Opportunities for engineered mitigation and response to hurricanes and tropical storms

Baxter E. Vieux, Ph.D., P.E.

Director, Natural Hazards and Disaster Research, National Weather Center

Professor, School of Civil Engineering and Environmental Science

University of Oklahoma

Rita—
NWS Warning, Sept 23, 2005

FOR SUSTAINED WIND 110 TO 130 MPH WITH GUSTS 140 MPH OR MORE:

CATASTROPHIC DAMAGE EXPECTED TO MAN MADE AND NATURAL STRUCTURES!

HOUSES OF POOR TO AVERAGE CONSTRUCTION WILL BE SEVERELY DAMAGED OR DESTROYED. WELL CONSTRUCTED HOMES WILL HAVE SUBSTANTIAL DAMAGE TO ROOF AND WALLS. DESTRUCTION MAY OCCUR TO HOMES WITH GABLED ROOFS... WITH THE WIND LIFTING THEM OFF. MORE THAN HALF OF ALL INDUSTRIAL BUILDINGS WILL BE DESTROYED...OTHERS WILL HAVE PARTIAL ROOF AND WALL DAMAGE. WOOD FRAMED GARDEN APARTMENT BUILDINGS WILL BE SEVERELY DAMAGED OR DESTROYED...AND OTHERS WILL HAVE PARTIAL ROOF AND WALL FAILURES.

HIGH RISE OFFICE BUILDINGS WILL SWAY DANGEROUSLY. MOST WINDOWS WILL BE BLOWN OUT...AND MODERATE STRUCTURAL DAMAGE IS POSSIBLE.

Engineered Structures

Rita—
NWS Warning, Sept 23, 2005

FLOOD WATCH FOR SOUTHEAST TEXAS UNTIL 7 PM CDT SATURDAY EVENING

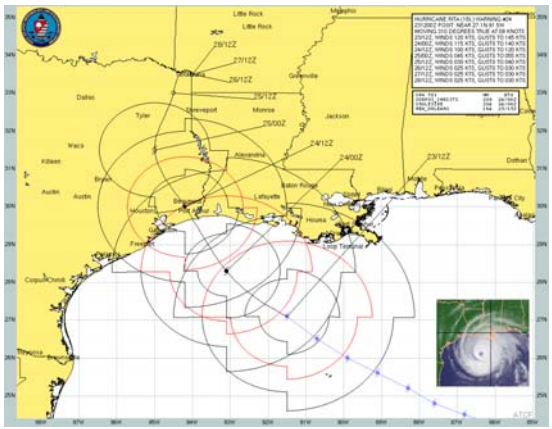
POWERFUL HURRICANE RITA IS FORECAST TO MAKE LANDFALL ALONG THE EXTREME UPPER TEXAS COAST JUST WEST OF SABINE PASS EARLY SATURDAY MORNING. RAINBANDS FROM RITA WILL BEGIN MOVING ONSHORE ACROSS THE EASTERN PORTIONS OF SOUTHEAST TEXAS THIS EVENING. RAINBANDS WILL BECOME WIDESPREAD AND INCREASE IN INTENSITY LATER THIS EVENING AND THROUGH SATURDAY MORNING.

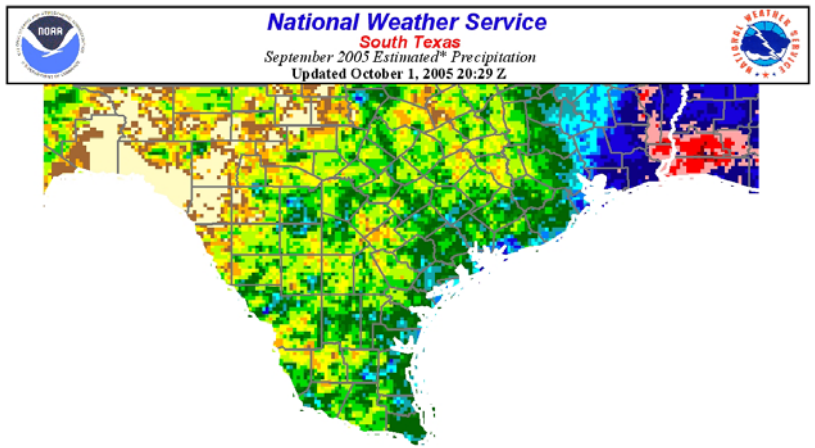
Wide range of rainfall amounts without reference to specific rivers

