



Hillsborough Transportation Planning Organization (TPO)

Storm Evacuation Forecast & Shelter-in-Place Scenarios Study

Final Report



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prepared for

Hillsborough TPO

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- School District of Hillsborough County
- City of Tampa Emergency Management
- City of Tampa Planning Department

Executive Summary

Hurricane evacuation and sheltering is a matter of life safety, and transportation plays a crucial role. The Hillsborough Transportation Planning Organization (TPO) continually supports emergency management programs and proactively works toward improving evacuations as part of long-range planning and congestion management processes. A typical strategy is to widen evacuation routes to maintain or reduce evacuation clearance times.¹ The purpose of this study was to identify and evaluate non-road-widening strategies to improve evacuation and sheltering in Hillsborough County.

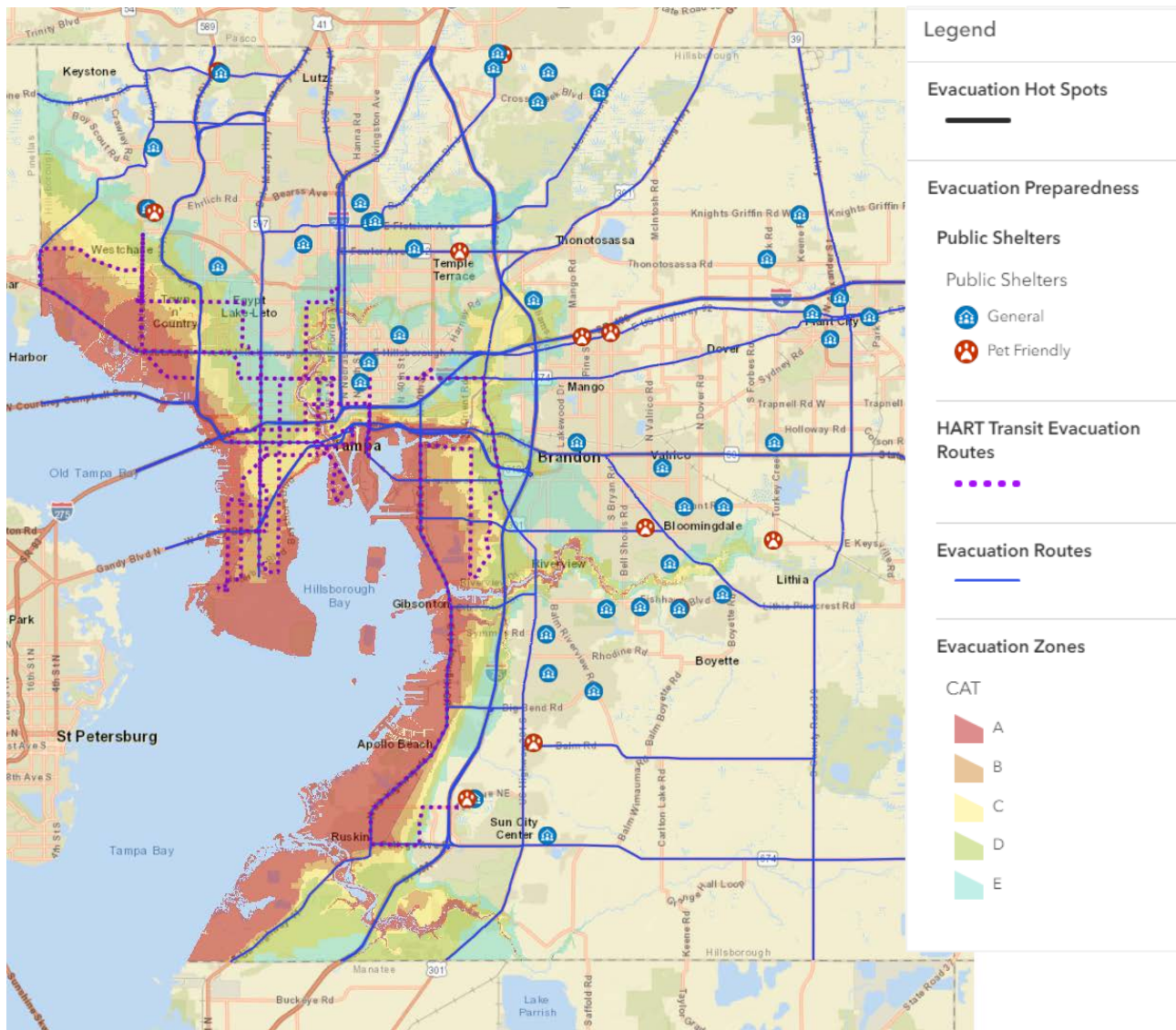
Residents and visitors have two choices when a hurricane heads their way: to shelter in place or evacuate to a safer location. Over a half million people, or a third of Hillsborough County, live in Evacuation Zone C, equivalent to a Category 3 hurricane. Evacuation zones reflect areas that may be inundated due to storm surge; people outside evacuation zones also may choose to evacuate due to intense winds. Hillsborough County has sufficient emergency shelter space to meet current evacuation needs. However, achieving clearance times to correspond with National Hurricane Center hurricane watches and warnings is a concern. For a Category 3 scenario, the clearance time is projected to take 24 hours, the same timeframe a hurricane warning would be issued prior to tropical storm force wind landfall. Figure ES-1 shows Hillsborough County's five evacuation zones, evacuation routes, emergency shelter locations, and transit routes during hurricane emergencies.

The purpose of this study was to identify and evaluate alternatives to road widenings to improve evacuation and sheltering for emergencies



¹ The term clearance time reflects the time duration between the declaration of an evacuation to the time for people to reach a shelter or other safe destination. This includes all residents and visitors that chose to evacuate even if not mandated to do so.

Figure ES-1 Existing Public Shelters and Evacuation Zones Map



Note: Evacuation Zones are determined by the Saffir-Simpson Hurricane scale (Zone A: 74-95 mph wind speed Category 1; Zone B: 96-110 mph Category 2; Zone C: 111-129 mph Category 3; Zone D: 130-156 mph Category 4; Zone E: 157+mph Category 5).

The first step of this study was to identify evacuation topics to study. The study team coordinated with partner agencies, especially the emergency management organizations for Hillsborough County, City of Tampa, and the Tampa Bay Regional Council, to obtain suggested topics. We prepared an on-line survey and held a virtual open house with internet/phone polling to solicit public input. The survey link also was made available via TPO social media, newsletters, the study website, and email and social media notices provided by partner agencies. People provided useful information through the open-ended questions of the survey; however, the number of responses was low. To supplement these results, the study team reviewed information from two university-led surveys: one from Florida International University that has been surveying Floridians' culture of preparedness for hurricanes for 15 years, and the second from the University of South Florida that conducted statewide surveys (with Hillsborough County specific data) for 2020 and 2021 regarding relationships between COVID-19 and hurricane evacuation and sheltering.

Based on the information obtained, the evacuation topics chosen are listed below along with the key strategies or topics the study team analyzed for each.

- traffic congestion: congestion hotspot location determination; contraflow, reversible lanes, and emergency shoulder use² for interstates; intersection and interchange improvements for arterials; traffic signal coordination; and phased evacuations.
- transit and paratransit services (e.g., access to shelters, friends/family, or supplies): emergency transit route locations for communities with large percentages of racial/ethnic minorities or low income³ or high percentages of people with disabilities; emergency transit route locations and mobile home park locations; and households with below poverty incomes served by emergency transit routes versus daily transit routes.
- trustworthy and real-time communications (e.g., storm tracking, evacuation levels, fuel availability): additional fixed (recommended) or portable dynamic message signs on arterials and interstates; housing weatherization programs; people reacting quickly to evacuation orders; and other evacuation behaviors.

Bruce B. Downs Blvd at Fletcher Avenue & Mango Road at Hillsborough Avenue are close to shelters, have high numbers of households with disabilities or are in TPO Environmental Justice areas

To better understand the congestion issue, a hotspot analysis was performed using travel speed data for the days leading up to landfall of Hurricane Irma.⁴ The top projected congested areas for interstate and arterials are shown in Figure ES-2 and listed in Tables ES-1 and ES-2. Two areas in particular should receive attention because of close proximity to shelters and high percentages of households with disabilities or designated as Environmental Justice areas by the TPO: Bruce B. Downs Boulevard at Fletcher Avenue and Mango Road at Hillsborough Avenue.

Figure ES-3 shows the daily and emergency transit routes, the locations of emergency shelters, and communities noted for environmental justice issues. The emergency transit routes provide a higher coverage⁵ for households with below poverty level incomes located in Zone A or Zone C (A/B/C), i.e., for category 1 and 3 hurricanes, than for Zone E (A/B/C/D/E), i.e., a category 5 hurricane, or the county as a whole.

Discussion with agency partners (Tampa and Hillsborough County), TPO committees, community organizations and an on-line survey was used to gauge reactions to the strategies and to vet the hotspot locations. Respondents agreed with the identified hotspot locations and liked the operational strategies of traffic signal coordination and evacuation phasing.

² The use of interstate shoulders for emergency evacuations is permitted in locations identified by the Florida Department of Transportation. Only one shoulder, often the inside shoulder, is designated, to allow for interchange access/egress and emergency vehicle access for incidents.

³ The study team used the communities designated for environmental justice for this purpose.

⁴ The analysis also factored in areas of congestion identified in the TPO's 2045 Long Range Transportation Plan; however, these data received lower weighting.

⁵ The study mile used a half-mile to a transit route stop for the daily transit service. For emergency service, a half mile to the route was used because of during emergencies drivers will pick people up at stops and when "flagged" by people.

Figure ES-2 Hurricane Evacuation Hotspot Locations

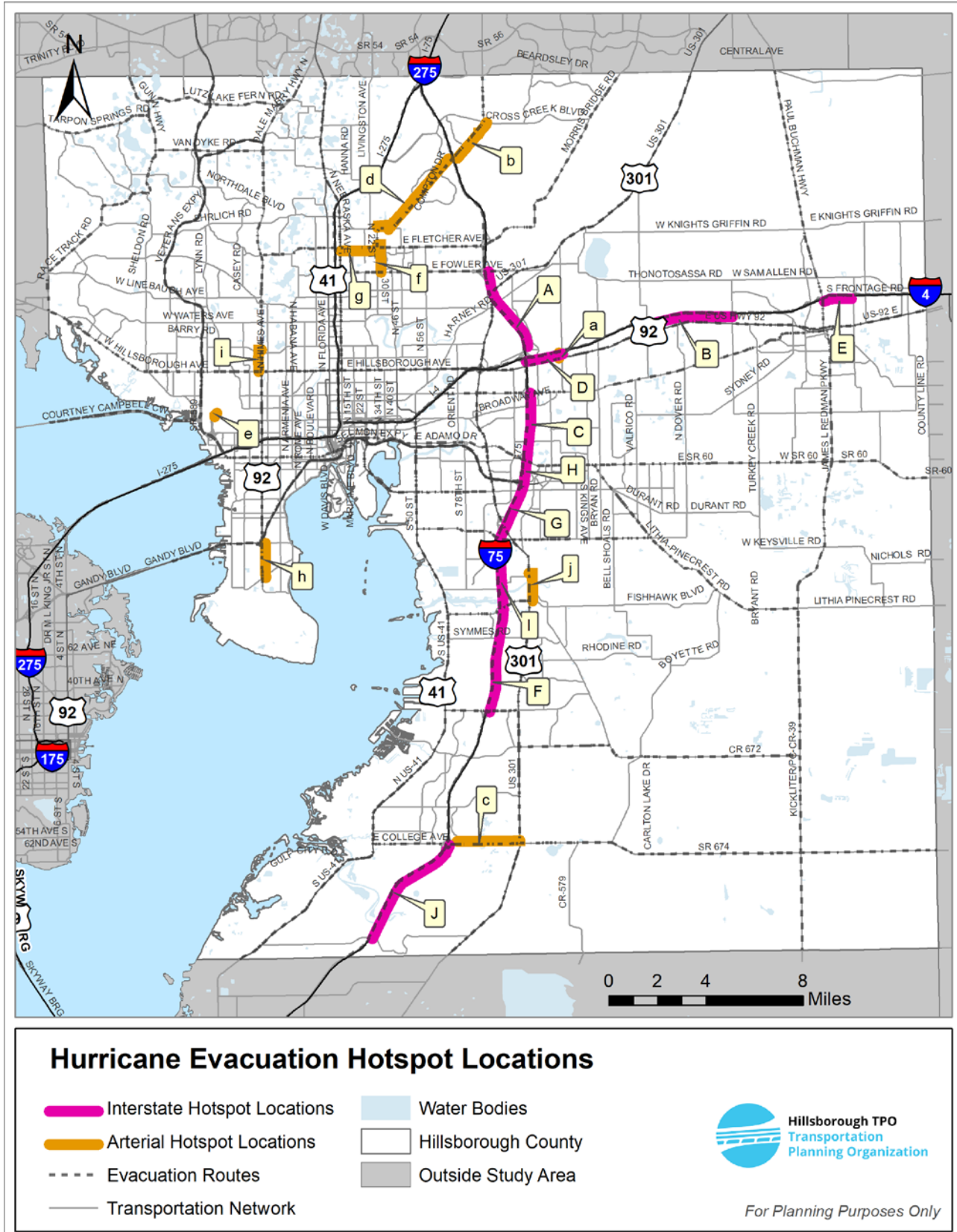


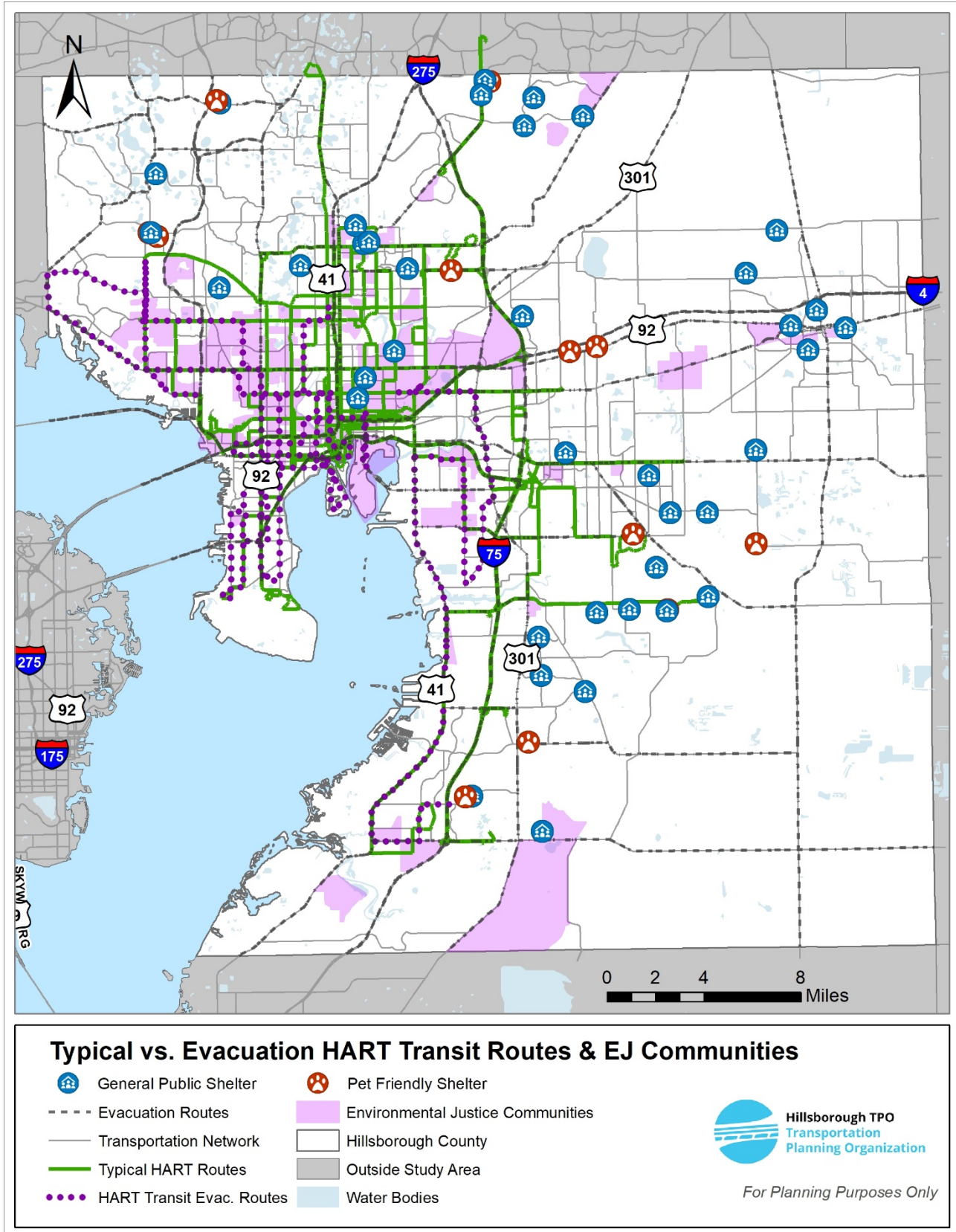
Table ES-1 Arterial Hurricane Evacuation Hotspot Locations

Location ID	Road	Between	And	Direction	Distance (miles)
a	Mango Rd	I-4 Ramps	Hillsborough Ave	SB	0.2
b	Bruce B. Downs Blvd	I-75 Ramps	New Tampa Rd	NB	1.9
c	Sun City Center Blvd	I-75 Ramps	US 301	WB	2.7
d	Bruce B Downs	Bearss Ave	I-75 Ramps	SB	4.3
e	George J Bean Pkwy	Airport Service Rd	Airport Recirculation Dr	NB	0.3
f	Bruce B. Downs Blvd	Fletcher Ave	Fowler Ave	NB	1.0
g	Fletcher Ave	Nebraska Ave	Bruce B. Downs Blvd	EB	1.5
h	Dale Mabry Hwy	Gandy Blvd	Interbay Blvd	NB	1.5
i	Dale Mabry Hwy	Sligh Ave	Hillsborough Ave	SB	0.8
j	US 301	Riverview Dr	Boyette Rd	NB	1.0

Table ES-2 Interstate Hurricane Evacuation Hotspot Locations

Location ID	Road	Between	And	Direction	Distance (miles)
A	I-75	Fowler Ave	I-4	NB	3.6
B	I-4	McIntosh Rd	Branch Forbes Rd	EB	3.6
C	I-75	Dr MLK Jr Blvd	Brandon Blvd	NB	2.8
D	I-4	I-75	Mango Rd	EB	1.5
E	I-4	Paul Buchman Hwy	Park Rd	EB	1.2
F	I-75	Gibsonton Dr	Big Bend Rd	NB	4.2
G	I-75	Selmon Expy	US 301	NB	1.9
H	I-75	Brandon Blvd	Selmon Expy	NB	1.0
I	I-75	US 301	Gibsonton Dr	NB	3.6
J	I-75	Sun City Center Blvd	Valroy Blvd	NB	5.1

Figure ES-3 Existing vs. Typical HART Transit Routes and EJ Communities



Analysis, research, or case studies are provided to address the strategies identified. For a more in-depth analysis, the study team simulated the effects of three strategies using the Florida Statewide Hurricane Evacuation Model (TIME) to assess the impacts on evacuation clearance times. Evacuation models like TIME are specialized travel demand models that include considerations unique to evacuations. Response and demand factors make up the main inputs of the TIME model. Clearance times are part of the final output. The study team identified an input factor to assess the issues identified below and ran the TIME model to determine the effectiveness of various approaches:

- traffic congestion: small/low-cost interchange or intersection improvements for the identified hotspot locations – short, low-cost lane additions at intersections or interchanges were incorporated in the modeled transportation network.
- traffic congestion: emergency shoulder use along the interstates – the TIME model included a variable to assign emergency shoulder use to interstates.
- trustworthy and real-time communications: people evacuating faster after being requested to leave – the response curve was changed to six hours instead of twelve.

Adding local capacity at intersections/interchanges or (effectively) adding capacity to the interstate through emergency shoulder use did not reduce evacuation clearance times. However, quicker evacuation compliance due to enhanced communication did reduce clearances times

Adding local capacity at intersections/interchanges or (effectively) adding capacity to the interstate through emergency shoulder use did not reduce evacuation clearance times. This was most surprising for the use of interstate shoulders; however, modelers noted that TIME gives preference to interstate travel because people evacuating tend to travel long distances. As such, evacuations that might have occurred off interstates will move to the interstates with additional capacity, reducing congestion on local roads. These results also show that adding capacity solely for evacuation purposes may not be warranted.

There was, however, a change in clearance times detected for the third strategy, whereby people react quicker to evacuation notices. The study team used this scenario to test providing enhanced communications and evacuation information.

Two major recommendations resulting from this study are:

- Multiple strategies are needed to reduce or maintain clearance times, particularly as the population increases. Transportation specific strategies are:
 - Improve travel flow such as with traffic signal coordination or addressing circuitous routes.
 - Invest in permanent dynamic message signs to assist with notifications and operations during emergencies.
 - Address traffic congestion at evacuation hot spot locations through small, low-cost improvements.
 - Review transit routes for coverage of evacuation zones including mobile home areas and coverage of the county as a whole for residents sheltering at home.

- Continue collaboration and coordination among emergency managers and transportation providers to leverage capabilities and resources. Of particular need is the collaboration regarding communications as part of emergency preparation, response, and recovery. Information is readily available through resources such as Hillsborough County's [Stay Safe](#) website. The TPO and transportation agencies can help share information provided to inform residents and visitors. Assistance and coordination on targeted messaging related to transportation should be considered. For example, reminding people that evacuating to friends/family inland only tens of miles away instead of longer distances can provide a safe location and reduce the likelihood of traveling on congested roads, thus improving evacuation for others; or providing information about the registration requirements for transport to medical needs shelters.

