The University of North Carolina at Wilmington (UNCW)
Hazard Assessment

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The University of North Carolina at Wilmington (UNCW) Hazard Assessment

This report is the first step in a hazard assessment process that UNCW can use to determine future mitigation and disaster resistant strategies to ensure continuity of research, academic and business functions in the face of a disaster. It assesses the likelihood and potential impact of a variety of natural and technological hazards, determines priorities and provides broad definition of mitigation strategies.

SETTING

The University of North Carolina at Wilmington was founded as Wilmington College in 1947 and has been one of the 16 constituent institutions in the North Carolina System since 1969. It is a 650-acre arboretum campus located on the outer coastal plain of North Carolina at an overall campus elevation from 20 feet to 50 feet. It has nearly 125 buildings in modified Georgian architectural style. The overall property value is over $180 million. UNCW has an 8-county economic impact annually of $390 million. Additionally, UNCW is currently undergoing the largest building program in its history. There are currently approximately 11,000 students and extensive research being conducted by the university.

Regionally, the campus is located in New Hanover County, North Carolina, approximately four miles west of the Atlantic Ocean. It is surrounded by the corporate limits of the City of Wilmington and is located at 601 South College Road (US Highway 132). The elevation of the main campus ranges from 10 feet above mean sea level (MSL) to 50 feet above MSL. Drainage is predominantly to the east ultimately draining into Bradley Creek, a tidal estuary. Two tributaries of Bradley Creek provide drainage to the campus. One, known as Clear Run is located along the northern property boundary and the other unnamed tributary in the southern third of the campus passing north of Lot EE and is recognized as a "blue line stream" upstream until Social and Behavioral Science Building where it then becomes a drainage feature ***(Topographical Map - Figure 1).*** There are numerous outlying portions of the UNCW campus including:

- **The Center for Marine Science, located on Myrtle Grove Sound approximately 6 miles south**
- **The Center for Marine Science Operations, located approximately 3 miles east**
- **Several historic structures in downtown Wilmington**
- **Undeveloped conservation properties in New Hanover and Brunswick Counties**
- **Several leased properties**

The scope of this assessment does not include outlying properties and is limited to the main campus.

New Hanover County is located in Southeastern North Carolina ***(Location Map - Figure 2)*** with its eastern boundary being the Atlantic Ocean and its western boundary predominantly being the Cape Fear River. The Northeast Cape Fear River and a land boundary with Pender County make up the northern border. New Hanover County is accessed by five major highways (US 17, US 421, US 74/76, US17, I-40). Only one (US 17) does not have to cross a body of water to enter the metropolitan areas of the county. Therefore New Hanover County can be relatively geographically isolated. This coupled with the fact that it is located on a cuspate cape that extends into the Atlantic Ocean makes it particularly susceptible to tropical cyclones.

PURPOSE

UNCW is recognized as one of six original Disaster Resistant Universities as part of a Federal Emergency Management Agency (FEMA) initiative. It is the purpose of this initiative to identify, assess and mitigate potential hazards that could adversely affect research, teaching and business operations on campus and share our experiences with other colleges and universities.

Locally, it is the goal of this initiative to make recommendations that will set in motion a "disaster resistant culture" in motion at UNCW that will allow us to:

- **Endure future disasters with minimal risk to life, property and the environment**
- **Resume teaching, research and business activities as quickly as possible**
- **Be a mentor to other colleges and universities in becoming more disaster resistant**

SCOPE

This report completes the first two steps in the process of hazard assessment and development of mitigation strategies. Before a university can begin to mitigate hazards and become disaster resistant, it must complete the following process:

- (**1) Conduct a historical review of hazards in the region**
- **(2) Determine the relative likelihood and impact of these natural and technological hazards, therefore developing a priority list.**

- **(3) Evaluate vulnerabilities to various disasters and identify sensitive and critical facilities.**
- **(4) Determine the financial impact of a disaster to both the University and the community to help support a cost-benefit analysis for mitigation strategies.**

Only after each of these steps are completed, can a mitigation strategy be determined, priorities set, a budget prepared and this compared with potential losses. By integrating each of these steps, hazard mitigation can be a powerful tool in reducing university losses due to disasters.