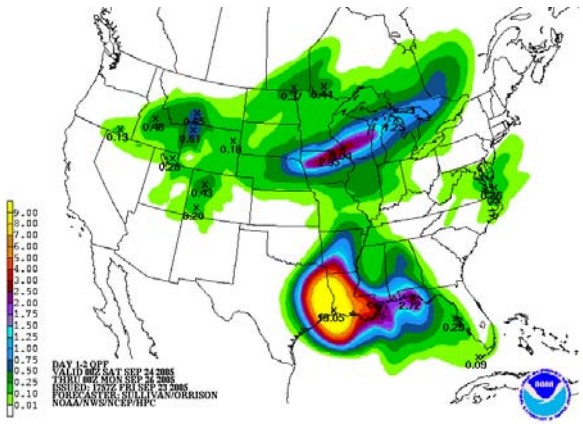
WIDESPREAD RAINFALL AMOUNTS OF 6 TO 10 INCHES WILL BE LIKELY MAINLY ALONG AND EAST OF GALVESTON....HOUSTON...NEW WAVERLY ...AUSTONIO LINE. LOCALLY HEAVIER RAINFALL AMOUNTS TO 20 INCHES MAY BE POSSIBLE THROUGH SATURDAY AFTERNOON. RITA IS EXPECTED TO SLOW DOWN AFTER MAKING LANDFALL...WHICH WILL PROLONG THE HEAVY RAINS.

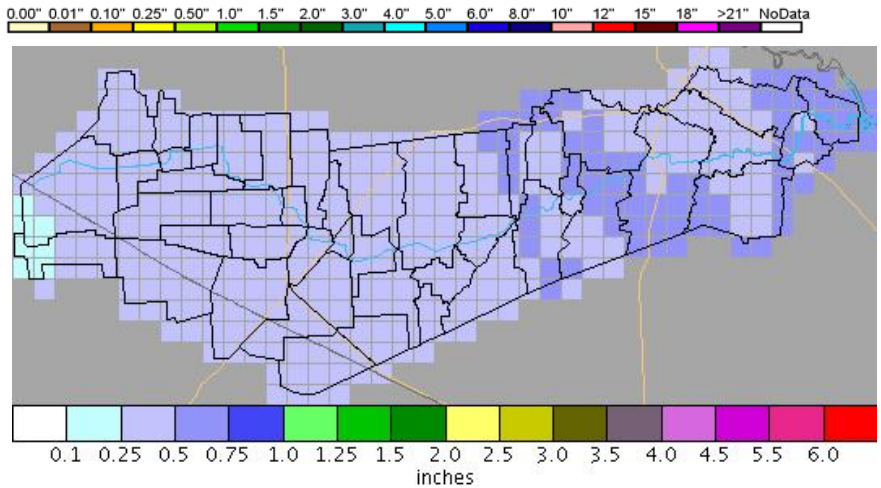
PEOPLE IN THE WATCH AREA SHOULD BE AWARE OF THE POSSIBILITY FOR HEAVY RAINFALL...AVOID LOW LYING AREAS...AND BE CAREFUL WHEN APPROACHING LOW LYING AREAS AND UNDERPASSES.

