THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Natural and Man-made Hazards Mitigation Plan

Maintained By:

The UAH Office of Emergency Preparedness under guidance from the UAH Disaster Resilient University Committee

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Acknowledgments

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1. Background and Purposes of the Plan

1.1 About the Plan

The University of Alabama in Huntsville (UAH) Natural and Man-made Hazards Mitigation Plan is a university-wide guide for all campus stakeholders. UAH departments and units that have participated in the preparation of this plan include: Academic Affairs, Environmental Health & Safety, University Police, Facilities and Operations, Office of Dean of Students, Staff Senate, Student Government Association, University Housing, Auxiliary Services, and Office of Vice President for Research. External organizations that have participated in the preparation of this plan include: Huntsville-Madison County Emergency Management Agency, National Weather Service (Huntsville), United States Army Acquisition College of Excellence, and Huntsville Fire & Rescue.

This plan fulfils the scope of work under the Pre-Disaster Mitigation Grant Program through which its development was funded. This plan complies with all of the eligibility requirements for FEMA grant assistance to participating entities and eligible sub-applicants, including the Hazard Mitigation Grant Program, the Pre-Disaster Mitigation Grant Program, and the Flood Mitigation Assistance Program.

The planning process began in March 2011 with the award of the Pre-Disaster Mitigation Grant from FEMA. UAH was a sub-applicant to the Alabama Emergency Management Agency for the grant award.

1.2 Scope

The area covered under the UAH Natural Hazards Mitigation Plan is the physical campus of UAH, located within the City of Huntsville in Madison County, AL. The plan addresses all natural hazards deemed to threaten property and persons within the campus boundaries, and also includes technological and man-made hazards. Both short-term and long-term hazard mitigation strategies are addressed, and implementation tasks are assigned. Funding alternatives have also been identified.

In addition to this section, the plan contains the following elements:

1. A profile of the campus geography, history, physical features, and other characteristics (Section 2, Campus Profile).

2. A description of the planning process that opens participation to all campus stakeholders, the public, businesses located on campus, and local, regional,

and State governments (Section 3, Planning Process).

3. A general assessment of the University's past and predicted exposure to natural, man-made, and technological hazards and the risks that it faces, including impact on buildings, and critical infrastructure and facilities with loss estimates (Section 4, Risk Assessment).

4. An assessment of the University's capabilities to implement hazard mitigation measures, and the goals, objectives, policies, and action items intended to effectively mitigate the campus' hazard risks (Section 5, Mitigation Strategies).

5. The short-range (5-year) mitigation action programs for the campus (Section 6, Campus Mitigation Action Programs).

6. Procedures for maintaining an active and effective long-range hazard mitigation planning and implementation program (Section 7, Plan Maintenance).

1.3 Authority

Section 409 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Public Law 93-288, as amended), Title 44 CFR, as amended by Section 102 of the Disaster Mitigation Act of 2000, provides the framework for state and local governments (and other eligible entities such as public institutions of higher education) to evaluate and mitigate all hazards as a condition of receiving Federal disaster assistance. A major requirement of the law is the development and five-year maintenance update of a local hazard mitigation plan.

1.4 Funding

This planning process was funded through the FEMA Pre-Disaster Mitigation Grant Program. The 75/25 matching grant was awarded in March 2011. UAH's matching requirement was met entirely through in-kind services provided by the University.

1.5 Purposes

Hazard mitigation is any action taken to permanently reduce or eliminate long-term risk to people and property from the effects of hazards. These hazards can be of any type, including natural hazards (such as tornados, floods, winter storms, earthquakes), human-related (such as civil disturbances, workplace violence, public health emergencies), and technological (including hazardous materials releases, structural fires, utilities interruptions). The campus community can take steps to prepare and implement mitigation measures for almost any type of hazard that may threaten its population, facilities, and infrastructure.

Hazard mitigation can identify a range of approaches to lower the costs and risks of future disasters and crisis events. For example, structural mitigation projects could include the installation of additional structurally reinforced (hardened) protective areas in new construction and renovations, the inclusion of in-building mass notification systems in all campus structures, or landscaping modifications to reroute water runoff and/or provide enhanced physical security.

Mitigation strategies can also involve non-structural initiatives, such as educational programs to inform the community about the risks the public and University property face in order to encourage them to develop comprehensive building emergency action plans and participate in drills and training offered by the University. Non-structural programs can also include developing and enforcing policies to ensure no construction in campus hazard areas, or to ensure that development that does occur will be resistant to the hazards threatening the area.

Mitigation programs and projects serve to lessen the university community's vulnerability to the hardships and costs associated with disasters and crisis events. The implementation of mitigation programs is a key component to achieving a sustainable campus community, one in which the educational, economic, and social needs of campus stakeholders coexist with natural environmental constraints and are protected from the disruptions and impacts of emergencies and disasters. Hazard mitigation planning must be closely coordinated with the university's overall planning and development efforts. The most effective way for UAH to achieve this objective is through a comprehensive hazard mitigation planning program. Comprehensive planning can provide the UAH community a safer, healthier, and more prosperous place to work and learn.

The purpose of the UAH Natural and Man-made Hazards Mitigation Plan is to develop a unified approach for dealing with identified hazards and hazard management problems. This plan serves as a guide for various UAH departments in their ongoing efforts to reduce vulnerability to the impacts produced by natural and man-made hazards. This mitigation strategy will be incorporated into the university's short- and long-term planning, to include the Campus Master Plan, Capital Development Plan, and other related planning activities.

Further, the plan seeks to accomplish the following additional goals:

- Establish an ongoing hazard mitigation planning program
- Identify and assess the hazards that pose a threat to life and property
- Evaluate additional mitigation measures that should be undertaken

- Outline procedures for monitoring the implementation of mitigation strategies.

This plan provides guidance for campus mitigation activities over the next five-year planning cycle. It encourages activities that are most effective and appropriate for mitigating the effects of natural and man-made hazards.

2. Campus Profile

2.1 History and Geographic Setting

The University of Alabama in Huntsville (UAH) is a public co-educational, state-supported research university within The University of Alabama System (UAS). UAS is comprised of the University of Alabama (Tuscaloosa), The University of Alabama at Birmingham, and UAH. UAH was founded as part of the University of Alabama in 1950 and became an autonomous campus with the UAS in 1969.

UAH is a research-intensive university committed to rigorous scholarship, innovative education, technological research, cultural growth, and entrepreneurial creativity. The University offers 71 degree-granting programs, including 31 bachelor's degree programs, 21 master's degree programs, and 15 Ph.D. programs through its five colleges – Business Administration, Engineering, Liberal Arts, Nursing, and Science – as well as the School of Graduate Studies.

Research activity has grown from $65 million in 2008 to over $97 million in 2013. Forty-seven percent (47%) of this funding was through U.S. Department of Defense contracts and grants, and twenty percent (20%) was received from NASA contracts and grant programs.

UAH is located within the City of Huntsville which is located in Madison County, Alabama. (see Figure 2.1. Map of Madison County; Figure 2.2. Map of Huntsville, AL) Madison County is located in north-central Alabama. The UAH campus is comprised of approximately 450 acres that included two small man-made lakes. The campus includes four multi-level student housing structures, one group of two-story apartment style structures, five fraternity/sorority houses, and one 99-bed hotel. There are three dining facilities located on campus. (see Figure 2.3 Map of UAH Campus)

UAH is a public university and as such its buildings are generally open to the public during normal business hours. The UAH library is typically open to the public seven days per week. UAH hosts many sporting events open to the campus community and the general public. These sporting events include basketball, baseball, softball, soccer, and tennis.

University Drive (U.S. Highway 72) serves as the northern campus boundary. The campus is bound on the south by the Norfolk Southern railway, which runs parallel and adjacent to Interstate 565. Sparkman Drive forms the western boundary for the main campus. Holmes Avenue NW bisects the campus. The eastern boundary is formed by Brickell Road north from Holmes Avenue, and Austin Drive south from Holmes avenue.

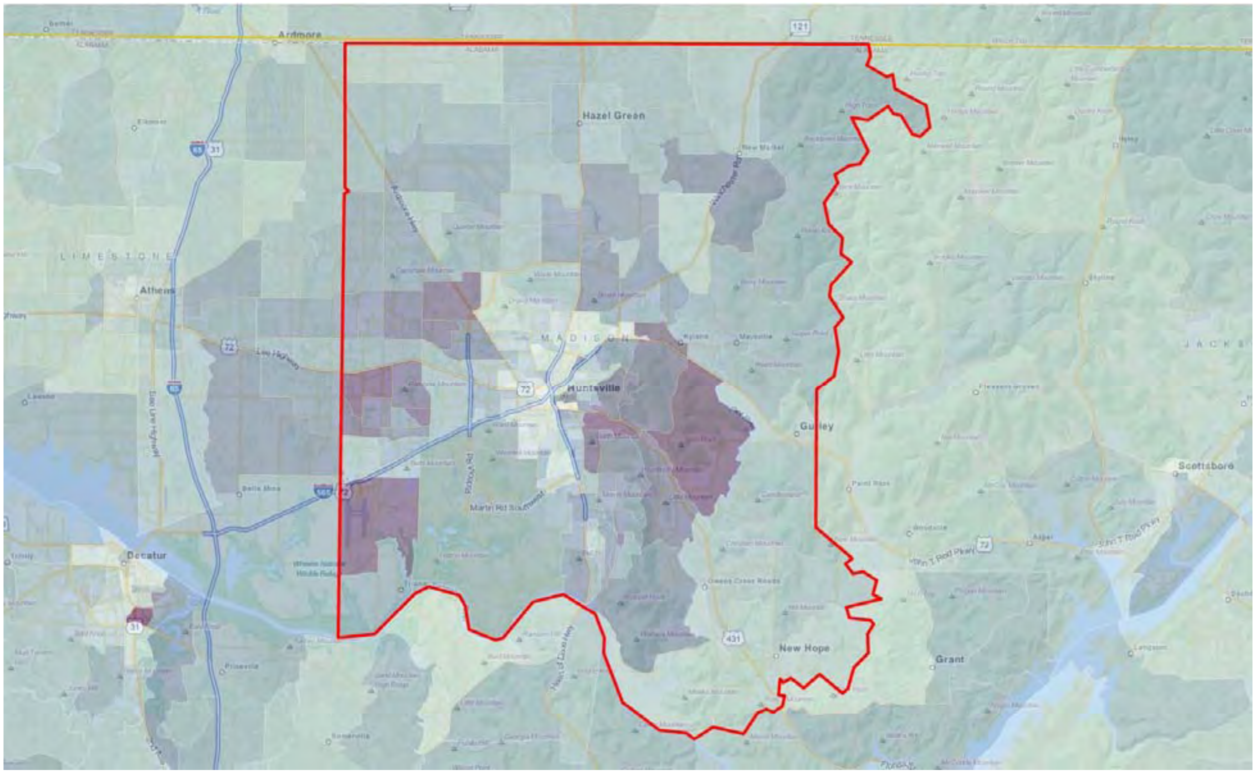

Figure 2.1 Map of Madison County, Alabama (source: www.citydata.org)