Stay Safe Website


Hillsborough County has a comprehensive site with information for use before, during and after a storm, providing checklists, guides and contact details <https://www.hillsboroughcounty.org/en/residents/stay-safe/storm>

This study helped to illuminate some of the issues affecting hurricane evacuation and sheltering, particularly regarding transportation. It also reinforces the leadership role emergency management organizations play. The TPO is encouraged to continue the conversations with emergency management agencies and transportation partners on ways to reduce/maintain evacuation clearance times. Next steps can be accomplished as part of the 2050 long range transportation plan (LRTP), annual updates to the transportation improvement program (TIP), special studies included in the Unified Planning Work Program (UPWP), or ongoing programs or initiatives. These steps include:

- Continue to support existing projects and investigating strategic, low-cost improvements at identified hotspot locations to reduce congestion bottlenecks. (LRTP)
- Identify funding opportunities to implement additional display messaging capabilities or other operational intelligence to foster safe, efficient evacuations. (LRTP, TIP)
- Perform a more thorough study of public transportation needs and recommendations for operations during evacuations, considering typical and emergency routes, coverage for mobile home parks and communities using transit, and transport options for people with medical needs who have a safe, non-shelter destination. (UPWP)
- Collaborate or support development of targeted messaging for use prior to and during emergency events. New residents should be informed and current residents reminded of actions needed to stay safe. (Program/Initiative)

Introduction and Background

A critical component of transportation agencies' policy and program decision-making is system resilience to disruption. Evacuation plans are one way to respond to disruptions, such as hurricanes, or flooding. These plans are part of state and county emergency operations plans, and include an inventory of available shelters, identification of evacuation routes, and transportation services for persons unable to evacuate on their own.



This study looked for alternatives to road widenings to enhance evacuation and sheltering for emergencies

The Storm Evacuation Forecast & Shelter-in-Place Scenarios Study supplements this ongoing work by providing a high-level analysis of Hillsborough County's evacuation practices today. The study evaluated best practices in evacuation regionally and nationally, assessed potential evacuation enhancement options in Hillsborough County, and developed a set of recommendations and next steps for the Hillsborough Transportation Planning Organization (TPO) and other agencies to consider for emergency response in Hillsborough County. The focus was on options beyond road widening and on actions within the TPO's areas of responsibilities.

The first stage of the study identified issues related to evacuation for Hillsborough County, such as evacuation congestion areas. The second step identified strategies to address the issues and assesses the strategies' ability to provide evacuation and sheltering benefits. The last step covered both the issues and strategies evaluations and provides recommendations for the TPO and partner agencies. Stakeholder and public outreach helped to identify issues to study. Stakeholder and public outreach also solicited input on the proposed strategies.

1.1 Existing Evacuation System

When a hurricane or tropical storm bears down on the region, residents must make a choice to stay in their homes or evacuate to another location, either with family/friends, lodging, or at public shelters. Several elements make up the evacuation and sheltering systems in Hillsborough County, including evacuation routes, public evacuation shelters, and special transit routes. These systems are shown in Figure 1.

- There are five levels of evacuation, zones A through E that are determined by hurricane category 1 through 5, namely by the Saffir-Simpson Hurricane scale:
 - Zone A: 74-95 mph wind speed Category 1.
 - Zone B: 96-110 mph Category 2.
 - Zone C: 111-129 mph Category 3.
 - Zone D: 130-156 mph Category 4.
 - Zone E: 157+mph Category 5.
- Although the evacuation zones relate to hurricane category and wind speeds, they delineate areas anticipated to be inundated by storm surge.
- There are 46 public shelters and 10 shelters accepting pets. Special needs shelters are available for those who register and have qualifying medical or physical conditions.
- Shelters are opened on an "as-needed" basis and may vary with each emergency.

- Nine transit routes provide services to shelters at Pizzo Elementary, Shields Middle, Smith Middle, and Middleton High Schools.
- In past years, the Hillsborough School District also has provided buses and drivers to assist in an emergency.

Large areas around the bay and inland for riverine areas are designated for evacuation. All roads are available for travel during an evacuation. Evacuation routes, however, are signed for motorists and are major north/south and east/west roads including interstates. The public transit routes shown in Figure 1 are established in times of emergency and are different from Hillsborough Area Regional Transit (HART)'s typical routes.⁶ Currently, all the public transportation providers are experiencing driver shortages which can further complicate evacuation operations.

Hillsborough County has sufficient shelter space to meet hurricane evacuation standards. Of concern however is the length of time required for people to get to a safe location when leaving evacuation zones after evacuation orders have been activated, also called clearance time. Keeping the clearance time down is important given the abbreviated period between a hurricane warning and landfall. For example, a level C evacuation, corresponding to a Category 3 hurricane is projected to require 24 hours for people to evacuate to shelters in Hillsborough County, the same amount of time between when an evacuation order is issued, and tropical storm force winds make landfall.



Hurricane warnings and evacuation orders are issued approximately 24 hours prior to landfall of tropical storm force winds

The clearance time for a Category 3 hurricane is 24 hours

Public education focuses on encouraging residents in surge vulnerable areas and mobile homes to evacuate. People who live in site-built homes outside the surge vulnerable areas are encouraged to prepare their homes and mitigate for potential winds, i.e., window and door protection, braced gable end roofs, and garage doors. People in inland areas living in safe structures are encouraged to shelter-in-place. Residents will make their own decisions whether to evacuate, with some choosing to leave their homes when uncertain how they will cope from the impacts of wind. However, the key message is to seek refuge within “tens of miles, not hundreds of miles.”

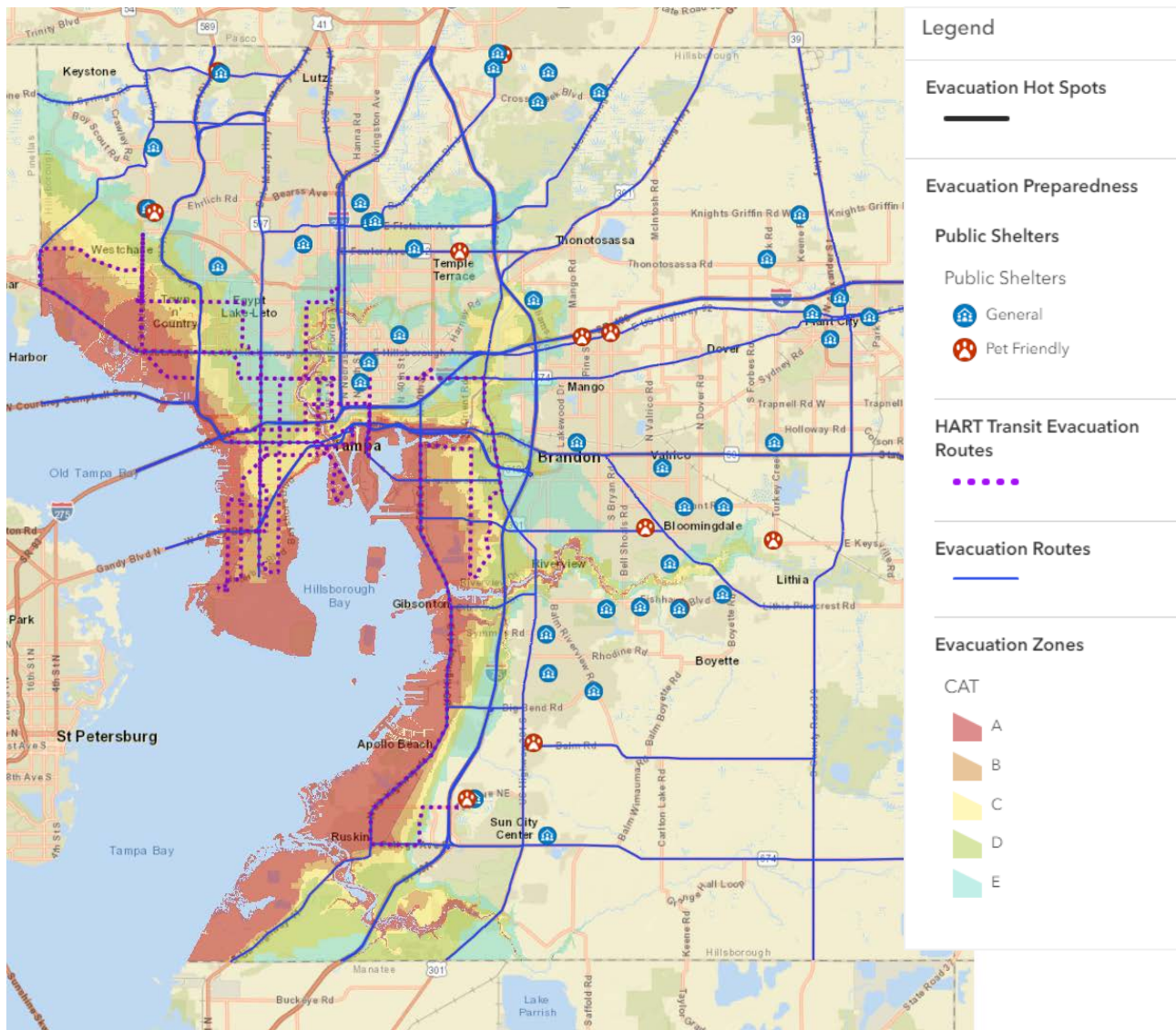


Key public message

Seek refuge within tens of miles, not hundreds of miles from your home

⁶ [Emergency Evacuation Maps | HART \(gohart.org\)](https://www.gohart.org)

Figure 1 Existing Public Shelters and Evacuation Zones Map



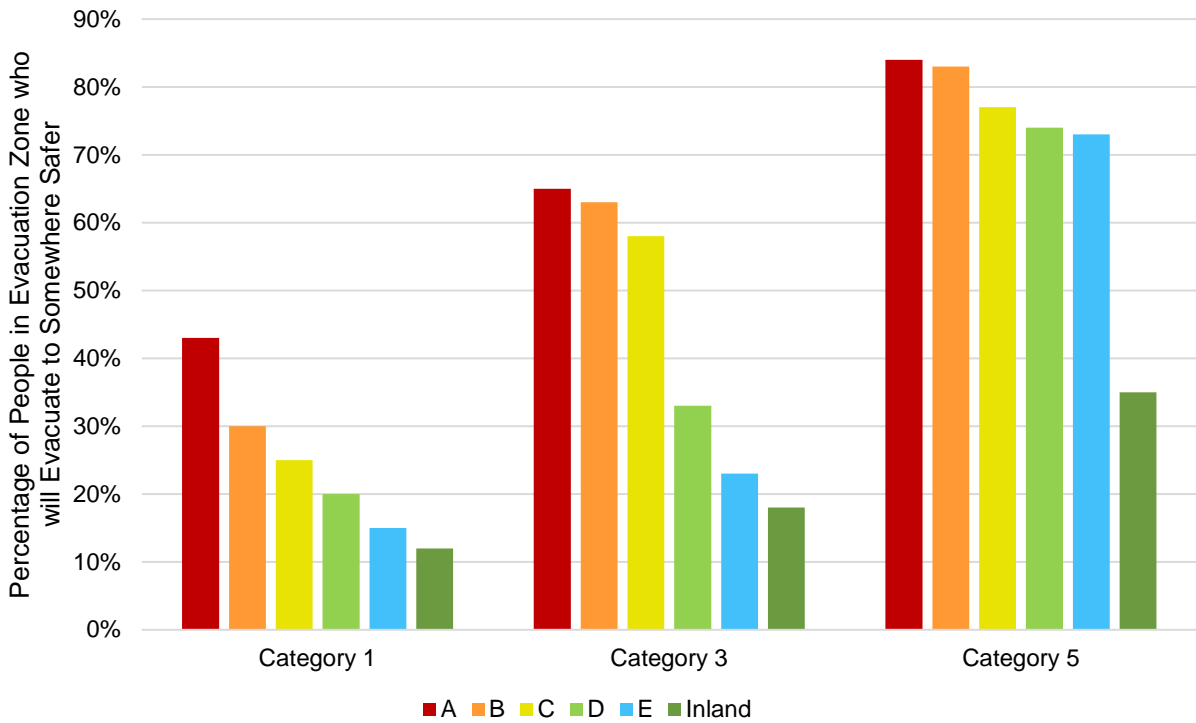
Note: Evacuation Zones are determined by the Saffir-Simpson Hurricane scale (Zone A: 74-95 mph wind speed Category 1; Zone B: 96-110 mph Category 2; Zone C: 111-129 mph Category 3; Zone D: 130-156 mph Category 4; Zone E: 157+mph Category 5).

1.2 Statewide Regional Evacuation Study

Statewide evacuation modeling assumptions and behaviors are studied and updates to the models made as part of the *Statewide Regional Evacuation Study Program* (SRESP) conducted for the regional planning districts in Florida, including the Tampa Bay Regional Planning Council.⁷ The most recent update studied behavioral data collected by surveys enhanced with location-based cell phone information for the first time. Figure 2 shows expected evacuation rates by storm severity and evacuation zone. (The term “inland” is used for geographic areas outside all evacuation zones.)

⁷ <https://www.floridadisaster.org/dem/preparedness/regional-evacuation-studies/>

Figure 2 Evacuation Rates by Evacuation Zone by Hurricane Category: Site-Built Home Residents

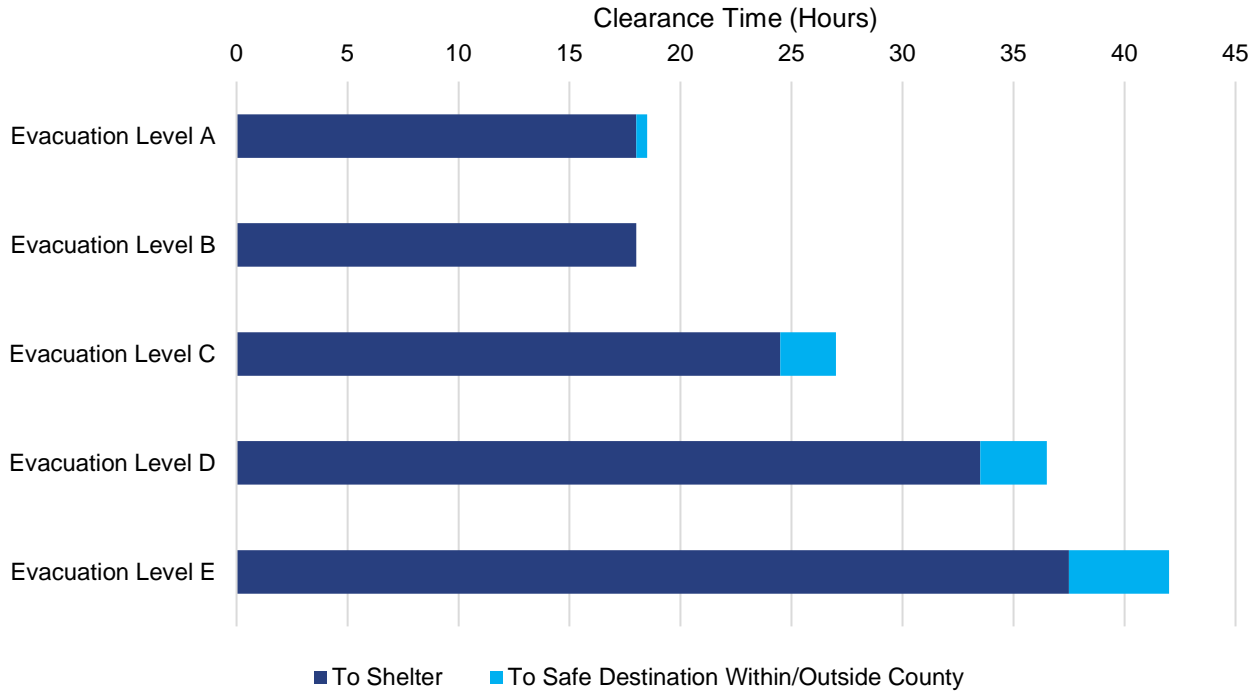


Clearance times refer to the amount of time the evacuation process will take once it has begun. Emergency management staff uses clearance times to determine a window of opportunity available to initiate evacuation orders and to ensure evacuees have enough time to reach evacuation destinations safely before storm arrival. Figure 3 shows the amount of time required for people in each of the evacuation zones to evacuate during a corresponding hurricane category. The figure shows times to evacuate to a shelter as well as the time required to evacuate to a safe destination (either inside or outside of Hillsborough County). This data is based on hurricane evacuation modeling and the model projects longer time to evacuate to a non-shelter destination, with the difference growing for more intense hurricanes. For example, evacuation zone C is expected to take approximately 24 hours for people to reach shelters and approximately three hours longer to reach other destinations. Emergency management personnel recommend people shelter in place if in a safe facility outside an evacuation zone. Traveling shorter distances to safe destinations with family, friends, or to a hotel/motel or shelter, is encouraged to reduce vehicles on roads during regional evacuations. County shelters are available to provide safety during a storm.



Traveling shorter distances to safe destinations (family, friends, hotel/motel, or shelter) is encouraged to reduce number of vehicles on roads during evacuations

Figure 3 Hillsborough County 2025 Operational Scenarios Clearance Times



The Florida’s Statewide Regional Evacuation Study Program (SRESP) conducted in 2021 used location-based services (LBS) data to infer actual behavior for the hurricane seasons from 2016 to 2020. The focus of this analysis was on the three hurricanes that struck Florida during this period: Matthew (2016), Irma (2017), and Michael (2018). Because the 2021 statewide regional study relied on phone application data, it provides a detailed picture of person travel during the three hurricanes. For Hillsborough County alone with a population of 1.4 million, 117,057, 482,545, and 134,829 unique devices⁸ were anonymously identified for Hurricanes Mathew, Irma, and Michael, respectively. Information about who evacuates, where they evacuate to, and whether they stay in-county are below. The information below provides a snapshot of data and additional information is provided in the Statewide Regional Study.

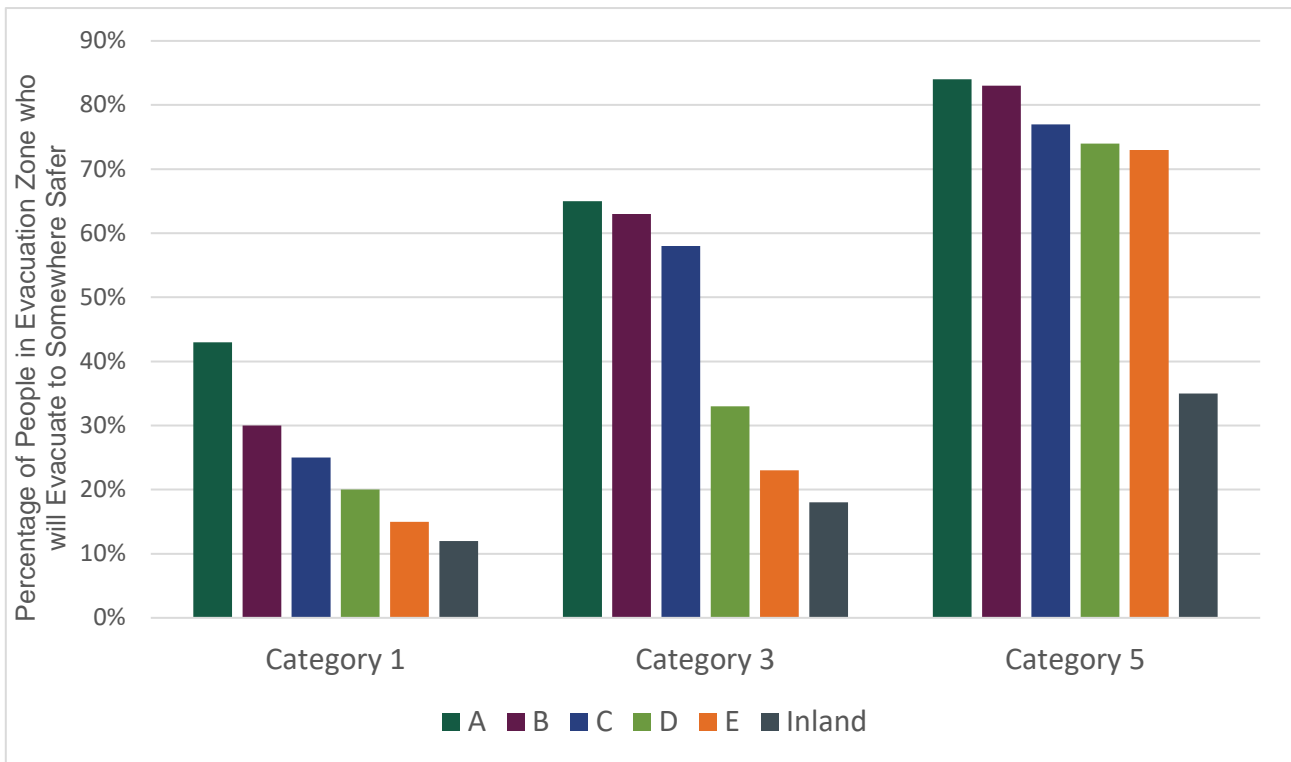
⁸ This compares to the original Statewide Regional Evacuation Study Program conducted between 2007-2008 surveying 18,800 Floridians regarding their behavioral response to hurricanes.

As reflected in Figure 4, the 2021 behavioral information shows those living closer to coastal areas evacuate at higher rates. However, 15 percent to 25 percent of people in evacuation zones will not evacuate for a Category 5 storm, which could place them in harm's way due to storm surge. Meanwhile over 10 percent of people outside evacuation zones (labeled inland for this study) will leave for a Category 1 storm, affecting evacuation clearance times. This information is for homes built on-site; people living in mobile homes or recreational vehicles are asked to evacuate for all categories of zones, i.e., they are to evacuate as part of Zone A.

