Hurricane Floyd Post Storm Assessment

- Executive Summary
- Recommendations

Behavioral Studies:

- Floyd Report
- Eastern NC
- Southeastern NC
- Northern SC
- Central SC
- Southern SC
- Northern GA
- Southern GA
- Northeast FL
- East-Central FL
- Treasure Coast FL
- Southeast FL
- Questionnaire

Return to Assessment Page

HOME

Hurricane Floyd Post Storm Assessment

In September 1999, the largest peacetime evacuation in the United States occurred as the result of Hurricane Floyd. This resulted in immediate funding for transportation and behavioral studies to determine what measures could be developed to reduce the traffic issues that occurred during the Floyd evacuation. The study was completed in May 2000. You can view the results of these studies by clicking on the items listed in the Table on the LEFT.

Hurricane Floyd Post Storm Assessment

- Executive Summary
- Recommendations

Behavioral Studies:

- Floyd Report
- Eastern NC
- Southeastern NC
- Northern SC
- Central SC
- Southern SC
- Northern GA
- Southern GA
- Northeast FL
- East-Central FL
- Treasure Coast FL
- Southeast FL
- Questionnaire

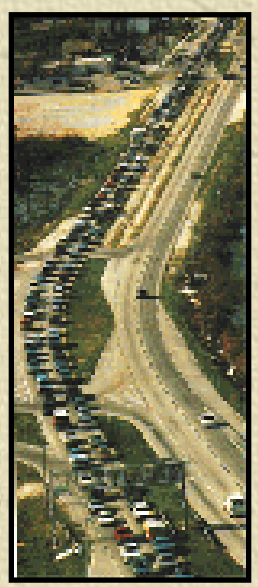
Return to Assessment Page

HOME

Executive Summary

Southeast United States Hurricane Evacuation Traffic Study This was contract work being performed by Post, Buckeley, Schuh, and Jernigan.

After Hurricane Floyd May 2000



In September 1999, the largest peacetime evacuation ever to take place in the United States occurred as the result of Hurricane Floyd. As a result of massive public response, huge out-of-county and out-of-state evacuee movements, and multiple states loading onto a limited road network within a very short timeframe, traffic congestion reached levels never seen by the public. The public's experience during the Floyd evacuation and their resulting outcry to elected officials and emergency management professionals "to fix the evacuation problem" has resulted in many federal, state, and local initiatives to better manage evacuations.

Study Purpose

At the federal level, under the directives of Vice President Gore, FEMA, USDOT, and the U.S. Army Corps of Engineers joined together to address problems that surfaced during the Floyd evacuation. Specifically, Florida, Georgia, South Carolina and North Carolina were promised that an initial effort would be accomplished by February 2000 to find out what the public did in response to Floyd, to develop a web based travel demand forecast system that would anticipate evacuation traffic congestion and cross state travel flows, and to coordinate with state DOTs on one way strategies and ITS technologies. To assist with this effort, PBS&J was hired as a consultant to produce the necessary products and facilitate the important coordination effort associated with the process.

Return to Top

Documentation and Coordination

Documentation for the study effort includes this Executive Summary and three technical memoranda which focus on three major areas:

Technical Memorandum 1 – Behavioral Analysis
Technical Memorandum 2 – Evacuation Travel Demand Forecasting System
Technical Memorandum 3 – Reverse Lane Standards and ITS Strategies

These three (3) Technical Memorandum can be viewed at : http://www.fematdfm.com

Each state has been an integral part of the development and review of work products. Staff from each state's emergency management office, department of transportation, and highway patrol have been of great assistance. A web site that was developed by the U.S. Army Corps of Engineers kept study participants abreast of study progress throughout the study. A brief summary of

key findings is provided for each of the three major technical components. Return to Top

Behavioral Analysis

Hazards Management Group of Tallahassee, Florida was hired to document the public's response to Floyd. Sixty-nine hundred phone interviews focusing on a variety of public response characteristics were accomplished with the public. Residents in coastal surge and non-surge areas, as well as residents in non-coastal areas, were contacted. The number of interviews accomplished in each state was as follows:

STATE	INTERVIEWS
North Carolina	1200
South Carolina	1800
Georgia	1200
Florida	2700
TOTAL	6900

Results from the interviews revealed some of the highest participation rates ever experienced in an evacuation. Participation rates from non-surge areas and inland adjacent counties were quite high and noteworthy. Most evacuees said they left due to notices from public officials and what they were hearing on The Weather Channel and local weather stations. Return to Top

Evacuation Participation Rates (%) in Hurricane Floyd

	Category 1 Surge Zone	Other Surge Zones	Coastal Non-Surge Areas	Adjacent Counties
Eastern NC	TBD	TBD	TBD	TBD
Southeastern NC	57	44	30	28
Myrtle Beach, SC	67	61	37	21
Charleston, SC	78	68	69	49
Beaufort, SC	88	80	64	26
Savannah, GA	90	86	61	33
Brunswick, GA	TBD	TBD	TBD	TBD
Northeast FL	80	44	30	24
East-Central FL	74	52	42	12
Treasure Coast FL	39	25	23	22
Broward-Dade FL	34	12	10	NA

Of equal importance was the finding that a large percentage of evacuees went out-of-county to find acceptable refuge from the storm. Return to Top

Evacuees Going Out-of-County (%) in Hurricane Floyd

	Category 1 Surge Zone	Other Surge Zones	Coastal Non-Surge Areas	Adjacent Counties
Eastern NC	TBD	TBD	TBD	TBD
Southeastern NC	61	70	18	25*
Myrtle Beach, SC	77	82	57	26*
Charleston, SC	91	99	100	93
Beaufort, SC	98	97	94	70*
Savannah, GA	93	97	93	88
Brunswick, GA	TBD	TBD	TBD	TBD
Northeast FL	75	78	74*	52*
East-Central FL	75	79	80	27*
Treasure Coast FL	52	51	50	46
Broward-Dade FL	29	7*	6*	NA

* Based on interviews with fewer than 30 evacuees

For Northeast Florida, Savannah, Charleston, and Wilmington (who were major contributors to the evacuation), it is interesting to see a percentage breakdown by state destination. Interstate traffic movements affected evacuations in neighboring states. Return to Top

Out-of-County Evacuees (%) by State Destination

	NE Florida	Savannah	Charleston	SE North Carolina
Florida	55	1	<1	
Georgia	32	84	<1	2
South Carolina	1	4	45	9
North Carolina	4	4	25	73
Virginia		<1	2	8
Alabama	7	3	2	
Tennessee	<1	1	5	1
Other	<1	<1	3	7

Although many other behavioral parameters are documented in Technical Memorandum 1, a final behavioral component is presented regarding public shelter use. These numbers are quite low compared to what would be expected: Return to Top

Evacuees Using Public Shelters (%) In Hurricane Floyd

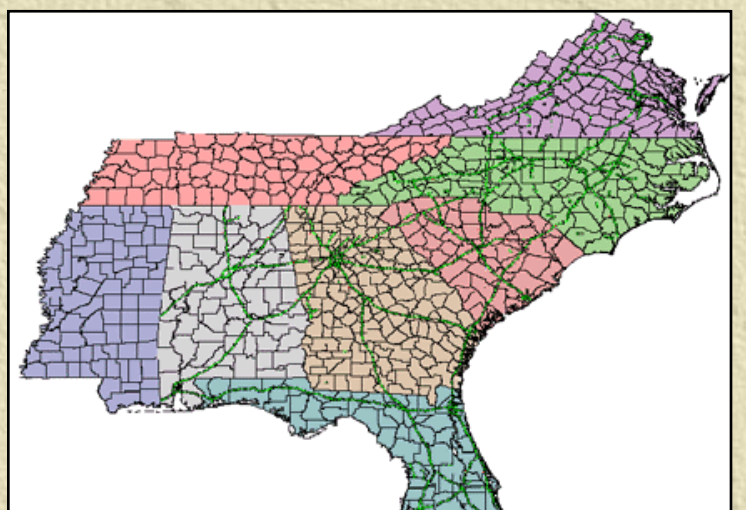
	Category 1 Surge Zone	Other Surge Zones	Coastal Non-Surge Areas	Adjacent Counties
Eastern NC	TBD	TBD	TBD	TBD
Southeastern NC	1	2	0	0*
Myrtle Beach, SC	2	3	6	0*
Charleston, SC	1	1	2	2
Beaufort, SC	1	2	5	4*
Savannah, GA	2	3	7	0
Brunswick, GA	TBD	TBD	TBD	TBD
Northeast FL	4	9	4*	4*
East-Central FL	4	5	0*	0*
Treasure Coast FL	TBD	TBD	TBD	TBD
Broward-Dade FL	3	17*	0*	NA

