



2023 Florida Keys Hurricane Evacuation Modeling

November 2023



Agenda

- FloridaCommerce Hurricane Evacuation Modeling Goals
- Community Engagement
- Florida Keys Evacuation Modeling Overview
- 2023 Baseline Modeling Process
- Results of 2023 Baseline Modeling Process
- Prospective Modeling for Possible Future Allocations
- Questions & Answers

FloridaCommerce Hurricane Evacuation Modeling Goals

- **Public Safety** - Ensure safe and timely evacuation of residents in an emergency, pursuant to Section 380.0552, Florida Statutes.
- **Quality of Life** - Promote balanced growth, affordable housing solutions, and a sound economic base.
- **Environmental Protection** - Protect the natural beauty and unique ecosystems in the Florida Keys, some of the most magnificent in the world.

Robust Community Engagement

- In June 2023, FloridaCommerce met with local leadership in Monroe County to discuss long-term recovery efforts post-hurricanes Ian and Nicole.
- FloridaCommerce received critical input from workshop attendees to inform future hurricane evacuation modeling to keep Florida Keys residents and visitors safe.



Hurricane Evacuation Modeling Workshops

- More than 100 individuals – from community members to local government representatives and stakeholders – participated in the public workshops to provide valuable insight.
- Public workshops were held in Key West, Marathon, and Key Largo.
- FloridaCommerce staff also held individual meetings with local government leadership and Monroe County staff.
- All workshops were live streamed in coordination with Monroe County and are available at www.floridajobs.org/FLKeysEvac



Florida Keys Evacuation Modeling Overview

Memorandum of Understanding (MOU) - 2012

- Directed by the Administration Commission (Governor and Cabinet).
- Signed by local governments within the Florida Keys, FloridaCommerce, and the Florida Division of Emergency Management.
- Memorialized an analysis of maximum build-out capacity for the Florida Keys, consistent with the requirement to maintain a 24-hour evacuation clearance time.
- Established 3,550 new residential building permit allocations.
- Modeled using 2010 census data (the 2020 census detailed data necessary for updated modeling recently became available).

Section 380.0552(9)(a)2., Florida Statutes

FloridaCommerce is the “State Land Planning Agency” and is responsible for facilitating a hurricane evacuation study for the Florida Keys ...

“... Amendments to local comprehensive plans in the Florida Keys Area must also be reviewed for compliance with the following ... 2. Goals, objectives, and policies to protect public safety and welfare in the event of a natural disaster by maintaining a hurricane evacuation clearance time for permanent residents of no more than 24 hours. The hurricane evacuation clearance time shall be determined by a hurricane evacuation study conducted in accordance with a professionally accepted methodology and approved by the state land planning agency.”

Administration Commission Rules

1. Develop a Memorandum of Understanding (MOU) that stipulates the input variables and assumptions used in the model.
2. Update the data for the Florida Keys Hurricane Evacuation Model as professionally acceptable sources of information are released (such as the Census, American Communities Survey, Bureau of Economic and Business Research, and other studies).
3. Use the variables and assumptions in the model to complete a build-out analysis.
4. Apply the derived clearance times to determine the remaining allocations.
5. Amend comprehensive plans to reflect the new allocations as needed.

Building Permit Allocation System

- As part of the overall evacuation strategy, the Florida Administration Commission adopted a building permit allocation system (BPAS) that caps the number of permits that can be issued for new residential structures.
- Based on existing infrastructure and evacuation strategies, and computer modeling that was performed in 2012, the projected maximum build out for the Florida Keys was estimated to be the development of an additional 3,550 allocations beginning July 2013. A portion of these allocations have been set-aside for affordable housing.
- At the March 7, 2013, meeting of the Administration Commission, the Commission voted to accept FloridaCommerce's recommendation of a building allocation of 3,550 and to distribute those allocations over a ten-year period, which ends in 2023.



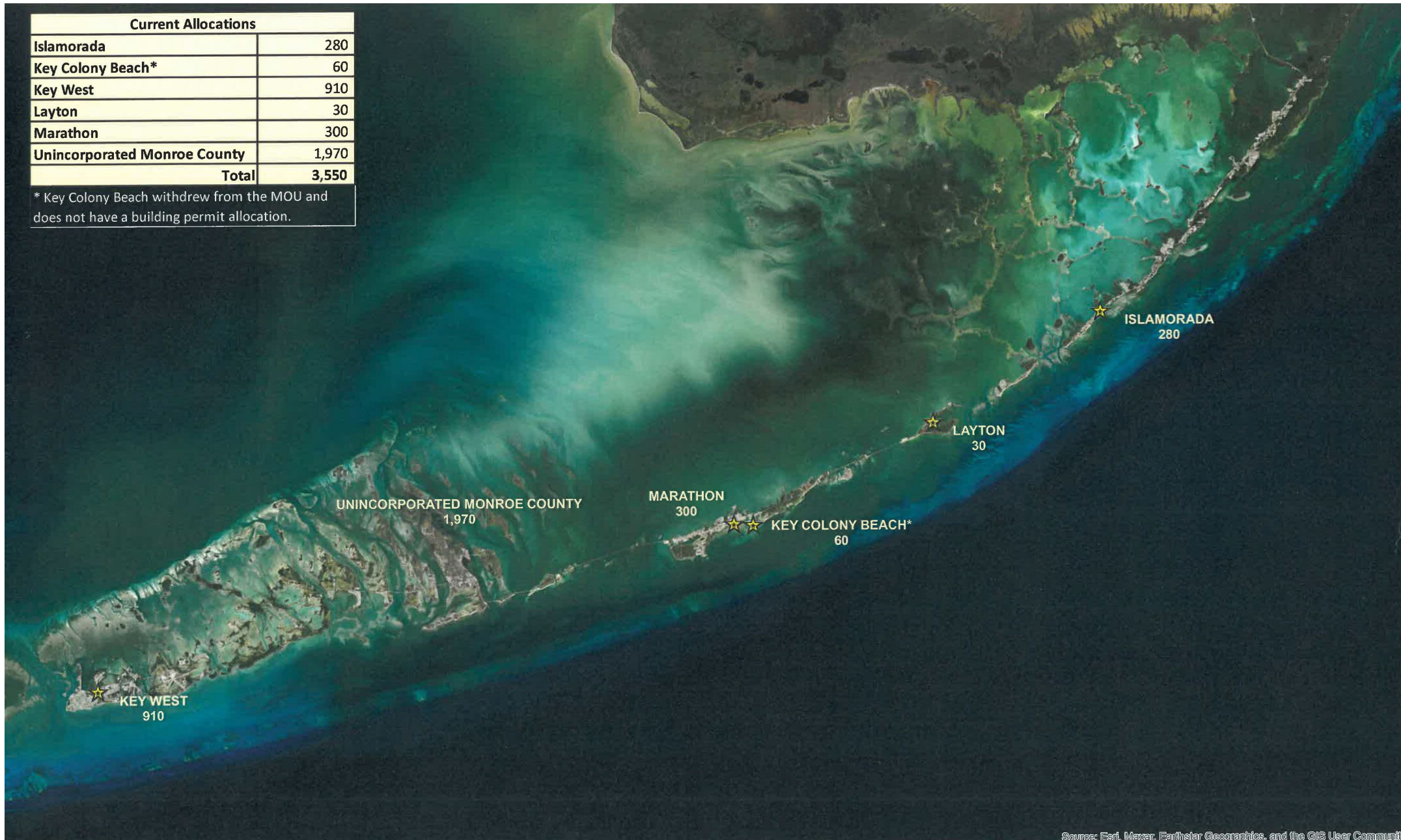
Areas of Critical State Concern & Key West