For residents in site built homes, 25% will not comply with evacuation orders

However, 10% of residents outside evacuation zones will leave

Figure 4 Evacuation Rates by Evacuation Zone by Hurricane Category (Site-Built Homes)



Of people evacuating for Category 1 storms, the SRESP noted a large share of people evacuating to stay with friends or family – approximately 80 percent of people living in mobile homes and 75 percent of people living in site-built homes. The next largest share would stay in hotels/motels. Less than 10 percent of people would evacuate to shelters. Figures 5 and 6 show this information.

Figure 5 Evacuation Locations (Site-Built Homes) by Evacuation Zone for a Category 3 Hurricane

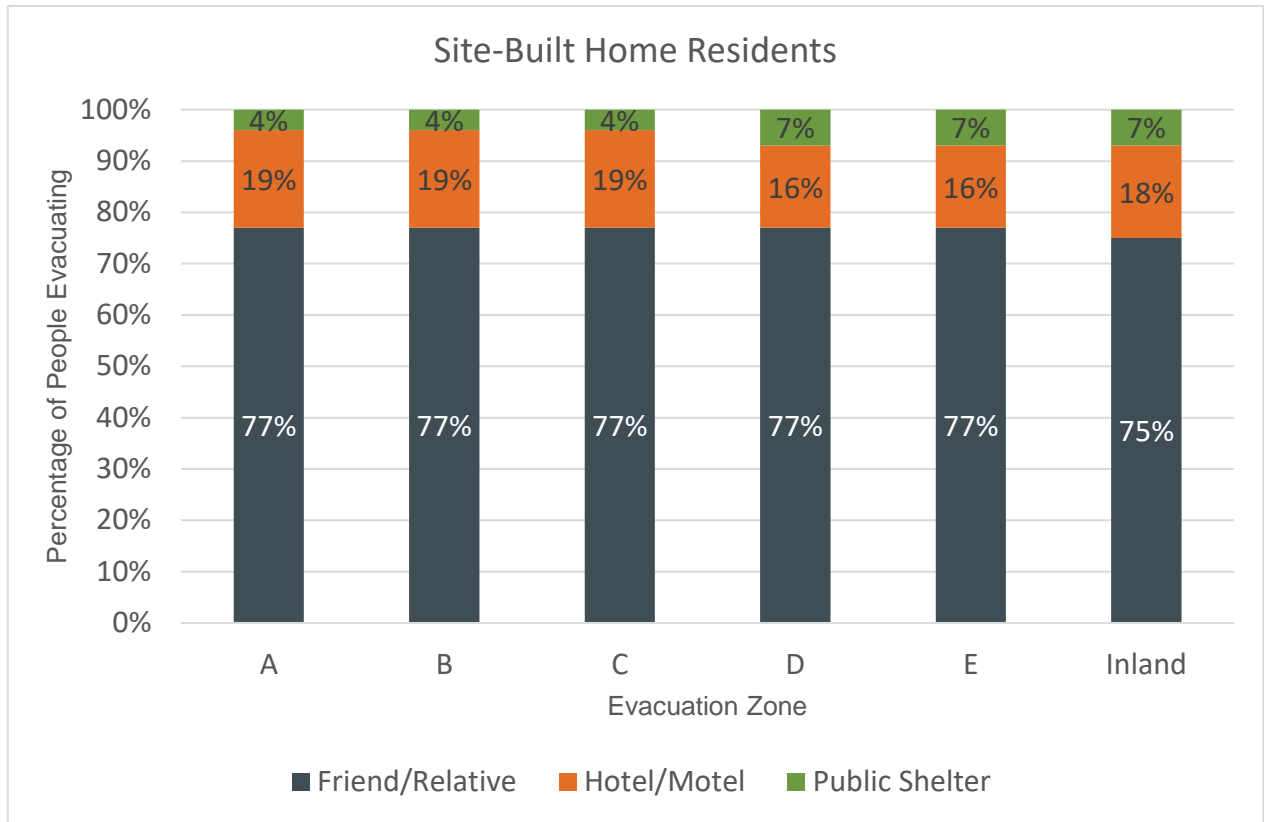
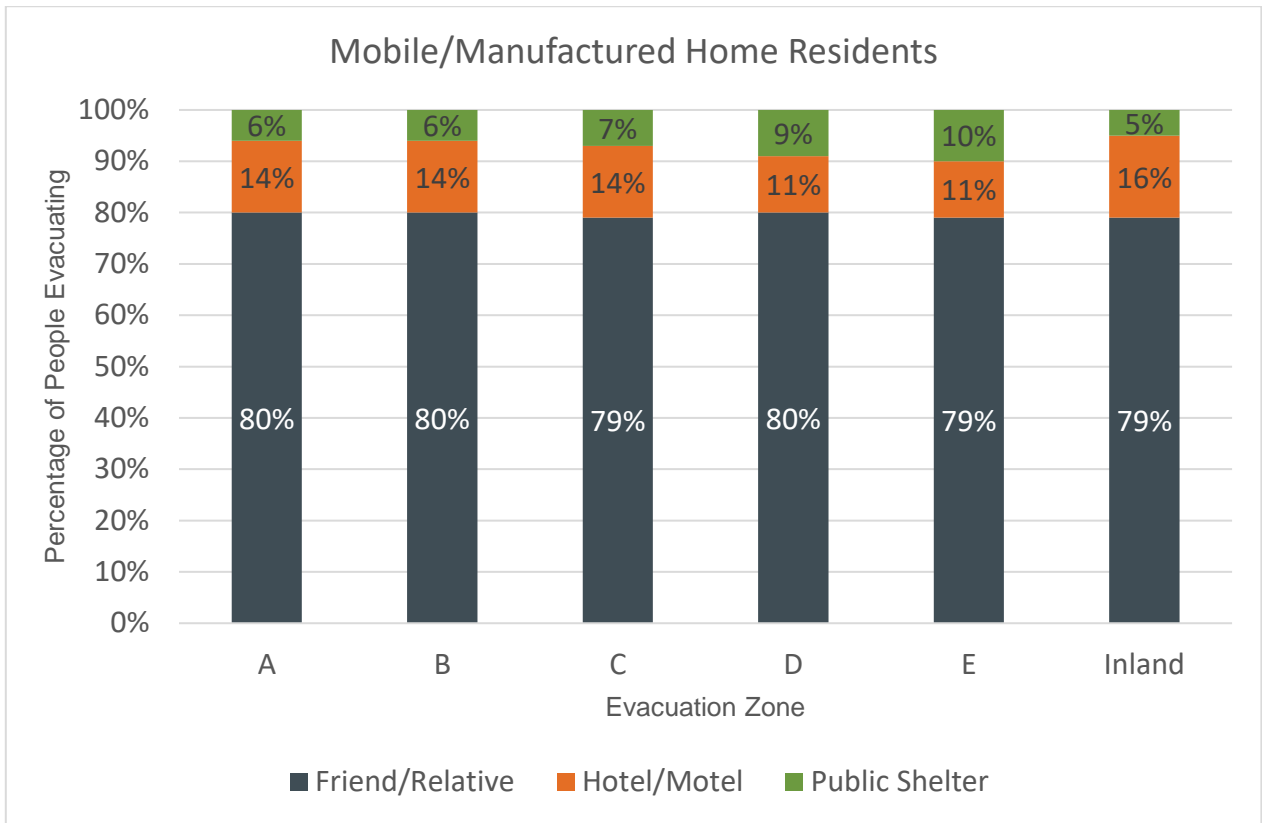


Figure 6 Evacuation Locations (Non-Site-Built Homes) by Evacuation Zone for a Category 3 Hurricane



Of the people evacuating, some will leave Hillsborough County. They could be traveling to second homes, staying with family and friends who live outside the County, or staying in motels/hotels, for example. Figures 7 and 8 show the percentages of people evacuating that leave Hillsborough County. People living in mobile homes/RVs in any of the evacuation zones A-E are expected to have the same percentages of people leaving the county regardless of hurricane strength. This is 40-45 percent. People inland will evacuate at slightly higher rates depending on hurricane category, at a 40-47 percent rate. People not living in mobile homes/RVs in evacuation zones B – E will leave the county at a rate between 47 and 50 percent. People in zone A will leave the county at slightly higher rates – 50-52 percent. Half the people living outside an evacuation zone (i.e., inland) that evacuate will leave the county.

Of people evacuating:

- 75-80% will stay with a friend of relative
- 11-19% will go to a hotel/motel
- less than 10% will go to a public shelter

Figure 7 People Evacuating that Leave Hillsborough County (Site-Built Homes)

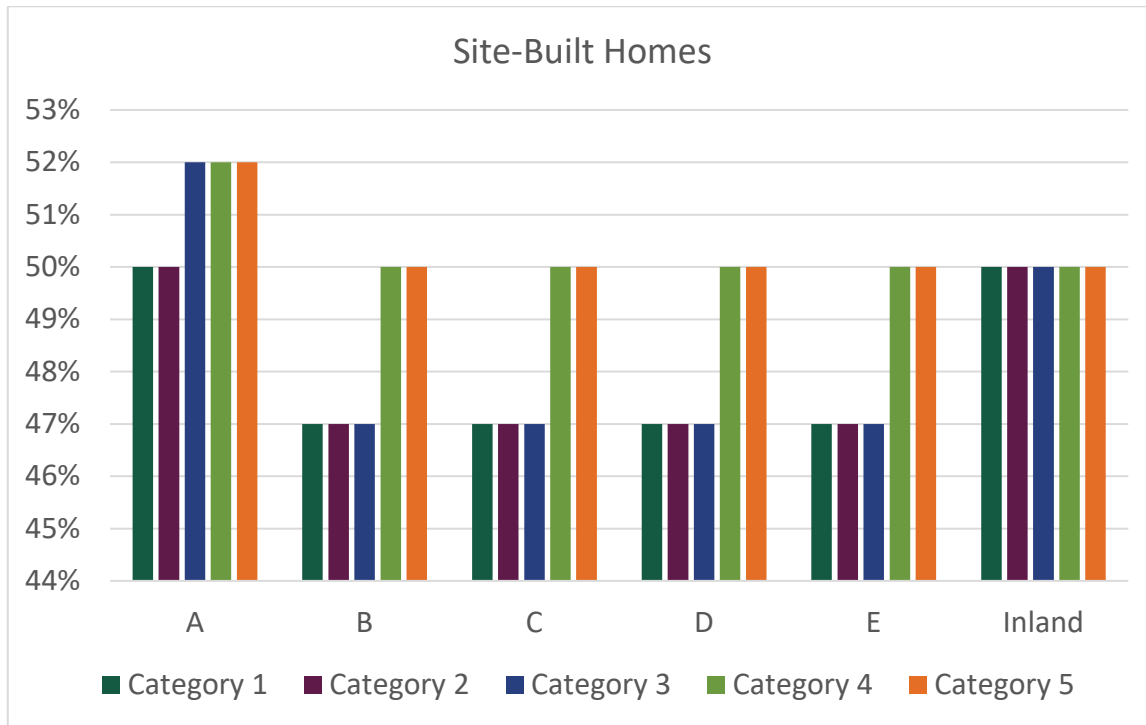
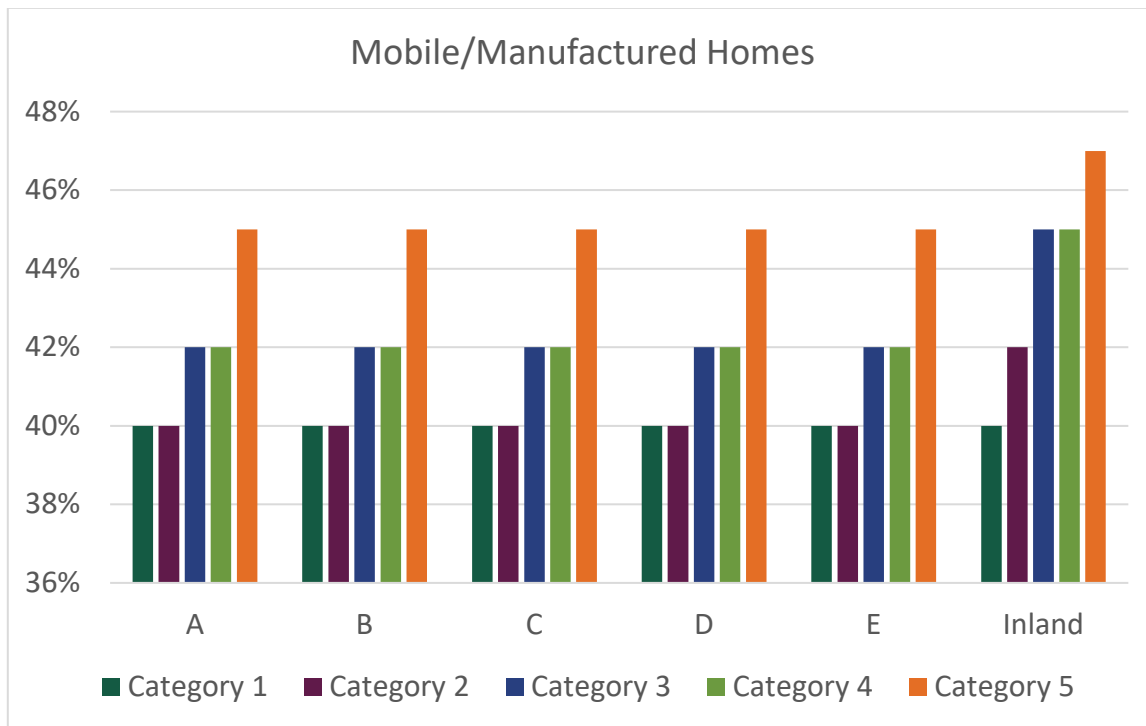


Figure 8 People Evacuating that Leave Hillsborough County (Non-Site-Built Homes)



As of April 2019, data⁹, there are 17,920 individual mobile home lots in Hillsborough County. Mobile home occupants countywide are told to evacuate when any evacuation order is given, starting with Zone A. These mobile home parks are located around the county, even in non-flood areas. Mobile home occupant demographics are typically more elderly, low-income, or otherwise disadvantaged than the average population. According to a 2019 study conducted by the University of South Florida¹⁰, “Slightly more than 36 percent of the [mobile home] households consisted entirely of elderly persons (65 and older); an additional 49.1 percent of the households included members 64 years of age or older; about 15.4 percent of the population were widowers living alone. These are segments of the population that could be categorized as having special needs especially during emergencies.” The mobile home park locations in Hillsborough County are summarized in Figure 9. The breakdown of mobile home lots by evacuation zone is shown in Table 1,

Table 1 Mobile Home Lots by Evacuation Zone in Hillsborough County

<i>Total Mobile Home Lots in Hillsborough County</i>		17,920
<i>Mobile Home Lots in Each Evacuation Zone</i>	A	3,012
	B	1,892
	C	1,496
	D	105
	E	905
	None	10,510

Note: According to April 2019 Florida DBPR data.

Not captured in the SRESP is the number of people that are concerned about pets when evacuating. This behavioral topic influences evacuation. FEMA guidance¹¹ includes a note about pets and evacuation: “Sixty-five percent (65%) of American households have pets, which includes a variety of animal species, and populations who are evacuating should bring their animals with them. If they are not able to bring their animals, a significant percentage of the population may not leave. When feasible, animals should remain with their owners during transport. By law, service animals—and, in some cases, assistance animals—must always remain with the owner.”

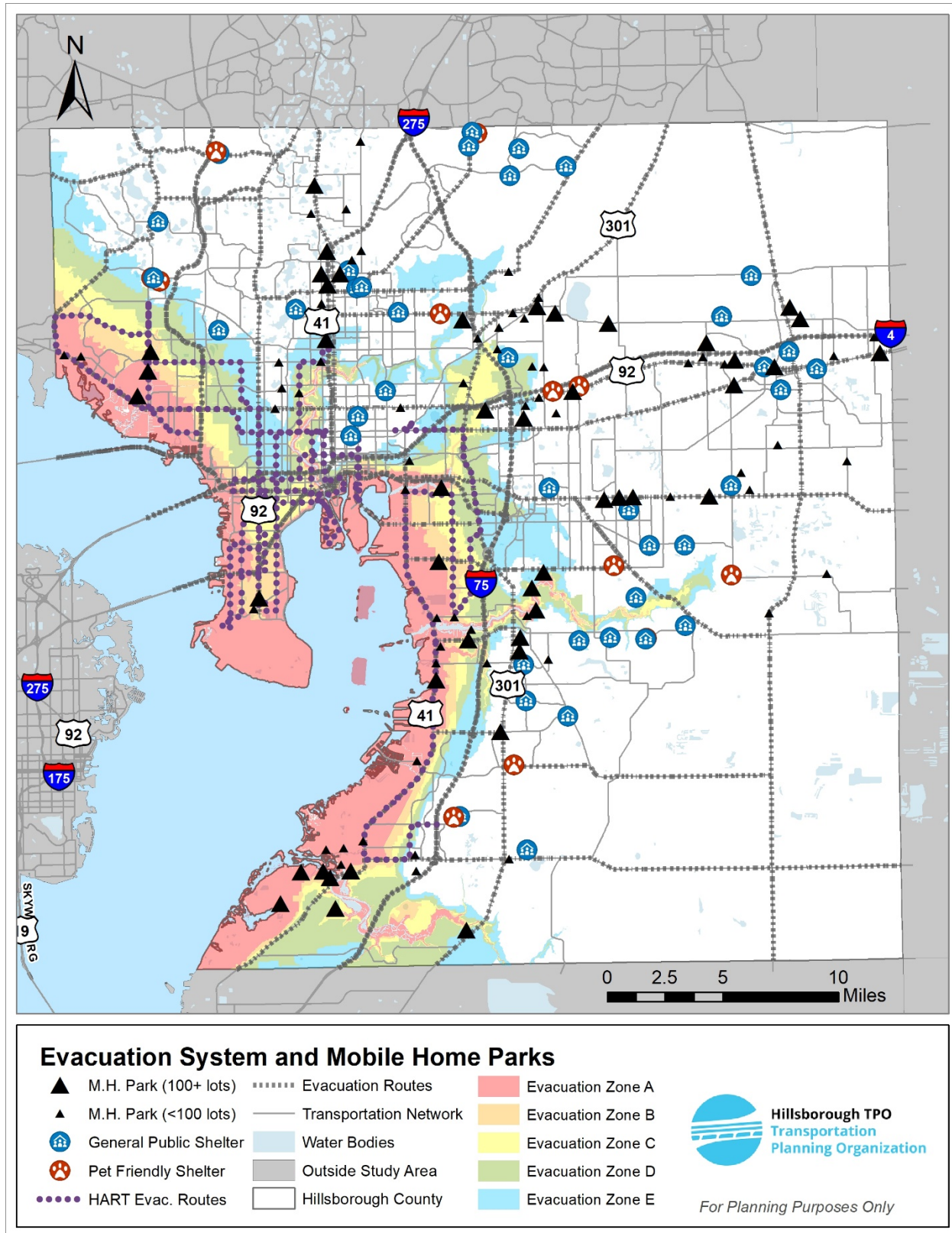
Surveys and stakeholder input indicates that people’s pets can be a contributing factor in their decisions concerning evacuation. The robustness of pet available shelters along with proper messaging and communication can help reduce this factor in improper evacuation.

⁹ University of Florida GeoPlan Center data compiled from Florida Department of Business and Professional Regulation. April 2019. [Condominiums, Timeshares, and Mobile Homes – Public Records – MyFloridaLicense.com](https://www.myfloridalicense.com)

¹⁰ “Mitigating the Effects of Hurricanes in Florida: Three Challenges of Upgrading Mobile Home Parks.” Stephen Schreiber, FAIA. University of South Florida. 2019.

¹¹ [Planning Considerations: Evacuation and Shelter-in-Place, Guidance for State, Local, Tribal, and Territorial Partners. FEMA. July 2019.](https://www.fema.gov)

Figure 9 Mobile Home Parks and Evacuation Zones in Hillsborough County



The SRESP results imply that many people often plan to shelter with friends or family for major storms. This additional preparation and travel could be disruptive to the shelter-in-place expectations concerning traffic demand on roadways. Preventing shadow evacuation (the voluntary evacuation of people from areas outside a declared evacuation area) can drastically help reduce demand on roadways during a mass evacuation, but changing the behavior is not easy. The best method from the Emergency Management side is to be early and often with communication efforts to educate the population on the benefits of sheltering in place when appropriate. Of those who should shelter in place, the more who stay with friends/family instead of evacuating the region, the better. And of those in sturdy homes, the more who stay in place instead of travel across town to friends/family, the better.

Evacuation decisions are impacted by behavioral factors. Such factors could include social connectedness, socio-economic and demographic background, and specific situations. Even more, past experience can impact whether some choose to evacuate.¹² These behavioral factors cannot be changed in real-time but can be understood when planning for emergency management. Even more time and effort toward assessing some of these behavioral impacts with model input adjustments may provide meaningful results.

1.3 Wind Risks

Hurricane evacuation is geared to move people from the life-threatening, damaging storm surge that can occur with tropical storms and hurricanes. Because hurricane strength is tied to wind speed, it is common for people to assume evacuation zones are relate to potential wind damage. Mobile and manufactured homes or recreational vehicles, however, are an exception and residents should evacuate to safer destinations for hurricane evacuations at all levels.

Wind risks to manufactured homes and site-built homes are well documented in the history of building code regulation and research around hurricane preparedness. Before 1976, there were virtually no regulated building standards on mobile home construction for wind resilience. In 1976, the Department of Housing and Urban Development (HUD) employed standards on mobile home construction. However, after dismal performance of mobile homes in Hurricane Andrew (1992), new wind standards went into effect in the HUD code in July 1994. After that, the state of Florida has progressively adopted tougher wind performance standards in housing construction including for mobile homes. An analysis of case studies conducted in 2009 documented typical damage experienced by manufactured and mobile homes in various hurricane category wind speeds, distinguishing between anchored and unanchored construction. The findings are summarized as follows:

- For sustained one minute sustained winds of 55 to 73 MPH at 33 feet (3-sec gusts 75 to 95 MPH): Manufactured houses perform well with occasional damage involving the removal of the roof covering, and damage to carports or sunrooms. Unanchored, single-wide homes can slide or roll especially if broadsided by the wind and in open terrain.
- For sustained one minute sustained winds of 74 to 95 MPH at 33 feet (3-sec gusts 96 to 115 MPH): Manufactured houses perform well with occasional damage involving the removal of the roof covering,

¹² Collins, J., Polen, A., McSweeney, K., Colón-Burgos, D., & Jernigan, I. (2021). Hurricane Risk Perceptions and Evacuation Decision-Making in the Age of COVID-19, *Bulletin of the American Meteorological Society*, 102(4), E836-E848. Retrieved Nov 24, 2021.

and damage to carports or sunrooms. Unanchored, single-wide homes can slide or roll especially if broadsided by the wind and in open terrain.

