UNIT FOUR
Making Better Decisions
Going back to what we have learned:

- Hurricanes are bad
- Different vulnerabilities for respective coastlines/agencies/sectors/
- Hurricanes can be forecast,
- There is error in forecast, and we communicate that error and can plan for it

So how do we plan now for a hurricane?
Better Information
Locally Informed Data and Analyses

North Carolina Hurricane Evacuation Study
Technical Data Report
Final Report – October 2016

Massachusetts Hurricane Evacuation Study
Technical Data Report
May 2016
INFORMED PLANS
It’s not the Plan, it’s the Process.

Step 1
Form a Collaborative Planning Team

Step 2
Understand the Situation

Step 3
Determine Goals and Objectives

Step 4
Plan Development

Step 5
Plan Preparation, Review & Approval

Step 6
Plan Implementation & Maintenance
**INFORMED DECISIONS**


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**WIND TREE PROBABILITIES FOR SELECTED LOCATIONS**

<table>
<thead>
<tr>
<th>TIME PERIOD</th>
<th>LOCATION</th>
<th>122 WAD</th>
<th>002 WAD</th>
<th>127 THU</th>
<th>002 WAD</th>
<th>127 FRI</th>
<th>122 SAT</th>
<th>122 SUN</th>
<th>126 MON</th>
</tr>
</thead>
<tbody>
<tr>
<td>002 WAD</td>
<td>122 AT</td>
<td>002 WAD</td>
<td>127 THU</td>
<td>002 WAD</td>
<td>127 FRI</td>
<td>122 SAT</td>
<td>122 SUN</td>
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<td>122 AT</td>
<td>002 WAD</td>
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<td>002 WAD</td>
<td>127 FRI</td>
<td>122 SAT</td>
<td>122 SUN</td>
<td>126 MON</td>
<td></td>
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<tr>
<td>127 THU</td>
<td>002 WAD</td>
<td>122 AT</td>
<td>002 WAD</td>
<td>127 FRI</td>
<td>122 SAT</td>
<td>122 SUN</td>
<td>126 MON</td>
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<tr>
<td>002 WAD</td>
<td>122 AT</td>
<td>002 WAD</td>
<td>127 THU</td>
<td>002 WAD</td>
<td>127 FRI</td>
<td>122 SAT</td>
<td>122 SUN</td>
<td>126 MON</td>
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<tr>
<td>127 FRI</td>
<td>122 SAT</td>
<td>122 SAT</td>
<td>122 SAT</td>
<td>122 SAT</td>
<td>122 SAT</td>
<td>122 SAT</td>
<td>122 SAT</td>
<td>122 SAT</td>
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<tr>
<td>122 SAT</td>
<td>122 SAT</td>
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<td>122 SUN</td>
<td>122 SUN</td>
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<td>122 SUN</td>
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<tr>
<td>126 MON</td>
<td>126 MON</td>
<td>126 MON</td>
<td>126 MON</td>
<td>126 MON</td>
<td>126 MON</td>
<td>126 MON</td>
<td>126 MON</td>
<td>126 MON</td>
<td>126 MON</td>
</tr>
</tbody>
</table>

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**TROPICAL STORM ARTHUR** - Thursday, July 3, 2014 09PM EDT (First Hr: 38) Advisory #6

- Central Location: 32.6 N 77.7 W
- Maximum Sustainable Winds: 60 mph (Cat 1)
- Movement: 10 mph NE

Wind Fields:
- **Tropical Storm** winds (34-63 mph)
- **Hurricane** winds (64+ mph)

---

*Image 0x-23 to 960x540*
MAKING BETTER DECISIONS

Study
- Identify Hazards
- Determine Vulnerability
- Evacuation Timing

Plan
- Inform Hazards and Risk
- Develop Timelines
- Identify Triggers

Execute
- Monitor Threat
- Assess Risk
- Take Action
Study
- Identify Hazards
- Determine Vulnerability
- Evacuation Timing

Plan
- Inform Hazards and Risk
- Develop Timelines
- Identify Triggers

Execute
- Monitor Threat
- Assess Risk
- Take Action

MAKING BETTER DECISIONS
"We're not that much smarter than we used to be, even though we have much more information. 

...that means the real skill now is learning how to pick out the useful information..."

The Signal and the Noise
- Nate Silver
BETTER INFORMATION
How do the hazards affect you?

RESOURCES
• Hurricane Evacuation Study
• **THIRA** Threat and Hazard Identification and Risk Assessment
• Flood Risk Maps
• HAZUS Modeling
• Historical events
• Local Knowledge
HES COMPONENTS

• Hazard Analysis
  What will be wet and what stays dry?

• Vulnerability Analysis
  Who/what will be affected in your community?

• Behavioral Analysis
  What is the Public thinking?

• Shelter Analysis
  What are your shelter needs?

• Transportation Analysis
  Where is traffic going to back up?
FAQs

- What will be wet? Dry?
- How high will the water get?
- How far inland?