- Areas of Critical State Concern are designated and administered under Section 380.05, F.S. Specific Areas of Critical State Concern are governed by certain statute and/or Administration Commission Rules.
- There are two Areas of Critical State Concern in the Florida Keys:
 - The City of Key West and the Florida Keys Area.
- The Florida Keys Area includes unincorporated Monroe County, and the municipalities of Layton, Islamorada, Marathon and Key Colony Beach.
- The Key West Area of Critical State Concern is governed by Chapter 28-36, Florida Administrative Code (F.A.C.), while the Florida Keys Area of Critical State Concern is governed by Section 380.0552, F.S.



Current Allocations	
Islamorada	280
Key Colony Beach*	60
Key West	910
Layton	30
Marathon	300
Unincorporated Monroe County	1,970
Total	3,550

* Key Colony Beach withdrew from the MOU and does not have a building permit allocation.



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community



2023 Baseline Modeling Process



Hurricane Evacuation Modeling Overview

Variables in the Transportation Interface for Modeling Evacuations (TIME)

- Tourist Units
- Mobile Home Units
- Site-Built Units
- Response Curve
- Participation Rates
- Vehicle Usage by Unit Type
- Vehicle Unit by Special Population
- Evacuation Stream
- Roadway Capacity
- Evacuation Procedures



Hurricane Evacuation Modeling Overview

- The 2012 MOU was based on a two-phase evacuation methodology. We continued this methodology for 2023.
 - Phase I (24 - 48 hours in advance of tropical storm force winds)
 - Non-residents and others, mobile home residents and military personnel evacuate.
 - Phase 2 (0 – 24 hours in advance of tropical storm force winds)
 - All permanent residents must evacuate.

Efforts to Update Hurricane Evacuation Modeling

- Reviewed updates to Florida Division of Emergency Management's regional evacuation model which include Monroe, Miami-Dade, and Broward Counties and using recently available detailed data from American Community Survey.
- Engaged a consultant to make the necessary updates to the model.
- Received and reviewed public input on considerations for the Hurricane Evacuation Modeling Update.
- Requested data from Florida Keys' local governments:
 - Number of vacant lots
 - Number of parcels purchased since July 2013
 - Status of Building Permit Allocations
 - Status/Number of Market Rate/Transient/Affordable Units



Developing Baseline Modeling

1. Based on 2012 two-phased modeling.
2. Factoring mobile homes in Phase 2 evacuation (permanent residents).
3. Including the Florida Keys Area of Critical State Concern and not including the Key West Area of Critical State Concern factoring mobile homes in Phase 2 evacuation.
4. Baseline Model including the Florida Keys Area of Critical State Concern and not including the Key West Area of Critical State Concern factoring mobile homes in Phase 2 evacuation.



Input Parameters for all Baseline Modeling

Phase 1: Non-Permanent Population
 12-Hour Response Curve
 Evacuation Level: E (maximum threat)

Phase 2: Permanent Population
 12-Hour Response Curve
 Evacuation Level: E (maximum threat)

SCENARIO INPUT PARAMETERS	
REGION	South Florida
BEHAVIORAL ASSUMPTION	100% Response
NETWORK PERIOD	2020
POPULATION PERIOD	2020
MODEL	Run Full Model
University POPULATION	Fall/Spring Session (100% in residence)
SHELTER STATUS	Primary Open
TOURIST INCLUDED	Yes (no override rates)

SCENARIO INPUT PARAMETERS	
REGION	South Florida
BEHAVIORAL ASSUMPTION	Planning Assumptions
NETWORK PERIOD	2020
POPULATION PERIOD	2020
MODEL	Run Full Model
University POPULATION	Out of Session (0% in residence)
SHELTER STATUS	Primary Open
TOURIST INCLUDED	No



Results of 2023 Baseline Modeling Process



Population Demographics Including Key West

Mobile Homes in Phase 2

Baseline Model 1: Phase 1 Non-Permanent Population

Areas	Site-Built Population	Mobile Home Population	University Population	Tourist Population	Total Evacuating Population
Key West	2,193	54	0	8,311	10,558
Lower Keys	225	190	0	292	707
Middle Keys	4,350	49	0	2,373	6,773
Upper Keys	2,118	38	0	4,291	6,447

RV/Van/Boat no Mobile Homes

Baseline Model 1: Phase 2 Permanent Population

Areas	Site-Built Population	Mobile Home Population	University Population	Tourist Population	Total Evacuating Population
Key West	23,798	2,792	0	0	26,590
Lower Keys	10,703	1,762	0	0	12,464
Middle Keys	9,318	1,083	0	0	10,402
Upper Keys	16,645	2,064	0	0	18,709



Vehicle Demographics Including Key West

Mobile Homes in Phase 2

Baseline Model 1: Phase1 Non-Permanent Population

Areas	Site-Built Evacuating Vehicles	Mobile Home Evacuating Vehicles	University Evacuating Vehicles	Tourist Evacuating Vehicles	Total Evacuating Vehicles
Key West	1,737	33	0	4,155	5,925
Lower Keys	170	133	0	146	449
Middle Keys	2,214	16	0	1,187	3,417
Upper Keys	930	29	0	2,146	3,105

RV/Van/Boat no Mobile Homes

Baseline Model 1: Phase 2 Permanent Population

Areas	Site-Built Evacuating Vehicles	Mobile Home Evacuating Vehicles	University Evacuating Vehicles	Tourist Evacuating Vehicles	Total Evacuating Vehicles
Key West	12,541	1,096	0	0	13,637
Lower Keys	6,114	1,143	0	0	7,257
Middle Keys	4,428	431	0	0	4,859
Upper Keys	7,377	1,326	0	0	8,703



Population Demographics Including Key West

Mobile Homes in Phase 1

Baseline Model 2: Phase 1 Non-Permanent Population

Areas	Site-Built Population	Mobile Home Population ¹	University Population	Tourist Population	Total Evacuating Population
Key West	2,193	3,237	0	8,311	13,741
Lower Keys	225	2,078	0	292	2,595
Middle Keys	4,350	1,247	0	2,373	7,971
Upper Keys	2,118	2,350	0	4,291	8,759

↑ Mobile Homes added to RV/Van/Boat

Baseline Model 2: Phase 2 Permanent Population

Areas	Site-Built Population	Mobile Home Population	University Population	Tourist Population	Total Evacuating Population
Key West	23,798	0	0	0	23,798
Lower Keys	10,703	0	0	0	10,703
Middle Keys	9,318	0	0	0	9,318
Upper Keys	16,645	0	0	0	16,645