Hurricane Rita— Precipitation and Flood Forecasts



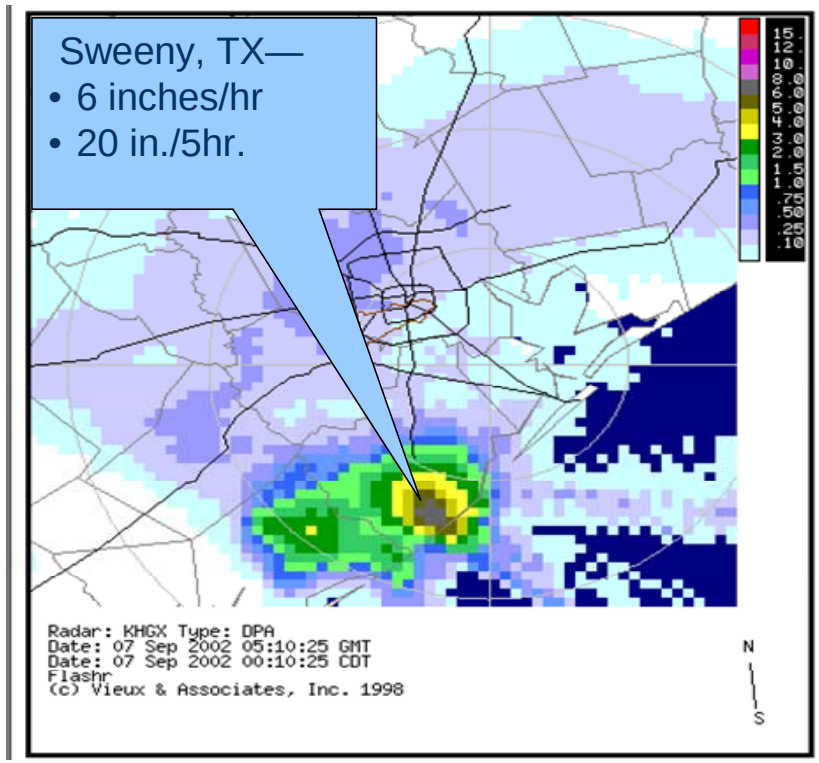






T.S. Fay from 9/7/2002

- It doesn't have to be a Hurricane to set world record rainfall amounts.
- T.S. Fay produced record amounts of rainfall and localized flooding.
- Radar rainfall shown here is from a commercial flood alert system that relies on NEXRAD radar and distributed modeling

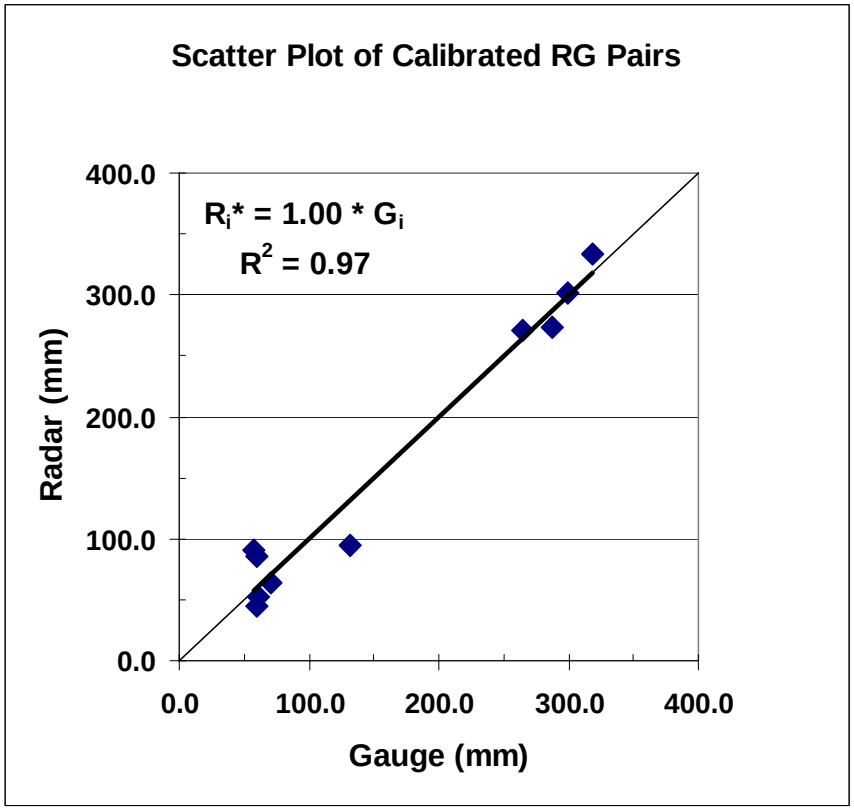


TS Allison (8-9 June, 2001)