- For sustained one minute sustained winds of 96 to 110 MPH at 33 feet (3-sec gusts 116 to 135 MPH): Structural damage can occur to manufactured homes. Unanchored, single-wide homes can slide or roll especially if broadsided by the wind and in open terrain. More common damage can include the displacement of the roof covering, carports, and sunroom additions. In a study of 1678 manufactured homes in Katrina, less than 10 percent sustained structural damage.
- For sustained one minute sustained winds of 111 to 130 MPH at 33 feet (3-sec gusts 136 to 155 MPH): Structural damage is more likely for manufactured homes. Unanchored, single-wide homes can slide or roll or vault especially if broadsided by the wind and in open terrain. More common damage includes the displacement of the roof covering, carports, and sunroom additions.
- For sustained one minute sustained winds of 131 to 155 MPH at 33 feet (3-sec gusts 156 to 175 MPH): Manufactured housing: Complete devastation is likely with shedding of metal cladding and destruction of the wooden box on top of the steel frames. Steel frames that are well anchored remained in place. However, those frames that are not anchored shift, roll, or are tossed.

According to National Oceanic and Atmospheric Administration (NOAA), damage can occur to well-constructed frame homes in Category 1 hurricanes starting with roof, shingles, siding, and gutters. In Category 4 strength winds, “well-built frame homes can sustain severe damage with loss of most of the roof structure and/or some of the exterior walls.” Figure 10 shows the National Hurricane Center’s full chart showing typical damage expected to frame homes from wind damage by hurricane category.

Evacuation behavior can be affected by how comfortable people are with the structural integrity of their homes, whether manufactured or site-built. At the threat of higher storm strength, many, even those in site-built homes, might question their safety for sheltering in place.

The study team researched local government practices for regulatory or policy mechanisms linking evacuation to a structure’s ability to withstand hurricane wind speeds. There was little precedent found and those local governments found to offer recommendations to the public tend to rely on the Saffir-Simpson scale and impacts mentioned above. In consulting emergency management personnel on the topic, they mentioned liability concerns as potential reasons. The research did produce examples of weatherization programs or programs addressing substandard housing conditions as local government tools to improve housing. Property Assessed Clean Energy (PACE) programs (<https://floridapace.gov/>) allow homeowners to finance home hardening improvements, such as new roofs or window shutters, through a special (non-ad valorem) assessment instead of paying for the improvements up front. The Florida Weatherization Assistance Program (<https://www.benefits.gov/benefit/1847>) provides grants to community action agencies, local governments, Indian tribes and non-profit agencies to fund energy saving repairs to households with low-incomes. Tampa Hillsborough Action Plan, Inc. is the local agency for Hillsborough County. The [Hillsborough County Consolidated Plan Program Year 2021 Through 2025](#) provides a description of housing needs by geographic area that may help identify communities containing housing with substandard conditions or in need of weatherization or hardening.

Figure 10 National Hurricane Center Typical Damage by Saffir-Simpson Hurricane Wind

Saffir-Simpson Hurricane Wind Scale		
Climatology Names Wind Scale Extremes Models Breakpoints		
<p>The Saffir-Simpson Hurricane Wind Scale is a 1 to 5 rating based only on a hurricane's maximum sustained wind speed. This scale does not take into account other potentially deadly hazards such as storm surge, rainfall flooding, and tornadoes.</p> <p>The Saffir-Simpson Hurricane Wind Scale estimates potential property damage. While all hurricanes produce life-threatening winds, hurricanes rated Category 3 and higher are known as major hurricanes*. Major hurricanes can cause devastating to catastrophic wind damage and significant loss of life simply due to the strength of their winds. Hurricanes of all categories can produce deadly storm surge, rain-induced floods, and tornadoes. These hazards require people to take protective action, including evacuating from areas vulnerable to storm surge.</p> <p>*In the western North Pacific, the term "super typhoon" is used for tropical cyclones with sustained winds exceeding 150 mph.</p>		
Category	Sustained Winds	Types of Damage Due to Hurricane Winds
1	74-95 mph 64-82 kt 119-153 km/h	Very dangerous winds will produce some damage: Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph 83-95 kt 154-177 km/h	Extremely dangerous winds will cause extensive damage: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (major)	111-129 mph 96-112 kt 178-208 km/h	Devastating damage will occur: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (major)	130-156 mph 113-136 kt 209-251 km/h	Catastrophic damage will occur: Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (major)	157 mph or higher 137 kt or higher 252 km/h or higher	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

3.0 Public and Partner Engagement

To obtain input about evacuation and sheltering issues of importance to Hillsborough County agencies, residents, businesses, and visitors, the study team used a variety of methods. A virtual open house with participant polling provided input, as did two on-line surveys made available on the study's website and noticed via newsletters and social media. TPO staff participated in community meetings. Data on Hillsborough County residents' opinions from a statewide pandemic and evacuation survey performed by the University of South Florida and an annual Florida International University survey were also used. More details on these items are described below.

3.1 Stakeholders and Partners

The study team coordinated with partner agencies, especially the emergency management organizations for Hillsborough County, City of Tampa, and the Tampa Bay Regional Council throughout the study. At a study kick-off meeting held on June 6, 2021, attendees from the Hillsborough TPO, the Hillsborough Planning Commission, Hillsborough County planners and emergency management staff, City of Tampa planners and emergency management staff, and Hillsborough Area Regional Transit (HART), discussed the study's purpose and had suggestions about evacuations and sheltering. Some of the items are:

- HART's focus has been on covering coastal areas and changes to accommodate communities of concern may support more people. A potential concern that shelters are not on bus routes was mentioned. Changing route patterns during an emergency also may cause confusion for riders.
- There were discussions on the need to coordinate, particularly with the State of Florida, during emergency evacuations and especially large events like hurricanes.
- Another topic mentioned was a need to look at future growth to be able to continue to support evacuation and shelter needs. The Tampa Bay Regional Planning Council is addressing this subject.

We prepared an on-line survey and held a virtual open house with internet/phone polling to solicit public input. The survey link also was made available via TPO social media, newsletters, the study website, and email and social media notices provided by partner agencies. People provided useful information through the open-ended questions of the survey; however, the number of responses was low. To supplement these results, the study team reviewed information from two university-led surveys: one from Florida International University that has been surveying Floridians' culture of preparedness for hurricanes for 15 years, and the second from the University of South Florida that conducted statewide surveys (with Hillsborough County specific data) for 2020 and 2021 regarding relationships between COVID-19 and hurricane evacuation and sheltering.

3.2 Surveys and Polling

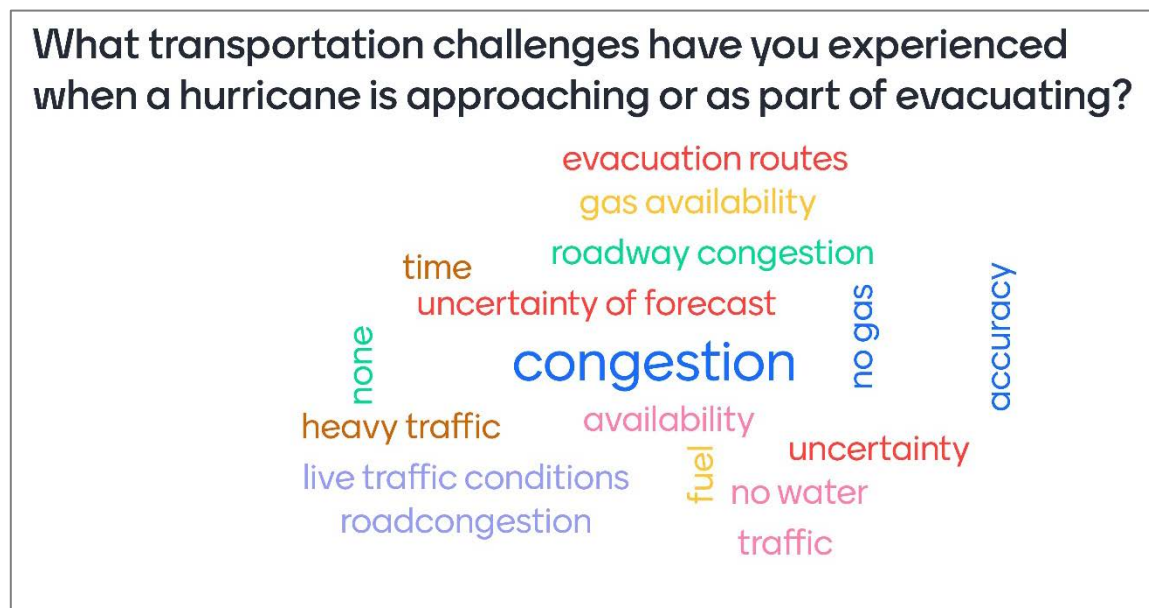
Open House Polling

On August 25, 2021, the TPO and study team hosted a virtual open house to explain the study’s purpose and seek feedback on evacuation issues. A video of the presentation¹³ was placed on the study website for public viewing at any time. Throughout the presentation polling was used to gather information. For most questions, respondents could choose up to three answers.

When determining whether to evacuate, storm severity is a principal factor for 94 percent, with 63 percent citing a place to stay, and 44 percent indicating no need to evacuate. If asked to evacuate, respondents would evacuate based on storm severity and their evacuation zone as the top two answers at 87 percent and 80 percent, respectively. Similarly, 87 percent indicated storm severity and staying with family/friends/pets at 80 percent as the top two answers for where they would evacuate, with two thirds indicating privacy or security as important.

There were two free answer questions with the first, see Figure 11, asking what transportation challenges people to have experienced when a hurricane is approaching or as part of an evacuation. Congestion was the top answer, including phrases such as road congestion, traffic, heavy traffic, and live traffic conditions. Gas and fuel availability was a frequent answer, along with storm forecast uncertainty or accuracy.

Figure 11 Online Survey Response Word Map



A final question asked if any considerations were not covered during the presentation or polling. Having access to real time or live data (about weather, gas availability, traffic, etc.) and traffic were frequent answers. Other comments related to uncertainty about evacuating, issues associated with returning home after evacuation, communication strategies, and increased evacuation times with increased residents and visitors.

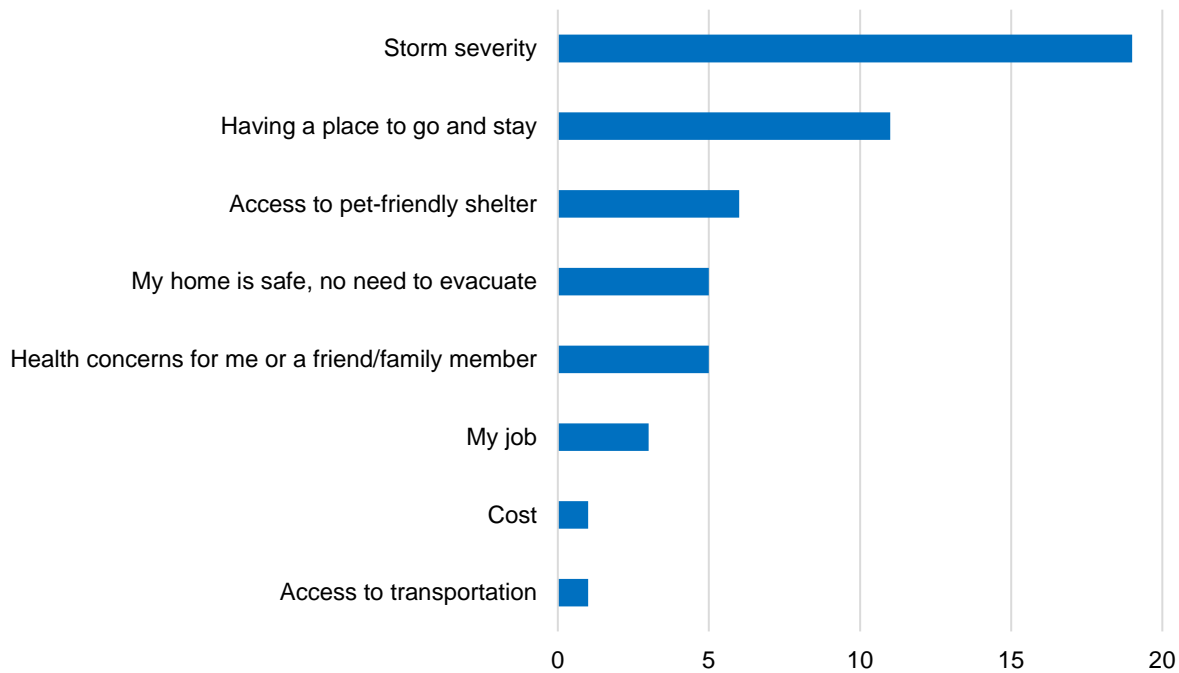
¹³ <https://www.youtube.com/watch?v=7rkqbTPqvoc>

Issues Survey

An on-line survey with questions like those asked at the open house was provided and noticed via the study's website and TPO social media. Given available space, respondents were given additional options, yet still chose at most three factors. Half of these respondents indicated they lived in an evacuation zone. Results are shown in Figure 12.

When determining if to evacuate, storm severity was identified most often, with the second popular answer as having a place to stay. Access to a pet-friendly shelter and no need to evacuate due to a safe home, were next. With more choices, respondents indicated health concerns for themselves or a family member as an important factor and job responsibilities were identified. Uncertainty about storm predictions and flooding potential were mentioned as key factors in determining whether to evacuate.

Figure 12 Online Survey Response on Important Factors for Whether or Not to Evacuate



When asked a question about when people would leave if asked to evacuate, respondents most frequently selected storm severity and projected path as well as based on evacuation zone and orders to leave, or storm location. For those who do not live in an evacuation zone, two-thirds were very likely or somewhat likely to shelter at home.

When asked about transportation challenges experienced in the past, traffic congestion and gasoline shortages were most frequently mentioned. Several noted that daily traffic congestion in non-emergency times discourages them from evacuating during a hurricane or tropical storm. Individuals mentioned lack of public transportation and flight cancellations.

Responses to the question about other considerations that may have been missed in the survey included many comments about traffic congestion and fixing roads. Several respondents indicated job responsibilities that

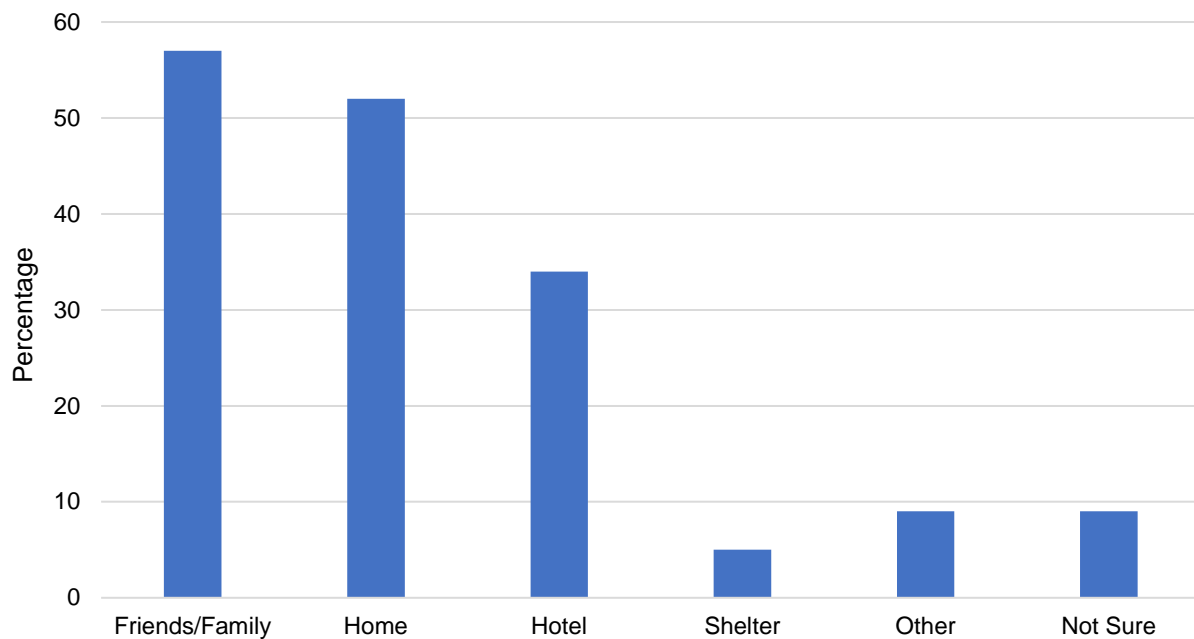
restrict evacuation. Growth, particularly in South Tampa was mentioned. Another suggestion was to provide access to resources (e.g., gas for personal vehicles, sandbags, and supplies) for those that will shelter in place.

USF Statewide and Hillsborough County COVID-19 and Evacuation Survey

Because of the small number of responses received during the open house and on-line surveys, the study team also considered results from two statewide surveys. The University of South Florida¹⁴ conducted statewide surveys in 2020 and 2021 regarding COVID-19 and relationships to hurricane evacuation and sheltering. Results from the 2021 survey is summarized here, based on responses they received from 234 participants for Hillsborough County (out of the original ~1000).

When asked where they saw themselves in case of a severe hurricane with high winds or flooding, 5 percent indicated they would evacuate to a shelter, 34 percent would evacuate to a hotel, 57 percent would go to a friend's or family member's house, 52 percent said they would stay at home. Nine percent said "other," and 8.5 percent did not know. Respondents were allowed to select multiple options.

Figure 13 Evacuation/Shelter Location for Severe Hurricane with Strong Winds



Many respondents, 29 percent taking the survey did not know if they live in an evacuation zone, while 18 percent knew they did not. Of the remaining, 24 percent, 10 percent, 7 percent, 5 percent, 7 percent of respondents live in zones, A, B, C, D, and E, respectively. Over three-fourths (76 percent) are homeowners.

When it comes to pet ownership, 55 percent say they have a pet, and it affects their evacuation decisions. 26 percent do not have a pet, and 18 percent have a pet, and it does not affect evacuation decisions.

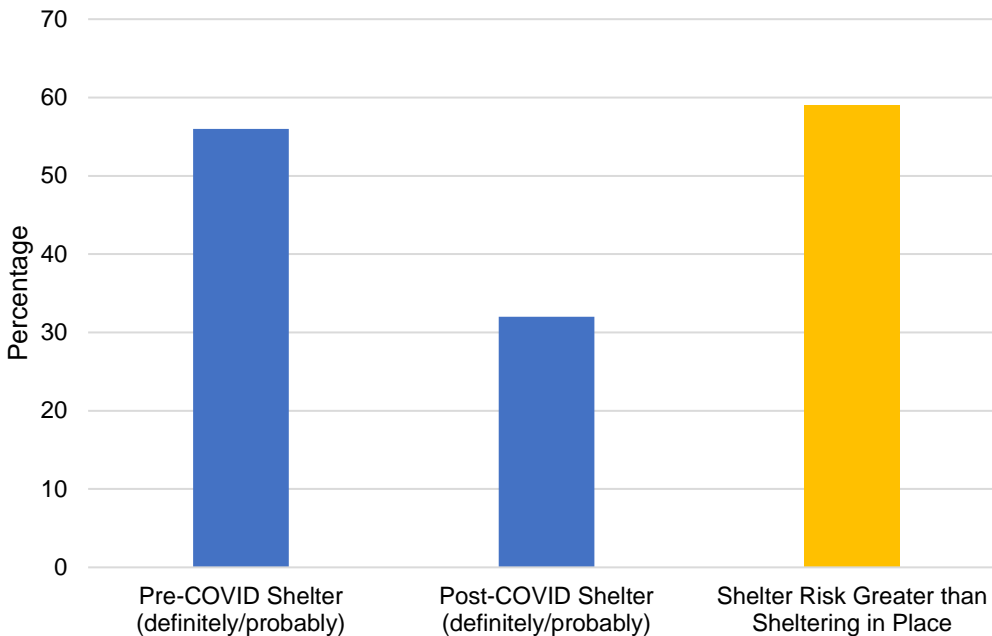
¹⁴ Collins, J., Polen, A., McSweeney, K., Colón-Burgos, D., & Jernigan, I. (2021). Hurricane Risk Perceptions and Evacuation Decision-Making in the Age of COVID-19, *Bulletin of the American Meteorological Society*, 102(4), E836-E848. Retrieved Nov 24, 2021.

Given their present situation, 66 percent said they think they could evacuate if a hurricane were to impact their area, with 26 percent more indicating maybe. Those indicating they could not or do not know consist of 7 percent and 1 percent, respectively. The most frequent answers for those that could not evacuate were traffic, pets, and a secure home. Nearly 99 percent indicated they would have reliable transportation to evacuate to a shelter or elsewhere.

COVID-19 has affected people's decisions regarding sheltering. Respondents indicated that before the pandemic 56 percent definitely or probably go to a shelter during an evacuation order. In the current situation, only 32 percent stated they would definitely or probably go to a shelter. Similarly, 59 percent indicated the risks of going to a shelter would be worse than sheltering in place.

COVID-19 has affected people's evacuation decisions. They indicated going to a shelter is less safe than sheltering in place.