- Hazard Analysis
HAZARD ANALYSIS

SLOSH Output by category, overlaid on a Digital Elevation Model
HAZARD ANALYSIS
What’s wet and what’s dry?
HAZARD ANALYSIS

Building evacuation zones

Zone 1

Zone 3
HAZARD ANALYSIS

Building evacuation zones with MOMs
# HAZARD ANALYSIS

**NYC Surge heights by bearing (MEOWS)**

<table>
<thead>
<tr>
<th></th>
<th>WNW</th>
<th>NW</th>
<th>NNW</th>
<th>N</th>
<th>NNE</th>
<th>NE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category 1</strong></td>
<td>12.6</td>
<td>12.1</td>
<td>10.7</td>
<td>8.8</td>
<td>6.6</td>
<td>5</td>
</tr>
<tr>
<td><strong>Category 2</strong></td>
<td>20.9</td>
<td>20</td>
<td>20.1</td>
<td>16.5</td>
<td>11.4</td>
<td>8.1</td>
</tr>
<tr>
<td><strong>Category 3</strong></td>
<td>26.6</td>
<td>27.6</td>
<td>27.4</td>
<td>23.4</td>
<td>17</td>
<td>11.3</td>
</tr>
<tr>
<td><strong>Category 4</strong></td>
<td>32.4</td>
<td>33.9</td>
<td>33.9</td>
<td>30.6</td>
<td>21.7</td>
<td>14.6</td>
</tr>
</tbody>
</table>

**Diagram:**

- **WNW**: 12.6, 20.9, 26.6, 32.4
- **NW**: 12.1, 20, 27.6, 33.9
- **NNW**: 10.7, 20.1, 27.4, 33.9
- **N**: 8.8, 16.5, 23.4, 30.6
- **NNE**: 6.6, 11.4, 17, 21.7
- **NE**: 5, 8.1, 11.3, 14.6

**Legend:**

- **WNW**: 12.6, 20.9, 26.6, 32.4
- **NW**: 12.1, 20, 27.6, 33.9
- **NNW**: 10.7, 20.1, 27.4, 33.9
- **N**: 8.8, 16.5, 23.4, 30.6
- **NNE**: 6.6, 11.4, 17, 21.7
- **NE**: 5, 8.1, 11.3, 14.6
HAZARD ANALYSIS
NYC evacuation zones

Hurricane evacuation zones
- 1 - Cat 1 NE, NNE, N; Cat 2 NE
- 2 - Cat 1 NNW, NW, WNW; Cat 2 NNE; Cat 3 NE
- 3 - Cat 2 N; Cat 4 NE
- 4 - Cat 2 NNW, NW, WNW; Cat 3 NNE
- 5 - Cat 3 N, NNW, NW, WNW; Cat 4 NNE
- 6 - Cat 4 N, NNW, NW, WNW

<table>
<thead>
<tr>
<th></th>
<th>Cat 1</th>
<th>Cat 2</th>
<th>Cat 3</th>
<th>Cat 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>NNE</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>N</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>NNW</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>NW</td>
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<td>4</td>
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<td>6</td>
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<tr>
<td>WNW</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

* For storms that exceed the parameters of the model, go up one zone

2010 Population

<table>
<thead>
<tr>
<th>Zone</th>
<th>Population</th>
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<tbody>
<tr>
<td>Zone 1</td>
<td>370,000</td>
</tr>
<tr>
<td>Zone 1+2</td>
<td>620,000</td>
</tr>
<tr>
<td>Zone 1+2+3</td>
<td>1,020,000</td>
</tr>
<tr>
<td>Zone 1+2+3+4</td>
<td>1,470,000</td>
</tr>
<tr>
<td>Zone 1+2+3+4+5</td>
<td>2,230,000</td>
</tr>
<tr>
<td>Zone 1+2+3+4+5+6</td>
<td>2,990,000</td>
</tr>
</tbody>
</table>
FAQs

• Who will be affected?
• What critical facilities are at risk?

• Vulnerability Analysis
### Hancock County, MS

<table>
<thead>
<tr>
<th>County Surge Area</th>
<th>Permanent Residential Structures</th>
<th>Non-Permanent Residential Structures</th>
<th>Total Residential Structures</th>
<th>Commercial Structures</th>
<th>Industrial Structures</th>
<th>Tourist Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>CATEGORY 1</td>
<td>2,281</td>
<td>0</td>
<td>2,281</td>
<td>89</td>
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<td>1</td>
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<tr>
<td>CATEGORY 2</td>
<td>5,007</td>
<td>253</td>
<td>5,330</td>
<td>209</td>
<td>4</td>
<td>2</td>
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<tr>
<td>CATEGORY 3</td>
<td>9,059</td>
<td>338</td>
<td>9,397</td>
<td>520</td>
<td>7</td>
<td>9</td>
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<tr>
<td>CATEGORY 4</td>
<td>9,480</td>
<td>380</td>
<td>9,860</td>
<td>525</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>CATEGORY 5</td>
<td>10,020</td>
<td>437</td>
<td>10,457</td>
<td>544</td>
<td>7</td>
<td>9</td>
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<tr>
<td>Non-Surge Area</td>
<td>5,518</td>
<td>682</td>
<td>6,200</td>
<td>99</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 3-7: Vulnerable Structures by Storm Surge Area

Mississippi Hurricane Evacuation Study – Technical Data Report – 2012
### Hancock County, MS

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Cat 1</th>
<th>Cat 2</th>
<th>Cat 3</th>
<th>Cat 4</th>
<th>Cat 5</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casino</td>
<td>2</td>
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<td>-</td>
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<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Dam</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>19</td>
</tr>
<tr>
<td>EOC</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>Fire</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Hazmat</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Hospital</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Hotels</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Police</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>School</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>1</td>
<td>-</td>
<td>1</td>
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<tr>
<td>Senior Center</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Shelter</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>7</strong></td>
<td><strong>12</strong></td>
<td><strong>25</strong></td>
<td><strong>6</strong></td>
<td><strong>2</strong></td>
<td><strong>32</strong></td>
</tr>
</tbody>
</table>

**Table 3-9: Critical Facilities Summary Table**

Mississippi Hurricane Evacuation Study – Technical Data Report – 2012
VULNERABILITY ANALYSIS
What facilities are at risk (GIS)?