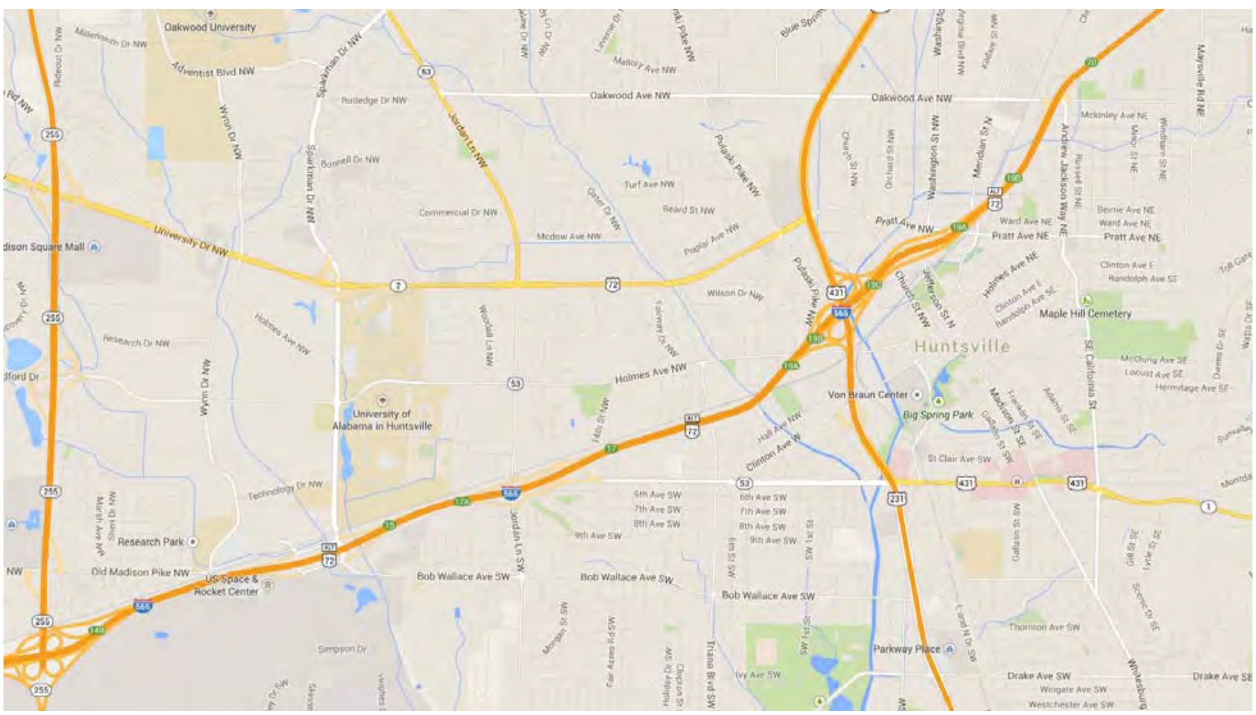

Figure 2.2 Map of Huntsville, AL with UAH Location (source: Google Maps)

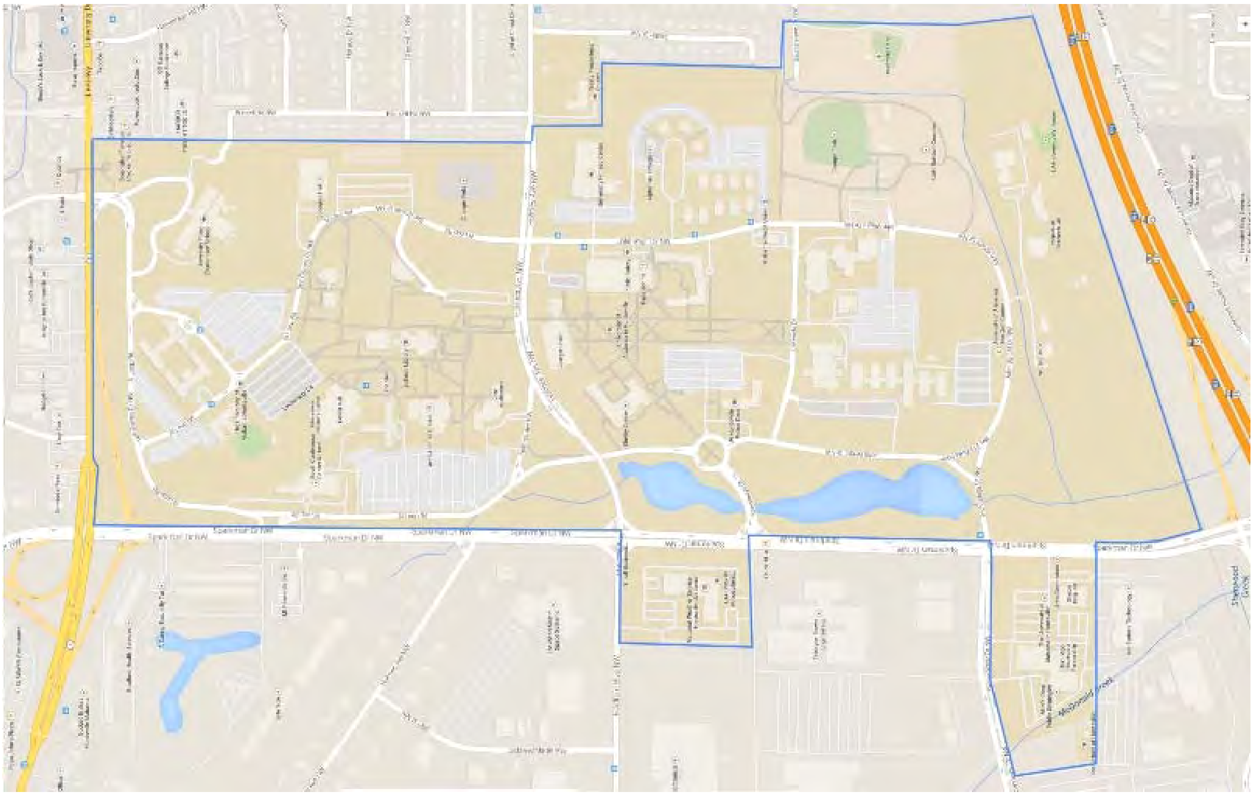

Figure 2.3 Map of UAH Campus (source: Google Maps)

2.2 Governance

The Constitution of the State of Alabama establishes the University of Alabama System and provides for a governing Board of Trustees. The Board is composed of three members from the Congressional district in which the Tuscaloosa campus is located and two members from each of the other six Congressional districts. The Governor and the State Superintendant of Education are ex-officio members of the Board. Those members who are not ex-officio are elected by the Board, subject to confirmation by the State Senate, and may serve up to three consecutive six-year terms.

The purpose of the Board is to ensure the effective leadership, management, and control over the activities of the institutions within the System in order to provide for a definitive, orderly form of governance, and to secure and continue responsive, progressive, and superior institutions of higher education. The primary functions of the Board are to determine the major policies of the System to include the review of existing policy; to define the mission, role, and scope of each campus; and to assume ultimate accountability to the public and political bodies of Alabama. Rules, policies, and procedures are promulgated to ensure that, through the UAS Office, the necessary flow of information for such accountability takes place.

The Board of Trustees executes its governance responsibilities through a Chancellor, who serves as the chief executive officer of the System. UAH's president heads the campus, has responsibility for campus administration, reports directly to the Chancellor, and through the Chancellor to the Board of Trustees.

2.2.1 Vision and Mission. As an institution of higher education, UAH has an educational mandate to fulfill. UAH's Mission and Vision statements:

> Mission: The University of Alabama in Huntsville is a research-intensive, internationally-recognized technological university serving Alabama and beyond. Our mission is to explore, discover, create, and communicate knowledge, while educating individuals in leadership, innovation, critical thinking, and civic responsibility and inspiring a passion for learning.
>
> Vision: The University of Alabama in Huntsville will be a preeminent, comprehensive, technological research-intensive university known for inspiring and instilling the spirit of discovery, the ability to solve complex problems, and a passion for improving the human condition – a university of choice where technology and human understanding converge.

2.2.2 Goals, Strategic Priorities, and Objectives

UAH offers an accessible, affordable, high quality education, relevant to an evolving technological, knowledge-driven world, in a research-intense environment. The University's goals are:

- Provide a safe educational and work environment
- Be nationally and internationally recognized as an institution to which government, industry, and academic leaders turn for opinions on societal issues, especially those involving technology.
- Strengthen and maintain a financial, physical, and personnel infrastructure that supports continuous quality enhancement and the pursuit of excellence in research an education.
- Ensure an environment where curiosity, discovery, innovation, and entrepreneurship are valued.
- Graduate students able to address problems through integration of knowledge across disciplines.
- Foster an environment of community service and engagement and global experience and understanding.
- Be unique in opportunities to explore and experience the relationships among technology, culture, and the arts.