Figure 14 Survey Results on Effects of COVID on Sheltering



Nearly 80 percent of respondents stated they were very or somewhat likely to evacuate for the next hurricane expected to have a major impact on their area. Items offered as ways that would help with the decision included better forecasting, more advanced notice, COVID precautions, evacuation infrastructure improvements, more information on shelters and evacuating, pet support, and traffic control.

Just 2.5 percent of respondents indicated they felt they need access to a special needs shelter; however, 20 percent reported they or someone in their household applied to determine eligibility for a special needs shelter/accommodations. On another question, 14.4 percent responded that someone in their household has a disability.

FIU Metropolitan Center Annual Hurricane Poll

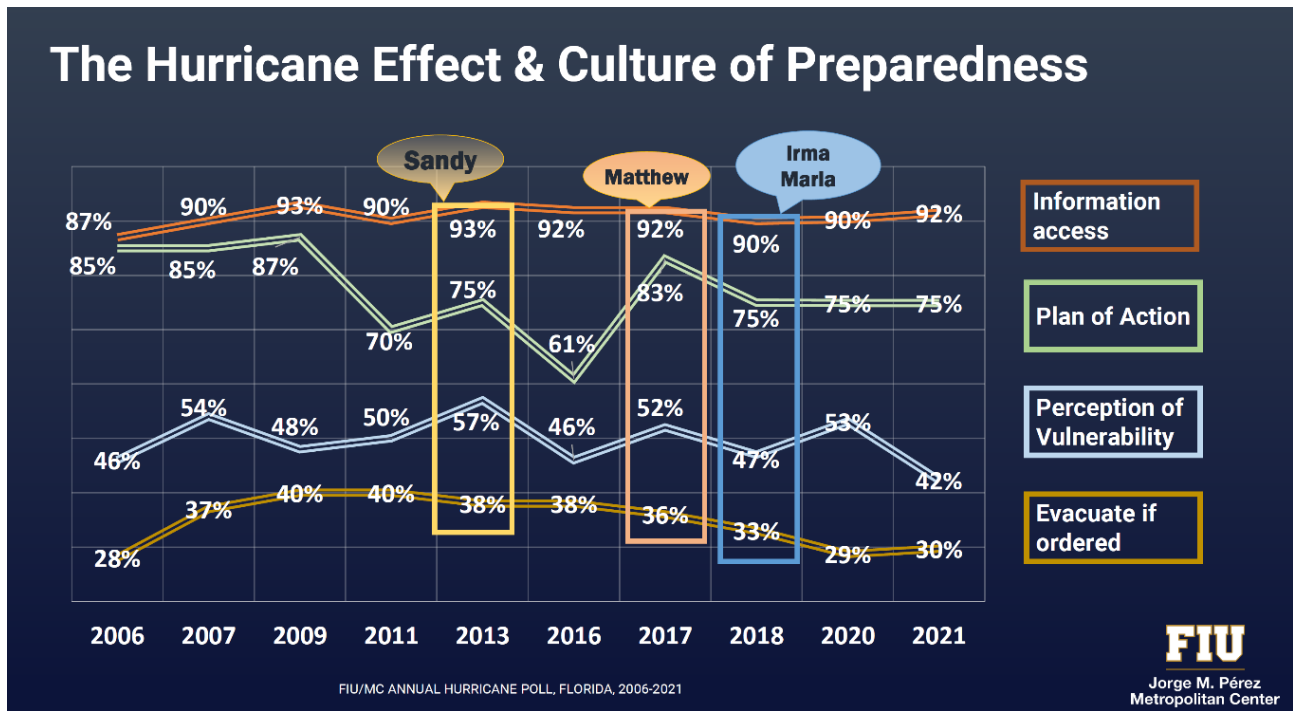
The Metropolitan Center at Florida International University (FIU) has conducted periodic statewide surveys since 2006 to gauge Floridians' preparedness and response to potential hurricanes. As shown in Figure 15,

they track the results in four broad areas: access to information, having a plan of action, perception of vulnerability, and willingness to evacuate if ordered. Contrary to the study open house polling and survey, 90 to 93 percent of poll respondents stated they have access to information about hurricanes. Respondents' perception of their vulnerability to an event and having a plan of action

Perception of vulnerability and event preparation depend on whether there was a hurricane in the previous year

tends to go up and down around 70 percent and 45 percent, respectively, depending on whether there was a significant hurricane in the previous year. In 2021, 75 percent indicated having a plan of action and only 42 percent perceived being vulnerable to a hurricane. The perception is the lowest percentage since the survey has been performed. Of particular concern, is that only 30 percent of respondents would evacuate if ordered. This compares with the Statewide Regional Evacuation Study for Tampa Bay, where over 12 percent and 35 percent of people outside all evacuation zones for category 1 and 5 hurricanes respectively, would evacuate.

Figure 15 FIU/MC Annual Hurricane Poll Results 2006-2021



3.2.1 Strategy Survey

After evacuation and sheltering issues were identified, the study team identified strategies to address them. An on-line survey was performed toward the end of the study to evaluate the public's reactions to proposed strategies. Table 2 shows questions and responses from this survey. The survey was available on the TPO's study website and also was made available via TPO social media, newsletters, the study website, and email and social media notices provided by partner agencies. Notices were sent to communities (zip codes) near a hot spot location and TPO staff also presented at community events and meetings. The Westshore Alliance and New North Transportation Alliance helped distribute information about the survey.

Table 2 Strategy Survey Reponses

Strategy	Yes	No	Maybe
This study is looking at solutions that do not require expensive major road widenings. Do you agree with making such changes to improve travel during a storm evacuation?	68%	11%	18%
Enhancements that modify a freeway interchange or add a turn lane at intersections could reduce congestion or delays. Do you agree with making such changes to improve travel during a storm evacuation?	68%	11%	19%
Changing traffic signals to allow more traffic to evacuate away from the storm or coast could improve travel during an emergency. Would you like to see this solution used during a storm evacuation?	86%	5%	14%
During evacuations, would you use the shoulder of the interstate to evacuate if it's allowed, such as on I-75 or I-4?	61%	13%	24%
Having accurate travel information during a hurricane is important. One solution being considered is adding more signs on roads and freeways to provide real time information on travel times to destinations, road closures or crashes, etc. These signs could be permanent or temporary, such as signs used during construction. Do you agree such changes to improve travel during a storm evacuation would be helpful?	68%	11%	26%
Hillsborough County is one of the fastest growing areas of Florida, which gains 700 new residents a day. One solution under consideration is the phasing of evacuations so that some people would be asked to evacuate sooner than others. For example, visitors staying at hotels could be asked to evacuate early. Would you be in favor of phasing emergency evacuations?	84%	3%	11%

For each question, survey participants were given an opportunity to elaborate about their choices. Some of the themes raised were:

- Avoid Major Road Widening – Many respondents stated it is important to look to cost-effective, faster solutions before widening roads. Some indicated road widening may be necessary, especially to accommodate future population growth.
- Interchange/Intersection Modifications – Many who liked this strategy felt it would be beneficial daily, not only during storms. Others noted that such solutions may not be feasible, could impact neighborhood safety, and recommended that costs be small.
- Traffic Signal Changes – This suggestion was well-liked by respondents, and several indicated they had experienced benefits in past storms elsewhere. One commenter mentioned coordination throughout an evacuation corridor to avoid congestion at the next county, and another noted that cross streets may need to be considered for local needs, such as access to a hospital.
- Emergency Shoulder Use – This suggestion also was generally liked, and respondents commented that the shoulder should be safe and free of debris for this solution. A few raised concerns about emergency vehicle access and lack of shoulders at narrow bridges or interchanges that could lead to congestion.

- Travel Information – Providing additional ways to convey information resonated with respondents. Some noted that technology/smartphone applications are preferred, and others were concerned about the use of temporary signage requiring staff for deployment and causing potential problems due to high winds.
- Evacuation Phasing – A large percentage of respondents liked the idea of phasing evacuations, frequently noting that congestion makes it difficult for all to evacuate at the same time. Phasing by evacuation zone was mentioned as an option. Several respondents noted that in an emergency people may be frantic and follow their own plans, contrary to emergency orders or recommendations.

One survey respondent indicated the survey did not touch on their evacuation and sheltering needs. They have medical needs, rely on a support animal, and use public transportation. Finding transportation for evacuation, especially with an animal, is difficult.

Part of this survey asked people about whether they had experienced congestion during an evacuation at any of the twenty hotspot locations (ten interstate and ten arterial). Information about these survey results is provided in Chapter 4.

3.3 Public Meetings

TPO staff with support from the study team undertook a diligent effort to obtain feedback on the study and progress through multiple existing community meetings and events. Activities included:

- A public meeting was held to kick off the study and introduce the project page
- A video of the open house was prepared and shared on the study website <https://www.youtube.com/watch?v=7rkgbTPqvoc>
- Surveys were sent to groups such as the Westshore Alliance, the Tampa Downtown Partnership, and the Hillsborough County Local Mitigation Working Group.
- TPO staff attended community meetings in the following areas to gather feedback on the study. These areas were targeted because of multiple hotspot locations or identification as Environmental Justice areas.

- University Area Community Development Corporation
- Wimauma area Community Development Corporation.

- A social media blast was conducted to gather additional feedback. Users shared the information with local groups and persons with disabilities Facebook groups.



3.4 Key Takeaways

Several key items are noteworthy from the review of various sources including, surveys, stakeholder meetings, and academic research:

- Uncertainty about a storm’s projected travel pattern and intensity impacts decisions as to whether or when to evacuate. Having more information, and more accurate information, would be helpful.
- Traffic congestion is a main concern identified as impacting decisions to evacuate. This can be from news reports, yet everyday traffic conditions were frequently mentioned as a need.
- Being with family or friends, including pets, is particularly important, along with security and privacy, to encourage compliance to evacuation orders. Pet friendly and special needs shelters are available and providing transportation access to them should be evaluated.
- Job responsibilities and access to transportation are important. It is appropriate to consider expanding the focus on or resources for people and communities that experience these challenges.
- The locations identified as congested “hotspots” during evacuations were confirmed as being congested, or expected/perceived to be, by survey participants.

A major focus of this study was on identifying actionable items the Hillsborough TPO can take to improve evacuation and sheltering during hurricane events. For example, the TPO cannot provide more accurate storm forecasts, yet there may be ways to assist in informing people to prepare for or stay alert to potential storm conditions.

4.0 Issues Identified and Assessed

The issues or topics identified for evaluation are discussed in this section, along with strategies to address these issues and the benefits or challenges of each. When assessing the strategies, the study team looked to state or national research for qualitative and quantitative outcomes. The issues and strategies fall into three categories:

- traffic congestion: congestion hotspot location determination; contraflow, reversible lanes, and emergency shoulder use¹⁵ for interstates; intersection and interchange improvements for arterials; traffic signal coordination; and phased evacuations.
- transit and paratransit services (e.g., access to shelters, friends/family, or supplies): emergency transit route locations for communities with large percentages of racial/ethnic minorities or low income¹⁶ or high percentages of people with disabilities; emergency transit route locations and mobile home park locations; and households with below poverty incomes served by emergency transit routes versus daily transit routes.
- trustworthy and real-time communications (e.g., storm tracking, evacuation levels, fuel availability): additional fixed (recommended) or portable dynamic message signs on arterials and interstates; people reacting quickly to evacuation orders; and housing weatherization programs or other evacuation behaviors.

For three strategies, the study team used evacuation modeling. The Florida statewide hurricane evacuation model, TIME (Transportation Interface for Modeling Evacuations), was run with various inputs for sensitivity analysis. Evacuation models like TIME are specialized travel demand models which include considerations unique to evacuations. Response and demand factors make up the main inputs of the TIME model. Clearance times are part of the final output. The study team identified an input factor to assess three of the issues identified below and ran the TIME model to determine the effectiveness of various approaches.

Clearance times are used as a measure for how long an evacuation is expected to take once it has begun. Emergency management staff uses clearance times to determine a window of opportunity available to initiate evacuation orders, and to ensure evacuees have enough time to reach evacuation destinations safely before storm arrival.

Clearance times are used to determine when to initiate evacuation orders and ensure evacuees have enough time to reach destinations before storm arrival

The Baseline scenario for the TIME model used the operational scenario¹⁷ and a Category 3 hurricane evacuation was assumed. The baseline inputs for the regional model run and results are identified in Table 3.

¹⁵ The use of interstate shoulders for emergency evacuations is permitted in locations identified by the Florida Department of Transportation. Only one shoulder, often the inside shoulder, is designated, to allow for interchange access/egress and emergency vehicle access for incidents.

¹⁶ The study team used the communities designated for environmental justice for this purpose.

¹⁷ Mandated and operational scenarios are part of the Statewide Regional Evacuation Study. The regional planning councils define the operational components for their region. The mandated scenarios require the same assumptions for all regions of the state.

Table 3 Baseline Regional TIME Model Inputs and Results

Inputs and Outputs	Baseline
Network and population period	2025
University population	100% residence
Shelter Status	All open
Emergency Shoulder Use	No
Response Curve	12-hr
Hurricane Category	3

Supporting evacuation and sheltering during emergencies is a joint effort among local, county, and state organizations, visitors, and residents to improve efficiency and keep as many people as safe as possible. The TPO aims to improve the storm evacuation and shelter-in-place process to the extent possible, yet certain factors remain out of the influence of the TPO. Table 4 lists some of those factors over which the TPO has influence and those they do not.

Table 4 Evacuation and Sheltering Factors Over Which the TPO Has Influence

TPO has influence... (direct or indirect)	TPO does <i>not</i> have influence...
Congestion during evacuations	Event related communications
Transportation operations	Behaviors affecting evacuation and sheltering
Transit operations	Evacuation orders
Provision of digital message signs	
Public education	

4.1 Traffic Congestion During Evacuations

4.1.1 Hotspot Locations

There were multiple suggestions to evaluate congested areas during evacuations and identifying major bottlenecks was a key element of this study. As such, areas that experienced unusually high congestion during evacuation for Hurricane Irma¹⁸ and public and partners also offered areas where they have experienced congestion. The study team also evaluated locations along evacuation routes or that provide access to shelters as part of identifying the most critical evacuation bottlenecks.

It is important to note that traffic from other counties evacuating through Hillsborough County is contributing to hotspot roadway locations. This is especially true for interstate hotspot locations – with traffic from Pinellas County evacuating through Hillsborough County to the east on I-4 and northbound on I-275, and traffic from southeast and southwest Florida evacuating north on I-75. However, this influx of traffic could also be impacting arterials near interstate exits on the hotspot list, such as Bruce B. Downs Blvd and Sun City Center Blvd, as evacuees exit the interstate in congested areas for food and fuel and to switch to parallel facilities. In addition

¹⁸ Hurricane Irma made landfall in Naples, FL area on September 10, 2017, in the evening as a Category 3 hurricane. It proceeded north passing just east Tampa as a Category 1 hurricane. In the days leading up to Irma’s landfall, many models predicted landfall along Florida’s southeastern or southwestern coasts, as well as probability of passing just west of Tampa Bay as a powerful storm.

to evacuees contributing to congested commercial areas, residents staying in place will be obtaining supplies and food/water.

The study team used HERE travel speed inventory data to perform a Hurricane Irma Evacuation Scenario Impact Analysis, which is detailed in Appendix A. HERE provides speed and travel time data and can be queried for historical time periods. Roadway segments were scored based on reduced travel speeds over days preceding hurricane landfall. This information was combined with projected congestion identified by the TPO as part of the 2045 long range transportation plan.

The study team narrowed the analysis to the top ten “hotspot” locations on arterial/city roads and top 10 interstate/freeway hotspot locations. Not all the hotspot locations corresponded with current evacuation routes, but most did. Figure 16 shows those hotspot locations, and they are listed in Table 5 and Table 6. Similarly, some areas with projected congestion, such as I-275, did not rise to the top of the list. However, congestion may occur at locations other than the top ten.

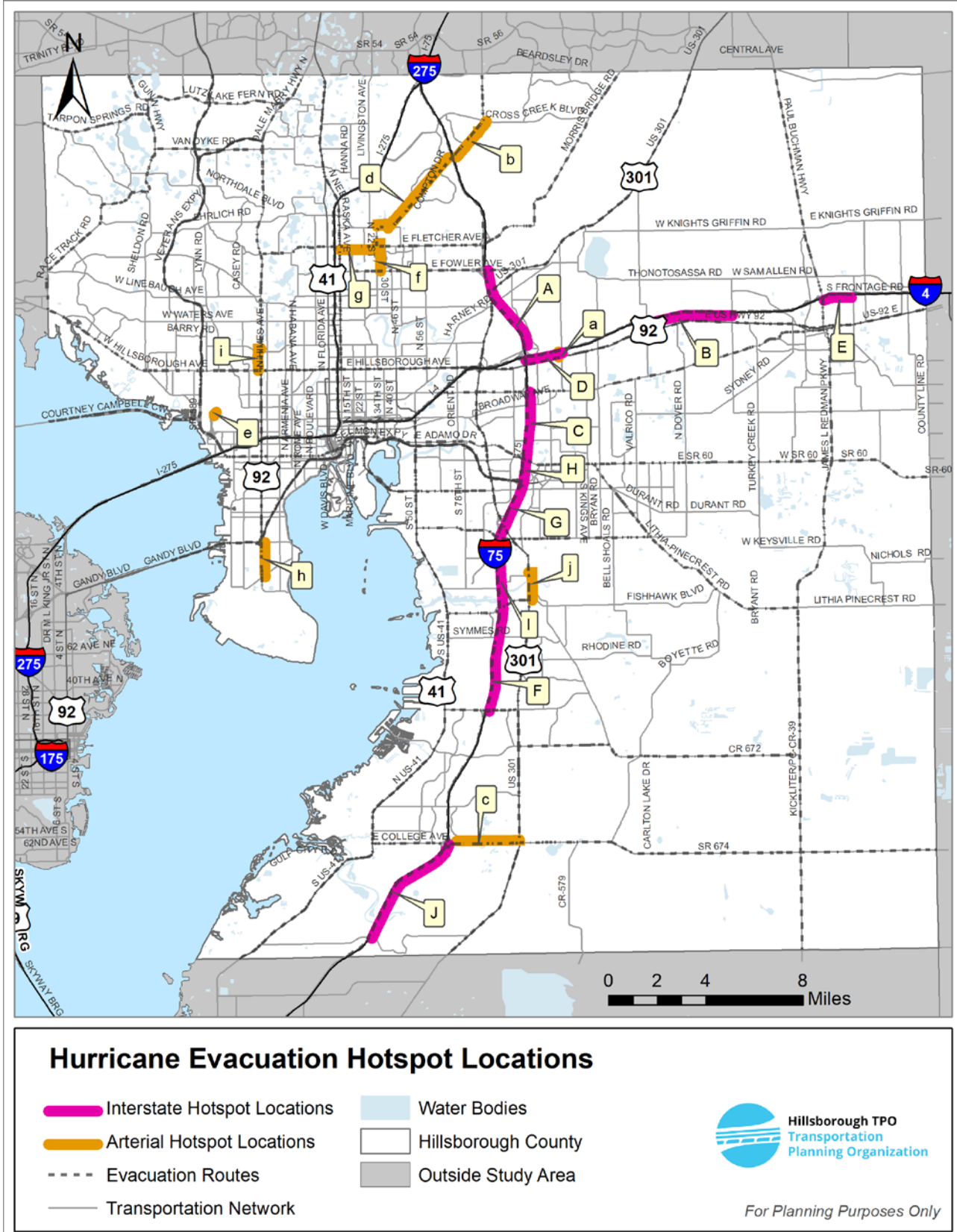
Table 5 Arterial Hurricane Evacuation Hotspot Locations

Location ID	Road	Between	And	Direction	Distance (miles)
a	Mango Rd	I-4 Ramps	Hillsborough Ave	SB	0.2
b	Bruce B. Downs Blvd	I-75 Ramps	New Tampa Rd	NB	1.9
c	Sun City Center Blvd	I-75 Ramps	US 301	WB	2.7
d	Bruce B Downs	Bearss Ave	I-75 Ramps	SB	4.3
e	George J Bean Pkwy	Airport Service Rd	Airport Recirculation Dr	NB	0.3
f	Bruce B. Downs Blvd	Fletcher Ave	Fowler Ave	NB	1.0
g	Fletcher Ave	Nebraska Ave	Bruce B. Downs Blvd	EB	1.5
h	Dale Mabry Hwy	Gandy Blvd	Interbay Blvd	NB	1.5
i	Dale Mabry Hwy	Sligh Ave	Hillsborough Ave	SB	0.8
j	US 301	Riverview Dr	Boyette Rd	NB	1.0

Table 6 Interstate Hurricane Evacuation Hotspot Locations

Location ID	Road	Between	And	Direction	Distance (miles)
A	I-75	Fowler Ave	I-4	NB	3.6
B	I-4	McIntosh Rd	Branch Forbes Rd	EB	3.6
C	I-75	Dr MLK Jr Blvd	Brandon Blvd	NB	2.8
D	I-4	I-75	Mango Rd	EB	1.5
E	I-4	Paul Buchman Hwy	Park Rd	EB	1.2
F	I-75	Gibson Dr	Big Bend Rd	NB	4.2
G	I-75	Selmon Expy	US 301	NB	1.9
H	I-75	Brandon Blvd	Selmon Expy	NB	1.0
I	I-75	US 301	Gibson Dr	NB	3.6
J	I-75	Sun City Center Blvd	Valroy Blvd	NB	5.1

Figure 16 Hurricane Evacuation Hotspot Locations



In the strategy survey, respondents were asked about their experiences and perceptions of these hotspot locations related to potential evacuation congestion. “Which of these areas have you experienced congestion during a past evacuation? Which of these areas would you expect or perceive to be congested during an evacuation?” Table 7 shows the responses for both questions for each hotspot location.