Storm Surge Areas
- Category 1
- Category 2
- Category 3
- Category 4
- Category 5

GeoPDF – Critical Facilities
South Carolina Hurricane Evacuation Study – 2013
FAQs

- Will the Public evacuate?
- Where will they go? How? When?
- Do they understand the threat?

- Behavioral Analysis
BEHAVIORAL ANALYSIS
What are people thinking?

SURVEY RESULTS

• Serious under-concern about surge

• Evacuation intent often overstated

• Evacuation intent highest for:
  – Major Hurricanes
  – Mandatory/Ordered Evacuations
  – Households with children
  – People with recent real hurricane experience

• Often get ‘False Experience’ effect
Figure 4-7: Cat 1-2 Hurricane and Likelihood of Leaving if Recommended or Ordered
BEHAVIORAL ANALYSIS

Where should I focus my outreach?

Evacuation Intent
- Very Likely
- Somewhat Likely
- Not Very Likely

Storm Surge Areas
- Cat 1
- Cat 2
- Cat 3
- Cat 4
- Cat 5

GeoPDF – Evacuation Intent
Mississippi Hurricane Evacuation Study – 2012
WHY DO PEOPLE EVACUATE?

- They understand their vulnerability/risk
- They were told to evacuate
FAQs

• Who will seek public shelter?
• How many shelter spaces are needed?
• In-county? Out-of-county?

• Shelter Analysis
SHELTER ANALYSIS
How many shelter spaces are needed?

SHELTER ANALYSIS
• Shelter Locations, with respect to Evacuation Zones and Storm Surge flood risk areas

• Potential Demand

• Identification of Deficits

Shelter usage rates (planning purposes)
• 3-8% Coastal
• 10% Inland
### Baldwin County, AL

<table>
<thead>
<tr>
<th>Evacuation Scenario</th>
<th>Total Evacuating People</th>
<th>Public Shelter Demand</th>
<th>Sheltering Capacity</th>
<th>Surplus/Deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low Occupancy</td>
<td>High Occupancy</td>
<td>Low Occupancy</td>
<td>High Occupancy</td>
</tr>
<tr>
<td>Category 1</td>
<td>60,660</td>
<td>101,821</td>
<td>1,576</td>
<td>1,990</td>
</tr>
<tr>
<td>Category 2</td>
<td>103,871</td>
<td>151,069</td>
<td>2,909</td>
<td>3,384</td>
</tr>
<tr>
<td>Category 3</td>
<td>113,773</td>
<td>162,005</td>
<td>3,567</td>
<td>4,052</td>
</tr>
<tr>
<td>Category 4</td>
<td>184,748</td>
<td>234,032</td>
<td>8,528</td>
<td>9,025</td>
</tr>
<tr>
<td>Category 5</td>
<td>211,125</td>
<td>260,502</td>
<td>10,898</td>
<td>11,295</td>
</tr>
</tbody>
</table>

Table 5-4: Evacuating Population and Public Sheltering Demand – Baldwin County

Alabama Hurricane Evacuation Study – Technical Data Report – 2012
<table>
<thead>
<tr>
<th>SHELTER DEMAND</th>
<th>POTENTIAL EVACUEES</th>
<th>REGULAR CAPACITY 7,953</th>
<th>EMERGENCY CAPACITY 15,906</th>
<th>ASSESSMENT OF CAPACITY</th>
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</thead>
<tbody>
<tr>
<td>1%</td>
<td>1,533</td>
<td>0</td>
<td>0</td>
<td>Regular Shelter Capacity Can Support Demand</td>
</tr>
<tr>
<td>2%</td>
<td>3,065</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>3%</td>
<td>4,598</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>4%</td>
<td>6,131</td>
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<td>0</td>
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<tr>
<td>5%</td>
<td>7,633</td>
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<td>0</td>
<td></td>
</tr>
<tr>
<td>6%</td>
<td>9,196</td>
<td>1,243</td>
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</tr>
<tr>
<td>7%</td>
<td>10,728</td>
<td>2,775</td>
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<tr>
<td>8%</td>
<td>12,261</td>
<td>4,308</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>9%</td>
<td>13,794</td>
<td>5,841</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td>15,326</td>
<td>7,373</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>13%</td>
<td>19,924</td>
<td>11,971</td>
<td>4,018</td>
<td>Over Capacity</td>
</tr>
<tr>
<td>15%</td>
<td>22,990</td>
<td>15,037</td>
<td>7,084</td>
<td></td>
</tr>
<tr>
<td>20%</td>
<td>30,653</td>
<td>22,700</td>
<td>14,747</td>
<td></td>
</tr>
</tbody>
</table>

Table 6: Population Seeking Shelter and Capacity in Zone 1
FAQs
• Where will traffic backup?
• What is the road capacity?
• How long will it take to evacuate?

• Transportation Analysis
TRANSPORTATION ANALYSIS
How long will it take to evacuate?