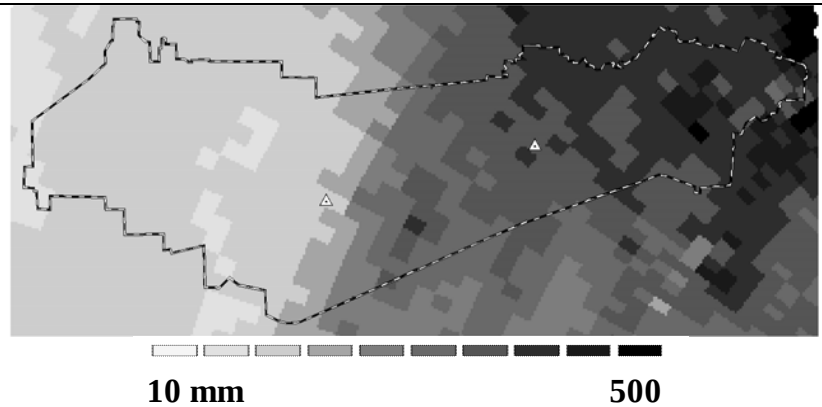
Predictability of flooding

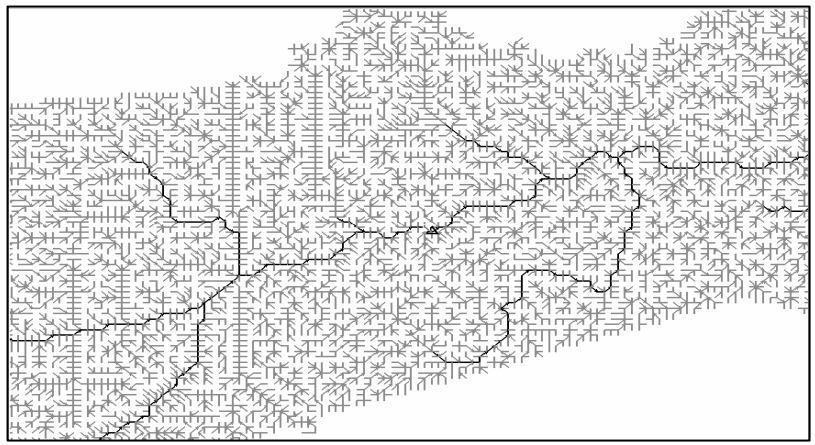
Texas Medical Center

T.S. Allison—
Event Reconstruction