The survey responses were from 43 people and the table shows over half of the respondents had experienced or perceived there to be congestion on the Interstate hotspots. If people evacuating anticipate congested interstates, they may not evacuate although they should. They may also use local and arterial roads to evacuate. While not as pronounced, the arterial hotspot locations are also recognized as areas where congestion may occur.

Table 7 Final Survey Hotspot Experience/Perceptions Responses

Hotspot Location	Experienced Evacuation Congestion	Perceive/Expect Evacuation Congestion
A: I-75 (Fowler Ave to I-4)	8	24
B: I-4 (McIntosh Rd to Branch Forbes Rd)	7	21
C: I-75 (Dr MLK Jr Blvd to Brandon Blvd)	9	22
D: I-4 (I-75 to Mango Rd)	7	16
E: I-4 (Paul Buchman Hwy to Park Rd)	5	16
F: I-75 (Gibsonton Dr to Big Bend Rd)	7	16
G: I-75 (Selmon Expy to US 301)	8	20
H: I-75 (Brandon Blvd to Selmon Expy)	8	18
I: I-75 (US 301 to Gibsonton Dr)	8	16
J: I-75 (Sun City Center Blvd to Valroy Blvd)	5	15
a: Mango Rd (I-4 Ramps to Hillsborough Ave)	4	18
b: Bruce B. Downs Blvd (I-75 Ramps to New Tampa Rd)	6	17
c: Sun City Center Blvd (I-75 Ramps to US 301)	5	9
d: Bruce B Downs (Bearss Ave to I-75 Ramps)	6	15
e: George J Bean Pkwy (Airport Service Rd to Airport Recirculation Dr)	2	7
f: Bruce B. Downs Blvd (Fletcher Ave to Fowler Ave)	4	17
g: Fletcher Ave (Nebraska Ave to Bruce B. Downs Blvd)	7	17
h: Dale Mabry Hwy (Gandy Blvd to Interbay Blvd)	6	16
i: Dale Mabry Hwy (Sligh Ave to Hillsborough Ave)	6	17
j: US 301 (Riverview Dr to Boyette Rd)	6	12

Note: uppercase IDs are freeway/interstate roads, lowercase IDs are arterial roads.

The Hillsborough TPO Long Range Transportation Plan (LRTP) outlines Cost Feasible roadway improvements for the next 25 years. Projects expected to be funded and begin in the next five years are outlined in the Transportation Improvement Program (TIP). Table 8 shows the status of any LRTP and TIP planned projects for the hotspot locations.

Table 8 Hotspot Locations LRTP Cost Feasible and TIP Programmed Improvements

Hotspot Location	LRTP Cost Feasible	Project in TIP
A: I-75 (Fowler Ave to I-4)	Add 4 express lanes	
B: I-4 (McIntosh Rd to Branch Forbes Rd)	Add 4 express lanes	
C: I-75 (Dr MLK Jr Blvd to Brandon Blvd)	Add 4 express lanes	
D: I-4 (I-75 to Mango Rd)	Add 4 express lanes	
E: I-4 (Paul Buchman Hwy to Park Rd)	Add 4 express lanes	
F: I-75 (Gibsonton Dr to Big Bend Rd)	Add 4 express lanes	
G: I-75 (Selmon Expy to US 301)	Add 4 express lanes	
H: I-75 (Brandon Blvd to Selmon Expy)	Add 4 express lanes	
I: I-75 (US 301 to Gibsonton Dr)	Add 4 express lanes	
J: I-75 (Sun City Center Blvd to Valroy Blvd)	Add 4 express lanes	
a: Mango Rd (I-4 Ramps to Hillsborough Ave)	Interchange improvement	X
b: Bruce B. Downs Blvd (I-75 Ramps to New Tampa Rd)	None	
c: Sun City Center Blvd (I-75 Ramps to US 301)	None	
d: Bruce B Downs (Bearss Ave to I-75 Ramps)	New Adjacent Facility	X
e: George J Bean Pkwy (Airport Service Rd to Airport Recirculation Dr)	None	
f: Bruce B. Downs Blvd (Fletcher Ave to Fowler Ave)	None	
g: Fletcher Ave (Nebraska Ave to Bruce B. Downs Blvd)	None	
h: Dale Mabry Hwy (Gandy Blvd to Interbay Blvd)	None	
i: Dale Mabry Hwy (Sligh Ave to Hillsborough Ave)	None	
j: US 301 (Riverview Dr to Boyette Rd)	None	

Some of the arterial hotspots are access roadways for residential gated/curvilinear street communities, namely Bruce B. Downs Boulevard corridors south and north of I-75. Methods of mitigating the impact of congestion during evacuation is ensuring these communities have all access/egress roads fully opened and have informed residents that alternate exits from the communities could ensure quicker travel.

To assess arterial congestion during evacuations, the study team used the TIME model with an assumed model network of increased capacity at the hotspot locations. The main goal of this exercise was to evaluate how increasing physical capacity through lane additions at distressed locations would impact the evacuation clearance time on a broad scale. One lane in each direction was added in the model network for all arterial hotspot identified roadways. These are short segments, and the lane additions were meant to capture small capital investments to improve intersections or interchange ramps.

Strategic investments did not improve clearance times, but may improve local access

The arterial hotspots TIME model assessment used a baseline of only Hillsborough County evacuating to test with a higher level of sensitivity. The TIME model with arterial hotspot additional capacity did not reduce the regional clearance time from 14.0 hours. The results are shown in Table 9. This assessment shows that adding strategic capacity at distressed locations on its own does not provide a meaningful effect to systemwide clearance time.

Table 9 TIME Model Assessment for Arterial Hotspot Congestion Sensitivity

Inputs and Outputs	Baseline	Arterial Hotspots Additional Capacity
Network and population period	2025	2025
University population	100% residence	100% residence
Shelter Status	All open	All open
Emergency Shoulder Use	No	No
Response Curve	12-hr	12-hr
Hurricane Category	3	3
Clearance Time In County (hours)	13.0	13.0
Clearance Time Out of County (hours)	13.0	13.0
Clearance Time To Shelter (hours)	12.5	12.5
Regional Clearance Time (hours)	14.0	14.0

4.1.2 Transportation Evacuation Operations

Transportation agencies are active during a major event, coordinating with emergency management staff and working to support efficient and safe travel for evacuation and response activities. Several operational items are highlighted below.

Traffic Signal Coordination

Traffic signal coordination is a mechanism to improve travel flow by adjusting signal timing to accommodate highly directional traffic movements. Additionally, specific signal timing may support extending a green light to allow people to clear an intersection or leave a neighborhood, for example. It is not uncommon for people experiencing congestion to mention difficulties in leaving their neighborhoods and accessing higher capacity routes during evacuation scenarios. Although traffic congestion during storm preparation and evacuation can be caused by many factors, directional traffic signal coordination on evacuation route and roadways feeding evacuation routes might reduce clearance times. Case studies have shown that in routine situations adaptive coordinated traffic signalization can reduce travel time through a corridor by over 30 percent.¹⁹ Developing a countywide evacuation signal timing plan might offer improvements to hotspot congestion. It would require additional investigations and modeling/simulation and multiple county coordination to address regional evacuation needs.

Circuitous Routes

Reducing circuitous routes is a suggestion to improve traffic flow during evacuations that must be applied on a case-by-case basis depending on the configuration or context. For example, some communities that control access to local roads may do so because the roads are private or are subject to restrictive covenants. Where no such limitations exist, providing access through communities may or may not achieve improved evacuation times if these roads are low-speed or are difficult to navigate. Similarly, in one situation the study team investigated, the entrances to the community are from a single collector/arterial road. Methods of mitigating the impact of congestion during evacuation is ensuring these communities have all access/egress roads fully opened and have informed residents that alternate exits from the communities could ensure quicker travel.

¹⁹ [Park, Byungkyu and Chen, Yin. University of Virginia Department of Civil and Environmental Engineering. Quantifying the Benefits of Coordinated Actuated Traffic Signal Systems: A Case Study. Virginia Department of Transportation.](#)

Phased Evacuations

For a category three hurricane, the projected clearance time for Hillsborough County is 24 hours. Evacuation clearance times will be difficult to maintain as Hillsborough County continues to grow in population and if larger numbers of people choose to evacuate instead of shelter-in-place. While not a transportation specific strategy, phased evacuations may improve overall clearance times. A phased evacuation frequently mandates that visitors, such as those in hotels, evacuate an area prior to the general public, typically about a day earlier. Another option might be to coordinate with MacDill Air Force Base, for example, to evacuate families and non-essential personnel early. This type of strategy requires information dissemination and communication strategies to address compliance. Emergency managers are cautious with this strategy due to uncertainties about storm path and intensity.

Interstate Contraflow

The interstate highways are major routes during evacuations. Florida is a long peninsular state, and evacuation is often northward using the key I-75 and I-95 corridors. For a northbound evacuation, contraflow operation of these interstates and Florida's Turnpike would convert southbound lanes to temporarily allow northbound travel. This approach requires significant emergency personnel (e.g., law enforcement) to close ramps and direct travel to maintain safety. Another disadvantage of contraflow is supplies and personnel to rapidly respond after a disaster often stage throughout Florida, and these goods and services are traveling in the opposite direction of evacuees. Contraflow takes personnel away from assisting with local communications and evacuations and prohibits staging by organizations such as the Federal Emergency Management Administration (FEMA), power suppliers, and building materials and food/water suppliers.²⁰ Emergency shoulder use (ESU) has been used for the past several years, whereby designated shoulder areas are opened as an additional travel, temporarily expanding travel capacity.

Contraflow requires large numbers of personnel to implement and reduces ability to stage supplies and personnel for recovery

Emergency Shoulder Use

Each of the identified interstate hotspot locations are on facilities identified for Florida Department of Transportation's (FDOT) Emergency Shoulder Use (ESU) plan in 2021.²¹ This plan is reviewed and updated each year. Only one shoulder is used to allow for emergency vehicle access if needed. Also, the interior shoulder is used where possible to avoid interchange conflicts. Shoulder debris removal is part of emergency preparedness.

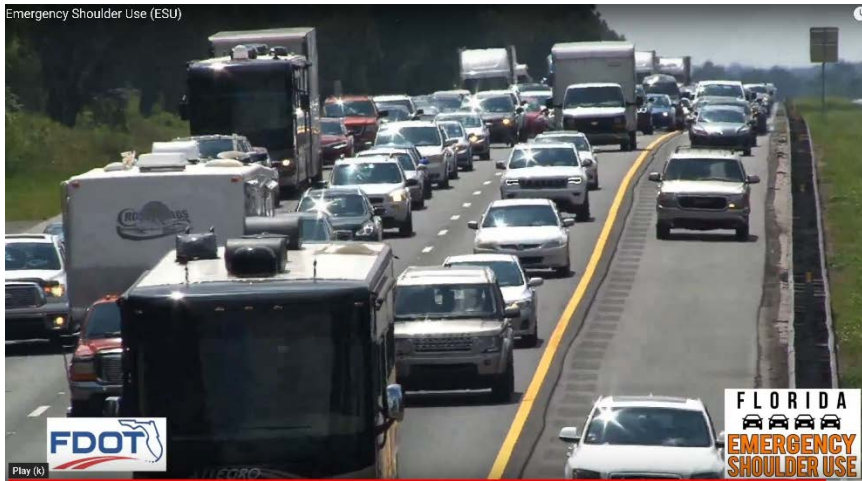
To assess evacuation operations on interstate roads, the study team executed a TIME model run comparing a scenario with ESU activated in the region against a baseline scenario without ESU. For the 2021 season, plans covered the following roadway segments within the Tampa Bay region:

- Eastbound I-4 from US 41 in Tampa (Hillsborough) to SR 417 in Celebration (Osceola), and
- Northbound I-75 from SR 951 in Naples (Collier) to SR 143 in Jennings (Hamilton).

²⁰ [Planning Considerations: Evacuation and Shelter-in-Place, Guidance for State, Local, Tribal, and Territorial Partners, FEMA, July 2019.](#)

²¹ <https://www.fdot.gov/emergencymanagement/esu/default.shtm>

Figure 17 Emergency Shoulder Use



The TIME results for interstate ESU operations did not detect a reduction in the clearance times compared to the baseline condition.²² However, the additional capacity provided by ESU operation, drawing travelers to the interstates, may provide relief on arterials needed for local sheltering preparations. This result also appears to indicate that interstate capacity may be a key influence on clearance times. As such, projects such as the managed or express lanes for I-75 as currently proposed in the cost feasible long range transportation plan may enhance evacuations. During emergency declarations, tolls are suspended on these facilities.

Table 10 TIME Model Assessment for Interstate Congestion Sensitivity

Inputs and Outputs	Baseline	Emergency Shoulder Use
Network and population period	2025	2025
University population	100% residence	100% residence
Shelter Status	All open	All open
Emergency Shoulder Use	No	Yes
Response Curve	12-hr	12-hr
Hurricane Category	3	3
Clearance Time In County (hours)	21.0	21.0
Clearance Time Out of County (hours)	21.0	21.0
Clearance Time To Shelter (hours)	20.0	20.0
Regional Clearance Time (hours)	21.0	21.0

Reversible Lanes

While contraflow operations may not be viable option, the Leroy Selmon Expressway, operated by the Tampa Hillsborough Expressway Authority (THEA), operates normally as a reversible direction facility. A specific evacuation scenario plan for emergency related fixed east bound travel on the Selmon Expressway could assist travel from evacuation zones. This would be particularly helpful due known congestion hotspots in the

²² The TIME model provides clearance time in half-hour increments. Modeling experts noted that TIME may have given preference to interstate travel because evacuations can be longer distances. However, if the clearance time were to be reduced by a half hour, that is less than three percent improvement for a 21.0-hour clearance time.

MacDill area (potentially demanding evacuation needs from MacDill Air Force Base²³). A westbound expansion into Pinellas County could also relieve congestion on existing east/west roadways during evacuations.

4.2 Transit/Paratransit Operations

To successfully evacuate coastal areas requires access to transportation – transportation to leave the area, or transportation to temporarily relocate to a shelter or inland with family and friends. For people with no or limited access to vehicles, transit service to shelters or interregional public transportation services, such as Greyhound or Amtrak, is critical. HART fully recognizes this situation and identifies nine evacuation routes used to support transport from coastal areas to one of four emergency shelters. The Hillsborough School District has helped when feasible to supplement evacuation services. Operations occur during daylight hours for as long as it is deemed safe by emergency personnel for buses to be on the road. The evacuation routes are displayed along with typical HART routes in Figure 18.

Periodic evaluation of these routes is important based on changes or increases in affected population. Daily transit riders also may need to use the service for evacuation, and maintaining routes that are well-known, instead of converting to a different operation schedule, should be considered to provide smoother evacuation. Identification of potential operational concerns, such as driver shortages, also is important. Similarly, information and communication about transportation options or the need to pre-register for services is critical. Supporting development of bus stop/station materials or in-vehicle messages prior to a hurricane (or hurricane season) is one concept that should be considered.

Congestion hotspots with proximity to shelters and increased transit/paratransit needs:

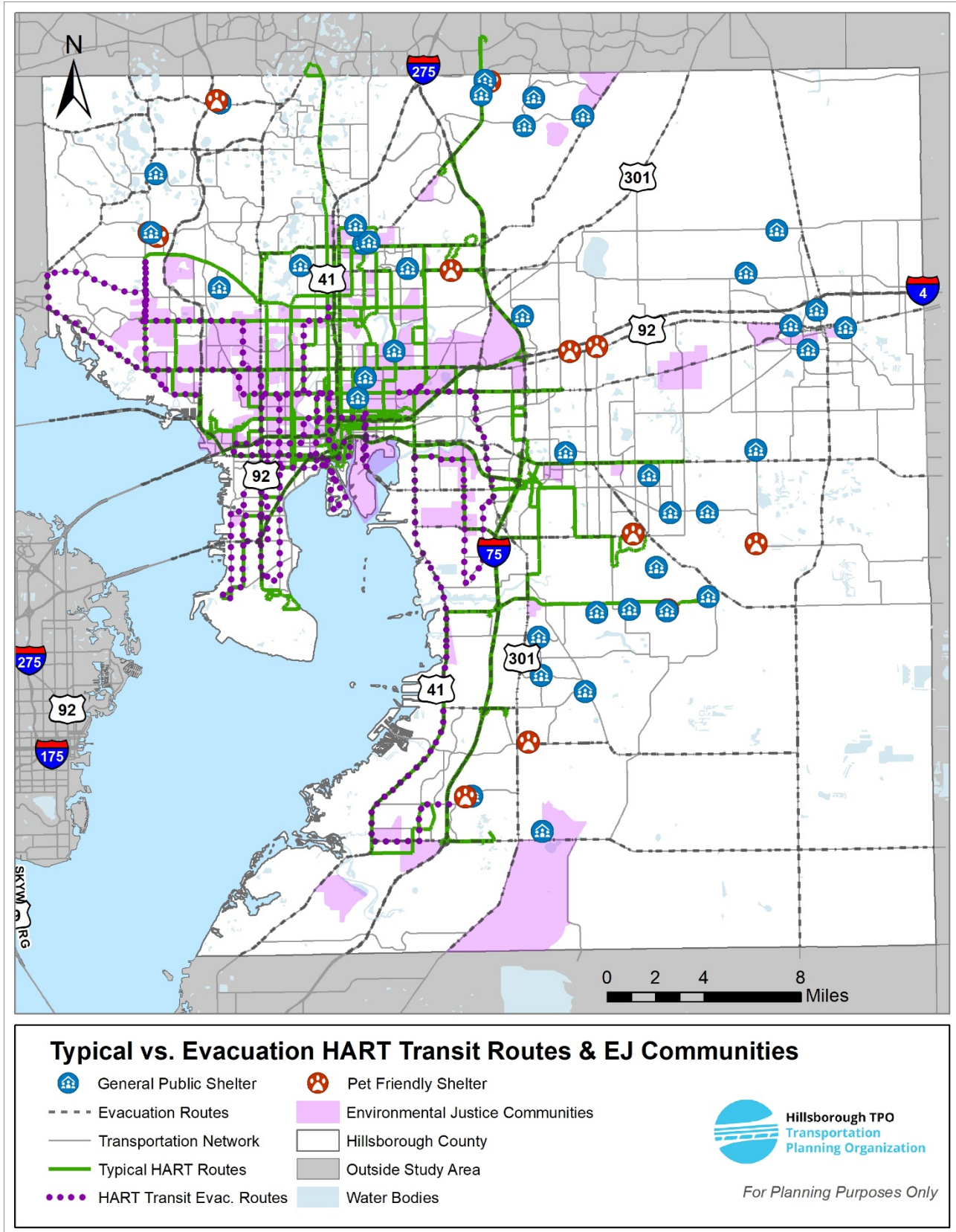
- 1) Fletcher Avenue at Bruce B. Downs Boulevard**
- 2) Mango Road at Hillsborough Avenue**

According to 2018 Census data²⁴, seven percent (5,160) of below poverty households in the county are within walking distance (1/2 mile) of a public shelter. This is slightly more than the 6.5 percent of total households in the county within walking distance of a shelter.

²³ “From Hurricane Irma evacuation to Maria recovery – the 6th OSS.” Airman 1st Class Adam R. Shanks. 6th Air Mobility Wing Public Affairs. October 10, 2017.

²⁴ Map Packages from Hillsborough Nondiscrimination Plan. March 2018.

Figure 18 Existing vs. Typical HART Transit Routes and EJ Communities



The current extent of the HART evacuation routes gives coverage to 11,210 below poverty households in Hillsborough County within evacuation zones A, B, and C (Category 3 hurricane). These are households within a half mile of an evacuation HART service route line because drivers in evacuation protocol will stop when flagged-down by a resident. This covers 76 percent below poverty households in those evacuation zones. This compares to 10,430 (71 percent covered) below poverty households in those evacuation zones covered by typical HART routes, those households within a half mile of HART stops. However, looking at different evacuation scenarios, there is much less coverage of below poverty households under evacuation service compared to typical HART service. These are show in Table 11.