HISTORICAL HAZARD INVENTORY

An historical hazard inventory was conducted for UNCW using the *NOAA Community Vulnerability Assessment Tool (New Hanover County, North Carolina, Case Study),* the North Carolina Emergency Management Hazard Mitigation website http://www.dem.dcc.state.nc.us/mitigation/flood.htm, as well as the North Carolina State Climate Office website http://www.dem.dcc.state.nc.us/mitigation/flood.htm. Additional data was provided by the Southeast Regional Climate Center (SRCC). These tools were used to determine the historical occurrence of disasters in the region.

Disasters considered for this assessment include:

- **Earthquakes**
- **Wildfire**
- **Tornadoes**
- **Severe Winter Weather**
- **Technological Disasters (hazardous materials spills, terrorism, nuclear disaster)**
- **Tropical Cyclones - Hurricanes (wind, rain induced flooding and storm surge)**

Each of these hazards was compared based on historical occurrence, probability, and potential impact. Additionally, broad areas of mitigation strategies were outlined for each. That evaluation follows:

Earthquake

UNCW is situated on a passive geologic margin, where seismic activity is very rare. Building codes classify this area as one with a low risk (Seismic Zone I) ***(Seismic Risk Map - Figure 3)***. However, earthquakes have occurred in the recorded history of North Carolina and there are

geologically inactive faults within the region. Approximately 10 earthquakes have occurred in this region in the past 200 years. Of these, only one, the Charleston, South Carolina earthquake of 1886, produced significant damage to any structures in the area. Therefore, historically the frequency has been rare and the damage has been limited. However, if an earthquake with the intensity of the Charleston quake was centered in New Hanover County, damage could be extensive. Mitigation strategies typically include major structural retrofitting and building design. Considering the very low possibility of occurrence and the extensive cost of mitigation strategies, it is unlikely that mitigation monies would be cost effective.

Wildfire

Historically, wildfires occasionally occur in southeastern North Carolina but not with the regional extent that they do in the western United States. The 1986 Holly Shelter Wildfire did significantly impact both New Hanover and Pender Counties burning greater than one million acres of woodlands. The NOAA Hazard Assessment mapped New Hanover County into three levels of wildfire risk low, moderate and high ***(NOAA Wildfire Risk -Figure 4)***. UNCW is located in the moderate zone predominantly being in a suburban environment, reducing the possible extensive spread of wildfire. Additionally, this suburban setting provides fire hydrants throughout the developed portions of the campus and the surrounding properties. The eastern most 150 acres is wooded and wildfire is a possibility although limited. Although costly, loss of structures is typically limited due to the noncombustible construction and damage to infrastructure is nil. Mitigation strategies include fire lines, building setbacks and controlled burns. UNCW has undertook several of these in the early 1990s. However, considering the relatively low cost of these measures, they should be revisited.

Tornado

Most tornadic activity in New Hanover County is associated with tropical systems. However, a limited number of extra-tropical tornados have occurred in New Hanover County. The potential impact of tornadoes is major but it is rare that it would affect the entire campus. Mitigation strategies include wind-resistant windows and doors and early warning and education to protect from loss of life.

Winter Weather

Severe winter weather, including snow and ice, is rare in the UNCW climate but not unheard of. Severe snow and ice storms have been recorded approximately 10 times in the last 50 years. With significant snow and ice accumulation being a relatively infrequent occurrence, the North Carolina Department of Transportation and local public works departments are typically not well suited for recovery. According to the SRCC an average of 0.7 days per year have snowfall occurrences of greater than one inch in New Hanover County. The maximum snowfall ever recorded was 13 inches in December of 1989. Typically, as little as one inch of accumulation can result in limiting the use of highways and sidewalks resulting in a loss or delay of basic services. Occasionally, winter weather results in power interruptions that could impact research, teaching and business operations. Emergency power generators and other mitigation strategies typically associated with hurricanes are effective in preparing for this type of emergency. Efforts are currently being undertaken to develop an integrated winter weather policy for UNCW and implementation is planned for Fall/Winter of 2003. The major emphases of this plan includes providing vital services to the 2,300 resident students and the resumption of research and classes when safe.

