Refuge
Rio Grande Wild and Scenic River
Big Bend National Park
Rio Grande
Rio San Miguel

The Southeast Texas HES: **Likely Evacuation destinations**

RtePM requires the selection of potential usage levels (weighting) of evacuation routes.

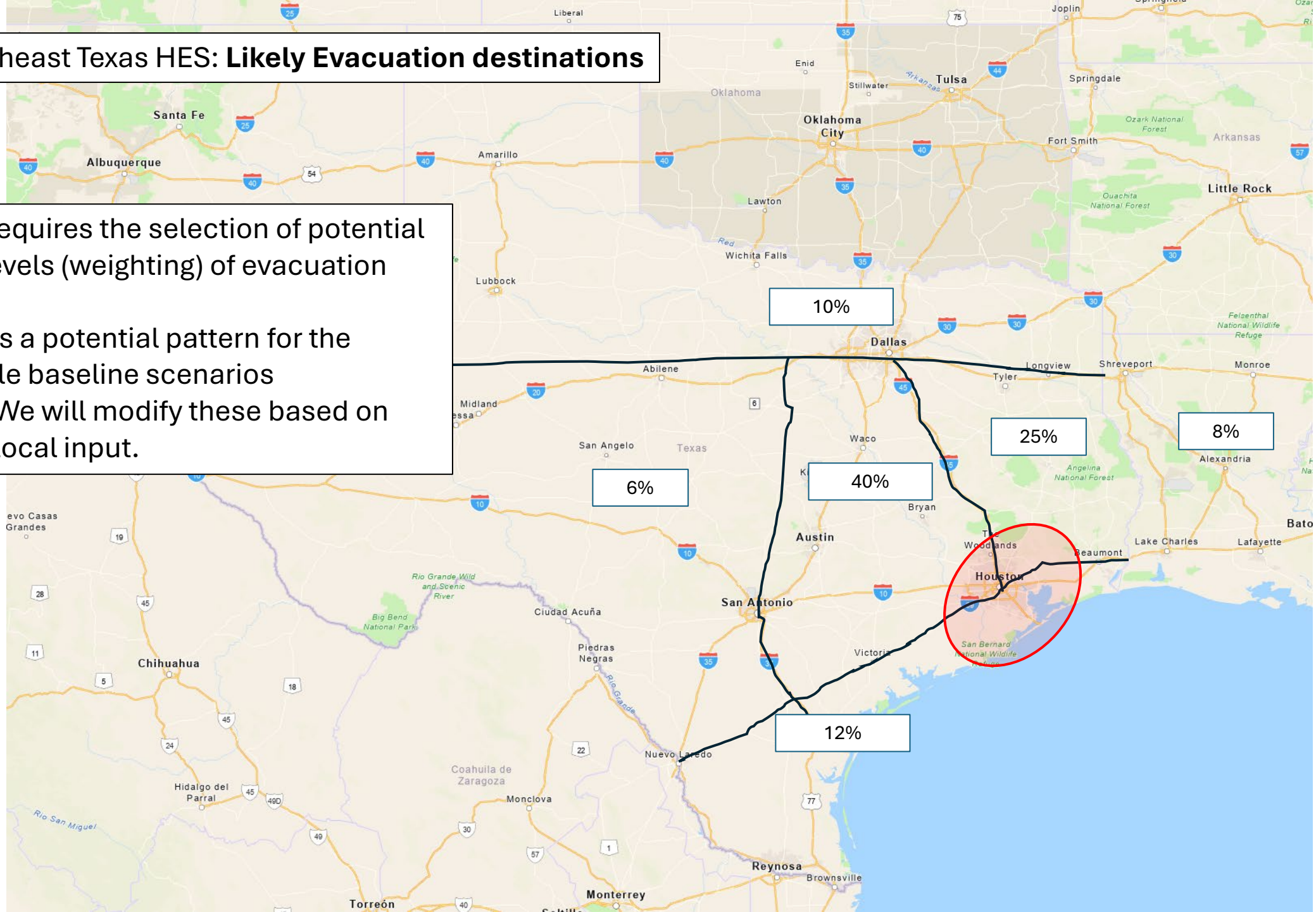
- This is a potential pattern for the Upper/Middle baseline scenarios
  - But modify for special scenarios, assuming a smaller relative percentage moving east.
  - We will modify these based on local input.