Vehicle Demographics Including Key West

Mobile Homes in Phase 1

Baseline Model 2: Phase1 Non-Permanent Population

Areas	Site-Built Evacuating Vehicles	Mobile Home Evacuating Vehicles ¹	University Evacuating Vehicles	Tourist Evacuating Vehicles	Total Evacuating Vehicles
Key West	1,737	1,263	0	4,155	7,155
Lower Keys	170	1,353	0	146	1,669
Middle Keys	2,214	496	0	1,187	3,897
Upper Keys	930	1,508	0	2,146	4,584


Mobile Homes added to RV/Van/Boat

Baseline Model 2: Phase 2 Permanent Population

Areas	Site-Built Evacuating Vehicles	Mobile Home Evacuating Vehicles	University Evacuating Vehicles	Tourist Evacuating Vehicles	Total Evacuating Vehicles
Key West	12,541	0	0	0	12,541
Lower Keys	6,114	0	0	0	6,114
Middle Keys	4,428	0	0	0	4,428
Upper Keys	7,377	0	0	0	7,377



Clearance Times Including Key West

EVACUATION CLEARANCE TIMES (Hours)				
	Baseline Model 1 (Includes KW, Mobile Homes in Phase 2)		Baseline Model 2 (Includes KW, Mobile Homes in Phase 1)	
	Phase 1	Phase 2	Phase 1	Phase 2
KEY WEST	12.5	12.5	12.5	12.5
LOWER KEYS	13.0	19.5	13.0	17.5
MIDDLE KEYS	14.0	23.0	14.0	21.0
UPPER KEYS	15.0	25.5	15.0	23.5
OUT OF COUNTY	15.5	26.0	15.5	24.0



Population Demographics Excluding Key West

Mobile Homes in Phase 2

Baseline 3: Phase 1 Non-Permanent Population

Areas	Site-Built Population	Mobile Home Population	University Population	Tourist Population	Total Evacuating Population
Lower Keys	225	190	0	292	707
Middle Keys	4,350	49	0	2,373	6,773
Upper Keys	2,118	38	0	4,291	6,447

RV/Van/Boat no Mobile Homes

Baseline 3: Phase 2 Permanent Population

Areas	Site-Built Population	Mobile Home Population	University Population	Tourist Population	Total Evacuating Population
Lower Keys	10,703	1,762	0	0	12,464
Middle Keys	9,318	1,083	0	0	10,402
Upper Keys	16,645	2,064	0	0	18,709




Population Demographics Excluding Key West

Mobile Homes in Phase 1

Baseline 4: Phase 1 Non-Permanent Population

Areas	Site-Built Population	Mobile Home Population ¹	University Population	Tourist Population	Total Evacuating Population
Lower Keys	225	2,078	0	292	2,595
Middle Keys	4,350	1,247	0	2,373	7,971
Upper Keys	2,118	2,350	0	4,291	8,759


Mobile Homes added to RV/Van/Boat

Baseline 4: Phase 2 Permanent Population

Areas	Site-Built Population	Mobile Home Population	University Population	Tourist Population	Total Evacuating Population
Lower Keys	10,703	0	0	0	10,703
Middle Keys	9,318	0	0	0	9,318
Upper Keys	16,645	0	0	0	16,645



Vehicle Demographics Excluding Key West

Mobile Homes in Phase 2

Baseline 3: Phase 1 Non-Permanent Population

Areas	Site-Built Evacuating Vehicles	Mobile Home Evacuating Vehicles	University Evacuating Vehicles	Tourist Evacuating Vehicles	Total Evacuating Vehicles
Lower Keys	133	133	0	146	449
Middle Keys	2,214	16	0	1,187	3,417
Upper Keys	930	29	0	2,146	3,105

RV/Van/Boat no Mobile Homes

Baseline 3: Phase 2 Permanent Population

Areas	Site-Built Evacuating Vehicles	Mobile Home Evacuating Vehicles	University Evacuating Vehicles	Tourist Evacuating Vehicles	Total Evacuating Vehicles
Lower Keys	6,114	1,143	0	0	7,257
Middle Keys	4,428	431	0	0	4,859
Upper Keys	7,377	1,326	0	0	8,703



Vehicle Demographics Excluding Key West

Mobile Homes in Phase 1

Baseline 4: Phase 1 Non-Permanent Population

Areas	Site-Built Evacuating Vehicles	Mobile Home Evacuating Vehicles ¹	University Evacuating Vehicles	Tourist Evacuating Vehicles	Total Evacuating Vehicles
Lower Keys	133	1,353	0	146	1,632
Middle Keys	2,214	496	0	1,187	3,897
Upper Keys	930	1,508	0	2,146	4,584

↑ Mobile Homes added to RV/Van/Boat

Baseline 4: Phase 2 Permanent Population

Areas	Site-Built Evacuating Vehicles	Mobile Home Evacuating Vehicles	University Evacuating Vehicles	Tourist Evacuating Vehicles	Total Evacuating Vehicles
Lower Keys	6,114	0	0	0	6,114
Middle Keys	4,428	0	0	0	4,428
Upper Keys	7,377	0	0	0	7,377



Clearance Times Excluding Key West

EVACUATION CLEARANCE TIMES (Hours)				
	Baseline Model 3 (Excludes KW, Mobile Homes in Phase 2)		Baseline Model 4 (Excludes KW, Mobile Homes in Phase 1)	
	Phase 1	Phase 2	Phase 1	Phase 2
LOWER KEYS	14.0	13.0	14.0	13.0
MIDDLE KEYS	13.5	14.0	13.5	14.0
UPPER KEYS	14.5	15.0	14.5	15.0
OUT OF COUNTY	15.0	15.5	15.0	15.5



Phase 1 & 2 Results Summary

Out-of-County Clearance Times

FLORIDA KEYS INCLUDING KEY WEST	
Mobile Homes in Phase 2	Mobile Homes in Phase 1
Phase 1	Phase 1
15.5	15.5
Phase 2	Phase 2
26.0	24.0