* Based on interviews with fewer than 30 evacuees

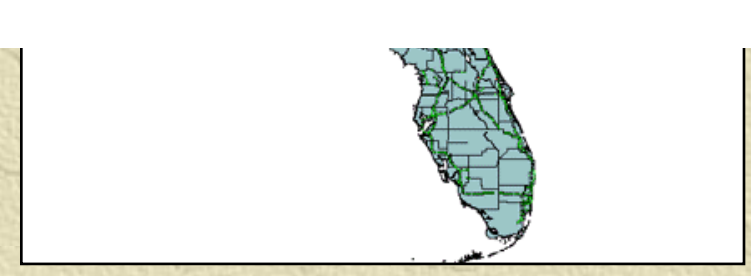
Return to Top

Web-based Evacuation Travel Demand Forecasting System

A web based evacuation travel demand model was constructed so that major traffic congestion areas and traffic flows could be anticipated and monitored for a Floyd type event. This important tool was developed using Microsoft's Visual Basic and ESRI's Map Objects, Map Objects IMS, and Arcview. Out-of-county evacuation traffic data calculated in FEMA/Corps hurricane evacuation study products and Regional Planning Council



hurricane studies were used as a baseline for the model.



The model is set up so that a state would dial up the model and input the following for each county responding:

- Category of hurricane
- Expected participation rate/compliance rate
- Tourist occupancy
- Destination percentages (optional/defaults encouraged)

Once these are submitted for each responding county, the model updates a number of system forecasts and graphics, providing key information for a significant hurricane threat. Other data that can be input real time are hour by hour traffic counts at locations where states have the ability to collect and communicate such information. Florida and South Carolina currently have such a capability at many strategic evacuation roadway locations. As traffic counts are input, accumulated traffic can be compared to system forecasts. **Return to Top**

Major outputs of the model include:

- **Expected congestion levels by major highway segment.**
- **Tables of expected vehicles crossing state lines by direction.**
- **Comparisons of traffic count station data to forecast condition.**
- **Numbers of vehicles generated by each county traveling to specific inland locations.**
- **Route information by segment including number of lanes, facility type, service volume, congestion measure.**

Ideally, the model will be housed at the FEMA Region IV Regional Operations Center and will become the primary tool by which an Evacuation Liaison Team (ELT) collects and disburses traffic and evacuation information to the states. The process requires that the states submit data and participate in

the web site during an actual threat. Meetings will be held in the spring of 2000 to work out operational details of the ELT. Return to Top

Hurricane Floyd Post Storm Assessment

In September 1999, the largest peacetime evacuation in the United States occurred as the result of Hurricane Floyd. This resulted in immediate funding for transportation and behavioral studies to determine what measures could be developed to reduce the traffic issues that occurred during the Floyd evacuation. The study was completed in May 2000. You can view the results of these studies by clicking on the items listed in the Table on the LEFT.

Major recommendations from this post-Floyd effort include:

1. Build an inland flooding component into the HES process using the ongoing North Carolina Hurricane Evacuation Restudy as a starting place.