To achieve these goals UAH has identified several strategic priorities and objectives. These include:

- Development and maintenance of an all-hazards mitigation plan
- Grow enrollment to 10,000 students by 2020
- Increase demographic diversity of student body

- Increase demographic diversity of faculty and staff
- Broaden and expand research portfolios

2.3 Campus Demographics

2.3.1 Student Demographics. UAH had a total student enrollment of 7,375 for Fall 2013, divided between females and males at 44.8 and 55.2 percent respectively.

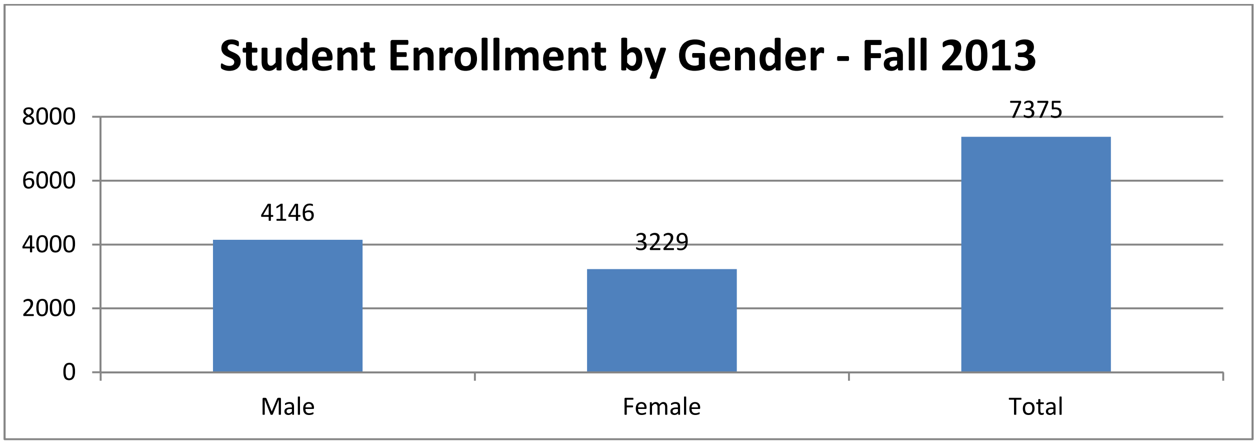

Figure 2.4. Student Gender Composition

Approximately 68.8 percent of UAH students are White, 14.1 percent Black, 2.3 percent Hispanic, 3.2 percent Asian/Pacific Islander, 1.4 percent American Indian/Alaskan Native, and other races account for an additional 10.2 percent.

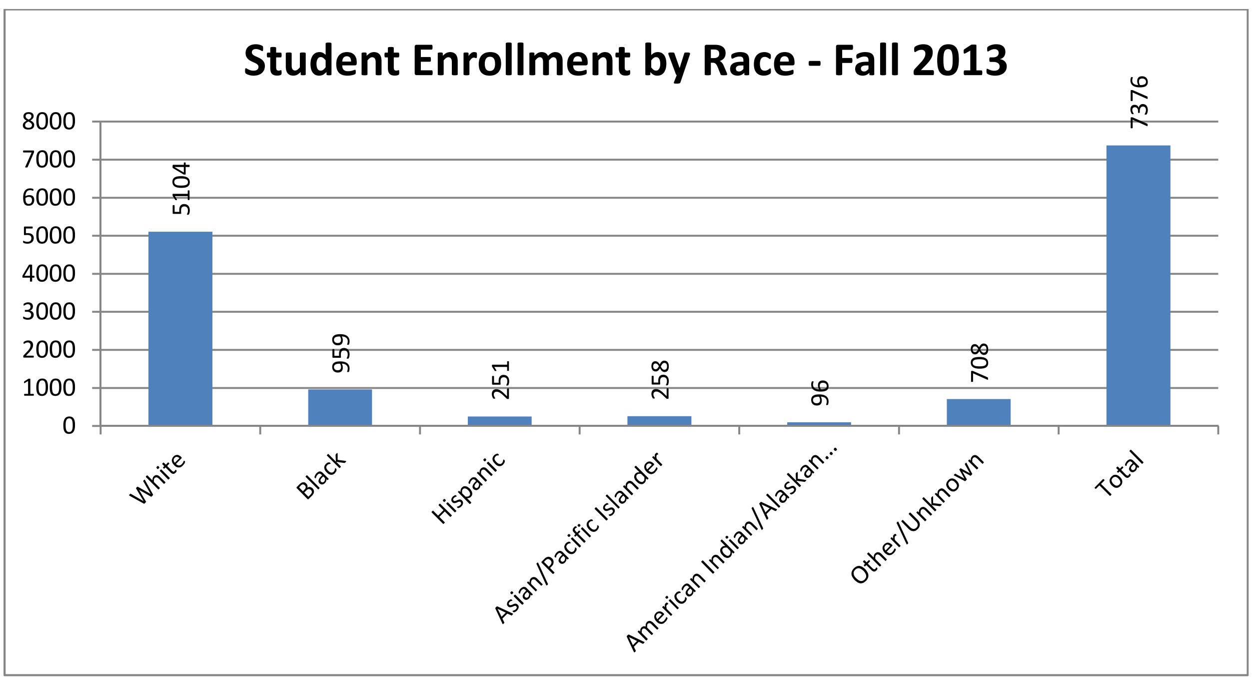

Figure 2.5. Student Race Composition

Total student enrollment has remained above 7,200 since 2009. (See Figure 2.6. Student Enrollment 1986 through 2013) UAH has a goal of 10,000 enrolled students by 2020.

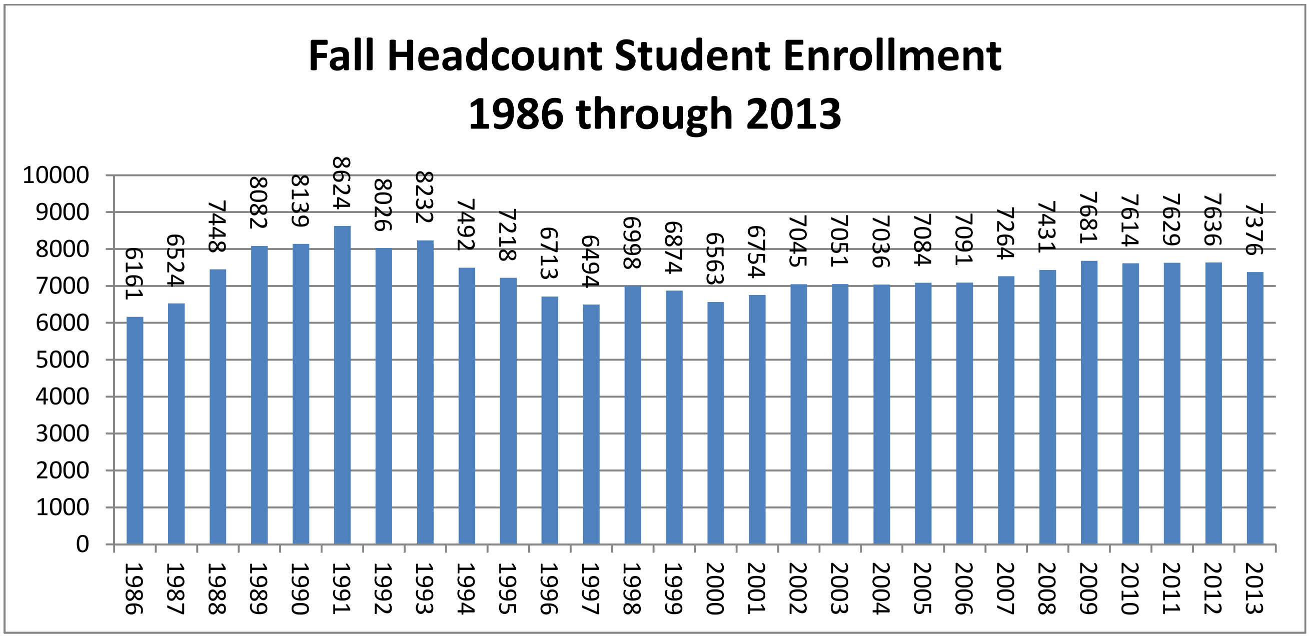

Figure 2.6. Student Enrollment 1986 through 2013

First-time Freshman enrollment represents a population segment more vulnerable to some natural and many man-made hazards. For these students, it is often their first experience away from home and away from direct parental supervision. First-time Freshman enrollment for Fall 2013 was 651. (See Figure 2.7) Approximately 98 of those first-time students were from out of state. An additional 27 were nonresident aliens.

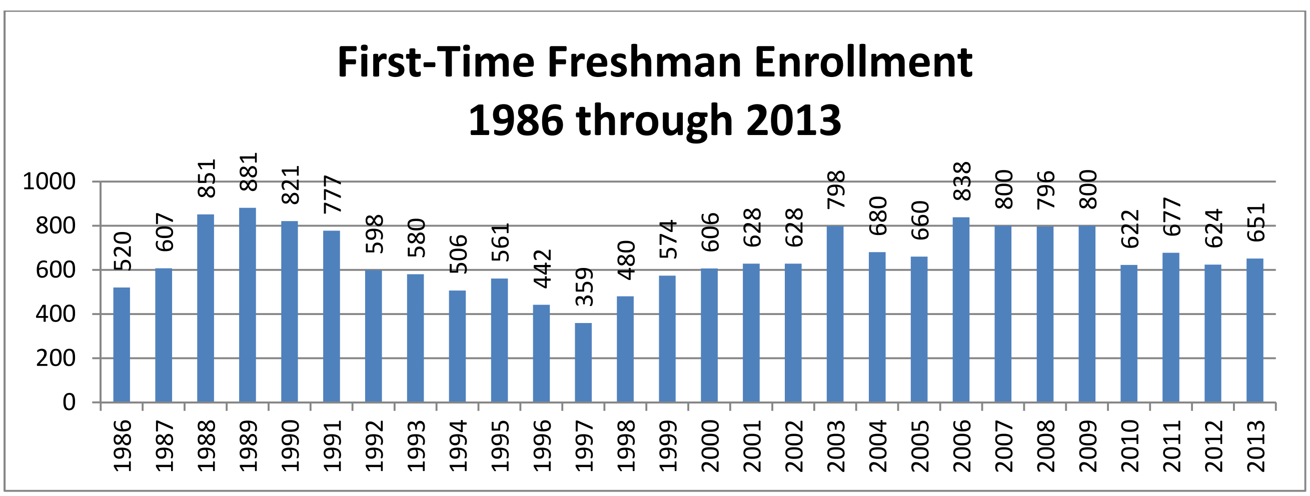

Figure 2.7. First-time Freshman Enrollment 1986 through 2013

UAH requires most first- and second-year students living outside of a 30-mile radius of campus to live in campus housing. In addition, some upperclassmen elect to remain in campus housing. There are four multi-floor residence halls, five Greek-themed housing units, and a multi-building apartment-style complex located on campus.