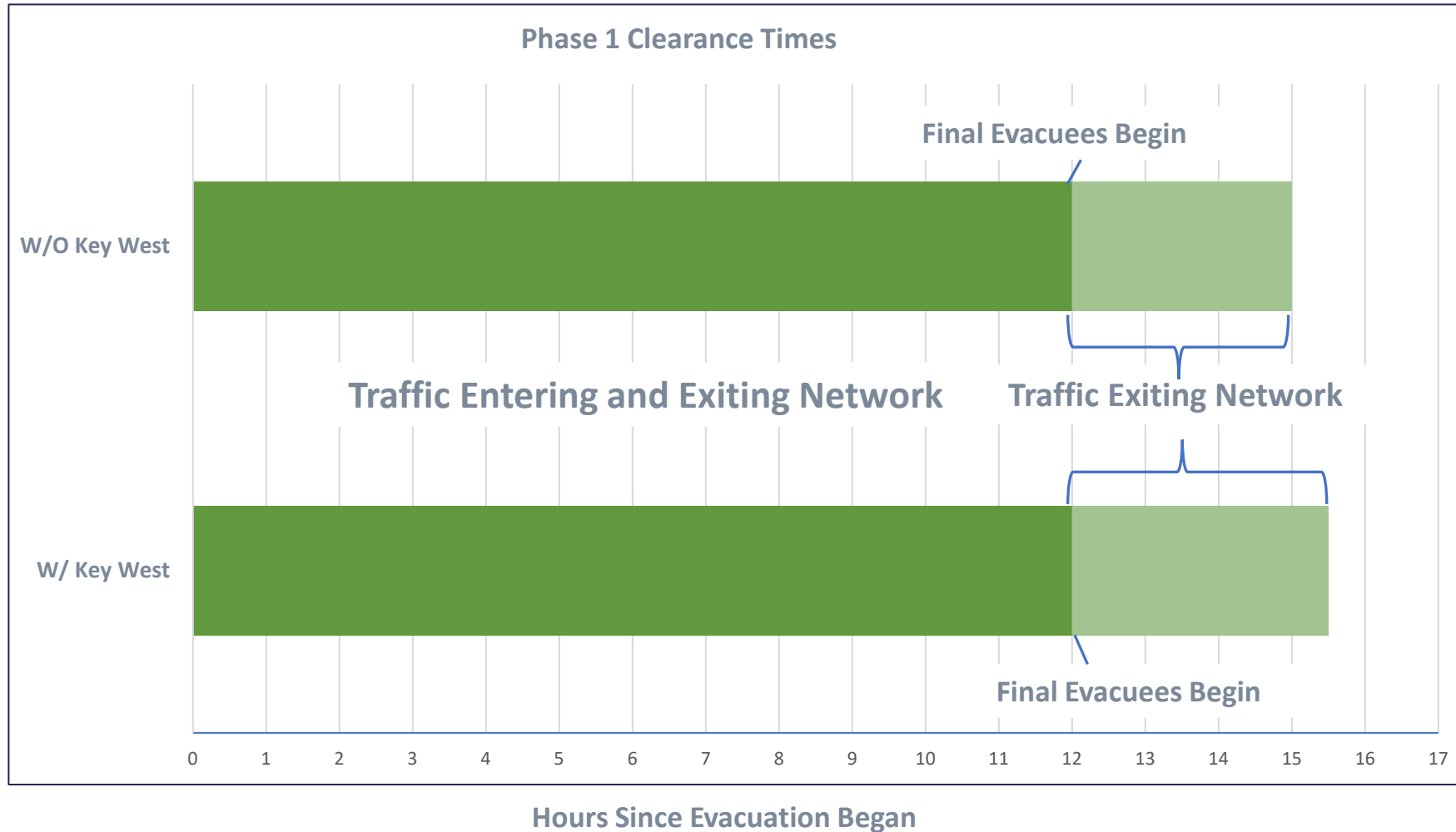
FLORIDA KEYS EXCLUDING KEY WEST	
Mobile Homes in Phase 2	Mobile Homes in Phase 1
Phase 1	Phase 1
15.0	15.0
Phase 2	Phase 2
15.5	15.5



Clearance Time Differences in Phase 1

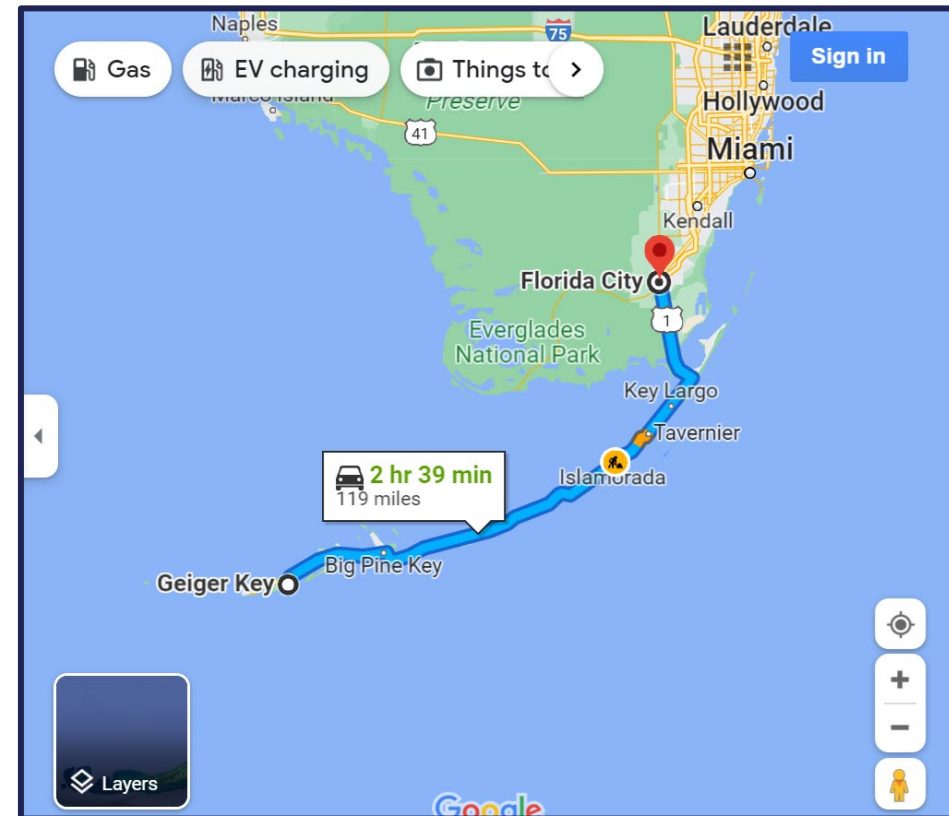
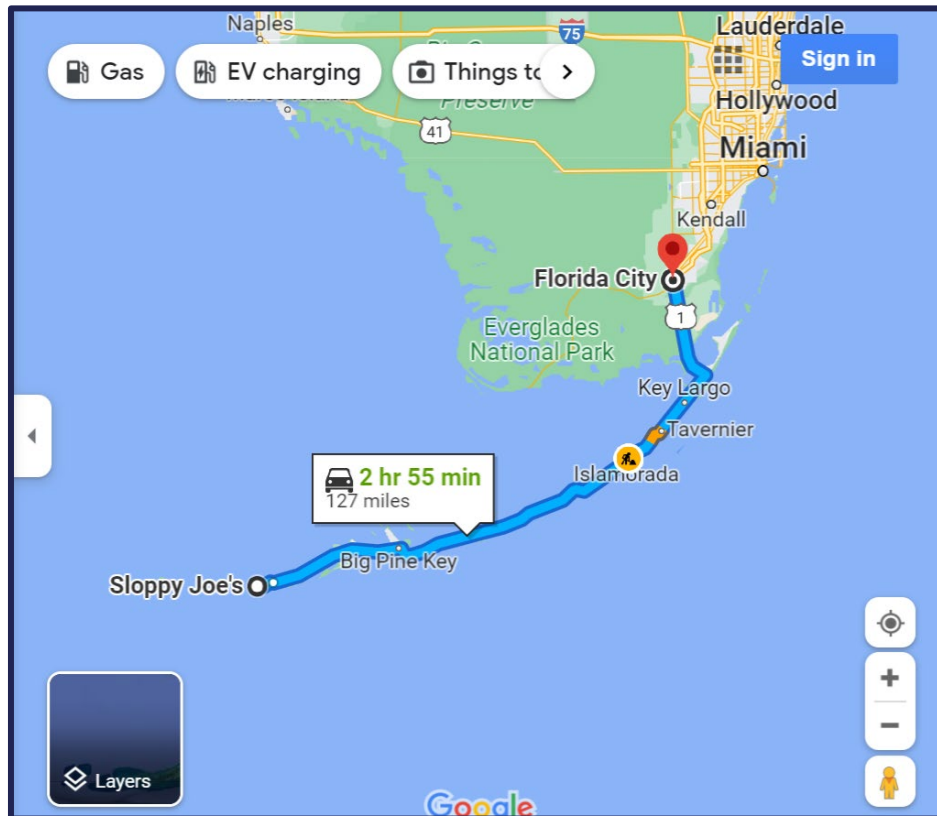
- Only 0.5-hour difference with Key West and Without Key West
- Congestion is not linear
 - System breaks down only when too many vehicles are present
 - Fewer vehicles means free-flowing traffic
- Not enough vehicles to cause congestion in Phase 1
- Clearance Times are longer when Key West is included in Phase 1 only because Key West is farther away