TRAFFIC MODEL INPUTS

• Demographics
• Behavioral Assumptions
• Evacuation Routes
• Roadway Capacities
• Travel Destinations
• Evacuation Scenarios
TRANSPORTATION ANALYSIS

Where will the traffic problems be?

• Traffic Patterns
  – Bottle Necks
  – Evacuating Vehicles

• Clearance Times
  – Response Rate
  – Seasonal Population
  – Evacuation Scenarios
    one-way, multi-state, etc
CLEARANCE TIMES

Time for the evacuating population to reach a point of safety

- First evacuating vehicle enters the road network
- Last vehicle reaches an assumed point of safety
- Includes travel time and waiting in congestion
- Doesn’t relate to any one particular vehicle
- Driven by bottlenecks
### Scenario ABC
501 reversal and 544 enhancement plan

**Horry County, SC**

**Scenario ABC** (501 reversal and 544 enhancement plan)

<table>
<thead>
<tr>
<th>Response</th>
<th>Low Occupancy</th>
<th>Med Occupancy</th>
<th>High Occupancy</th>
<th>Extreme Occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLOW</td>
<td>22</td>
<td>26</td>
<td>29</td>
<td>31</td>
</tr>
<tr>
<td>MEDIUM</td>
<td>20</td>
<td>24</td>
<td>27</td>
<td>29</td>
</tr>
<tr>
<td>FAST</td>
<td>19</td>
<td>23</td>
<td>26</td>
<td>28</td>
</tr>
<tr>
<td>IMMEDIATE</td>
<td>18</td>
<td>22</td>
<td>25</td>
<td>27</td>
</tr>
</tbody>
</table>

**Table 6-44: Evacuation Clearance Times – Scenario ABC**

South Carolina Hurricane Evacuation Study – Technical Data Report – 2013

**Figure 6-6: Evacuation Zones**

South Carolina Hurricane Evacuation Study – Technical Data Report – 2013
Study
- Identify Hazards
- Determine Vulnerability
- Evacuation Timing

Plan
- Inform Hazards and Risk
- Develop Timelines
- Identify Triggers

Execute
- Monitor Threat
- Assess Risk
- Take Action
INFORMED PLANS
It’s not the Plan, it’s the Process.

Step 1: Form a Collaborative Planning Team
Step 2: Understand the Situation
Step 3: Determine Goals and Objectives
Step 4: Plan Development
Step 5: Plan Preparation, Review & Approval
Step 6: Plan Implementation & Maintenance
FAQs
• What forces us to react?
• What is acceptable risk?
• What assumptions can I make?

• **Identify Hazard Triggers**
## Lane Reversal Decision Factors

<table>
<thead>
<tr>
<th>Decision Factor</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>The storm’s current/projected intensity and the public perception of the threat to their safety.</td>
<td>Category 3 or greater storm portrayed through the media as a significant threat will probably require the use of lane reversal.</td>
</tr>
</tbody>
</table>
| Tourism occupancy: High tourist occupancy greatly increases evacuating population and thereby increases traffic congestion. | For a Category 1 or 2 storms, monitor traffic flow and have lane reversal ready. A Category 3 or greater storm will indicate the need for reversal.  
(Note: Beaufort County requires Highway 278 reversal during tourist season at 85% tourist occupancy) |
<table>
<thead>
<tr>
<th>Storm Category</th>
<th>Island &amp; Low-lying Areas</th>
<th>South &amp; East of Abercom/US-204</th>
<th>East of Abercom/US-204</th>
<th>Islands &amp; East of Abercom/US-204</th>
<th>South &amp; East of Abercom/US-204</th>
<th>East of I-95</th>
<th>Entire County</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat 5</td>
<td>MANDATORY</td>
<td>MANDATORY</td>
<td>RECOMMENDED</td>
<td>MANDATORY</td>
<td>MANDATORY</td>
<td>MANDATORY</td>
<td>MANDATORY</td>
</tr>
<tr>
<td>Cat 4</td>
<td>EARLY SOUTH &amp; EAST</td>
<td>MANDATORY</td>
<td>RECOMMENDED</td>
<td>MANDATORY</td>
<td>MANDATORY</td>
<td>MANDATORY</td>
<td>MANDATORY</td>
</tr>
<tr>
<td>Cat 3</td>
<td>SOUTH</td>
<td>MANDATORY</td>
<td>RECOMMENDED</td>
<td>MANDATORY</td>
<td>MANDATORY</td>
<td>MANDATORY</td>
<td>MANDATORY</td>
</tr>
<tr>
<td>Cat 2</td>
<td>24+30NH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cat 1 Direct</td>
<td>18+24NH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cat 1 Parallel to Coast</td>
<td>24+30NH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tropical Storm Direct</td>
<td>18+24NH</td>
<td></td>
<td></td>
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<tr>
<td>Tropical Storm Parallel Coast</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arrival Tropical Storm</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Islands and Low-lying Area Early Evacuations are 6 to 12 hours prior to Mandatory Evacuations

Hours for Evacuation + Added Hours for Nursing Home (NH) and Special Needs Evacuations