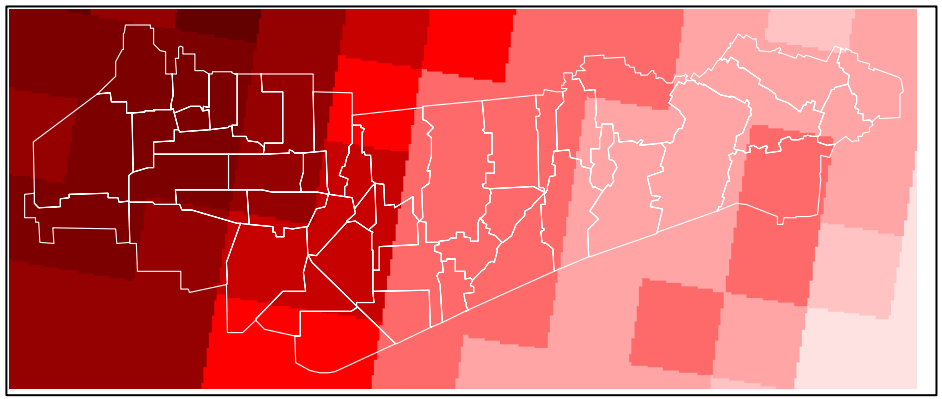
Allison 3rd



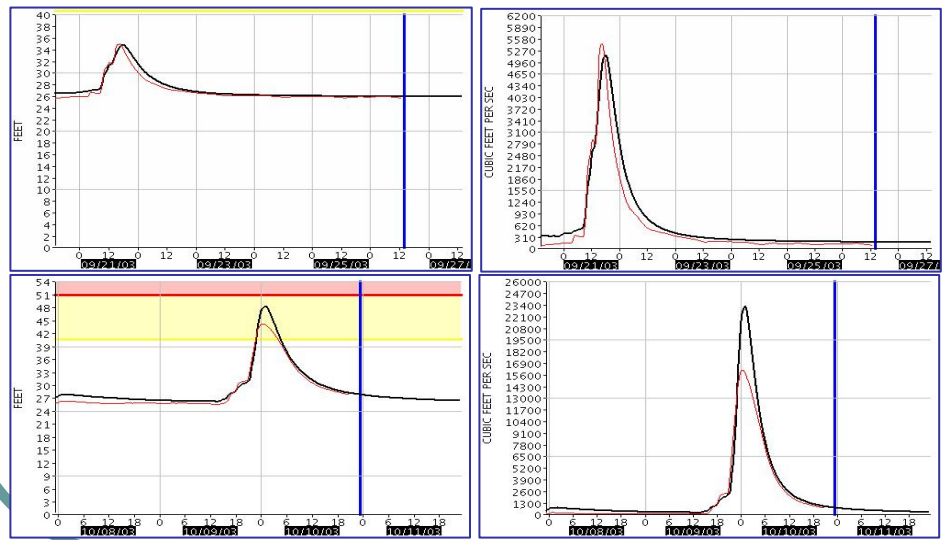


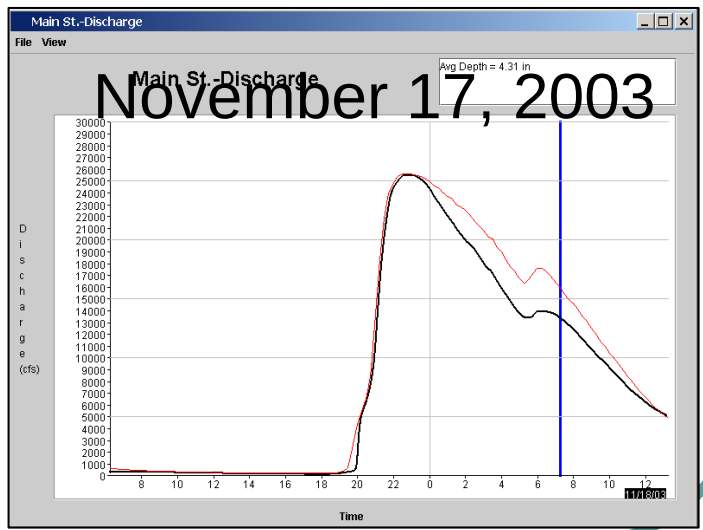
Calibrated Radar Distributed Model Input