The Southeast Texas HES: **Likely Evacuation destinations**

RtePM requires the selection of potential usage levels (weighting) of evacuation routes.

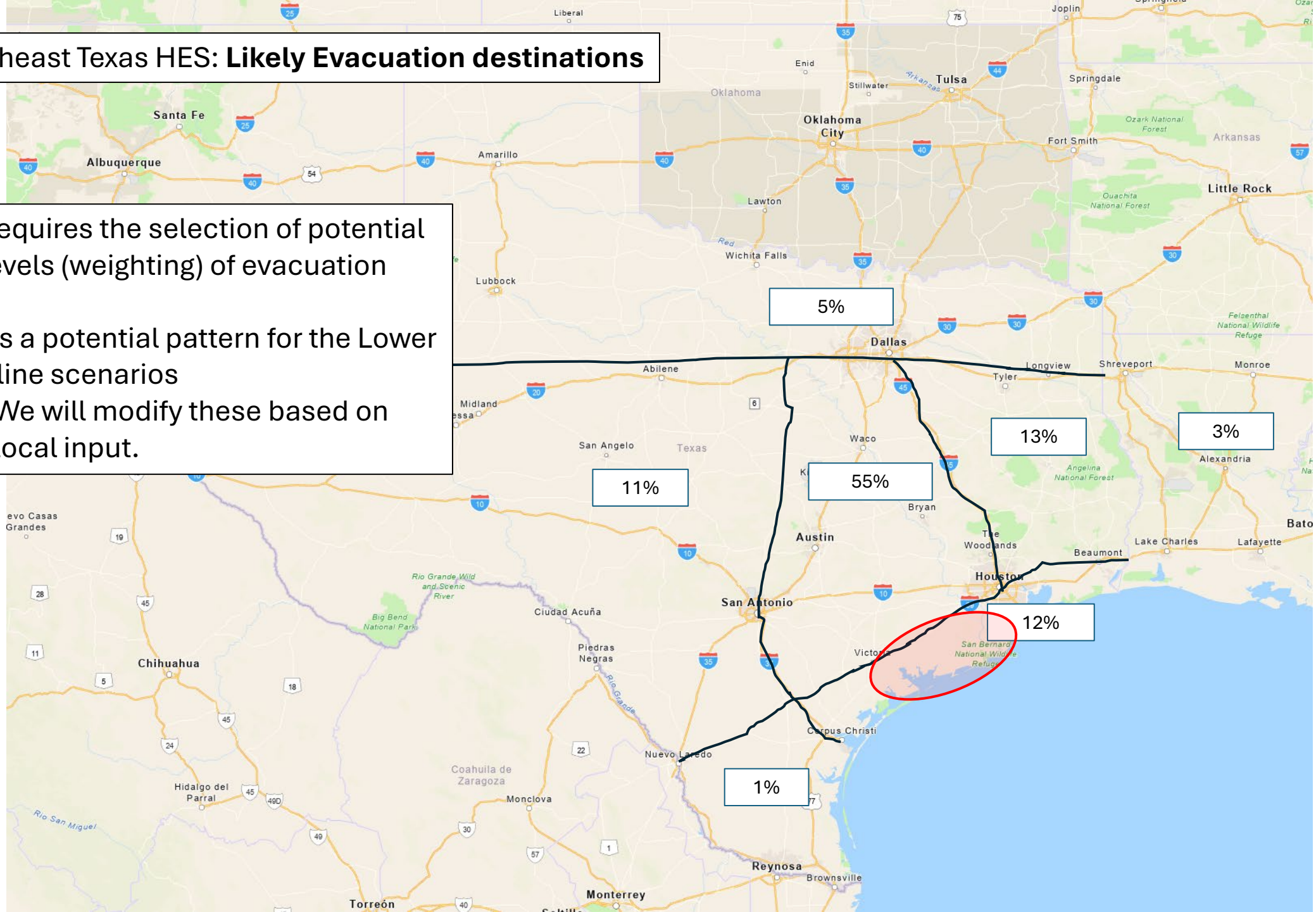
- This is a potential pattern for the Middle baseline scenarios
  - We will modify these based on local input.



The Southeast Texas HES: **Likely Evacuation destinations**

RtePM requires the selection of potential usage levels (weighting) of evacuation routes.