Chatham County Evacuation Guidelines (Not Current)
## NWS PRODUCT TIMELINES

### When is key information available?

<table>
<thead>
<tr>
<th>Normal Operations</th>
<th>1b Elevated Threat</th>
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<tr>
<td>Year Round</td>
<td>Hurricane Season</td>
<td>120hr - 72hr</td>
<td>72hr - 48hr</td>
</tr>
<tr>
<td></td>
<td></td>
<td>48hr - 36hr</td>
<td>36hr - Landfall (Onset of TS Winds)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Post Landfall</td>
</tr>
</tbody>
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**Hurricane Evacuation Study (HES) products**
(Surge MOMs, Surge Maps, Evacuation Zones, Clearance times, other planning data)

**Coastal Flood Loss Atlas**

**Tropical Weather Outlook**
- Public Advisory
- Forecast Discussion
- Wind Speed Probabilities
- Track and Cone
- Probabilistic wind timing via Hurrevac

**Wind timing via Hurrevac**
- Extreme Wind Warnings
- Tide Gauges/USGS
- Flash Flood Warnings

**Surge MEOWs**
- River Forecasts
- Flood Outlooks
- River Flood Warnings

**QPF Rainfall forecasts**
- TS/Hurricane Watches
- TS/Hurricane Warnings

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- Hurricane Local Statements

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**Tornado Watches & Warnings**
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### Tropical Weather Outlook

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# NWS PRODUCT TIMELINES

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#### TIME

(Onset of TS Winds)
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- TS/Hurricane Warnings

Hurricane Local Statements

Storm Surge Probabilities & Inundation Map

Storm Surge Watch
- Storm Surge Warning

Tornado Watches & Warnings

TIME
FAQs

• When do we open shelters?
• When do we need to deploy?
• How do we stay synchronized?

• Decision Timelines
Horry County Evacuation Timeline for ABC Scenario

**DECISION TIMELINES**

**Evacuation scenario decision timeline**

**ARRIVAL OF TS WINDS**

- OPCON 4
  - 91hr
  - 29 hrs
  - Heightened Situational Awareness

- OPCON 3
  - 62hr
  - 11 hrs
  - Evacuation Decision

- OPCON 2
  - 51hr
  - 9 hrs
  - Preparation Time Assemble Resources

- OPCON 1
  - 42hr
  - 15 hrs
  - Clearance Time With Lane Reversal
  - 27 hrs
  - FINISH Evacuation Must Be Finished
  - XX hrs
  - LANDFALL

OPEN Emergency Operations Center

START Mandatory Evacuation Starts

Horry County Evacuation Timeline for ABC Scenario
# Hurricane Readiness Checklist

<table>
<thead>
<tr>
<th>PRIORITY LEVEL</th>
<th>PERSONNEL RESPONSIBLE</th>
<th>STATUS OF TASK</th>
<th>DATE/TIME COMPLETED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hurricane preparedness - prior to June 1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Hurricane Planning

- Update local hurricane operation, evacuation plans and resource lists
- Revise Standard Operating Procedures (SOPs)
- Review local emergency management ordinances and update
- Test Hurrevac and/or other hurricane tracking software
- Review Stafford Act Policies with State Emergency Management
- Mitigate Vulnerable Critical Facilities
- Solidify and review mutual aid agreements
- Determine evacuation decision making authority w/ line of succession

## Emergency Operations Center (EOC)

- Replenish supplies and check equipment
- Test communication lines
- Update activation plans and train staff
- Update HURREVAC to latest version
# Hurricane Readiness Checklist

## Storm Impacts Imminent (~36 hours)

### Hurricane Watches and Warnings Issued

<table>
<thead>
<tr>
<th>Storm Watch</th>
<th>PRIORITY LEVEL</th>
<th>PERSONNEL RESPONSIBLE</th>
<th>STATUS OF TASK</th>
<th>DATE/TIME COMPLETED</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Conference calls with NOAA local WFO/RFC/SPC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Continue to monitor HURREVAC and other systems</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Monitor storm track and provide local government officials updates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Anticipate the possible arrival of rainfall and tornados</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Monitor river stages and rainfall forecast</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Emergency Operations Center (EOC)

<table>
<thead>
<tr>
<th></th>
<th>PRIORITY LEVEL</th>
<th>PERSONNEL RESPONSIBLE</th>
<th>STATUS OF TASK</th>
<th>DATE/TIME COMPLETED</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Activate EOC (partial or full based on clearance times and threat)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Request primary ESF support agencies provide EOC briefings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Complete and distribute EOC situation reports, as applicable</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Prepare EOC facility- Mitigate for Winds, Water, etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
DECISION TIMELINES
Scenario-based Operational Levels

FEMA RVI Hurricane Plan
Study
• Identify Hazards
• Determine Vulnerability
• Evacuation Timing

Plan
• Inform Hazards and Risk
• Develop Timelines
• Identify Triggers

Execute
• Monitor Threat
• Assess Risk
• Take Action
## INFORMED DECISIONS

There is a storm. Analyze. Respond.