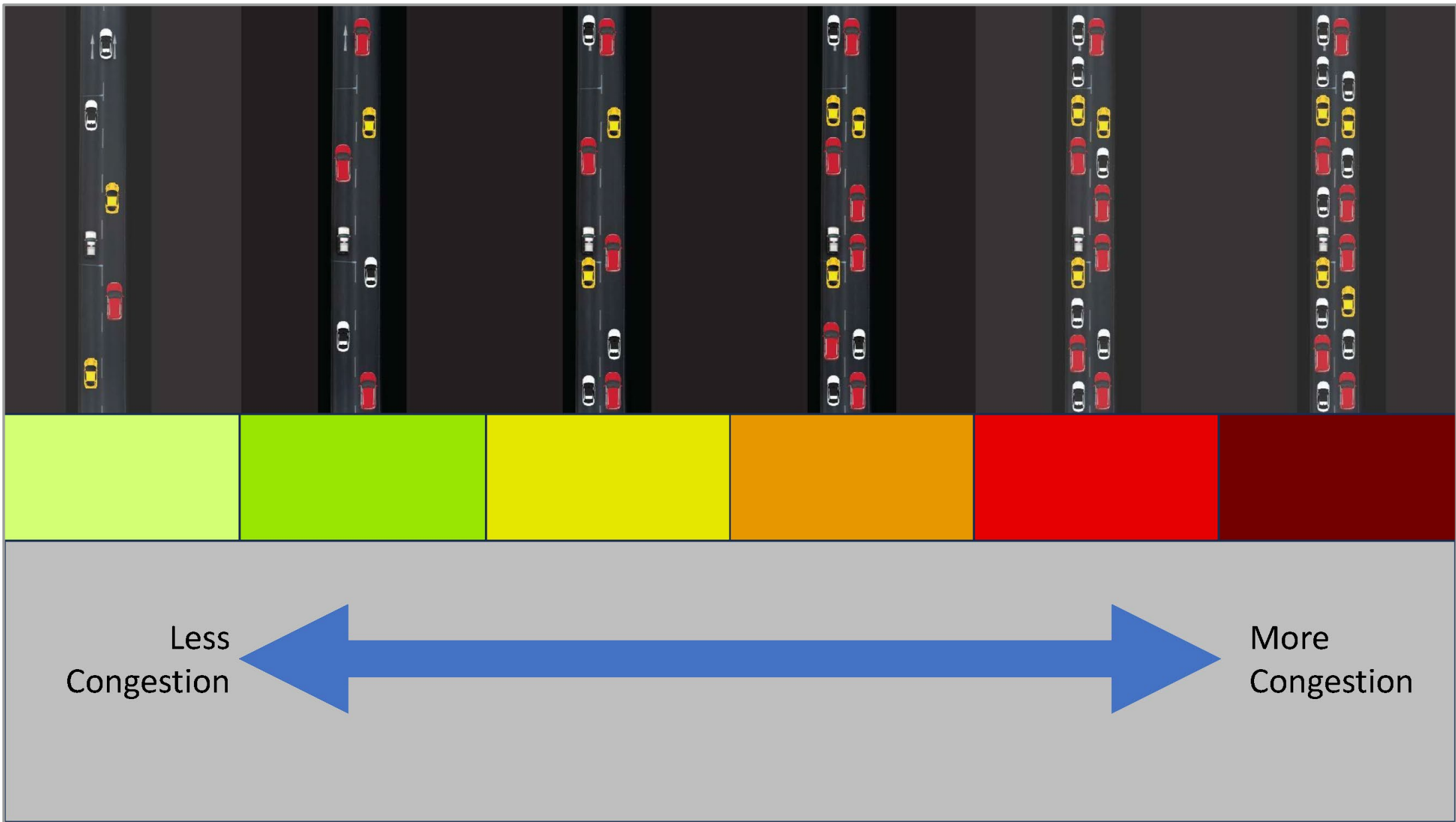
Clearance Time Differences in Phase 1



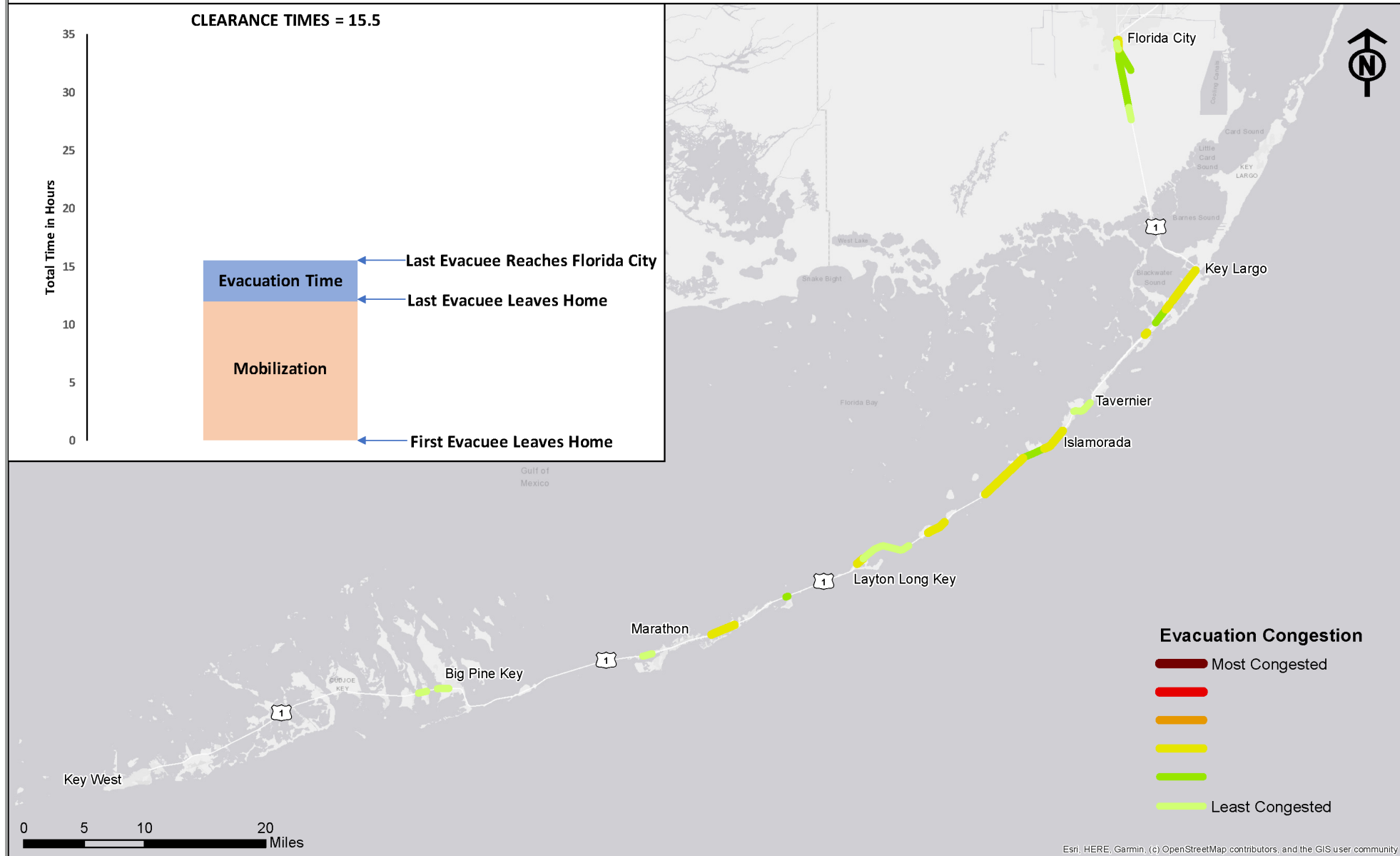
Clearance Time Differences in Phase 1