Table 11 Below Poverty Households Access to Transit in Typical and Evacuation HART Service by Storm Severity Scenario

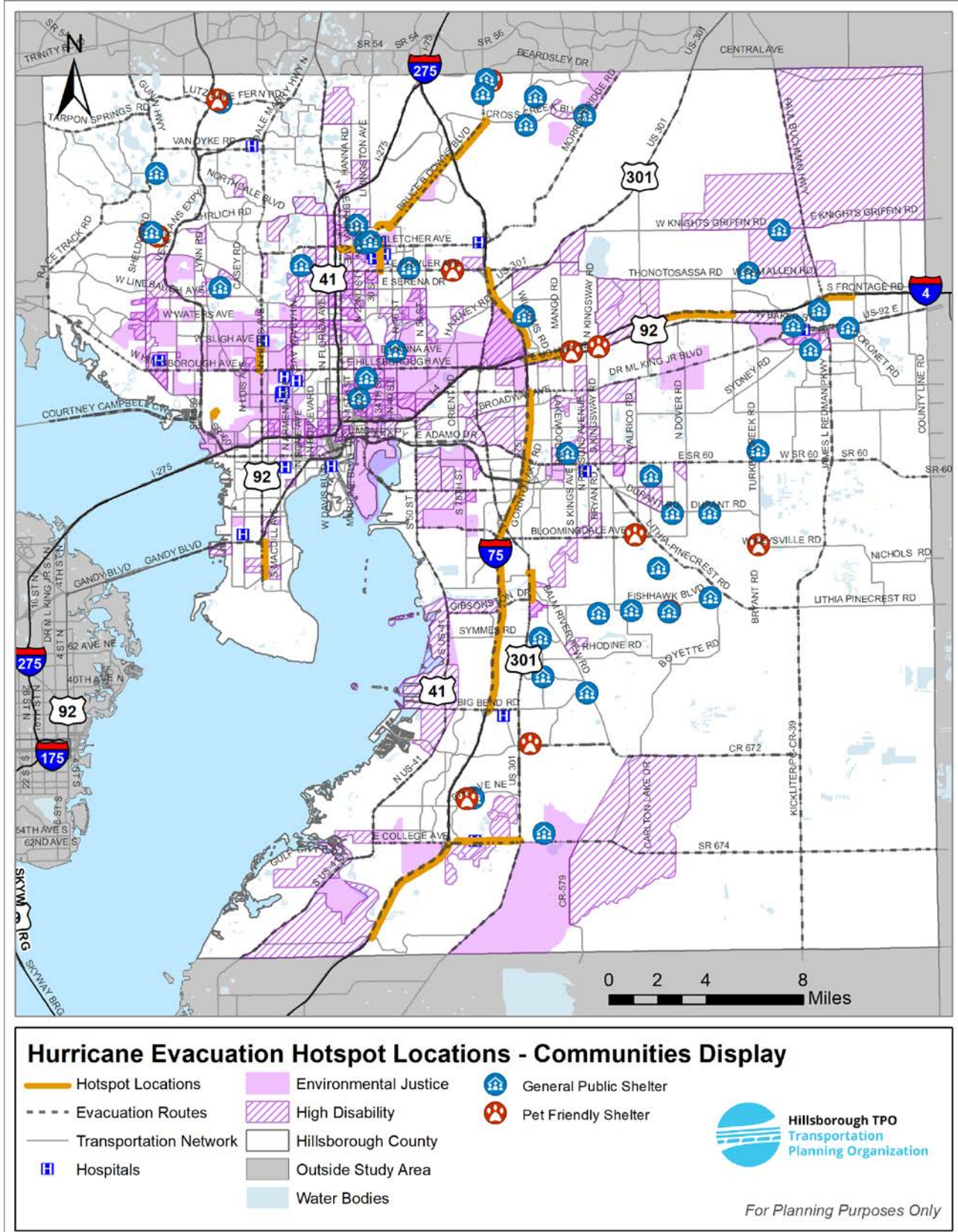
	<i>Total Households in Zones</i>	<i>Within Half Mile of Typical HART Service Stops (% covered)</i>	<i>Within Half Mile of Evacuation HART Routes (% covered)</i>	<i>Percent Change in Coverage by Evacuation Routes (%)</i>
Category 1 (Zone A)	7,219	4,270 (59%)	3,950 (55%)	-7%
Category 3 (Zones A/B/C)	14,684	10,430 (71%)	11,210 (76%)	+7%
Category 5 (Zones A/B/C/D/E)	31,851	23,010 (72%)	19,610 (62%)	-15%
All of Hillsborough	73,474	46,018 (63%)	22,760 (31%)	-51%

One consideration for public transit operation is residents with disabilities, as well as areas with households of low income or racial/ethnic minorities that may have less access to private transportation options. The Hillsborough TPO maps racial/ethnic minorities and low-income populations by block group in its Non-Discrimination Plan as Environmental Justice (EJ) Communities²⁵. The methodology for locating EJ communities is based on National Institute for Transportation and Communities (NITC) guidance and input from TPO staff. Figure 19 shows these communities by block group along with areas of high disability population, marked by more than one standard deviation above the median for the county, along with the evacuation congestion hotspots and public shelters. The role of public transit in evacuations is to ensure that all people can access public evacuation shelters, other family/friends, and stores for preparation in a timely manner. The Fletcher Avenue at Bruce B. Downs Boulevard and Mango Road at Hillsborough Avenue congestion hotspots both cause concern due to their proximity to EJ and high disability communities and public shelters.

Another consideration is public transportation for residents of mobile home or RV communities. As noted previously, these communities tend to have residents that are older, have disabilities, and may be living alone.

²⁵ Hillsborough MPO Nondiscrimination Plan. March 2018. Page 74.

Figure 19 Communities of Concern and Environmental Justice Communities



4.3 Communications

Several open house and survey participants indicated a need for more information about evacuation and sheltering, immediately prior to and during an evacuation. Storm unpredictability is a factor and emergency management personnel, not TPO staff, are responsible for communications. This report section is geared toward identifying ways the TPO or transportation agencies can assist with communications during a potential or actual emergency.

The TPO has a separate set of stakeholders that it can inform through its social media presence. It also might be able to take on informational campaigns prior to or during hurricane season about evacuation for those needing transportation assistance or ways to find fuel or services during an evacuation or afterward. Communications during recovery, such as about debris clean up schedules and road openings or check points, may be another consideration depending on the recommendations and considerations by emergency and operations agencies.

Stay Safe Website

Hillsborough County has a comprehensive site with information for use before, during and after a storm, providing checklists, guides and contact details <https://www.hillsboroughcounty.org/en/residents/stay-safe/storm>

While the TPO will rely on emergency management staff to craft messages, it could work with local and regional partners to provide additional equipment to display information, such as digital message signs on the interstate or at key locations on arterials. These signs could be used to communicate road closures, shelter locations, detours, or channels for obtaining information, such as referring travelers to 511 or Hillsborough County's *Stay Safe* website. If requested by emergency management personnel, these signs could be used to notify travelers of a potential storm, or mandated evacuations. As an operational procedure, allocating and dispersing portable message signs (able to withstand

hurricane winds) could provide benefit in tandem with prepared plans for portable sign messages. A portable and stationary dynamic messaging plan, in coordination with and support from all Emergency Management stakeholders, could help improve evacuation clearance by improving response curves and increasing sheltering-in-place.

To assess event related communication affects, the study team executed a TIME model run with response curve inputs set shorter than a default level in a baseline scenario. This response curve input was only changed for Hillsborough County, with surrounding counties unaffected. This scenario assumes that enhanced communication has resulted in people in Hillsborough County reacting more quickly and evacuating sooner, namely that people were informed early and reacted expeditiously.

Table 12 displays the inputs used for this model run, along with clearance time results. This scenario assumed response curves of six hours, down from the baseline 12-hour curves. Of the various scenarios tested, the improved communication scenario provided the largest identifiable benefit, reducing the regional clearance time from 21.0 to 20.5 hours and reducing the clearance time to shelters from 20.0 to 16.0 hours. Large clearance time reductions would be seen if evacuees in other counties also respond sooner.

Table 12 TIME Model Assessment for Improved Communication

Inputs and Outputs	Baseline	Improved Response Curves
Network and population period	2025	2025
University population	100% residence	100% residence
Shelter Status	All open	All open
Emergency Shoulder Use	No	No
Response Curve	12-hr	6-hr
Hurricane Category	3	3
Clearance Time In County (hours)	21.0	20.5
Clearance Time Out of County (hours)	21.0	20.5
Clearance Time To Shelter (hours)	20.0	16.0
Regional Clearance Time (hours)	21.0	20.5

As mentioned above, communication equipment deployment could be assisted by a prepared plan for dynamic and/or portable message sign disbursement and messaging. Research has indicated that evacuation notice level (mandatory, voluntary, advisory, or recommended) and location-based messaging can affect the level of appropriate response during evacuations.²⁶ Hurricane Rita is known as a case study in poor system communication which resulted in fatal evacuation efforts. A paper on this topic indicates that in September 2005 an estimated 2.5 – 3.7 million people evacuated the Texas coastline, when a significant heat wave also affected the region. The combination of severe gridlock and excessive heat led to between 90 and 118 deaths even before the storm arrived (with only seven directly caused deaths from Hurricane Rita in Texas). Forty-seven percent of those in the areas who did not reside in an evacuation zone reported evacuating.²⁷

FEMA publishes recommendations on improving public messaging for evacuation and shelter in place.²⁸ Among their recommendations are:

- Understand potential impediments to action and take steps to address these barriers in advance.
- Make evacuation decisions easier by only issuing mandatory evacuations.
- Provide residents and tourists with multiple ways of knowing if they are in a zone under an evacuation order.
- Use multiple, authoritative messaging channels that include photos or links to other visual information about the hazard and encourage individuals to share this information with friends and families.
- Provide frequent updates with information that can reduce the stress of the unknown related to evacuation.

This study scenario also offers some suggestions for phased evacuation mentioned previously. Spreading out evacuation, by having people react sooner, helps improve overall evacuation rates. However, asking people to evacuate is a burden on households, and emergency management staff use caution with these types of decisions.

²⁶ Improving Coastal Storm Evacuation Messages. Cuite, Cara L, et al. Weather, Climate, and Society, Vol. 9, Iss. 2. April 1, 2017.

²⁷ Weisgerber, C. & Butler, S. (2006, April). “Should we stay or should we go? Leadership communication in the face of a potentially catastrophic hurricane.” Paper presented to the Crisis Communication Division of the Southern States Communication Association, Dallas, TX

²⁸ [FEMA. Improving Public Messaging for Evacuation and Shelter-in-Place: Findings and Recommendations for Emergency Managers from Peer-Reviewed Research. April 2021.](#)

5.0 Recommendations

There are many broad and specific recommendations for the TPO to consider based on the assessment of identified issues. The following goals broadly summarize how the TPO can address issues concerning evacuation and sheltering in Hillsborough County:

1. **Engage in multiple strategies to improve evacuation and sheltering.** There is not one action that will enhance evacuation times. With expected increased population, it will become more imperative to consider and engage multiple, simultaneous strategies.
2. **Continue collaboration and coordination with emergency managers and transportation providers.** Many of the strategies involve collaboration between the TPO and other agencies/departments. The TPO is constrained in support that can be provided operationally and during events. However, the TPO can bring multiple parties together to continue sharing information and cooperating to improve emergency preparation and planning.
3. **Continue education as part of emergency preparation.** Evacuation and sheltering plans often only work as well as residents and visitors are aware of them. The TPO can assist in identifying opportunities to inform the public prior to hurricane season and when storms are forming/approaching to carry them out. These materials and plans must be in place early to activate quickly when needed.

Based on study results, it is clear that single strategies often do not lead to major improvements. However, a comprehensive approach with multiple strategies can lead to meaningful improvement in evacuation and sheltering outcomes. Also, many of the recommendations for the TPO require collaboration and coordination with other partners. Continuing to work together with emergency managers and providers on many of these strategies is crucial for effective planning and implementation. Evacuation and sheltering plans and programs can only work if the public is aware of them and include them in their personal planning and decision making. Educating the public remains a vital piece of planning for evacuation and sheltering strategies. These main ideas apply to the following recommendations.

5.1 Traffic Congestion

Based on the results of this study, recommendations to consider regarding congestion are:

- Minor arterial improvements in evacuation “hotspots” (where it has been experienced and is perceived as an evacuation bottleneck) could improve local congestion. Intersection and interchange ramps improvements can assist during evacuation and daily operations.
- Florida’s interstate system is the backbone of evacuation, supporting long distance travel to safe destinations. The proposed managed lanes projects on I-75 and I-4 will provide significant capacity improvements. As tolls are traditionally suspended, these additional lanes will enhance evacuation.
- Coordinating with FDOT and informing the public on Emergency Shoulder Use (ESU) operation prior to hurricane season and before a storm can address some concerns about their operations. For example, travelers want to know what to expect concerning shoulder debris, rumble strips, narrow bridges, or interchanges. Law enforcement manages access/egress to/from ESU areas, shoulders are cleared of debris, and slower speeds make travel in narrow areas safer.

- The Tampa-Hillsborough Expressway Authority also plays a role in evacuation, and it is important as part of the regional evacuation plan for continual eastbound flow on the Leroy Selmon Expressway during the approach of a storm. Once recovery is underway and people can return home, a fixed westbound flow may ease travel and congestion. Extensions west into Pinellas County may improve regional evacuations.
- Consider phased evacuations to regulate flow of volume on critical evacuation routes. Options could include evacuating visitors early or coordinating with larger communities, such as the MacDill Airforce Base. Emergency managers are sensitive to asking people to leave early given the chance a hurricane may not affect an area due to a shift direction. For that same reason, compliance can be compromised unless the phasing is mandatory. It is a known tool to reduce evacuation clearance times with those considerations. The Florida Keys are an example where phased evacuations are used.
- Improve travel flow such as with traffic signal coordination for improved travel flow corridors supporting evacuation while providing local neighborhood access or investigating locations of circuitous routes and identifying evacuation enhancing solutions.

5.2 Transit/Paratransit

Transit is a crucial mode of travel for many, including Hillsborough residents most vulnerable to emergencies. In an evacuation scenario, efficiently moving people to shelter locations is essential. Both paratransit and fixed route transit operations should be leveraged as an opportunity for evacuees, and access/route updates must be clearly communicated. Here are some recommendations to consider regarding transit:

- Continue to develop and enhance annual transit evacuation plans, coordinating established transit routes, temporary routes, access to shelters and or regional transit centers. This also should address paratransit and similar services.
- HART will look into evacuation routes given evacuation zone and population changes. The focus historically has been on covering coastal areas and changes to accommodate communities of concern may support more people. Maintaining existing route patterns during an emergency may reduce confusion for riders.
- Investigate the effectiveness of maintaining consistent transit route operation, with supplements for key areas needing evacuation support.
- Consider ways to expand services for those without personal vehicles, such as coordinating to provide transportation networking companies (TNCs), such as Uber or Lyft, or taxi services, or providing connections to interregional transit providers such as Greyhound or Amtrak. This is important for families and individuals with health issues or pets/support animals that may be able to stay with family or friends instead of going to a shelter.
- Provide information about paratransit and transit evacuation plans and operations to transit users, on buses/stops/etc. prior to hurricane season and ideally immediately prior to a storm. For example, inform riders about the need to register for transportation assistance or a space at a special needs shelter.

5.3 Communications

Improved communication and response time was identified in this study as one of the most impactful strategies to improve evacuation. Regional evacuation clearance times improved in the TIME model when response time curve inputs were reduced. The faster residents respond to evacuation declarations, the quicker more people can get to safety. This requires clear, trust-worthy, and effective communication. Some recommendations to consider regarding communication are:

- Maintain standards laid out in Hillsborough's Nondiscrimination and Equity Plan. Include multiple languages and means for conveying information as feasible when preparing and responding to an emergency or hurricane.
- Work with emergency management staff and consider incorporating emergency management communications in the TPO's public participation and involvement plan.
- Make efforts for all communications targeted appropriately pre-season, as well as pre-storm.
- Develop a plan to acquire and deploy permanent (preferred) or portable message signs, in coordination with emergency management officials, especially in evacuation zones, to communicate relevant information.
- Coordinate, particularly with the State of Florida, during emergency evacuations on information provided on the interstate digital message signs, with the intent of providing real-time information.
- Helping residents, owners, and businesses to create evacuation plans may prove beneficial. For example, the TPO could engage a speaker's bureau in coordination with emergency management personnel.

Another method of expediting evacuation/sheltering clearance equitably and efficiently is ensuring the public is well-educated on plans and information. Educated residents and visitors are more prepared and can react quicker the more they are aware of evacuation and sheltering options. The lack of recent hurricanes can lead to complacency that is difficult to overcome. Some recommendations to consider regarding education are:

- Make public aware of all useful options, evacuating to a shelter, to an inland family/friend, shelter in place, or leaving the region, emphasizing that people need only travel tens of miles instead hundreds of miles to be safe. Special emphasis on how to evacuate with pets is warranted.
- Make basic evacuation plan information accessible in preparation for storm season via social media and other community relevant means. Help promote Hillsborough County's existing *Stay Safe* website with information on what to do.
- Hurricane forecast implications, warnings and their meaning, timing required to finalize decisions. This item should also factor in information about congestion that increases during evacuation as people delay evacuation.

5.4 Coordination and Collaboration

Beyond communications, there are other recommendations regarding coordination and collaboration to make evacuation and sheltering overall more efficient and effective. These recommendations relate to creating and communicating plans.

- Coordinate with local governments or agencies to assess housing (e.g., year built, structural conditions) to assess vulnerability to high winds and provide opportunities for improvement, such as weatherization funding or PACE programs. These could be targeted outside evacuation zones to support sheltering-in-place and improve evacuation clearance times.
- Coordinate with local governments on potential strategies to improve efficiency during evacuations, such as considering evacuation or sheltering needs during as part of development applications. For example, providing multiple access points or access roads to support local and drive-through travel, or reinforced, hardened community centers that can serve as neighborhood shelters (e.g., for tornados.)

5.5 Equity

An important consideration for evacuation/sheltering preparation is equity. It is crucial to care for the most vulnerable people in the community during emergencies. People with health concerns or special needs, or those who use public transit for daily needs have special situations and needs for evacuation. Those who have less access to technology may need targeted communications to provide crucial updates from emergency management. Residents who lack access to private transportation may need mobility assistance to access public shelters or family and friends. Those who reside in homes unable to withstand hurricane force winds may wish to evacuate even if not in a hurricane evacuation zone. Here are some recommendations for the TPO and partners to consider:

- Congestion management and public transportation needs to ensure communities with high percentages of people with disabilities or of ethnic/racial minorities can reach shelters or places of safety during emergencies. Two areas in particular are highlighted: Fletcher Avenue at Bruce B. Downs Boulevard and Mango Road at Hillsborough Avenue.
- Utilize TPO data, studies, and research (such as on traditionally disadvantaged communities, e.g., households without a car, those that speak languages other than English) to support emergency management preparation, response, recovery, and mitigation.
- Ensure people without smartphones or computers also have access to all communications. Prepare flyers, signs, etc. and disperse from accessible places like grocery stores, laundromats, community centers, buses, etc.

6.0 Next Steps

This study helps illuminate some of the issues affecting hurricane evacuation and sheltering, particularly regarding transportation. It also notes the leadership role emergency management organizations play. The TPO is encouraged to continue the conversations with emergency management agencies and transportation partners on ways to reduce/maintain evacuation clearance times. Next steps can be accomplished as part of the 2050 long range transportation plan (LRTP), annual updates to the transportation improvement program (TIP), special studies included in the Unified Planning Work Program (UPWP), or ongoing programs or initiatives. These steps include:

- Continue to support existing projects and investigating strategic, low-cost improvements at identified hotspot locations to reduce congestion bottlenecks. (LRTP, congestion management process)
- Identify funding opportunities to implement additional display messaging capabilities or other operational intelligence to foster safe, efficient evacuations. Additional cameras, sensors, signal coordination, and Smart City improvements can assist in monitoring evacuations, quickly address incidents, and support any needed diversions or detours. (LRTP, TIP, partner agencies)
- Perform a more thorough study of public transportation needs and recommendations for operations during evacuations, considering typical and emergency routes, coverage for mobile home parks and communities using transit, and transport options for people with medical needs who can go to safe, non-shelter destinations. (UPWP, partner agencies)
- Collaborate or support development of targeted messaging for use prior to and during emergency events. New residents should be informed and current residents reminded of actions needed to stay safe. (Program/Initiative) Some of the types of targeted messages identified during the study are:
 - Shelter-in-place if outside an evacuation zone and your residence is wind-safe.
 - People need only evacuate short distances, i.e., to inland areas, to be safe.
 - Run from flood, hide from wind, encouraging people in evacuation zones to evacuate when mandated.
 - Waiting until the last minute to decide whether to evacuate may mean being stuck in traffic.

Appendix A Hurricane Irma Evacuation Impact Analysis

Data

HERE Data - HERE (formerly Nokia Here) powers its map with data from more than 80,000 sources, including highly precise static data captured by its 3D mapping cars and a wide array of dynamic data. HERE can provide speed and travel time data and has extensive coverage. HERE data is segmented based on directional segments called Traffic Message Channels (TMC).

HERE data can report average travel speed for each TMC in select time intervals and can be queried for historical time periods.

Background

Hurricane Irma made landfall in Naples, FL area on September 10, 2017, in the evening as a Category 3 hurricane. It proceeded north passing just east Tampa as a Category 1 hurricane. In the days leading up to Irma's landfall, many models predicted landfall along Florida's southeastern or southwestern coasts, as well as probability of passing just west of Tampa Bay as a powerful storm.

On the evening of September 6, Governor Rick Scott ordered state offices, public schools, and state universities to be closed on Thursday September 7 and Friday September 8. Evacuations were ordered by officials in southeast and southwest Florida, as well as Tampa Bay in the days leading up to Irma's landfall.

Comparison

Hillsborough County Public Schools opened on August 10th in 2017. Therefore, a comparison timeframe of three weeks prior to the evacuation study day was found to be appropriate, normal days (adjustments made for Thursday and Friday noted below). A simple average of available speed data from the equivalent hours of the study days for the three prior weeks was used as baseline for each comparison. For instance, the Wednesday (9/6) analysis shows speed reductions as compared to the average of daily speed for 8/16, 8/23, and 8/30.