---

**WIND SPEED PROBABILITIES FOR SELECTED LOCATIONS**

<table>
<thead>
<tr>
<th>TIME PERIOD</th>
<th>LOCATION</th>
<th>12H ADV 00Z Thu 12/7 PRT 12H SAT 12H SUN</th>
<th>12H ADV 00Z Thu 12/7 PRT 12H SAT 12H SUN</th>
<th>12H ADV 00Z Thu 12/7 PRT 12H SAT 12H SUN</th>
<th>12H ADV 00Z Thu 12/7 PRT 12H SAT 12H SUN</th>
</tr>
</thead>
<tbody>
<tr>
<td>00Z Thu</td>
<td>12/7</td>
<td>12/7 PRT 12H SAT 12H SUN</td>
<td>12/7 PRT 12H SAT 12H SUN</td>
<td>12/7 PRT 12H SAT 12H SUN</td>
<td>12/7 PRT 12H SAT 12H SUN</td>
</tr>
<tr>
<td>24Z Thu</td>
<td>12/7</td>
<td>12/7 PRT 12H SAT 12H SUN</td>
<td>12/7 PRT 12H SAT 12H SUN</td>
<td>12/7 PRT 12H SAT 12H SUN</td>
<td>12/7 PRT 12H SAT 12H SUN</td>
</tr>
<tr>
<td>36Z Thu</td>
<td>12/7</td>
<td>12/7 PRT 12H SAT 12H SUN</td>
<td>12/7 PRT 12H SAT 12H SUN</td>
<td>12/7 PRT 12H SAT 12H SUN</td>
<td>12/7 PRT 12H SAT 12H SUN</td>
</tr>
<tr>
<td>48Z Thu</td>
<td>12/7</td>
<td>12/7 PRT 12H SAT 12H SUN</td>
<td>12/7 PRT 12H SAT 12H SUN</td>
<td>12/7 PRT 12H SAT 12H SUN</td>
<td>12/7 PRT 12H SAT 12H SUN</td>
</tr>
<tr>
<td>72Z Thu</td>
<td>12/7</td>
<td>12/7 PRT 12H SAT 12H SUN</td>
<td>12/7 PRT 12H SAT 12H SUN</td>
<td>12/7 PRT 12H SAT 12H SUN</td>
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</tr>
</tbody>
</table>

---

**Map**

Tropical Storm Arthur - Thursday, July 03, 2014 5 PM EDT (Coastal Advisory W)

- Center Location: 32.5 N 77.7 W
- Maximum Sustained Wind: 38 mph (Cat 1)
- Movement: 12 mph NC

---

**Legend**

- Hurricanes
- Tropical Storms
- Tornadoes
- Special Advisories

---

**Weather Conditions**

- Flood Warnings
- Storm Warnings
- Hurricane Warnings
FAQs

• What’s the forecast?
• A threat to my community?
• When are hazards expected?

• NHC Forecasts
NHC FORECASTS
Where is the storm going?

National Weather Service
Tropical Cyclone Products

Outlook
> 5 Days
Large uncertainty
More products needed

5 Day Forecast
Public Advisory
Wind Speed %
Forecast Discussion

3-5 Days
3-5 Days
Few products

2-3 Days
2-3 Days
Detailed products

1-2 Days
1-2 Days
Warnings

TS/Hurricane Watches
TS/Hurricane Warnings
TS/Hurricane Local Statements
Operational Storm Surge Products

Note: The cone contains the probable path of the storm center but does not show the size of the storm. Hazardous conditions can occur outside of the cone.

Current information: Hurricane Michael
Center location: 20° 2' N 85° 3' W
Maximum sustained wind: 80 mph
Movement: N at 9 mph
Forecast positions:

Potential track area:
Day 1-3
Day 4-5

Watches:
Hurricane
Tropical Storm

Warnings:

Current wind extent:

FEMA
NHC FORECASTS

What are the storm characteristics?

[Images of two maps showing surface wind fields of Hurricane Arthur and Hurricane Sandy, with annotations for watches, warnings, sustained winds, and position]
## NHC FORECASTS

Where is the storm going?

### TROPICAL STORM ISAAC WIND SPEED PROBABILITIES NUMBER 21

**NWS NATIONAL HURRICANE CENTER MIAMI FL**

AL092012

0900 UTC SUN AUG 26 2012

---

**WIND SPEED PROBABILITIES FOR SELECTED LOCATIONS**

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>TIME</th>
<th>PERIODS</th>
<th>FORECAST HOUR</th>
<th>--</th>
<th>--</th>
<th>--</th>
<th>--</th>
<th>--</th>
<th>--</th>
</tr>
</thead>
<tbody>
<tr>
<td>PANAMA CITY FL</td>
<td>12Z WED</td>
<td>002 THU</td>
<td>(12)</td>
<td>3</td>
<td>X</td>
<td>3(3)</td>
<td>22(25)</td>
<td>30(55)</td>
<td>16(71)</td>
</tr>
<tr>
<td></td>
<td>12Z THU</td>
<td>002 FRI</td>
<td>(24)</td>
<td></td>
<td>X</td>
<td>X( X)</td>
<td>1( 1)</td>
<td>13(14)</td>
<td>15(29)</td>
</tr>
<tr>
<td></td>
<td>12Z FRI</td>
<td>002 SAT</td>
<td>(36)</td>
<td></td>
<td>X</td>
<td>X( X)</td>
<td>X( X)</td>
<td>3( 3)</td>
<td>6( 9)</td>
</tr>
<tr>
<td></td>
<td>12Z SUN</td>
<td>12Z MON</td>
<td>(48)</td>
<td></td>
<td>X</td>
<td>X( X)</td>
<td>X( X)</td>
<td>1( 1)</td>
<td>14(15)</td>
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<td>MOBILE AL</td>
<td>12Z WED</td>
<td>002 THU</td>
<td>(12)</td>
<td>3</td>
<td>X</td>
<td>X( X)</td>
<td>5( 5)</td>
<td>24(29)</td>
<td>35(64)</td>
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<td>12Z THU</td>
<td>002 FRI</td>
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<td></td>
<td>X</td>
<td>X( X)</td>
<td>X( X)</td>
<td>1( 1)</td>
<td>8( 9)</td>
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<tr>
<td>GULFPORT MS</td>
<td>12Z WED</td>
<td>002 THU</td>
<td>(12)</td>
<td>3</td>
<td>X</td>
<td>X( X)</td>
<td>3( 3)</td>
<td>21(24)</td>
<td>34(58)</td>
</tr>
</tbody>
</table>