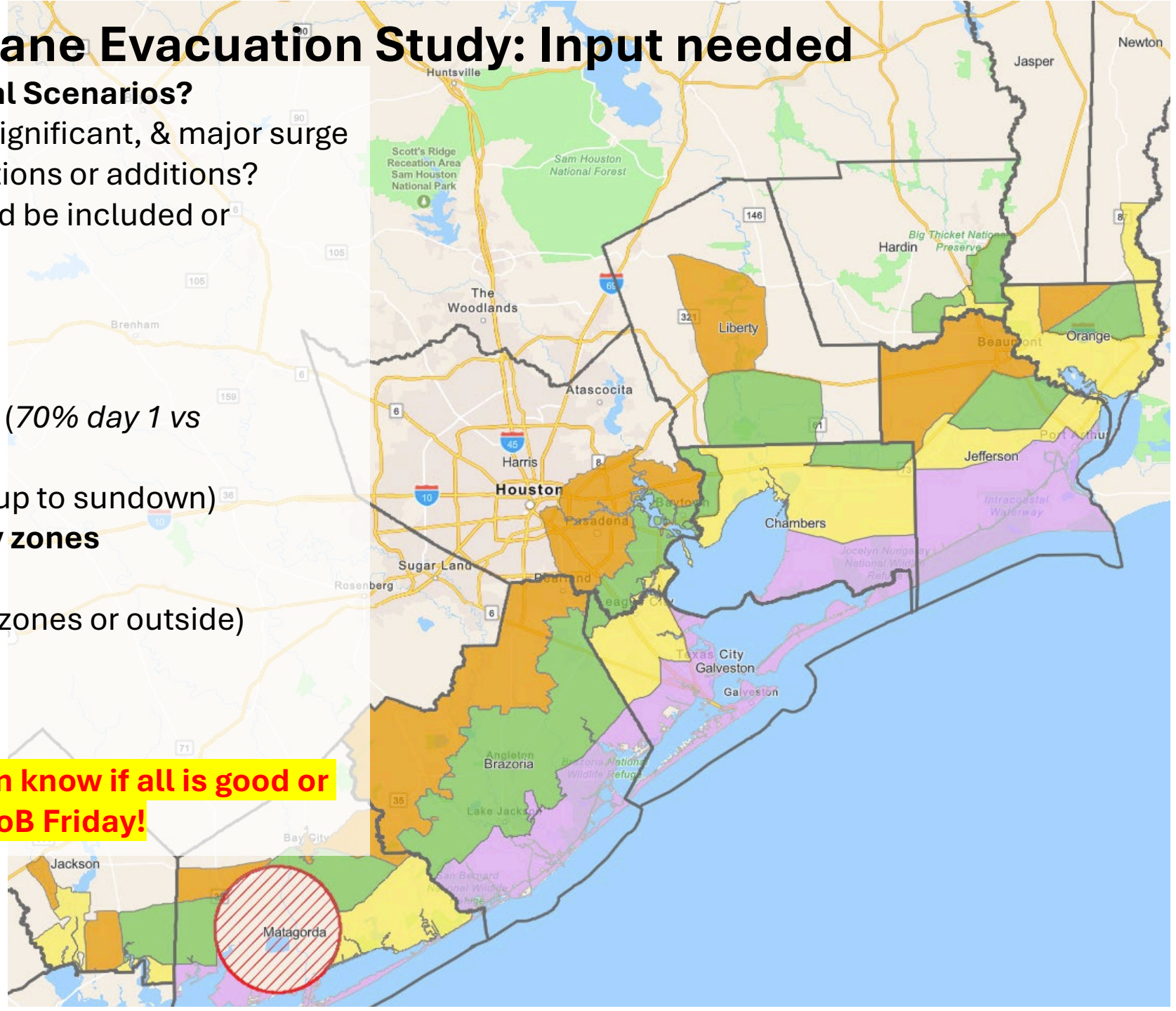
- This is a potential pattern for the Lower baseline scenarios
  - We will modify these based on local input.