Key West is farther away from Florida City.

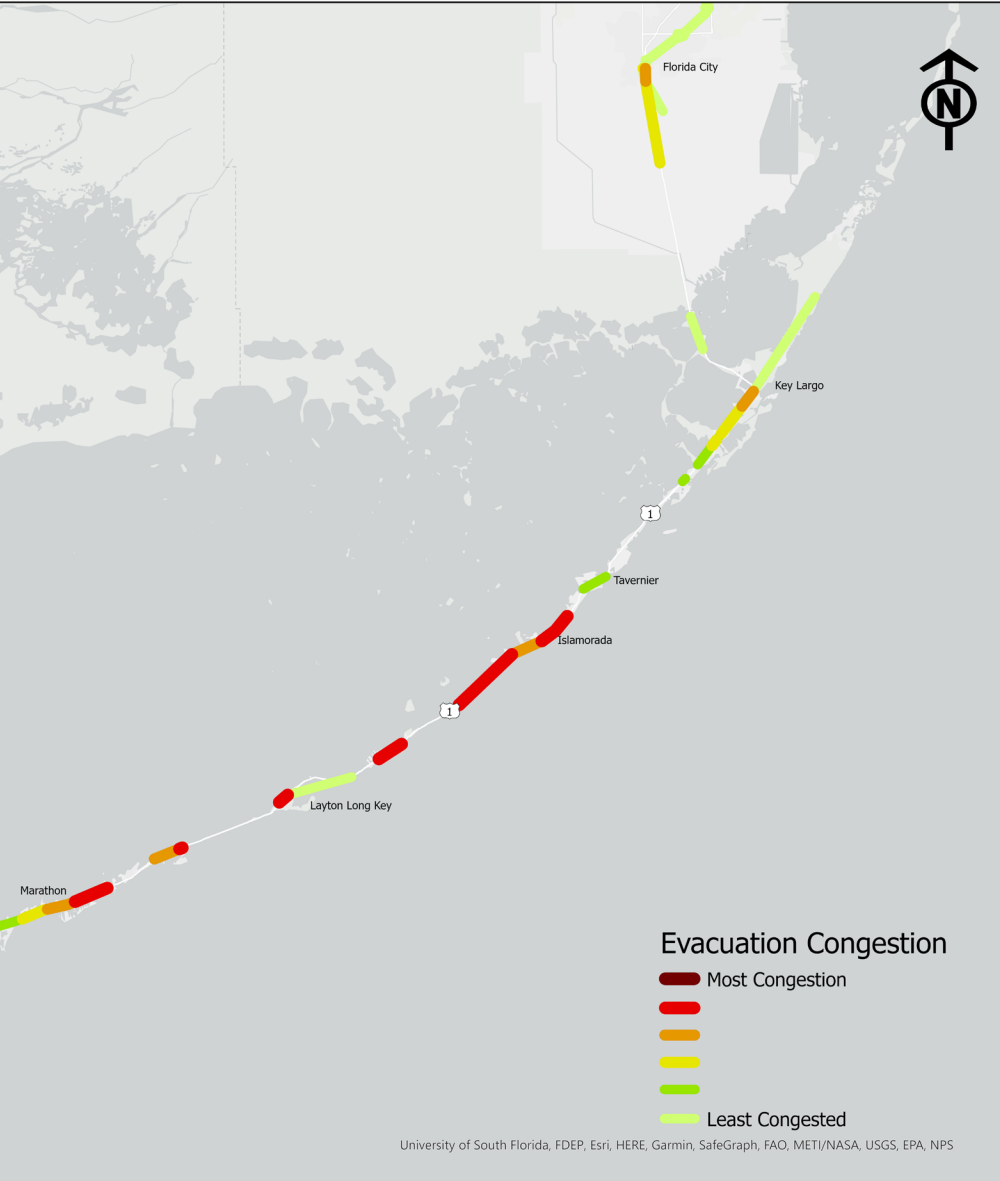
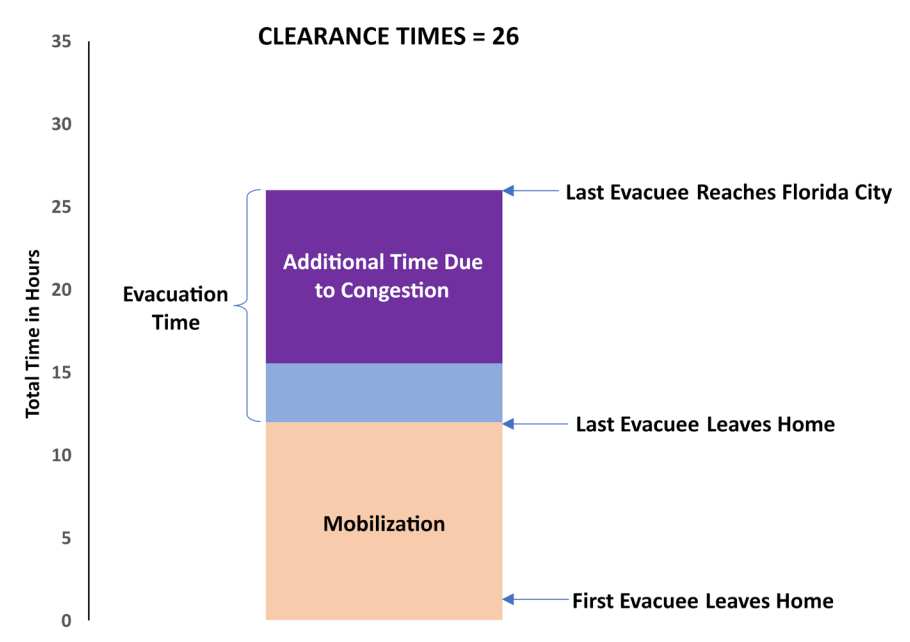