---

**Earliest Reasonable Arrival Time of Tropical-Storm-Force Winds**

[Map showing arrival times for tropical-storm-force winds]
Evaluate the storm threat.
FAQs

• What is the forecast?
• Evacuation start times?

• Hurrevac
POLL QUESTION
Do you have a Hurrevac account?

A. Yes, and I use it regularly.
B. Yes, but I am unfamiliar with how to use it.
C. I just registered for an account.
D. I do not have an account.
HURREVAC

HURREVAC

• Hurricane tracking and decision support tool
  – Uses NHC forecast data
  – Calculates evacuation start times

• A resource for EMs during evacuations
  – Common forecast picture

• Reports
  – Wind timing
  – Evacuation timing
  – Storm summary
HURREVAC

• Web based
  – No downloads or software to install
  – Use your computer, tablet or phone
  – Access your profile/preferences anywhere

• SLOSH Display
  – MOMs & MEOWs
  – MEOW mixer

• Register online
  https://register.hurrevac.com/
Hurricane Mallory Forecast track. Watches/Warnings. Size.
Hurricane Mallory

Advisory 13

5am, Mon, Sep 9, 2019 EDT

Sat 2AM 90mph Cat 1 N 7mph
Fri 2AM 105mph Cat 2 NNE 6mph
Thu 2AM 110mph Cat 2 NNE 8mph
Wed 2AM 120mph Cat 3 N 10mph
Tue 2AM 125mph Cat 3 NW 13mph
Mon 5AM 115mph Cat 3 NW 13mph

Impact Exploration
- Tropical Weather Outlook
- Surge

Evacuation Decision Support
- Clearance Times
Arrival and departure times for winds of at least tropical storm strength. The earliest reasonable, latest reasonable, and most likely times are based upon probabilistic data that considers forecast uncertainty.

This report is relative to the following location: lon: -76.48, lat: 34.89

Tropical Storm (34kt/39mph)

<table>
<thead>
<tr>
<th>TIME OF ARRIVAL</th>
<th>DATE</th>
<th>DAY</th>
<th>HOURS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earliest Reasonable</td>
<td>9/10</td>
<td>7PM EDT</td>
<td>38</td>
</tr>
<tr>
<td>Most Likely</td>
<td>9/11</td>
<td>4AM EDT</td>
<td>47</td>
</tr>
<tr>
<td>Deterministic</td>
<td>9/11</td>
<td>5AM EDT</td>
<td>48</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TIME OF DEPARTURE</th>
<th>DATE</th>
<th>DAY</th>
<th>HOURS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most Likely</td>
<td>9/12</td>
<td>11AM EDT</td>
<td>78</td>
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<tr>
<td>Latest Reasonable</td>
<td>9/13</td>
<td>11PM EDT</td>
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<tr>
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<td>9/12</td>
<td>3AM EDT</td>
<td>70</td>
</tr>
</tbody>
</table>
The purpose of the wind timing table is to show when specific wind thresholds are expected to be exceeded at a particular location.

**Displaying data in NC for: Counties**

<table>
<thead>
<tr>
<th>State</th>
<th>County</th>
<th>34kt Start</th>
<th>50kt Start</th>
<th>64kt Start</th>
<th>64kt End</th>
<th>50kt End</th>
<th>34kt End</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC</td>
<td>Carteret</td>
<td>09/11 3am</td>
<td>09/11 1pm</td>
<td>09/11 5pm</td>
<td>09/12 3am</td>
<td>09/12 3am</td>
<td>09/12 3am</td>
</tr>
<tr>
<td>NC</td>
<td>New Hanover</td>
<td>09/11 3am</td>
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<tr>
<td>NC</td>
<td>Brunswick</td>
<td>09/11 3am</td>
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<tr>
<td>NC</td>
<td>Onslow</td>
<td>09/11 4am</td>
<td>09/11 6pm</td>
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<td>09/11 10pm</td>
<td>09/12 3am</td>
<td>09/12 3am</td>
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<tr>
<td>NC</td>
<td>Jones</td>
<td>09/11 5am</td>
<td>09/11 7pm</td>
<td></td>
<td>09/12 12am</td>
<td>09/12 3am</td>
<td>09/12 3am</td>
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<tr>
<td>NC</td>
<td>Craven</td>
<td>09/11 5am</td>
<td>09/11 5pm</td>
<td></td>
<td>09/12 3am</td>
<td>09/12 3am</td>
<td>09/12 3am</td>
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<tr>
<td>NC</td>
<td>Pender</td>
<td>09/11 5am</td>
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<td>NC</td>
<td>Hyde</td>
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<td>09/11 4pm</td>
<td>09/11 9pm</td>
<td>09/12 3am</td>
<td>09/12 3am</td>
<td>09/12 3am</td>
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<tr>
<td>NC</td>
<td>Dare</td>
<td>09/11 6am</td>
<td>09/11 5pm</td>
<td>09/11 11pm</td>
<td>09/12 3am</td>
<td>09/12 3am</td>
<td>09/12 3am</td>
</tr>
<tr>
<td>NC</td>
<td>Pamlico</td>
<td>09/11 6am</td>
<td>09/11 6pm</td>
<td>09/12 12am</td>
<td>09/12 3am</td>
<td>09/12 3am</td>
<td>09/12 3am</td>
</tr>
<tr>
<td>NC</td>
<td>Beaufort</td>
<td>09/11 7am</td>
<td>09/11 8pm</td>
<td></td>
<td>09/12 3am</td>
<td>09/12 3am</td>
<td>09/12 3am</td>
</tr>
<tr>
<td>NC</td>
<td>Duplin</td>
<td>09/11 8am</td>
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<td></td>
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</tr>
</tbody>
</table>
09/09/2019, 5:00 am