Technological Disasters

Technological disasters include hazardous materials releases, nuclear disasters, cyber attack and terrorist activities. While there is no history of these events at UNCW, they are a possibility. Over 7,000 hazardous chemicals, biological agents and radioactive materials are utilized in research on campus. College Road is a major transportation route for hazardous materials, and a nuclear plant is located approximately 15 miles south. The university conducts a wide variety of community activities and is home to the largest public venue in the region. It invites the public to be part of our community and supports research that could be controversial to fringe groups. Therefore, it could be a target for terrorist activities, as well as, a source of chemical, biological or radioactive agents. Current activities include involvement with the Local Emergency Planning Committee (LEPC), and a strong relationship with New Hanover County Emergency Management and extensive training of our Environmental Health & Safety (EH&S) and University Police personnel. The broad scope of possible incidents is wide, and mitigation activities are limited to increased security, planning, emergency notification and education.

Hurricanes and Tropical Cyclones

The following quotation from the North Carolina State Climate Office adequately summarizes the Hurricane History of North Carolina "*North Carolina has a long and notorious history of destruction by hurricanes. Ever since the first expeditions to Roanoke Island in 1586, hurricanes are recorded to have caused tremendous damage to the state. Reliable classification of the intensity of tropical cyclones began in 1886. Since that time, there have been 951 tropical cyclones that have been recorded in the Atlantic Ocean and the Gulf of Mexico. Approximately 166 or 17.5% of those tropical cyclones passed within 300 miles of North Carolina…the coast of North Carolina can expect to receive a tropical storm or a hurricane once every four years, while a tropical cyclone affects the state every 1.3 years."*

A hurricane has made landfall within 50 miles of New Hanover County 12 times in the last 100 years. Between 1996 and 1999 four hurricanes made landfall within 50 miles of New Hanover County. UNCW has a direct history of five hurricanes passing within 50 miles of the campus since it has been at this location (1961). Two of these, Bonnie and Fran, were "major hurricanes" of Category 3 or greater. The last Category 4 hurricane to pass within 50 miles of UNCW was Hazel in October of 1954. A Category 5 hurricane has never made landfall in North Carolina during recorded history. In fact, over the past 100 years only two Category 5 hurricanes have made landfall in the continental United States. They were the 1935 Florida Keys hurricane and Camille that made landfall in Mississippi in 1969.

Due to the coastal and subtropical location of UNCW, the possibility of extreme, extra-tropical wind and rain events is likely to include severe thunderstorms, and "nor'easters." According to the SRCC, in the past 100 years, there have been 27 days with rainfall of two inches or greater in New Hanover County. Mild flooding and wind damage, predominantly due to falling trees, has been experienced on campus. Lightning damage is more scattered and more frequently damages electronic equipment and only occasionally structures. Since they are similar in many ways to hurricanes and hurricane mitigation methods will address these concerns, they are grouped with Tropical Cyclones for the purpose of this report.

EXPECTED IMPACTS

While UNCW has endured several Category 3 hurricanes and adequately understands their impact, the impact of a Category 4 or 5 hurricane is unknown. Therefore, the *NOAA Community Vulnerability*

Assessment Tool (New Hanover County, North Carolina, Case Study) was used to model the potential impact of both a Category 4 and Category 5 storm. This was augmented with topographic data and historical data of damages gained during Category 3 hurricanes. The primary mechanisms of destruction from hurricanes are wind, flooding by rainfall and storm surge, and coastal erosion. Each of these aspects was modeled for their impact on UNCW during a Category 4 or Category 5 storm.

Flooding

FEMA Flood Insurance Risk Maps (FIRM) are used to determine the relative risks of properties to flooding, and delineate the 100-year and 500-year flood plains. During hurricane Floyd, it was determined that much of the data used to compile the FEMA flood maps was dated and may be inaccurate. Currently a project to update these maps, using state of the art technology, is being undertaken. It is anticipated that this data will become available in December 2003 and it will be integrated into this report at that time.