Distributed model accuracy



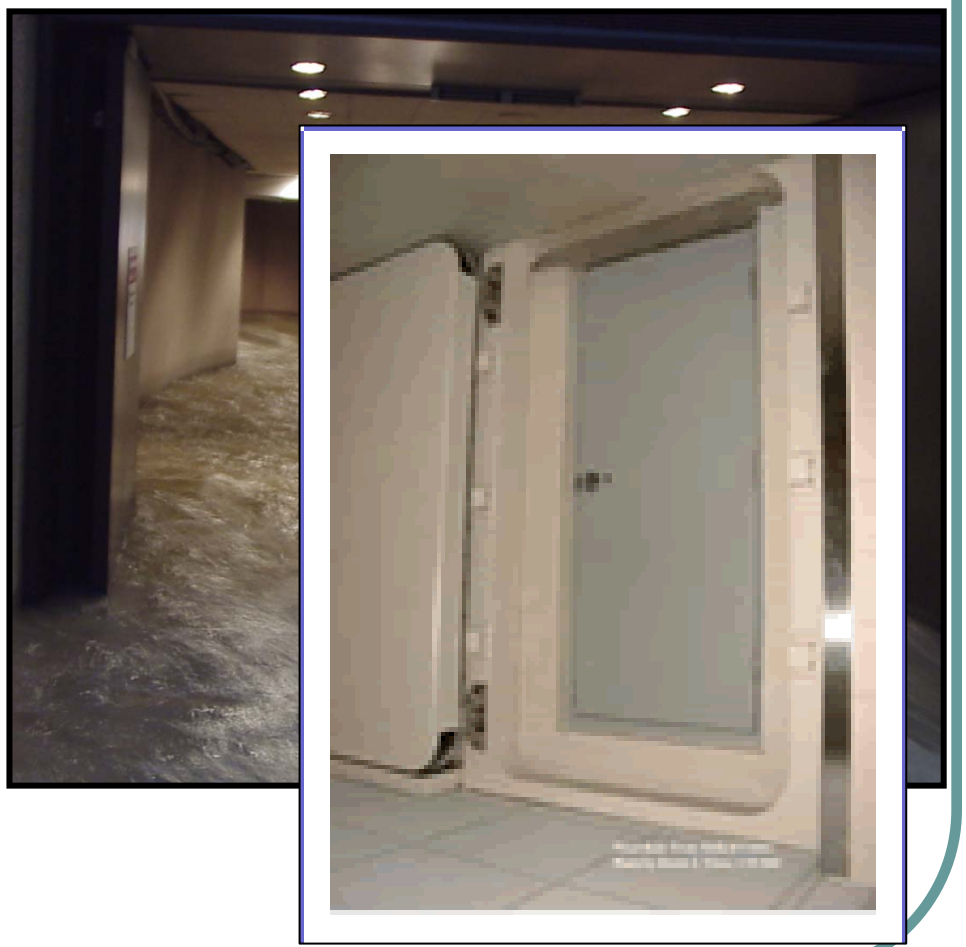
Real-time and post analysis accuracy comparison to observed streamflow