The purpose of the evacuations timing table is to show, for each location, when the onset of tropical-storm-force winds is expected and provide the earliest and latest times for making evacuation decisions based on the range of evacuation scenarios and settings that the user has selected.

This report uses your saved Evacuation Scenarios and Timeline actions.

<table>
<thead>
<tr>
<th>State</th>
<th>County</th>
<th>Scenario</th>
<th>Earliest-Reasonable TS Onset Time</th>
<th>Most-Likely TS Onset Time</th>
<th>Clearance Time</th>
<th>Earliest Evac Start Time</th>
<th>Latest Evac Start Time</th>
<th>TS WSP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC</td>
<td>Carteret</td>
<td>B/Slow/Worst/County</td>
<td>Tue 07 PM</td>
<td>Wed 04 AM</td>
<td>39 hrs</td>
<td>Mon 04 AM</td>
<td>Mon 01 PM</td>
<td>93</td>
</tr>
<tr>
<td>NC</td>
<td>Carteret</td>
<td>B/Mod/Med SP/County</td>
<td>Tue 07 PM</td>
<td>Wed 04 AM</td>
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<td>Mon 05 PM</td>
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<td>B/Fast/High SP/County</td>
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HURREVAC
Calculating evacuation start time

- Storm Forecast
- Arrival Time of TS Winds
- HES Data
  Pre-determined Evacuation Zones and Scenarios
- Clearance Time

= Evacuation Start Time
HURREVAC
Calculating evacuation start time

Storm Forecast

Arrival Time of TS Winds

47 hr

HES Data
Pre-determined evacuation zones and scenarios

Cat 3

Evacuation Start Time

8 hr

Calculation: 47 hr - 39 hr = 8 hr
HURREVAC makes recommendations for evacuation start times based on how long it takes to evacuate a vulnerable population ahead of the arrival of tropical-storm-force winds (34kt/39mph). To utilize this capability of the program, you must first select one or more evacuation scenarios from a region's Hurricane Evacuation Study. Refer to the Study's technical data report, or ask your state's Hurricane Program Manager for guidance on making selections appropriate to a particular storm situation.

**Total Evacuation hours: 39**

- **Scenario:** Scenario B
- **Response:** Slow (9 hour) response
- **Seasonal Population:** Worst-case number of evacuees from seasonal population
- **Scope of Reported Time:** Time to evacuate the county
The purpose of the evacuations timing table is to show, for each location, when the onset of tropical-storm-force winds is expected and provide the earliest and latest times for making evacuation decisions based on the range of evacuation scenarios and settings that the user has selected.

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REGISTRATION
https://register.hurrevac.com/
Questions/Comments?
INFORMED DECISIONS
Hurricane Evacuation Study

FAQs
• Confidence? Contingencies?
• What is the forecast/evacuation timing?
• Can we get a briefing?

• Hurricane Liaison Team
BACKGROUND

• Initial idea arose in the early 1990s

• Proven during response to the 1995 Hurricane Season Erin and Opal

• Formalized in 1996 Request from Governor of Florida to FEMA and NHC Director
“The Hurricane Liaison Team’s mission is to improve our Nation’s capability to respond to hurricanes through the rapid exchange of critical information between the National Hurricane Center and Federal, State, Local, Tribal and Territorial emergency managers.”
RAPID COMMUNICATIONS

- Partnership between the NWS and FEMA
  - FEMA Hurricane Program Managers
  - FEMA Reservists
  - NWS meteorologists and hydrologists
REGIONAL HPM

- Technical Knowledge
- State/Local Relationships
- Deploy to NHC
RESPONSIBILITIES

• Real-time interpretation, assessment and guidance;
  – Apply NHC forecasts with Regional, State and local response evacuation plans

• Forum for EMs to ask questions,
  – Reinforce decisions;
  – Assist with use of NHC forecasts and predictive modeling

• Provide NHC visibility on State and local protective actions
  – Improve messaging
RESPONSIBILITIES

- Facilitate two-way communications
  - Between the NHC and EMs
  - Common forecast picture
  - Relay EM issues to improve NWS/NHC messaging

- Video/Teleconferences
  - NHC/NWS
  - FEMA and other Federal Agencies
  - Emergency Operations Centers (EOCs)
Katrina (2005)
Charley (2004)
Sandy (2012)
Michael (2018)
Harvey (2017)
Isaac (2012)
Questions/Comments?