The FEMA FIRM map for Wilmington (panel number 37017-0005C) was examined and an excerpt of this panel is included as ***(FEMA Flood Risk Map - Figure 5)***. The only areas that were identified on the FIRM as being in the 100 year or 500 year flood plain were immediately adjacent to Clear Run (a tributary of Bradley Creek) along the northern boundary of the campus. This area is not currently developed nor does the 2020 Master Plan indicate this area for development.

Using the *NOAA Community Vulnerability Assessment Tool (New Hanover County, North Carolina, Case Study)* modeling data, a Flood Risk Map ***(NOAA Flooding Risk – Figure 6)*** was developed. Most of the campus was in the "no flood risk zone." However, four areas that were in the slight flood risk zone were identified. This model uses soil types, surface water features and elevation data to predict flood prone zones.

Historically, the maximum rainfall in the continental United States associated with a tropical cyclone was 24 inches. During hurricane Floyd, 17.72 inches of rain was recorded in a 48-hour period with nearly five inches of rain in the previous week. Areas of flooding identified during this rain event coincide closely with the Flooding potential map included in Figure 5. It is estimated that a Category 4 or 5 storm resulting in rainfall amounts of 15-25 inches could be expected.

In this type of event, one flooding area would be the intersection of Racine Drive and Randall Drive (Lot H). The drainage ditch on the northern property boundary fills, and drainage in this area is poor. Flooding could fill Parking Lot H, and historically has filled Lot G. There is not modeled nor has there been a historical impact to buildings in this area. One of the more significant impacts of this area being flooded would be the limiting of access to the water tower. The closing of this intersection would restrict emergency traffic on this side of the campus.

The second area of flooding is on the southwest corner of campus, immediately south of Lot K. This area is broad and flat with a poorly drained soil. It traditionally floods and it is shown on the modeled data. The principle impacts of floods in this area are limiting road traffic through the southern entrances of the campus although impacts to the electrical substation being located near this area should be investigated.

The third area of flooding is the undeveloped area along the southern unnamed tributary of Bradley Creek. These areas do not present a threat to campus buildings, roadways, or infrastructure.

The fourth area of flooding is the most problematic. The central drainage flooding extends from parking Lot E, by the University Union, along the main drainage ditch to Lot AA near University Police. Buildings included in this flood area are the University Union, Social & Behavioral science, Warwick Center, Burney Center and Cameron Hall, in addition to a new classroom building and several of the University Apartments. All of these buildings other than the Apartments are built on a crawl space and this would offer some protection. However, flooded crawl spaces present several heath problems and mechanical rooms at ground level would present an opportunity for loss of all building systems in these areas. Improved drainage has improved this situation. However, additional mitigation efforts and design standards for these areas are warranted.

Although not identified on the modeled flood data, historically the intersection northwest of Lot T has flooded, and this is also an area of new development. Additional drainage for this area should be investigated.

Wind

Wind can be one of the more damaging components of a hurricane. High winds can damage roofs, shatter windows, collapse large doors, down utility lines and trees throughout the region, produce a variety of other missiles from lighter outdoor fixtures and debris and finally, result in total building collapse if the building envelope is compromised. As discussed before, UNCW has experienced wind damage from Category 3 storms but all of these were at the lower end of the Category 3 range. According to the NOAA Hazard Assessment, New Hanover County is partitioned into two wind zones as shown in ***(NOAA Wind Risk - Figure 7)***. The main campus is located within the low wind risk zone. However, based on previous experiences, this area does warrant hazard mitigation strategies. These strategies include wind resistant windows and doors on critical facilities and design standards developed for new buildings with critical facilities. Additionally, design standards for skylights, atriums, roofs, and rooftop mounted equipment and moveable items are recommended to limit damage.