2. Continue to refine the development of storm tide mapping, automating line delineation while lowering study production costs.

3. Use the Internet as a tool for disseminating storm surge mapping information as Wilmington District has done in creating "ncstormsurge.com."

4. Continue to use post storm assessments as the primary tool for providing behavioral data to the HES process.

5. Run scenarios with higher out-of-county evacuee percentages for strong storm clearance time calculations.

6. Capitalize on the behavioral finding by HMG that the public is willing to try phased evacuations and alternative highway routes if instructed by government officials.

7. Hold meetings to discuss ways in which the public's response/behavior can be changed through media messages so that highway congestion can be lessened.

8. Reduce public shelter percentages in the transportation analysis so that demand estimates are more realistic.

9. Examine public shelter locations for vulnerability to freshwater flooding.

10. Provide training/preparedness of non-American Red Cross personnel to provide shelter assistance during an evacuation.

11. Increase awareness of public shelter locations for local population prior to a hurricane season.

12. Improve communication of shelter locations and opening and closings throughout an evacuation.

13. Provide pre-season preparedness in Spanish for areas with large population of Hispanics, particularly rural areas.

14. Provide Spanish-speaking shelter personnel for those areas with large population of Hispanics.

15. Use rest stops and visitor information centers as information dissemination points for evacuees en route.

16. Provide generators to shelters due to the high number of shelters with loss of utilities.

17. Increase security at shelters in North Carolina that reported problems due to shelters being opened for extended periods of time.