Phase 2 No Allocations Excludes Key West and Includes Mobile Homes



Phase 2 No Allocations Including Key West and Mobile Homes



University of South Florida, FDEP, Esri, HERE, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NPS



Baseline Modeling Recap

Baseline Modeling		Phases	Florida Keys Including Key West		Florida Keys Without Key West	
			Mobile Homes in Phase 2 (Vehicles)	Mobile Homes in Phase 1 (Vehicles)	Mobile Homes in Phase 2 (Vehicles)	Mobile Homes in Phase 1 (Vehicles)
Baseline Modeling	Shows Baseline- Does not include additional prospective allocations	Phase 2	26.0	24.0	15.5	15.5
		Phase 1	15.5	15.5	15.0	15.0



Baseline Modeling Results + Prospective Modeling

- Baseline Modeling is based on current Census and American Community Survey Data.
- Prospective Modeling adds dwelling units to the model to determine evacuation times if additional building permit allocations were permitted.
- The 2023 Hurricane Evacuation Model looked at five different prospective scenarios and evaluated the time it would take to evacuate the Keys.



Prospective Modeling for Possible Future Allocations



Clearance Times Summary

Deliverable 5: Baseline Modeling			Phases	Florida Keys Including Key West		Florida Keys Excluding Key West	
				Mobile Homes in Phase 2 (hours)	Mobile Homes in Phase 1 (hours)	Mobile Homes in Phase 2 (hours)	Mobile Homes in Phase 1 (hours)
Baseline Modeling	Shows baseline - does not include additional prospective allocations		Phase 2	26.0	24.0	15.5	15.5
			Phase 1	15.5	15.5	15.0	15.0
Deliverable 6: Prospective Modeling for Future Allocations							
S1	3,550 Allocations	Distribute based on county/municipality population size	Phase 2	27.5	25.5	15.5	15.5
			Phase 1	15.5	15.5	15.0	15.0
S2	3,550 Allocations	Distribute based percentage of vacant lands per county/municipality	Phase 2	28.0	26.0	15.5	15.5
			Phase 1	15.5	15.5	15.0	15.0
S3	3,550 Allocations	Distribute based on current allocations: (1,970-Monroe, 300-Marathon, 280-Islamorada, 910-Key West, 30-Layton, 60-Key Colony Beach)	Phase 2	28.0	26.0	15.5	15.5
			Phase 1	15.5	15.5	15.0	15.0
S4	Minimal Allocations (11 allocations/yr)	Distributes Monroe County (5); Marathon (2); Islamorada (2); Key West (2 – affordable only)	Phase 2 (10 Years Growth)	26.5	24.0	15.5	15.5
			Phase 2B (20 Years Growth)	26.5	24.0	15.5	15.5
			Phase 1	15.5	15.5	15.0	15.0
S5	One Unit/Vacant Lot	Distributes 7,954 units	Phase 2	31.0	28.5	17.0	16.5
			Phase 1	15.5	15.5	15.0	15.0