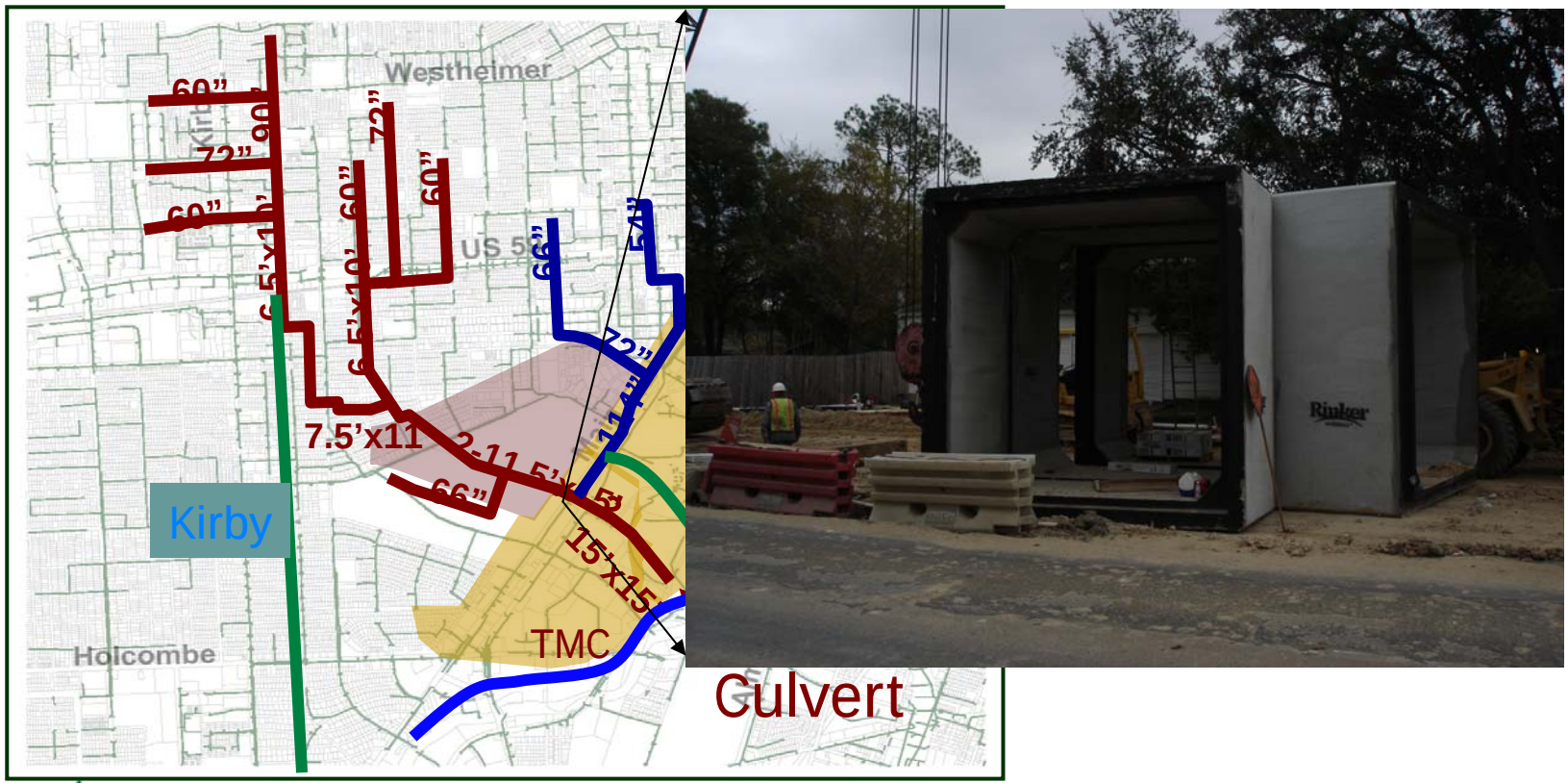


Hydrologic Prediction

- Engineered mitigation Infrastructure design e.g., flood doors/gates
- Real-time operations, evacuation and logistics.
- Planning for evacuation and facility design.
- Reduced property damage and loss of life



Engineered Infrastructure



THOMPSON

Beyond Landfall—Redesign after Hurricanes

Improved infrastructure capacity as a result of Tropical Storm Allison

Design and construction goes on after 5-years.

Warning systems go hand in hand with infrastructure improvements

Research needs

- Characterizing recurrence interval and strength of hurricanes has potential benefits to the insurance industry, individuals, and businesses in the coastal zone.
- Limited duration of observations or inadequate sampling density, there are often insufficient historical records to properly account for the rainfall depth or windspeed along the coast. Statistical characterization and design standards are needed.
- Warning systems could be developed that integrate specific organizational response to flood levels. Flood warning systems have been developed to provide more detailed information than is available to, or even useful for, the general public.
- The atmospheric measurements useful for predicting landfall and strength during the storm become important ingredients in re-design of infrastructure.
- Development and deployment of information technologies for flood prediction and warnings after the storm provide ways to reduce future impacts and reduce societal vulnerability.

Recent Publications

Gourley, J.J., and B.E. Vieux, 2006. A Method for Evaluating the Accuracy of Quantitative Precipitation Estimates from a Hydrologic Modeling Perspective. *J. of Hydrometeorology*. Forthcoming.

Einfalt, T., K. Arnbjerg-Nielsen, D. Faure, N.-E. Jensen, M. Quirmbach, G. Vaes, B.E. Vieux, C. Golz, 2004. Towards a Roadmap for Use of Radar Rainfall Data in Urban Drainage. *J. of Hydrology*. 299(3-4), pp. 186-202. Special Issue on Urban Hydrology.

Vieux, B.E., and P.B. Bedient, 2004. Assessing urban hydrologic prediction accuracy through event reconstruction. *J. of Hydrology*. 299(3-4), pp. 217-236. Special Issue on Urban Hydrology.

Bedient, P.B., W.C. Huber, and B.E. Vieux. Hydrology and Floodplain Analysis, Addison-Wesley Publishing Co., Reading, Massachusetts, 4th Edition. Forthcoming.