18. Improve communications with evacuees while en route by providing traffic information at rest areas or through radio.

19. Provide a tool to help emergency managers anticipate evacuation traffic coming from other jurisdictions or states.

20. Work with each state's DOT to provide local emergency managers "real-time" traffic count information.

21. Calculate and report worst household commute times in addition to clearance times for each storm scenario.

22. Run clearance time calculations for reverse lane operations.

23. Provide traffic condition thresholds which would trigger implementation of various traffic control alternatives.

24. Work with USDOT and the state DOT's to implement ITS to facilitate evacuations.

25. Run clearance time scenarios with larger out-of-county percentages and greater participation of inland counties.

26. Conduct more training sessions with local EMS' regarding the HURWIN 95 model.

27. Develop a rainfall forecasting component to HURWIN 95.

28. Enhance INLAND WINDS model to better predict wind fields.

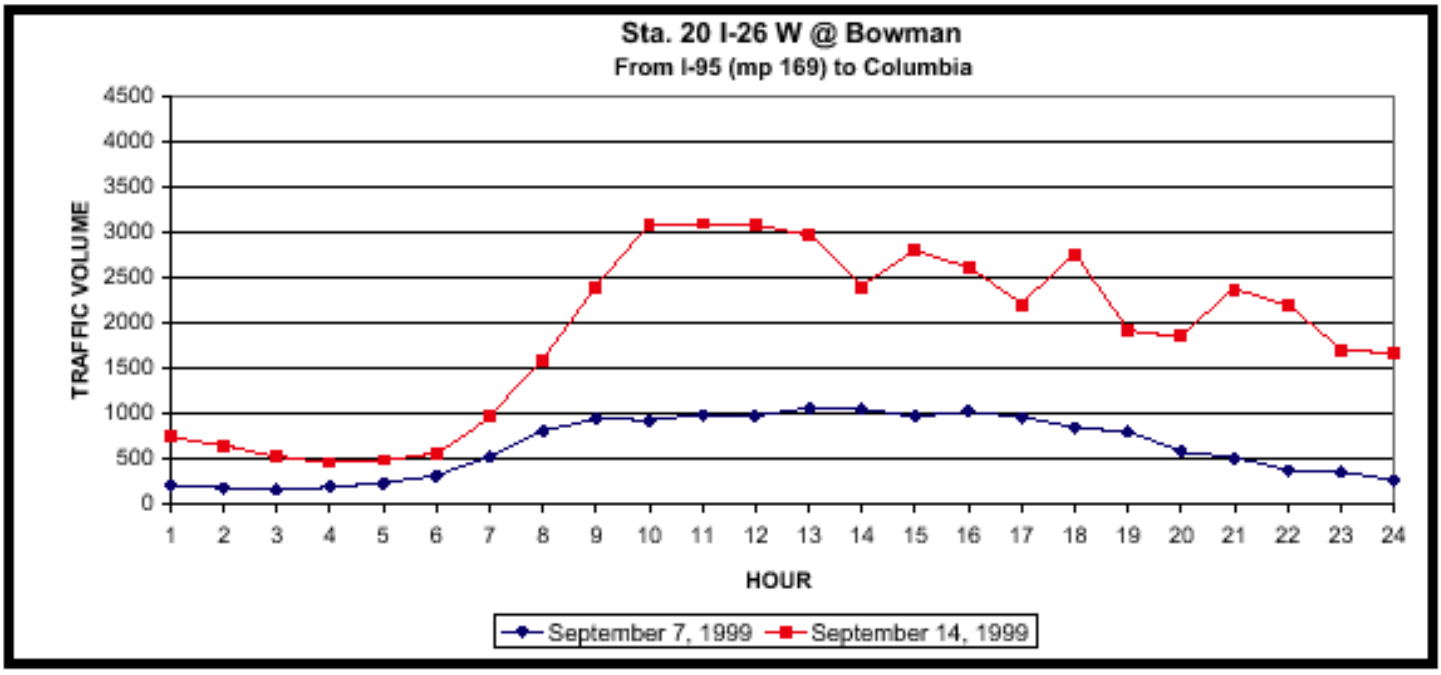
29. Encourage NOAA to work on models to improve the wind field forecasting.

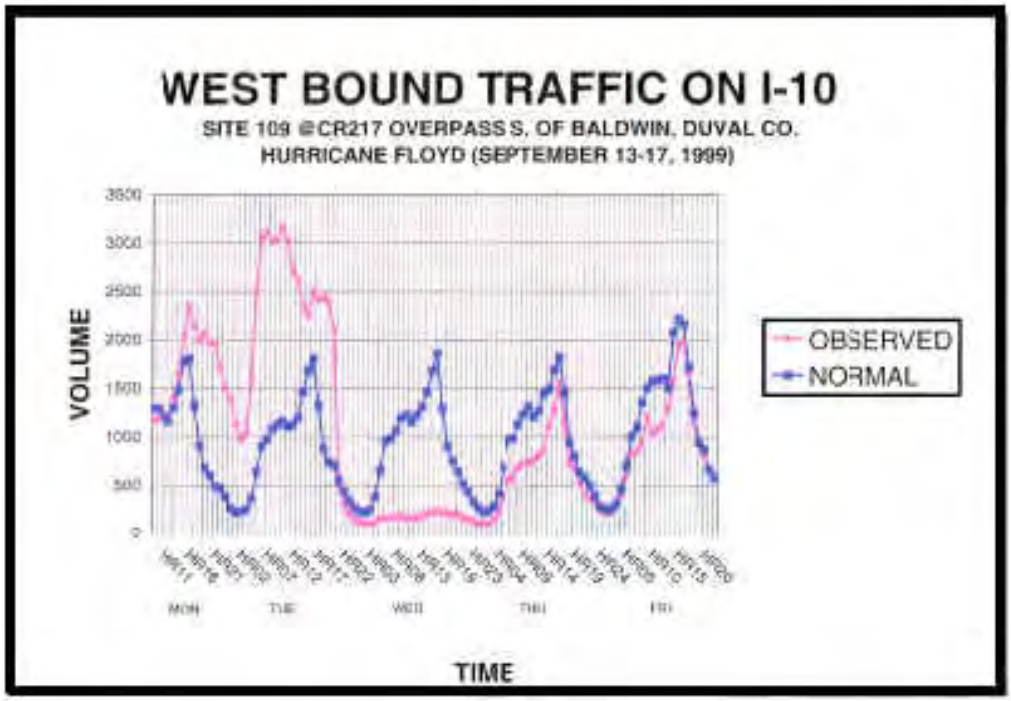
30. Explore possibility of adding real-time traffic count information to HurrWin95 or another tool.