Total capacity for all on-campus housing combined is 1677 persons. As of September 2013 there were approximately 1145 individuals living on campus. The following chart summarizes on-campus resident population figures from Fall 2005 through Fall 2013:

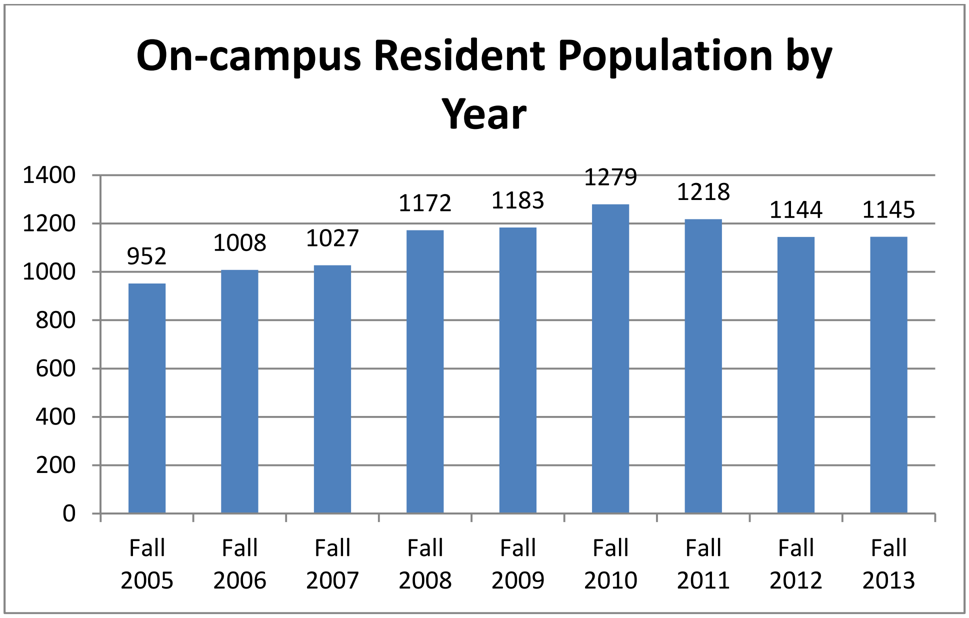

Figure 2.8. On-campus resident populations by year 2005 through 2013

The student resident population is composed of approximately 60 percent male and 40 percent female on average. UAH does not track race or ethnicity of student residents.

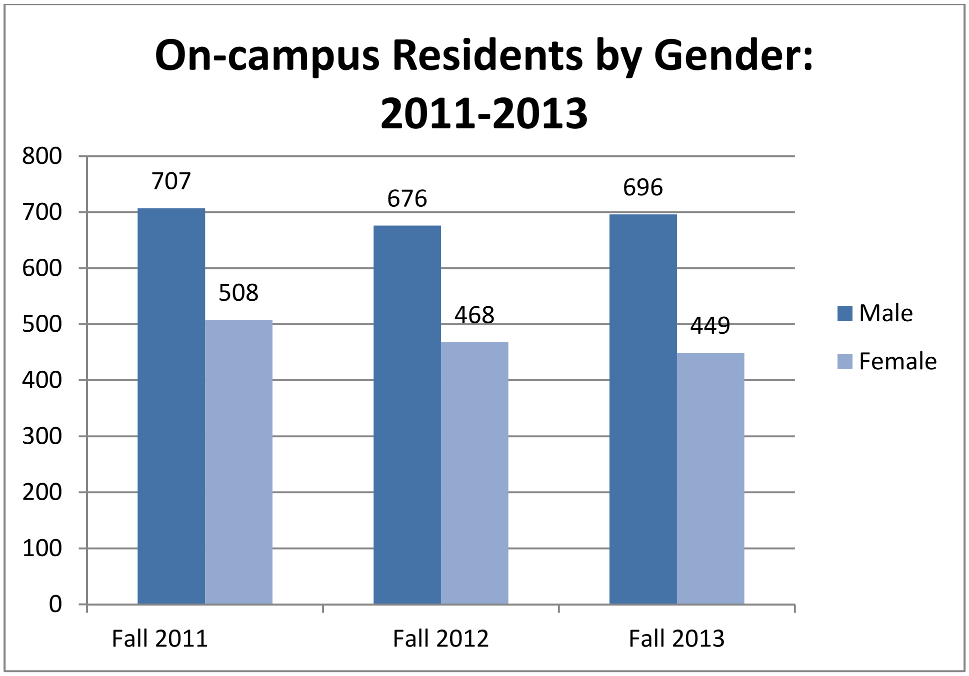

Figure 2.9 On-campus Residents by Gender: 2013

2.3.2 Employee Demographics. UAH employs over 1,300 faculty and staff. The employee population includes both full- and part-time positions. The employee population is composed of approximately 77.9 percent White, 13.3 percent Black, 1.3 percent Hispanic, 6.8 percent Asian/Pacific Islander, 0.6 percent Native American/Alaskan Native, and less than 0.1 percent Other/Unknown. Employment data as of August 2013 shows that UAH's employee population of 1,349 was 55.2 percent male and 44.8 percent female. (see Figure 2.10 Employee Race and Gender Composition)

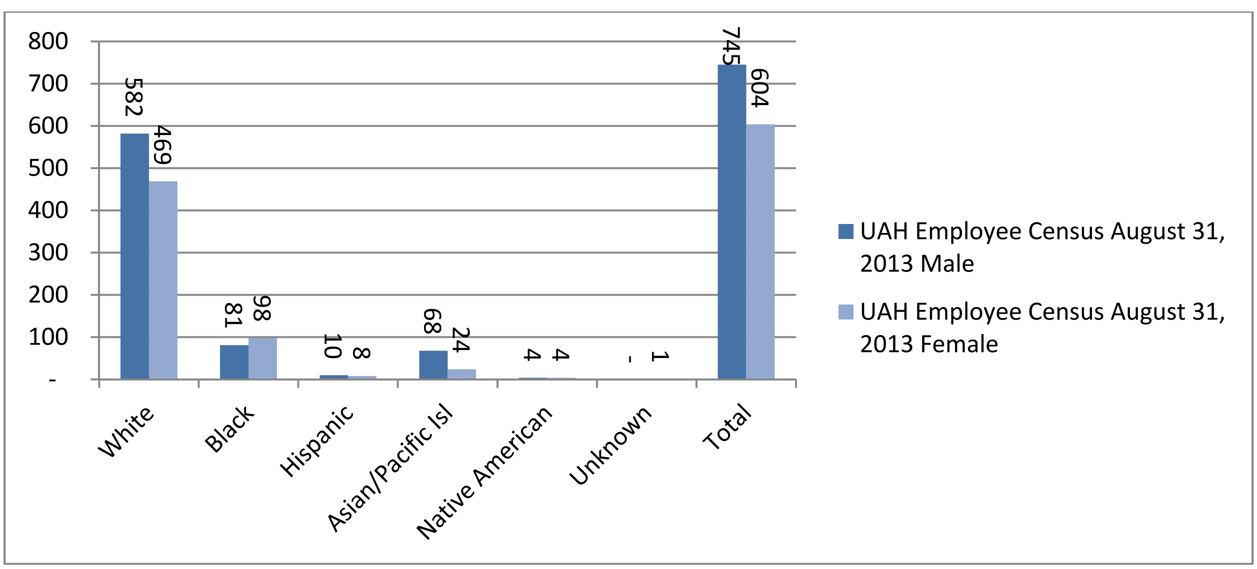

Figure 2.10. Employee Race and Gender Composition

2.3.3 Visitor and guest demographics. UAH organizations host a wide range of events that draw a diverse set of demographics. These demographics vary based on the nature of the event. Events include sports events, convocations, graduations, lectures, sports and cheerleading clinics, music performances and concerts, and student activity events.

2.4 Economy

By virtue of its mission and financial impact, UAH plays a leading role in the Huntsville/Madison County economy. UAH is one of the top ten employers in the city of Huntsville according to 2013 statistics from the Chamber of Commerce of Huntsville/Madison County. UAH employs in the educational, administrative, support services, research and development, and public safety sectors.

UAH had a total annual operating budget of $219,992,324 for fiscal year 2013-14. Revenue sources include tuition and fees, state appropriations, auxiliary services, external contracts, grants, and scholarships. Expenses include salaries and wages, fringe benefits, miscellaneous operating costs, and utilities.

On a statewide level, an economic impact study completed in 2012 shows that UAH had a direct economic impact of $297.6 million and indirect impact was estimated to be $386.8 million for a total impact of $684.4 million during 2009-2010. That impact led to the creation of an estimated 7,700 jobs statewide. UAH affects business in the state of Alabama in two ways: 1) Direct expenditures for goods and services by the university, its employees, students and visitors. This spending supports local businesses, which in turn employ local individuals to sell the goods, and provide the services needed by the university's constituents. 2) Induced or indirect spending within the state of Alabama.

UAH pays over $35 million in tax revenue to state and local governments, including sales, property, and business tax payments.

2.5 Physical Features

The UAH campus consists of approximately 400 acres located within the city of Huntsville, Alabama. The terrain is slightly sloping hills with minimal changes in elevation for most of the campus. (See Figure 2.11. UAH Campus Topology, and Figure 2.12. Madison County and City of Huntsville Topology) Huntsville and Madison County's soils are derived from sedimentary rocks and are moderately well to extremely well drained. Elevations on campus range from approximately 625 feet to 700 feet above sea level. The surrounding areas range between approximately 600 and 800 feet above sea level.