Southeast Texas Hurricane Evacuation Study: Input needed

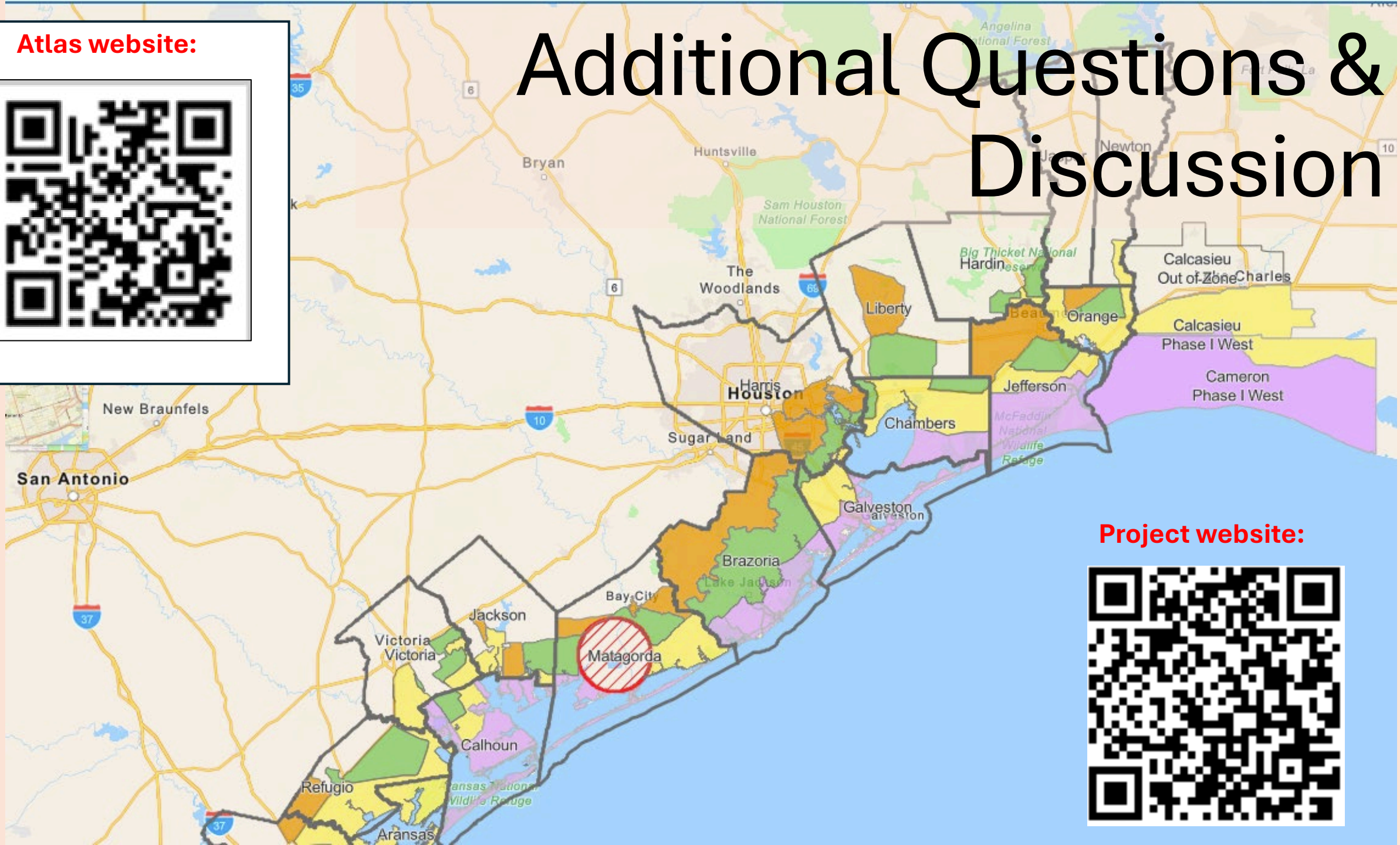
1) Modifications to **Baseline** or **Special Scenarios?**
   - **Baseline:** limited, moderate, significant, & major surge
   - **Special:** Additional considerations or additions?
   - **Counties/parishes** that should be included or excluded?
2) Variable assumptions?
   - **Response times**
     - 8-hour vs 2-day
       - Tweaks across days? (*70% day 1 vs 30% day 2)*
       - start/end times (sunup to sundown)
   - **Varying participation rates by zones**
     - evacuation zones called
     - shadow evacuation area (zones or outside)
3) **Destination regions**?
4) **Other issues**?

Contact Kyle or Gerald letting them know if all is good or additional issues by CoB Friday!



Additional Questions & Discussion

Atlas website:



Project website:

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    - HES oversight, input and technical support, coordination with county, local, & regional government, agencies, and stakeholders.

- Texas A&M HRRC and TTI
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