Scoring

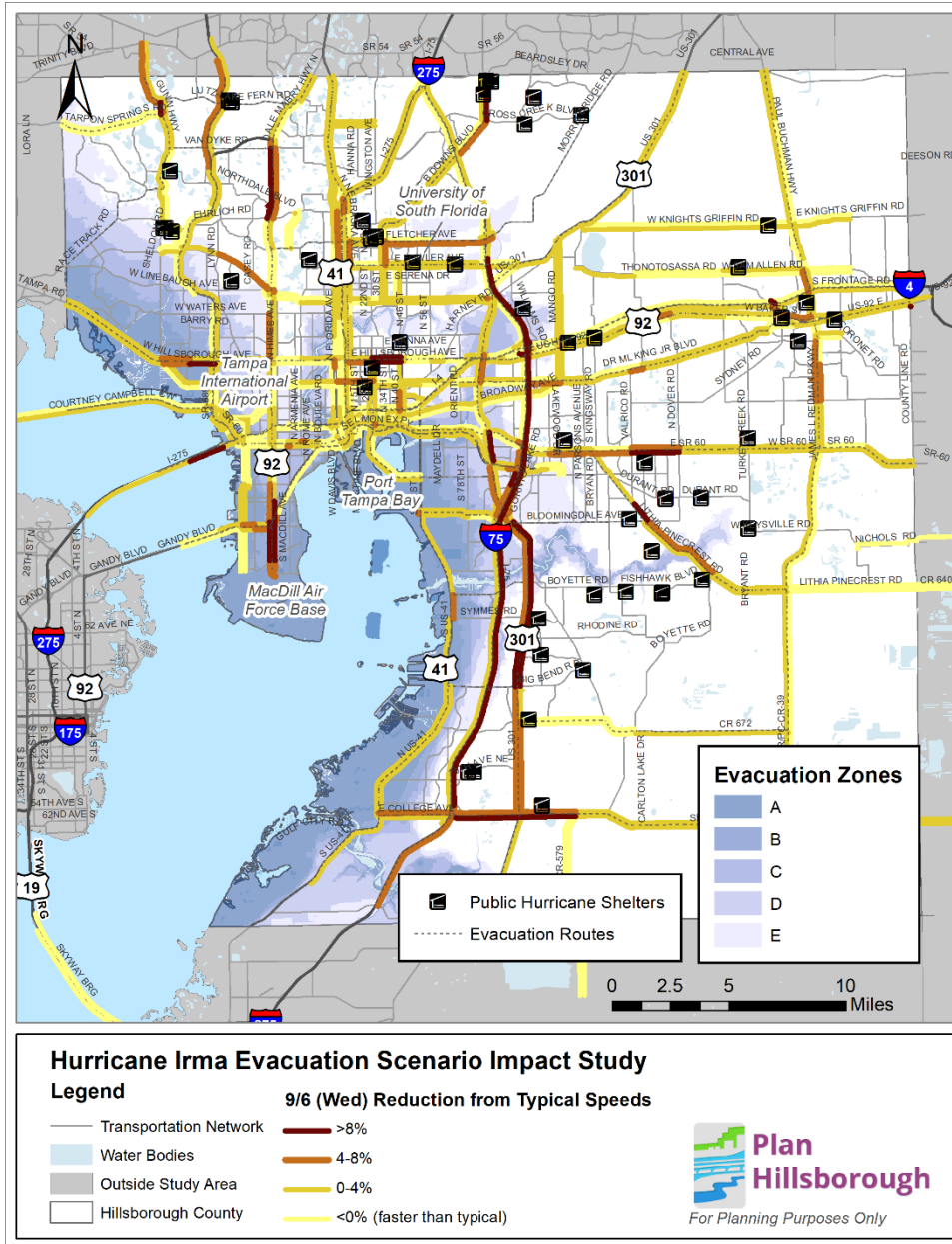
The study team used HERE travel speed inventory data to perform a Hurricane Irma Evacuation Scenario Impact Analysis. A composite score from that analysis was assigned as the sum across all days (Wednesday-Sunday) of daily score: 0 if no speed reduction; 1 if speed reduction 0-4%; 2 if speed reduction 4-8%; 3 if speed reduction >8%. Congestion during normal peak travel times was assessed using the 2045 Tampa Bay Regional Planning Model 2045 projected V/C ratio for planning LOS.

To identify hot spots that experienced slower than normal traffic during Hurricane Irma evacuation periods as well as are expected to experience significant congestion in the future, these locations were ranked according to Priority Level, which denotes the nature of the overlap between the Hurricane Irma Evacuation Study Composite Score and 2045 Model projected V/C (LOS D). For arterial roads, Hurricane Irma Evacuation Composite Scores were subdivided into three categories: high (5+), medium (3-4), and low (1-2). V/C ratios were subdivided into three categories, high (>1.20), medium (>1.10-1.20), and low (>1.00-1.10). For freeway roads, Hurricane Irma Evacuation Composite Scores were subdivided into three categories: high (5+), medium (3-4), and low (1-2). V/C ratios were subdivided into three categories, high (>1.50), medium (>1.30-1.50), and

low (>1.00-1.30). Priority Level is an order of the overlap of severity of the two. For instance, a location with high Irma Evacuation Composite Score and high V/C ratio is Priority Level 1, a location with high Composite Score and medium V/C ratio is Priority Level 2, and so on. Within Priority Level, locations are sorted by Irma Composite Score first, then V/C ratio order. Only locations with overlap in Priority Levels one through six were included in the initial consideration – overlap of medium-low, low-medium, and low-low were not considered for hotspot evaluation.

Wednesday (9/6/17)

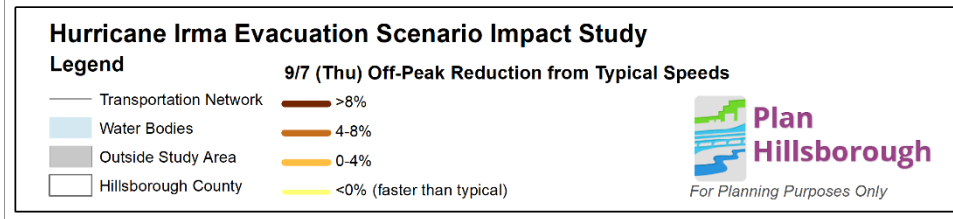
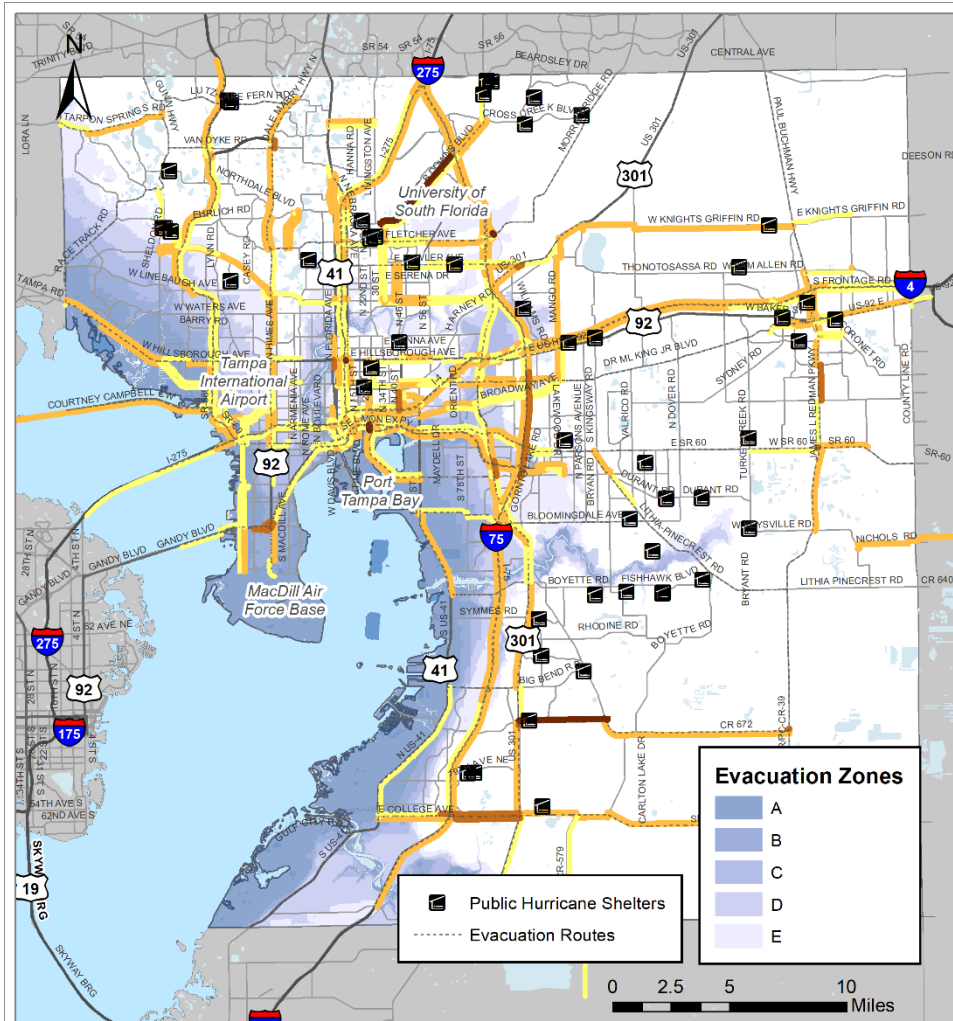
Full day average speed used.



- North-South speed reduction likely influenced by those evacuating from SE/SW Florida headed north (through traffic).
- Howard Frankland Bridge speed reductions observed, but not other Bay bridges.
- Heavy traffic around MacDill Airforce base possibly due to evacuation efforts for sensitive equipment.

Thursday (9/7/17)

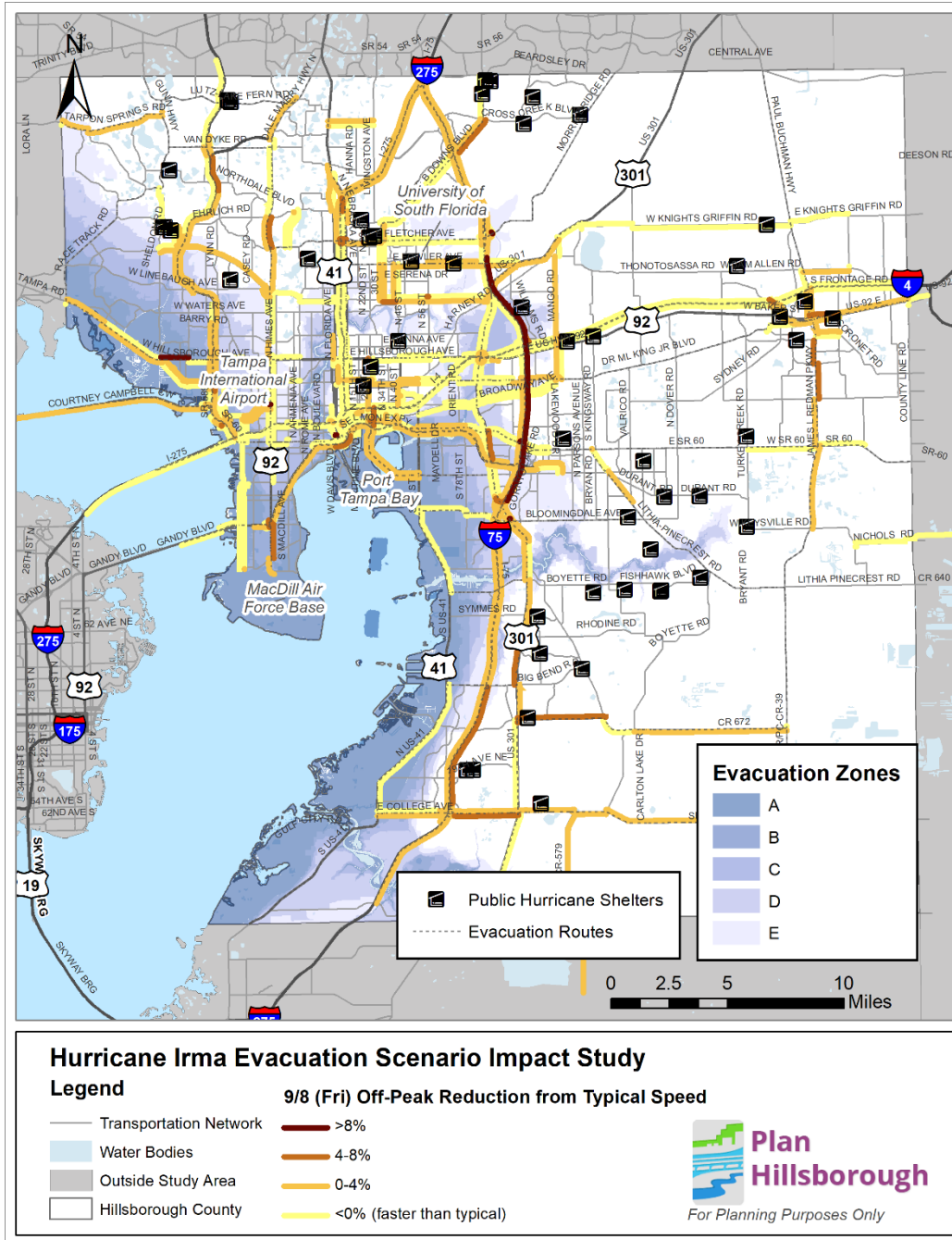
Because of shut down order for 9/7 and 9/8, non-peak (7-10 am and 4-7 pm) speeds were compared.



- Less dramatic speed reductions on Thursday partially due to the cancelling effect of the state offices, public schools and universities being ordered shut.
- Some slower speed still observed on I-75 as well as on SR 674, the MacDill Airforce Base area, and Bruce B. Downs Blvd.

Friday (9/8/17)

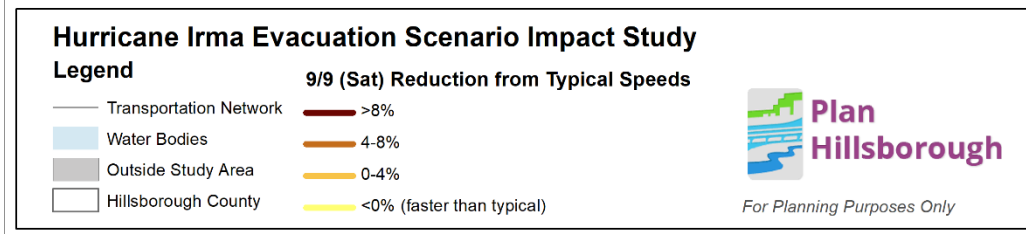
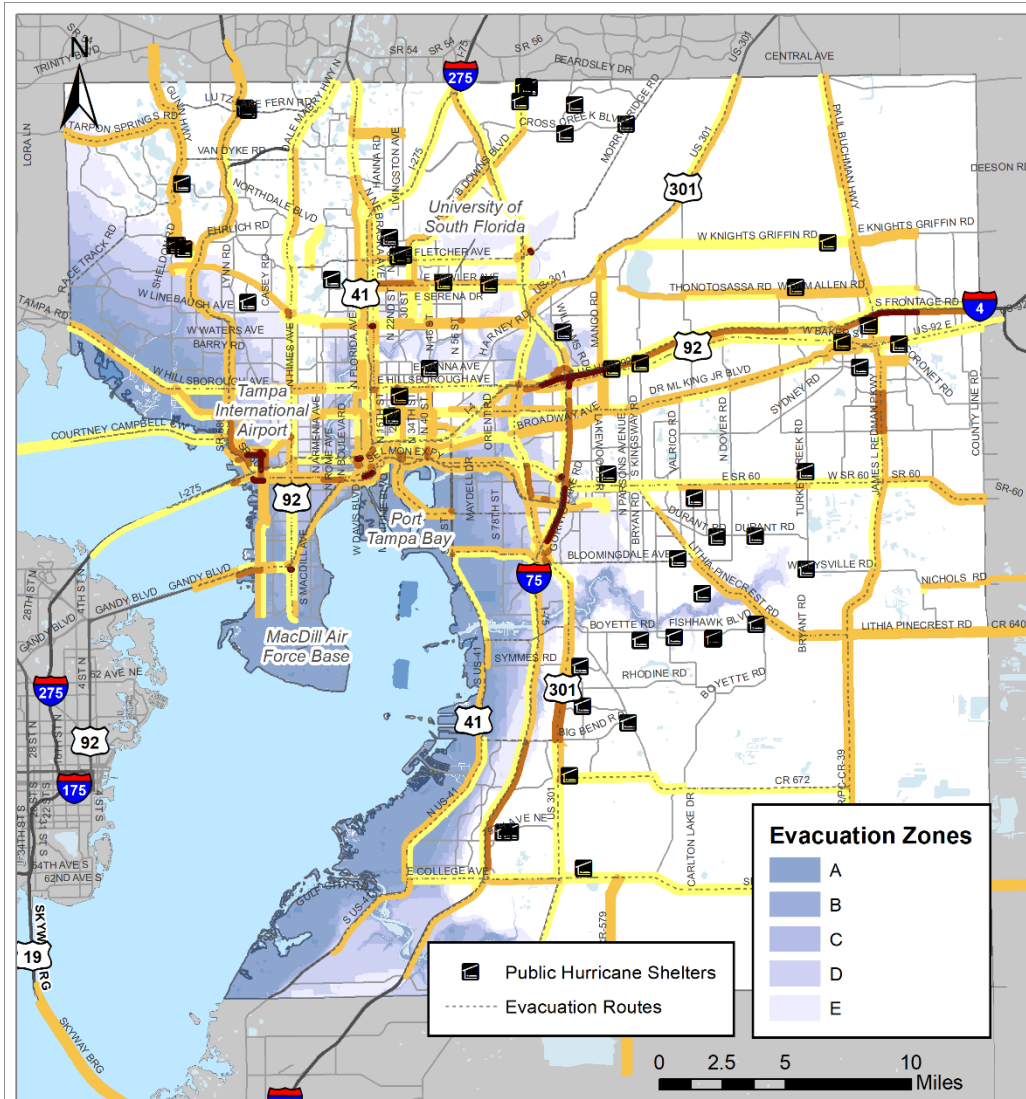
Because of shut down order for 9/7 and 9/8, non-peak (7-10 am and 4-7 pm) speeds were compared.



- I-75 showing major slowdowns northbound, possibly due to northbound evacuation traffic from southeast and southwest Florida.
- Some instances of slower speeds on SR 589/ Veterans Expressway.
- Slow speeds still prevalent in the MacDill Airforce Base access area.

Saturday (9/9/17)

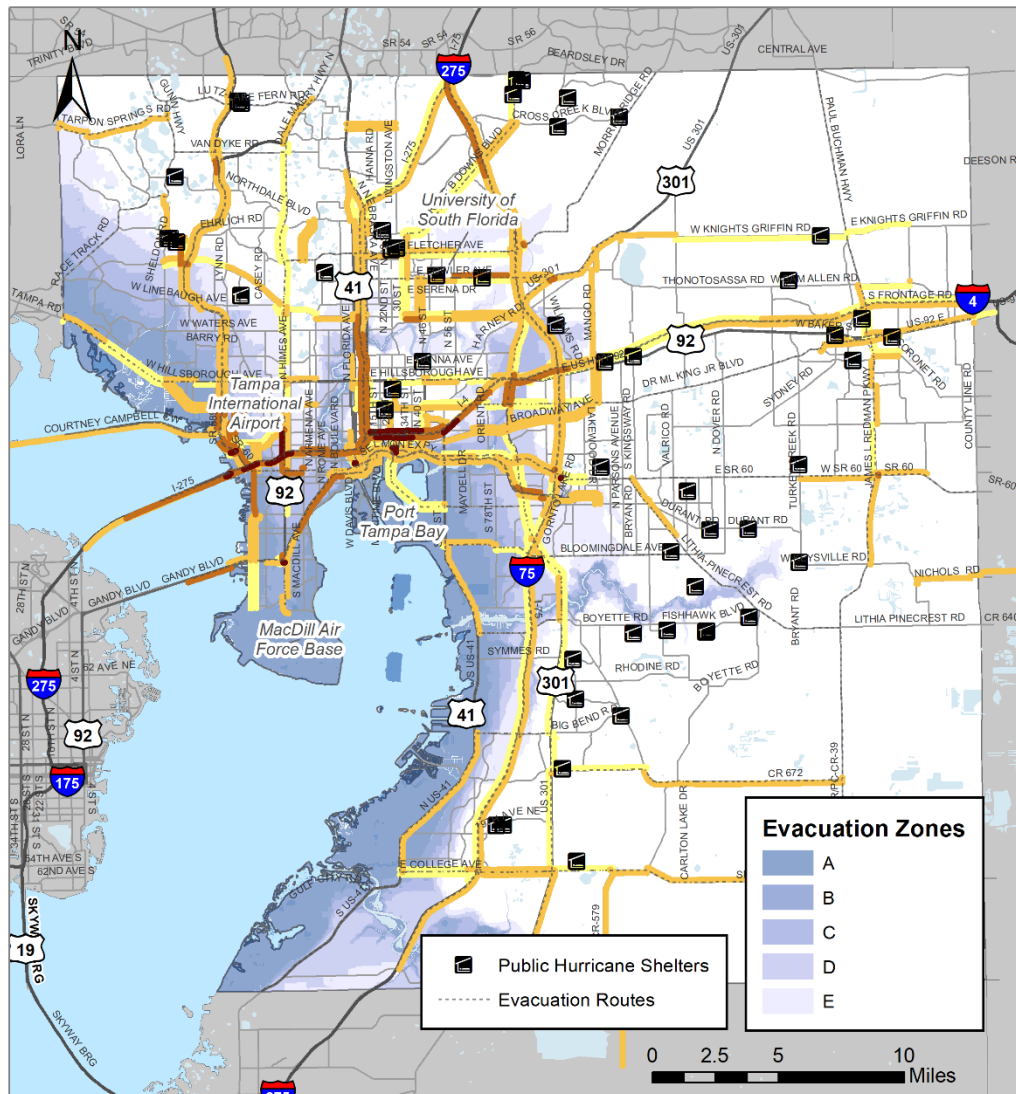
Full day average speed used.



- I-75 speed reduction still observed.
- I-4 speed reduction observed dramatically, possibly impacted by Tampa Bay area residents evacuating to Central Florida.
- Dramatic speed reductions observed on roads near Tampa International Airport/ Westshore area.
- Some widespread but not extreme speed reductions observed on SR 39, possibly another through route for northbound traffic evacuating from southwest Florida.

Sunday (9/10/17)

Because weather impacts from feeder bands of Hurricane Irma became evident as soon as Sunday afternoon, only speeds for Sunday AMs were used.



Hurricane Irma Evacuation Scenario Impact Study

Legend

— Transportation Network	— >8%
Water Bodies	— 4-8%
Outside Study Area	— 0-4%
Hillsborough County	— <0% (faster than typical)



For Planning Purposes Only

- Pervasive speed reductions observed throughout the area, particularly in western Hillsborough County. This could have been impacted by 'last minute' preparation and evacuation activity.
- All three Bay bridges from Pinellas County to Hillsborough showed reduced speeds, two with speed reductions greater than four percent. This was possibly caused by Pinellas County residents evacuating east.
- High speed reductions observed on I-4, as well as on I-275 in the Westshore/Airport area.