Two man-made lakes and a discharge stream handle storm runoff and drainage for much of the western portion of the campus property. A storm runoff stream running parallel to the southern-most portion of John Wright Drive handles storm runoff and drainage for much of the southern portion of campus. Drainage for other areas of campus is handled through the City of Huntsville storm sewer system. Surface drainage is dendritic, flowing southward. (See Figure 2.13. Flood Plain Map – UAH Campus)

The campus includes approximately 2.9 million square feet of building space between approximately 40 buildings. Most campus buildings are classified as National Fire Protection Association (NFPA) Type I fire resistive structures.

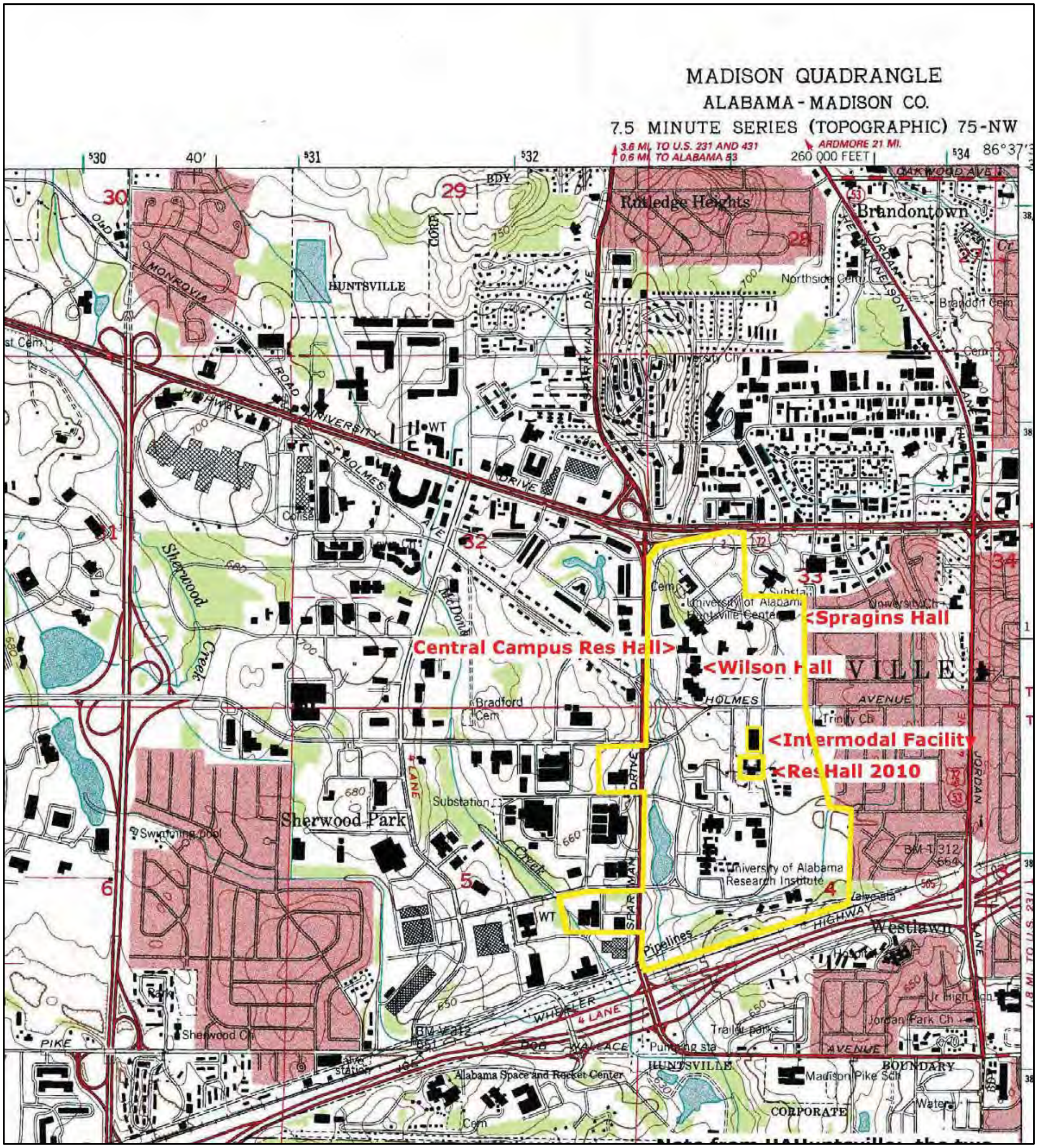

Figure 2.11. UAH Campus Topology (map source: Geological Survey of Alabama)

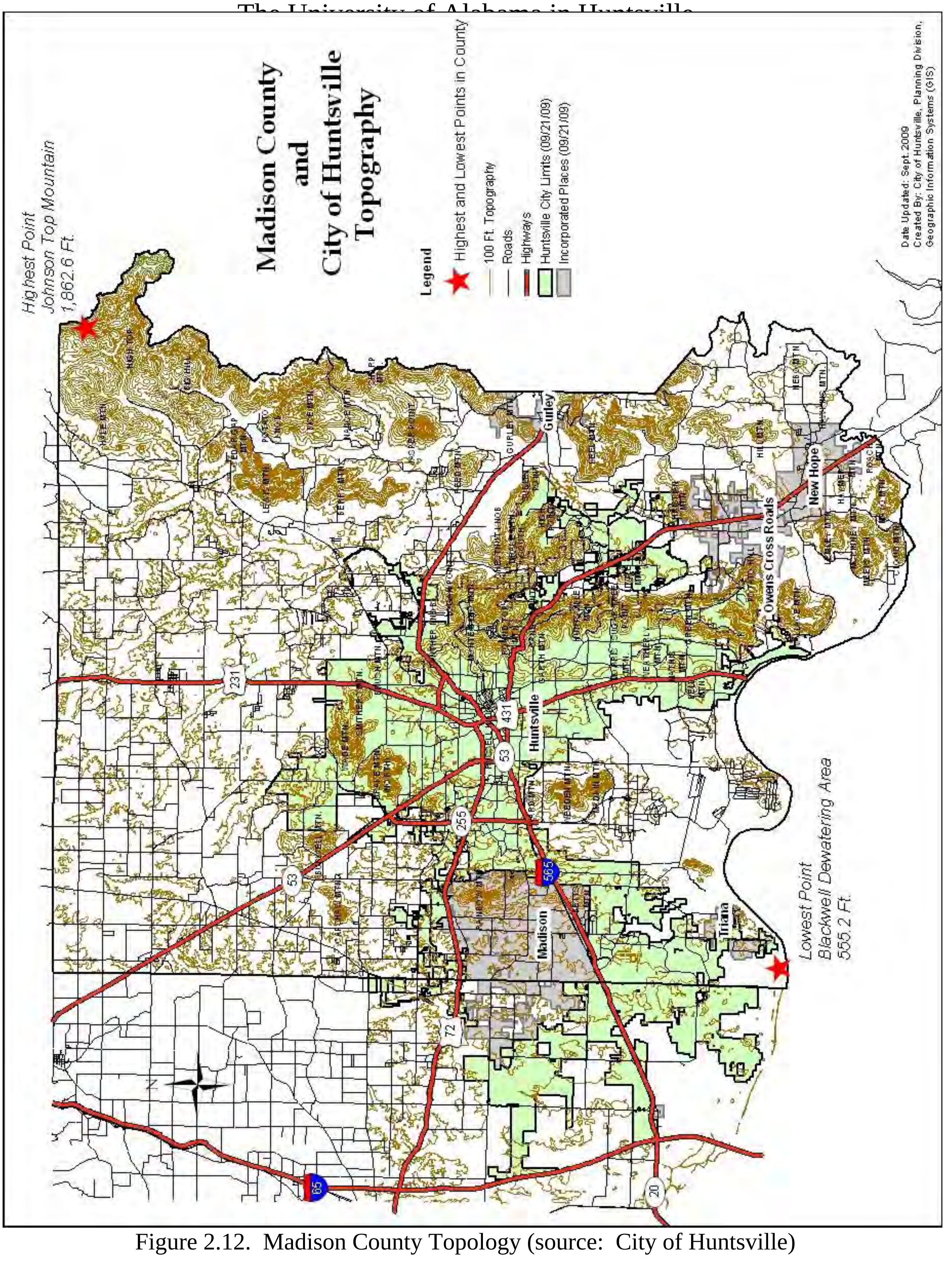

Figure 2.12. Madison County Topology (source: City of Huntsville)