Coastal Erosion

Coastal erosion is amplified during hurricanes due to the storm surge, high winds and increased wave action. New Hanover County is once again partitioned into two zones ***(NOAA Coastal Erosion Risk – Figure 8)*** with the main campus being within the low risk zone. This risk is limited to the barrier island communities throughout the county.

Storm Surge

Finally, storm surge is the mound of water that is associated with a hurricane that literally inundates large portions of land. This can be complicated by astronomical high tides and increased rainfall before landfall. Southeastern North Carolina has not experienced a hurricane with a significant storm surge since Hazel in 1954. The NOAA modeled impact storm surge is shown in Figure 9 ***(NOAA Storm Surge Risk – Figure 9)***.

First, it should be noted that there is no impact of storm surge on campus for a Category 3 storm or below. A Category 4 storm would only slightly impact the parking and roadway system on the eastern portion of the campus. However, a Category 5 hurricane would inundate nearly the entire support area of campus, most of the residence halls, and Wagoner Hall the primary dining facility. It should be noted however, that the storm surge prediction is as ground elevation, prior

to any grading. Additionally, Wagoner Hall, Honors and International Houses, and University Police are built on crawl space foundations that may offer some protection from inundation. Considering the infrequency of a Category 5 storm and the magnitude of impact, the primary mitigation strategy is for development restrictions within this area, redundancy of critical facilities or, at a minimum, plans to address the relocation of vital service prior to the impact of a Category 5 storm.

Impact Summary

Following this process, a hazard assessment matrix was developed. Each hazard was assigned a number between one and five representing the relative likelihood and likewise a score between one and five representing potential impact. These values were multiplied together to yield a total hazard assessment value for that hazard. As can be shown on the following matrix, risks associated with tropical cyclones hold the top four slots.

UNCW Hazard Assessment Inventory			
Hazard	Frequency (1-5)	Potential Impact (1-5)	Total Priority Score
Hurricane/Rain-Flood	**4**	**4**	**16**
Hurricane-Wind	**3**	**5**	**15**
Tornado	**2**	**5**	**10**
Hurricane-Storm Surge	**2**	**4**	**8**
Wildfire	**2**	**3**	**6**
Severe Winter Weather	**3**	**2**	**6**
Terrorism/WMD	**1**	**5**	**5**
HAZMAT Incident	**2**	**2**	**4**
Earthquake	**1**	**4**	**4**
Coastal Erosion	**1**	**2**	**2**

CONCLUSIONS AND RECOMMENDATIONS

The evaluation undertaken in this report is a powerful tool in the development of mitigation strategies and sets the foundation for UNCW to become a more disaster resistant university.

This report has developed a UNCW Hazard Assessment Matrix that helps prioritize where mitigation efforts should begin to receive the greatest impact. Based on this matrix, it is apparent that the principle threats to UNCW and the New Hanover County area are hurricanes. The mitigation strategies applied for hurricanes also yield results in areas of extra-tropical storms . To accommodate this growth, we are developing "Design Standards." These standards should integrate the values of disaster resistant construction including the following:

- **Consult the FEMA Coastal Construction Standards during building design**
- **Install wind resistant windows, doors and rooftop systems**
- **Install emergency generators and consider the portability of these generators**

Planning of campus development should address disaster resistance as part of the site selection process:

- **Select sites outside the modeled flood zones and the storm surge zones.**
- **Utilize drainage options other than the "main drainage ditch" that is nearing practical capacity.**

Finally, the single largest mitigation action that can be taken is the development of departmentally specific all hazards response plans. One area that this needs to include is response to the Category 4 and Category 5 modeled results. The research efforts and critical services have begun this process immediately.

In continuing with the hazard assessment model, the next two steps that should be taken are:

- **Evaluate vulnerabilities to various disasters and identify sensitive and critical facilities.**
- **Determine the financial impact of a disaster to both the University and the community to help support a cost-benefit analysis for mitigation strategies.**

Once these are completed, specific mitigation strategies can be determined, priorities set, a budget prepared and implementation of these measures undertaken. Education and planning are the keys to building the culture of disaster resistance at UNCW and other communities and universities throughout the nation.