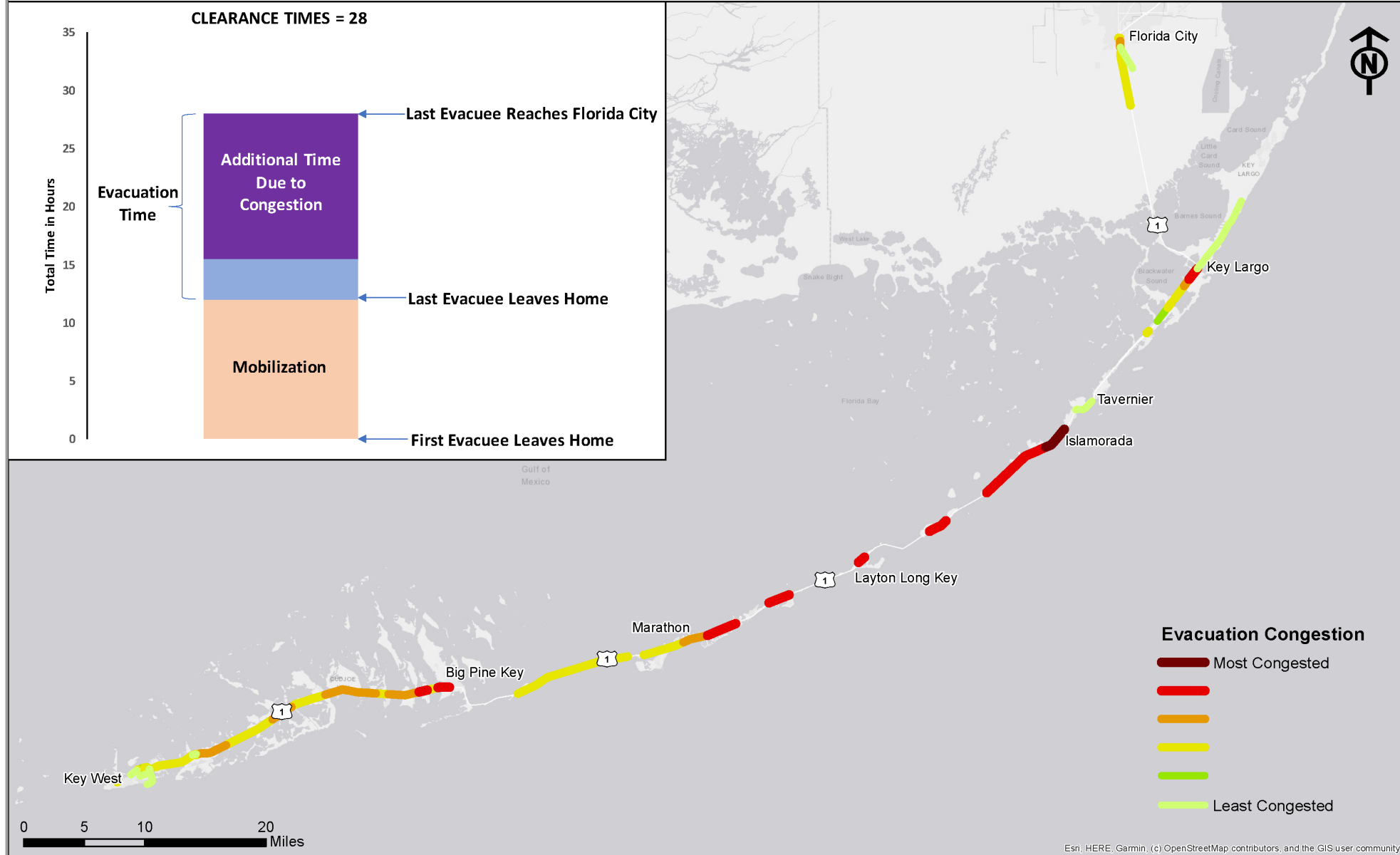


Vehicle Demographics Summary

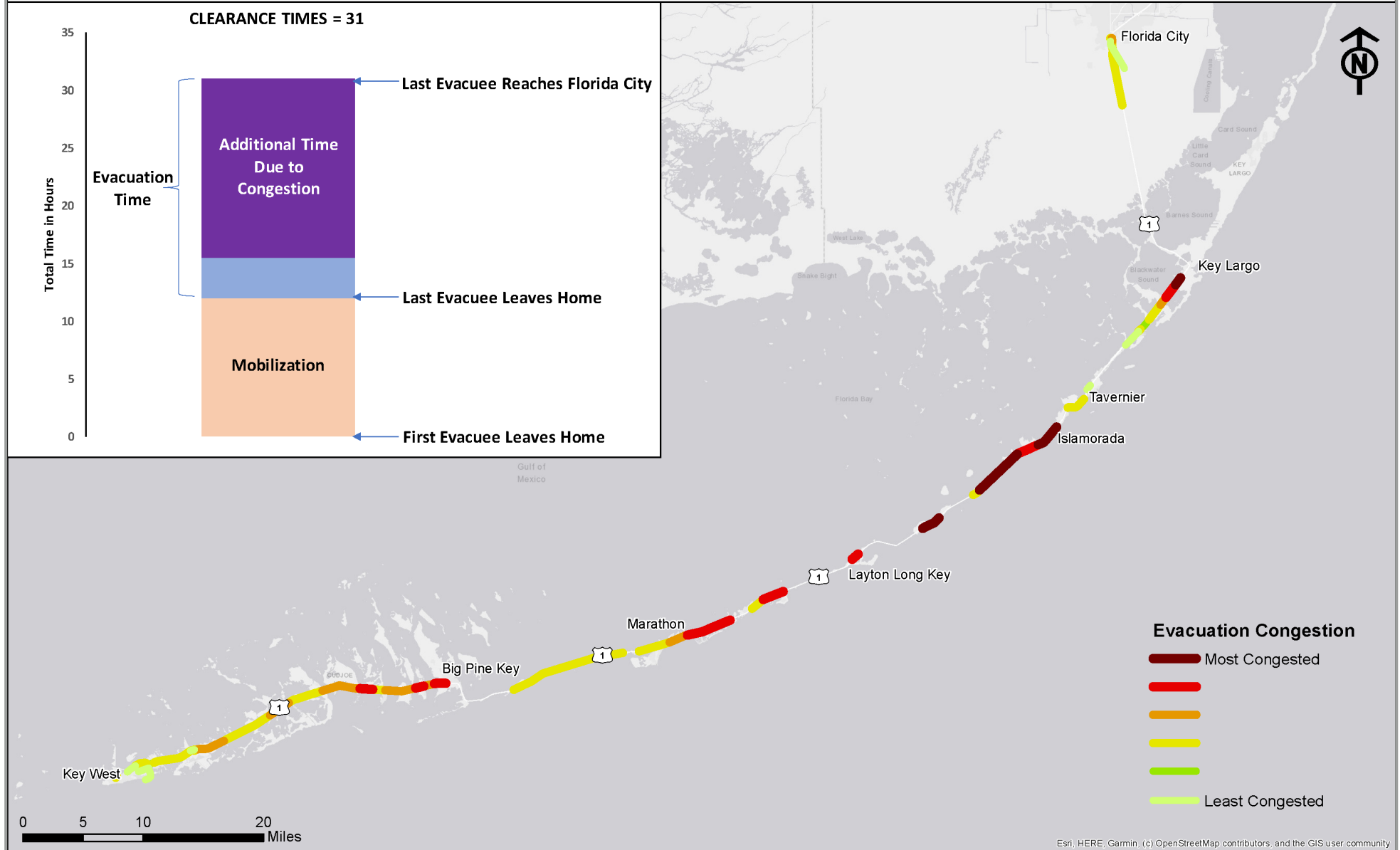
Deliverable 5: Baseline Modeling			Phases	Florida Keys Including Key West		Florida Keys Excluding Key West	
				Mobile Homes in Phase 2 (vehicles)	Mobile Homes in Phase 1 (vehicles)	Mobile Homes in Phase 2 (vehicles)	Mobile Homes in Phase 1 (vehicles)
Baseline Modeling	Shows baseline - does not include additional prospective allocations		Phase 2	34,456	30,460	20,819	17,919
			Phase 1	12,896	17,305	6,934	10,113
Deliverable 6: Prospective Modeling for Future Allocations							
S1	3,550 Allocations	Distribute based on county/municipality population size	Phase 2	36,876	32,765	22,164	19,176
			Phase 1	12,896	17,305	6,934	10,113
S2	3,550 Allocations	Distribute based percentage of vacant lands per county/municipality	Phase 2	37,214	33,101	22,612	19,623
			Phase 1	12,896	17,305	6,934	10,113
S3	3,550 Allocations	Distribute based on current allocations: (1,970-Monroe, 300-Marathon, 280-Islamorada, 910-Key West, 30-Layton, 60-Key Colony Beach)	Phase 2	37,208	33,096	22,189	19,201
			Phase 1	12,896	17,305	6,934	10,113
S4	Minimal Allocations (11 allocations/yr)	Distributes Monroe County (5); Marathon (2); Islamorada (2); Key West (2 – affordable only)	Phase 2 (10 Years Growth)	34,646	30,536	20,948	17,961
			Phase 2B (20 Years Growth)	34,721	30,609	20,992	18,004
			Phase 1	12,896	17,305	6,934	10,113
S5	One Unit/Vacant Lot	Distributes 7,954 units	Phase 2	40,489	36,377	24,726	21,738
			Phase 1	12,896	17,305	6,934	10,113



Phase 2 Current Allocation Includes Key West and Mobile Homes



Phase 2 Maximum Allocation Includes Key West and Mobile Homes



Questions & Answers



Contact Us

Thank You.

If you have questions or comments about this presentation, please contact us.



Bureau of Community Planning and Growth

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