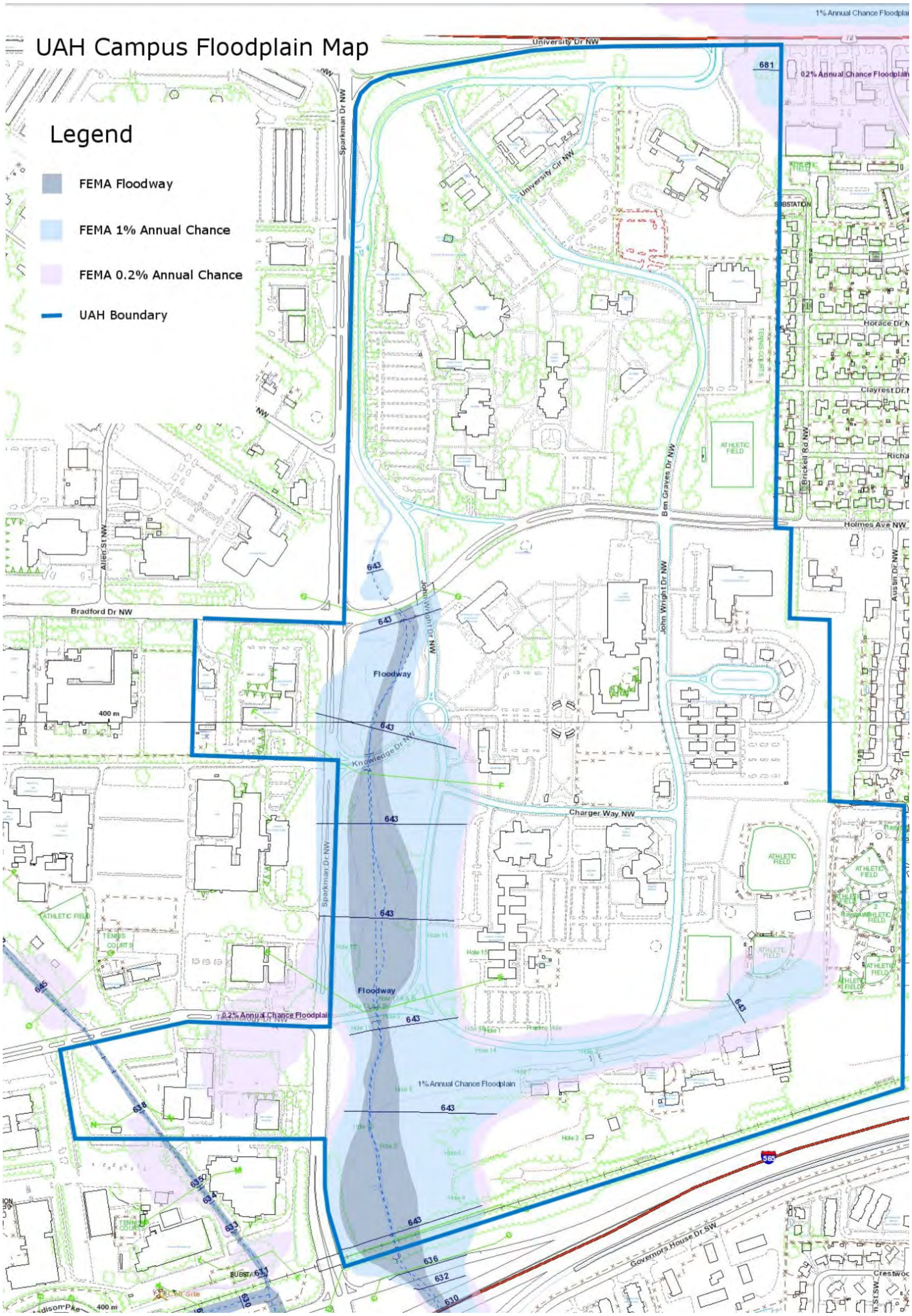

Figure 2.13. Flood Plain Map – UAH Campus (source: City of Huntsville)

2.6 Transportation

Figure 2.14 shows the major transportation routes in Madison County. Interstate 565 is within 50 yards of the south border of the campus. This interstate spur is one of the major transportation arteries into and out of Madison County and the city of Huntsville. The campus is also bordered to the south by a CSX railway line which runs parallel to Interstate 565 through the city of Huntsville. U.S. Highway 72 (University Drive) serves as the northern border of the campus. U.S. 72/University Drive is a major local business transportation route and connects the cities of Huntsville and Madison, Alabama.

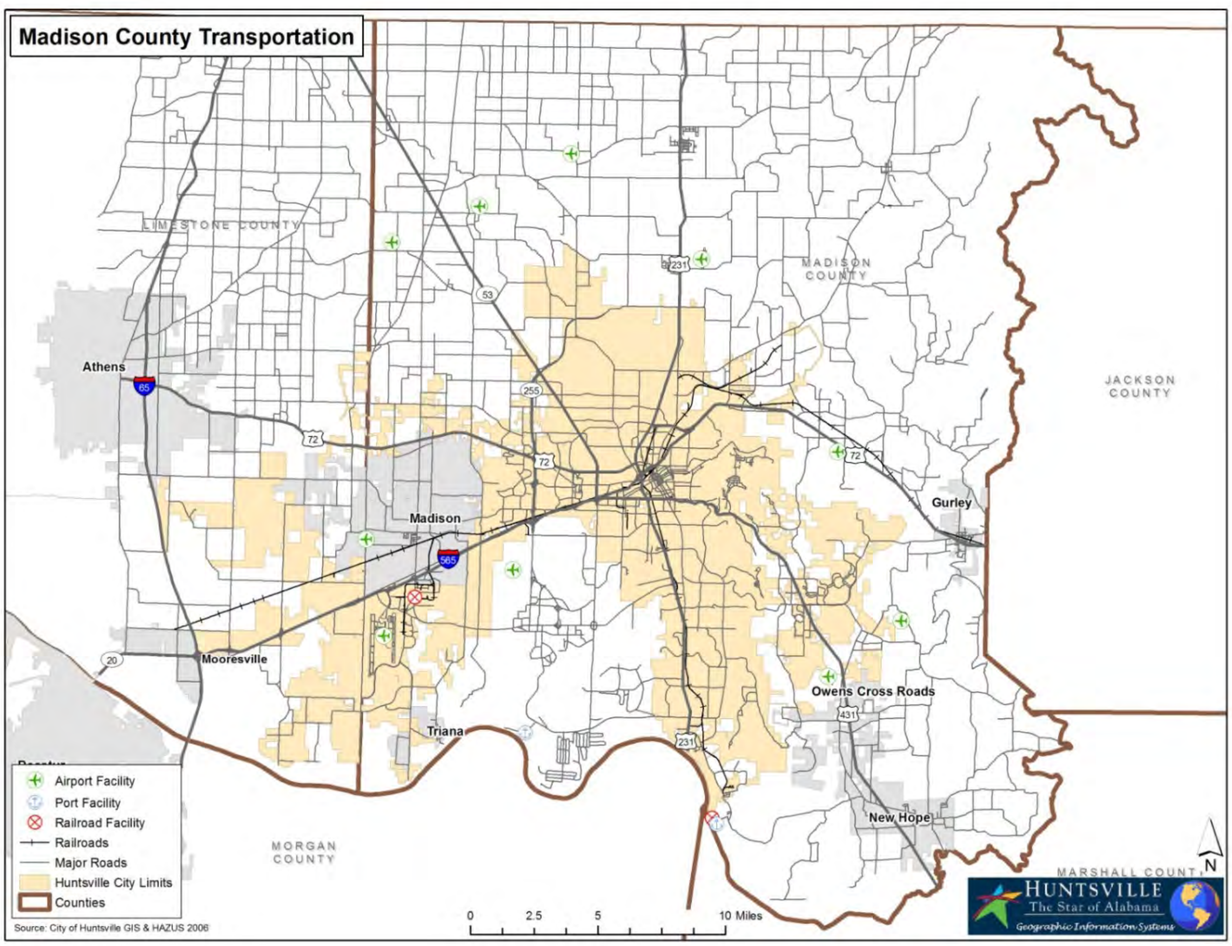

Figure 2.14. Madison County Transportation Routes

2.7 Utilities

Huntsville Utilities, owned by the City of Huntsville, provides gas, water, and electric service to the UAH campus. The utility is governed by three separate boards appointed by the Huntsville City Council. The utility operates in conjunction with the City of Huntsville Water Pollution Control Department and Sanitation Department. UAH provides its own trash collection services and transports refuse to the City of Huntsville Landfill, owned and operated by the city's Solid Waste Authority.

2.7.1 Natural gas. Natural gas is utilized in numerous facilities on campus. Gas is provided by the Huntsville Utilities. At the time of this writing, the utility receives its natural gas supply from a pipeline from the Gulf of Mexico.

2.7.2 Water. Water is supplied to the campus by Huntsville Utilities. The utility obtains its supply from local underground aquifers and the Tennessee River. Water is purified by the utility in accordance with governmental regulations, and water quality is closely monitored by a certified laboratory.

2.7.3 Electricity. Electricity is supplied to the campus by Huntsville Utilities. Electricity is purchased by the utility from the Tennessee Valley Authority.

The campus is divided between two electricity transmission substations. A line just south of Holmes Avenue, running roughly east and west, serves as the dividing line for the two grids. This places roughly two thirds of the campus facilities on the grid serving the northern portion of the campus, and the remaining portion of campus on the grid serving the southern portion of campus.

3. The Planning Process

3.1 Planning Process

The UAH Emergency Management Operations Group (EMOG) contains representatives from all segments of University operations. The EMOG membership contributed to the threat identification and hazard risk assessment process. A Disaster Resilient University Committee (DRUC) was formed as part of the scope of the mitigation planning project. The DRUC includes representatives from the Huntsville-Madison County Emergency Management Agency, the National Weather Service, Huntsville Fire and Rescue, and from local businesses operations. The DRUC provided guidance and oversight for the overall plan development. The plan was developed by a Hazard Mitigation Planning Team (HMPT), who conducted extensive research in while developing hazard profiles and compiling information for the business impact analysis. This integrated planning process helped align this Plan's goals, risk assessments, and mitigation measures with those of the University, the City of Huntsville, Madison County, and the surrounding community. The process further helped to ensure this Plan compliments the existing Madison County Natural Hazards Mitigation Plan, last updated in 2009.

The parties participated in various committee meetings, committee assignments, public meetings, and other planning activities completed during the drafting and updating phases of this Plan. The DRUC and Hazard Mitigation Planning Team conducted public hearings to receive public comments from the campus and surrounding community prior to adoption of the Plan.

3.2 Disaster Resilient University Committee (DRUC)

The DRUC, comprised of representatives from several segments of University operations and other representatives from the surrounding community concerned with disaster and emergency response, provided review and guidance during the development of this Natural and Man-made Hazards Mitigation Plan (Plan). The members of the DRUC and the organizations they represent are show in Figure 3.1.

DRUC members were appointed by their respective agencies or UAH operational units. The DRUC will provide guidance for the Plan development and for future maintenance and updates. Staff from UAH's Facilities and Operations Administration area served the planning process in a support role.

During the planning process, members of the DRUC held five meetings from January 2012 through May 2015. Members of the HMPT met frequently to review progress on hazard profile development and business impact analysis development. Documentation of these meetings in the form of sign-in sheets and meeting agendas are available at the UAH Office of Emergency Preparedness. The kick-off meeting occurred in January 2012, and was held at the Facilities and Operations conference room in the Physical Plant Building.