[Go back]

Traffic Conditions, Reverse Lane Standards, and ITS Strategies

All available traffic counts collected by the state DOTs during Floyd were graphed and analyzed. The hour-by-hour and daily count totals confirmed and supported the congestion levels reported by the public and highway patrol. The highest per lane volumes seen during the Floyd evacuation on interstate facilities were between 1500 and 1600 vehicles per lane per hour. The diagrams below show typical traffic count summaries developed with the Floyd traffic data. The locations are I-26 westbound out of Charleston and I-10westbound out of Jacksonville. Valuable evacuation information regarding evacuation flow, duration, and queuing that can be seen using the data: Return to Top





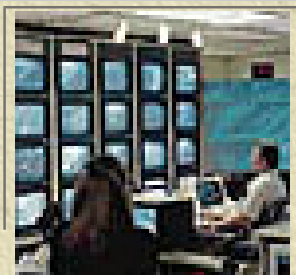
Extensive coordination with each state's DOT and highway patrol occurred to review existing one way/reverse lane plans for hurricane evacuations. Meetings were held in each state to discuss every aspect of traffic operations for reverse lane strategies used during Floyd on I-16 in Georgia and I-26 in South Carolina (and yet to be implemented on I-40 in North Carolina and the Florida Turnpike in Florida). Best features of each plan were noted and a comprehensive checklist of features that must be addressed for reverse laning in any location were compiled. The following table shows the features that must be addressed for reverse lane operations and a qualitative assessment of the impacts/benefits that might be present for a contra-flow lane, using a shoulder, or reversing all lanes in one direction: Return to Top

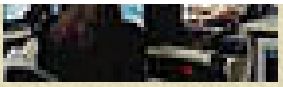
Alternative Strategies Impacts

	Normal	3 Lanes w/ Contra-flow	3 Lanes w/ Shoulder	Lanes Reversed
Costs				
Capital	Low	High	Low	Medium
Recurring(per event)	Low	High	Low	Medium
Geometry				
Capacity	Low	Low	Medium	High
Congestion	Highest	Medium	Medium	Low
Design	None	Medium	None	High
Guardrail Treatments	No Change	Medium	Low	High
Shoulder Design/Maintenance	No Change	Low	High	Low
Safety	Low	Lowest	Medium	Medium
Law Enforcement				
Emergency Access	Lowest	Low	Very Limiting	Limiting
Incident Management	Lowest	Medium	Very Limiting	Medium
Patrol Needs	Lowest	Low	High	High
Roadblock Needs	Lowest	Medium	Medium	High
Traffic Control				
Barricade Needs	None	Very High	Very Low	Medium
Highway Advisory Radio Needs	No Change	Very High	Low	High
RPM Needs	No Change	High	No Change	High
Permanent Sign Needs	No Change	Medium	Very Low	Medium
Temporary Sign Needs	No Change	Very High	Very Low	High
DMS	No Change	Very High	No Change	High
Other				
Implementation Time	None	Very High	Very Low	Medium
Mobilization Time	None	Very High	Very Low	Medium

A final area that was addressed with each state's DOT and highway patrol was that of Intelligent Transportation Systems (ITS) technologies that could be used to manage hurricane evacuations. State by state recommendations were developed and focused on elements of the following ITS technologies: Return to Top

Automated vehicle location systems	Freeway control
Traffic information dissemination	Surveillance systems
Navigation/route guidance system	Signal control systems



Computer aided dispatching	Incident management	
Communications between field devices and control centers		

A map was provided showing locations where ITS applications are recommended. Tables were developed with rough cost estimates for each treatment. **Return to Top**