Name	Title	Organization
Randy Barbour	Contract Administrator I	UAH Office of VP for Research
Kevin Bennett	Emergency Management Coordinator	UAH Office of Emergency Preparedness
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Figure 3.1. DRUC Membership

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Kevin Bennett	Emergency Management Coordinator	UAH Office of Emergency Preparedness
Whitney Cosby	Research Assistant	UAH College of Liberal Arts
Robert Griffin	Assistant Professor	UAH Department of Atmospheric Science

Cameron Handyside	Research Engineer IV	UAH Earth Systems Science Center
Vikalp Mishra	Research Assistant	UAH College of Science

Figure 3.2 HMPT Membership

Over the course of the DRUC and HMPT meetings, each member was asked to provide input into the planning process. The information provided from the members' participation help form the basis for this Plan. Members unable to attend meetings were provided with meeting agendas and minutes, and asked to provide their input within any timeframes established by the two groups for receiving specific information.

3.3 Public Involvement

The DRUC and HMPT solicited public input into the mitigation plan through meetings, survey, newsletters, emails, and the UAH web site. The campus community was encouraged to provide input through their area's representative on the DRUC. They were also invited to attend meetings and provide their comments and concerns. Appendix A contains a copy of the survey provided to the EMOG during the business impact analysis portion of the planning process.

During the plan development process, draft versions of the Plan were posted on the UAH Office of Emergency Preparedness web site: http://facilities.uah.edu/erp/ with an invitation for the campus and surrounding community to comment and suggest updates for the plan via a direct link to email to the UAH Emergency Management Coordinator, who passed all comments and suggestions to the Committee chair. As updates were approved to the Plan by the committee and a draft updated version was completed, the updated previous draft version was replaced on the web site with the most current version.

A public meeting was held on August 28, 2014 at the Physical Plant Building on the UAH campus. Attendees were encouraged to comment on their perception of type and severity of risks and threats, and ways to mitigate both natural and man-made hazards.

The final Plan was approved by the DRUC and forwarded to the EMOG on [xxxx,xx,xxxx] following a final public hearing held on *[XXXXX, XX, 2015]*. The EMOG formally recommended the University President approve the plan and forward it to the University of Alabama System Board of Trustees for formal recognition and adoption at the *[XXXX, XX, 2015]* board meeting, held on the campus of the [XXXXXXXXXX (UAB,UAH, or UA) in XXXXXXX, Alabama. The Board officially recognized and adopted the Plan at this meeting.

3.4 Interagency Coordination

During the Plan development process, various agencies were chosen based on their relationship to the University and their vested interests in the UAH hazard mitigation planning process. The U.S. Army, NASA and the National Weather Service's Huntsville Forecast Office each have offices on the UAH campus and thus are key stakeholders.

The following agencies were invited to participate in the plan development process:

Federal Agencies:
- NASA Marshall Space Flight Center
- National Weather Service, Huntsville Forecast Office
- United States Army Acquisition Center of Excellence

State Agencies:
- Alabama Emergency Management Agency (final plan review, grant funding)

Local Agencies:
- Huntsville-Madison County Emergency Management Agency
- Huntsville Fire and Rescue

3.5 Participating Jurisdictions and Organizations

The campus' surrounding community falls within the jurisdiction of the City of Huntsville. The City participated in the planning process by response agencies direct representation on the planning committee or by agency review and comment during the plan development process.

3.6 Integration with Existing Plans

This document will be incorporated into the UAH Emergency Management Plan (EMP) administered through the UAH Office of Emergency Preparedness (OEP). The University will conduct an annual review of the EMP in conjunction with the mitigation strategies that are currently in progress or planned for implementation. OEP will work with University administration to ensure that mitigation strategies are adequately addressed and incorporated to the fullest extent possible in the review cycle for the EMP.

The requirements of this mitigation plan shall also be integrated into any revisions of existing comprehensive risk management plans and/or future planning documents at the appropriate time. Specific measures for plan integration are included in the Community Mitigation Action Programs for the University (see **Chapter 6**).

Integrated into this Plan is information from the following plans, studies, reports, and from other resources:

- Madison County Natural Hazards Mitigation Plan, 2009 revision
- NOAA and NWS records
- Flood Insurance Studies and Flood Insurance Rate Maps
- United States Geological Survey
- University of Alabama System reports and statistics

- UAH Capital Development Plan
- UAH Campus Master Plan

3.7 Professional Planning Guidance

No professional consultant services were utilized during the development of this Plan. The Plan was prepared by the HMPT under the review and guidance of the DRUC and UAH EMOG.

4. Hazard Identification and Risk Assessment

4.1 The Risk Assessment Process

This risk assessment identifies all known natural and man-made hazards affecting the UAH campus. It provides information on the history and extents of hazards, evaluates the possible effects, identifies vulnerable populations and assets (buildings, facilities, essential infrastructure), and estimates potential losses that might occur. The risk assessment process identifies the most critical problems and issues that require mitigation actions.

4.2 Identification of Hazards and Hazard Probabilities

4.2.1 Identification. UAH has identified hazard types and assessed possible threats to the university's assets (personnel and property). The UAH Police Department, Office of Emergency Preparedness, Office of Environmental Health and Safety, Facilities Department, Office of Information Technology, research staff from the UAH Earth Systems Science Center, and the Emergency Management Operations Group reviewed lists of all potential hazards and identified those that threaten the campus. Members of those groups then ranked the risk or probability that the hazard will occur on or near campus and the threat of damage and/or operational interruption that might be incurred should the event take place.

This section describes the types of hazards UAH is vulnerable to, based on historical events and potential for future occurrence. This Plan recognizes and includes the following hazards:

- Natural Hazards
    - Weather related
        - Floods (flash floods/stream floods)
        - Hurricanes
        - Tornadoes
        - Severe weather
            - Thunderstorms
            - Straight-line winds
            - Lightning
            - Hail
        - Winter storms
        - Extreme heat and drought
    - Geological
        - Landslides
        - Sinkholes
        - Earthquakes
    - Health hazards
        - Pandemic influenza
        - Tuberculosis
        - Pertussis

    - Hepatitis
    - Other communicable diseases (measles/mumps/rubella/norovirus etc.)
- Man made hazards
  - Hazardous material incidents
  - Terrorism
  - Criminal activities
    - Violent crimes
    - Property crimes
    - Civil unrest/disobedience
    - Cyber crimes
  - Fire (human caused)
  - Flood (other than natural causes)
  - Technology failure
  - Utilities interruption

Not all of these hazard types are entirely decoupled; some of them are interdependent; thus, if one occurs it may induce other events. For instance, many of the natural hazard types (such as floods and tornadoes) may lead to technology failures. Therefore, while all the above mentioned hazardous events are analyzed independently, it should be noted that some of them may be interrelated and act as a catalyst for other hazards.

4.2.2 Methodology. The Emergency Management Operations Group (EMOG) reviewed a list of all potential hazards and identified those that threaten the campus. Next, members ranked the risk or probability that the hazard will occur on the campus and the threat of damage that might be incurred should the event take place. Table 4.1 summarizes the results of this ranking. The hazard ranking summary worksheet is included in Appendix B.

The hazard identification process for this study was carried out at multiple spatial scales. For some hazard types, the spatial extent of the hazard – such as criminal activity, fire hazard, sinkholes, etc. – may be limited to the campus boundaries. However, most natural hazards have much larger spatial domains. For instance a tornado event may impact multiple counties. Additionally, UAH has a large percentage of students who live in surrounding communities and adjacent counties. All employees live in surrounding communities and adjacent counties. Therefore, the analysis for this hazard study is done at three spatial scales: the UAH campus, Madison County (including Huntsville, AL), and at a multi-county level. The multi-county level includes four surrounding counties: Morgan, Marshall, Limestone, and Jackson.

Data from multiple sources was utilized by the Planning Group to study and analyze the hazards both temporally and spatially. A geographic information system (GIS) tool was used to select data at all required spatial levels. Using this data, both temporal and spatial analyses were performed at each level. The temporal analysis was done to assess the annual distribution and trends over the years for which data was available. Monthly distributions were used to assess seasonality. Similarly, a spatial analysis was done to assess the presence of high risk zones. Historical trends and spatial extents were then used to evaluate the probability of future occurrence and potential impacts.

Table 4-1. Hazard Identification/Risk Assessment Exercise

Hazard	Exp.	Risk	Impact	Comments
Tornadoes	Y	Severe	Very Severe	History of fatalities and property damage in area
Severe Thunderstorms	Y	Very Severe	Severe	
Flooding	Y	Severe	Moderate	Risk is primarily to south and southwest campus
Winter storms	Y	Moderate	Moderate	Occurs almost annually with operational interruptions
Landslides	N	Negligible	Negligible	Campus topography not conducive to landslides
Droughts/heat waves	Y	Slight	Slight	Impact on public water systems, may require rationing or voluntary usage reductions
Wildfires	Y	Slight	Slight	Potential for human-caused wildfire in some undeveloped areas of campus
Sinkholes	Y	Slight	Moderate	History of occurrences on campus, underground aquifer system believed present on parts of campus
Hurricanes	Y	Minimal	Minimal	Potential for heavy rains, flooding, severe weather
Dam/levee failures	Y	Minimal	Negligible	Failure of campus lake levee would impact undeveloped property in flood plain area
Earthquakes	Y	Minimal	Minimal	History of small earthquakes in region
Health Crisis	Y	Minimal	Slight	Includes all naturally-occurring communicable diseases
HazMat Incident	Y	Minimal	Slight	
Terrorism	Y	Minimal	Slight	
Criminal Activities	Y	Moderate	Moderate	Includes violent, property, and cyber crimes
Fire (human caused)	Y	Moderate	Moderate	
Man-made flood	Y	Minimal	Minimal	Includes plumbing and piping failures
Technological	Y	Minimal	Moderate	
Utilities failure	Y	Minimal	Severe	Includes water, electricity, natural gas, sewage

4.2.3 Data Sources. Given the nature of hazards included in this study, multiple data sources were utilized. The flood zones in this study were mapped using GIS analysis of digital flood maps from FEMA Flood Insurance Rate Maps (FIRM). Further, the National Ocean and Atmospheric Administration (NOAA) severe weather database and the National Climate Data Center (NCDC) weather-related hazard database provided historical and spatial location information. In addition, data for geologically based hazards (such as earthquake, sinkholes, landslides etc.) were obtained from the Geological Survey of Alabama (GSA) and United States Geological Survey (USGS).

Health hazard data were obtained from the Alabama Department of Public Health (ADPH), the Centers for Disease Control and Prevention (CDC), and the World Health Organization (WHO). Communicable disease health hazards were analyzed at county and state levels. Hazardous material data was available from the Environmental Protection Agency's (EPA) toxic release inventory (TRI) as well as from the U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA), and UAH's Office of Environmental Health and Safety (OEHS). Historical data on reported criminal activity on and immediately adjacent to campus was obtained from the City of Huntsville and UAH police departments.

4.3 Significant Hazard Events – Local and Regional

4.3.1 Federally Declared Disasters. Between 1970 and 2012, thirty federally declared disasters occurred in a five-county area surrounding the University of Alabama in Huntsville campus. These counties and the number of disasters recorded in each include: Madison (14), Limestone (14), Morgan (15), Marshall (24), and Jackson (17). Some of these disasters are specific to a particular county while others are spread over multiple counties. Table 4.2 provides a brief description of these significant hazard events; please note that the information in this table was obtained from the FEMA list of federally declared disasters for Alabama and may not include some of the minor events in the region. There were 23 major disaster declarations (DR), two (2) fire management (FS) declarations, and five (5) emergency declarations (EM).

Table 4.2: Federally Declared Disasters (1970-2012)

Disaster Number	IH	IA	PA	HM	Declaration Date	Disaster Type	Title*	Declared Counties
369		Y	Y	Y	03/27/1973	DR	TR;FL	Jackson/Limestone/**Madison**/Marshall/Morgan
388		Y	Y	Y	05/29/1973	DR	SS; FL	Jackson/Marshall
422		Y	Y	Y	04/04/1974	DR	TR	Jackson/Limestone/**Madison**/Marshall/Morgan
532		Y	Y	Y	04/09/1977	DR	SS; FL	Marshall/Morgan
578		Y	Y	Y	04/18/1979	DR	ST; WD; FL	Marshall
848		Y	Y	Y	11/17/1989	DR	SS; TR	Jackson/**Madison**
856		Y	Y	Y	02/17/1990	DR	SS; TR; FL	Jackson/Marshall/Morgan
890		Y	Y	Y	01/04/1991	DR	SS; FL	Jackson/Limestone/**Madison**/Marshall/Morgan
1013			Y	Y	03/03/1994	DR	SW; IS; FF	Limestone/Marshall
1019		Y	Y	Y	03/30/1994	DR	SS; TR; FL	Marshall
1047		Y	Y	Y	04/21/1995	DR	SS; TR; FL	Marshall
1104		Y	Y	Y	02/23/1996	DR	SW; IS; FF	Jackson/Limestone/**Madison**/Marshall/Morgan
1260			Y	Y	01/15/1999	DR	SW	Limestone/**Madison**/Morgan
1317			Y	Y	02/18/2000	DR	SW	Jackson
1352		Y	Y	Y	12/18/2000	DR	SS; TR	Limestone
1399		Y	Y	Y	12/07/2001	DR	SS; TR	**Madison**/Marshall
1442	Y	Y	Y	Y	11/14/2002	DR	SS; TR	Marshall/Morgan
1466	Y	Y	Y	Y	05/12/2003	DR	SS; TR; FL	Jackson/Limestone/**Madison**/Marshall/Morgan

1549	Y	Y	Y	Y	09/15/2004	DR	Hurricane IVAN	Jackson/Limestone/**Madison**/Marshall/Morgan
1687	Y	Y	Y	Y	03/03/2007	DR	SS; TR	Jackson
1836			Y	Y	05/08/2009	DR	SS; FL;TR; STW	Jackson/Marshall
1908	Y		Y	Y	05/03/2010	DR	SS; FL;TR; STW	Marshall
1971	Y		Y	Y	04/28/2011	DR	SS; FL;TR; STW	Jackson/Limestone/**Madison**/Marshall/Morgan
2276			Y		09/18/1999	FS	Farms Fire	Jackson
2395			Y		11/20/2001	FS	Fire	Jackson
3045			Y	Y	07/20/1977	EM	Draught	Jackson/Limestone/**Madison**/Marshall/Morgan
3095			Y	Y	03/15/1993	EM	Severe Snow, SW	Jackson/Limestone/**Madison**/Marshall/Morgan
3217			Y		09/10/2005	EM	Hurricane Katrina Evacuation	Jackson/Limestone/**Madison**/Marshall/Morgan
3292			Y		08/30/2008	EM	Hurricane Gustav	Jackson/Limestone/**Madison**/Marshall/Morgan
3319			Y		04/27/2011	EM	SS;TR; STW	Jackson/Limestone/**Madison**/Marshall/Morgan

*(**Source:** http://www.fema.gov/media-library/assets/documents/28318?id=6292)*

*HR	Heavy Rain	ST	Storm	IH	Individual/Household Program
FL	Flood	SW	Severe Winter	IA	Individual Program
TR	Tornado	IS	Ice Storm	PA	Public Assistance Program
SS	Severe Storm	FF	Flash Flood	HM	Hazard Mitigation Program
WD	Wind	STW	Straight Line Wind	WS	Winter Storm

4.4 Significant Natural Hazard Events Affecting the UAH Campus

This section contains brief summaries of significant hazard events affecting the campus. It is not an exhaustive or comprehensive list but reflects significant events having notable impact on the campus and/or campus operations.

4.4.1 Tornadoes – historical. On April 27, 2011 a series of tornados impacted the North Alabama area. The tornados damaged major power transmission lines, resulting in a total disruption of the electrical grid in the majority of Madison County. The UAH campus was without power for seven (7) days. The tornado event occurred at the beginning of final exams for the Spring 2011 semester. As a result, UAH was forced to cancel final exams, close the campus for the duration of the power outage, and postpone commencement ceremonies scheduled to occur the following week.

UAH encouraged all on-campus student residents to return home; however, there were approximately 200 students unable to do so. Many were international students unable to change flights or make other travel arrangements. Some were domestic students unable to make travel arrangements. UAH provided food and shelter to these students until they were able to return home or in some cases until the power was restored. During the power outage UAH experienced a shortage of diesel fuel, which was used to power emergency generators on critical buildings and systems. UAH estimates that during the extended power outage it was losing approximately $5,000 per hour (during normal business hours) in contracts and grant revenue income.

In January 2010, an F2 tornado passed approximately one (1) mile southeast of the campus. No damage was reported on campus. Images of the tornado were captured by cameras operated by UAH. See Images 4.1 and 4.2.

Image 4.1 *Image 4.2*
(January 2010 tornado captured by UAH campus cameras)

In April 1974, an F3 tornado tracked through the center of what is now part of the UAH campus. This area of campus was undeveloped at the time of the tornado. There are no records of damage to campus structures from this event.

In December 1967 the National Weather Service tornado database for Madison County shows that an F1 tornado passed just south of the campus property boundary. There are no records of damage to campus structures.

4.4.2 Severe thunderstorms – historical. Damage from severe thunderstorms may be caused by straight-line winds, lightning, hail, or heavy rainfall. For the purposes of this Plan, heavy rainfall is included under the Floods subsection.

In 2014, a lightning strike during a severe thunderstorm caused significant damage to electrical systems at the UAH Charger Park athletic complex. Lightning struck a stadium lighting pole causing physical damage to the reinforced concrete pole. Electrical energy from the strike traveled along the wiring and damaged circuits, circuit breakers, and other equipment.

In May 2011, a severe thunderstorm with high sustained straight-line winds tore a metal roof from one campus apartment building. Water damage from rainwater resulted to portions of the building's interior. Several trees were also damaged in multiple campus locations.

In 2008, a severe thunderstorm with high winds caused a tree to fall against the side and roof of the Tom Bevill Center building on campus, resulting in damage to the structure, rooftop HVAC equipment, and to a natural gas pipe servicing the HVAC system.

In 2009, a severe thunderstorm with high sustained straight-line winds tore a metal roof from a campus apartment building. Water damage from rainwater resulted following the roof damage.

4.4.3 Floods and flash floods – historical. In May 2003, heavy rainfall on the campus resulted in roadway, parking lot, and building flooding. The southernmost sections of John Wright Drive and Technology Drive were inundated; some sections of the roadways were covered in several feet of water. Heavy rainfall also resulted in the flooding of the loading dock area at the National Space Science and Technology Center (NSSTC) building. Runoff from the storm exceeded the capacity of the dock drainage system and flood waters flowed through the first floor connector entrance of the building. Several landscaped areas were damaged and flood waters caused significant soil erosion at one bridge connecting John Wright Drive to the shared parking areas for several south-campus buildings.

There have been instances of heavy rainfall exceeding the capacities of building storm drainage systems. This has resulted in flooding of basement areas at Morton Hall, Salmon Library, Madison Hall, and other locations.

4.4.4 Sink holes – historical. A large sinkhole occurred on the campus in July 1967 in the vicinity of Knowledge Drive. It damaged a section of the roadway and surrounding grounds. The sinkhole was caused by soil erosion – a combination of rock dissolution and karst activity – in an underground aquifer system which is still present in the area.

In December 2013 a 2.5 foot diameter sinkhole occurred in the vicinity of the Nursing Building. The sinkhole formed during construction operations for a building addition. The formation of the sinkhole was attributed to rock dissolution and karst activity.

4.5 Hazard: Floods

4.5.1 Nature of hazard. The United States Geological Survey (USGS) describes a flood as "any relatively high stream-flow overtopping the natural or artificial banks in any reach of a stream." There are many reasons a flood may occur; heavy or prolonged rainfall events over large areas, locally intense thunderstorms, and rapidly melting large snow packs (with or without accompanying rainfall) can all lead to flooding.

The *Madison County Natural Hazards Mitigation Plan* defines a "flash flood" as:

> "…a term widely used by flood experts and the general population. However there is no single definition and method to distinguish flash flooding from riverine and other floods.
> For the purposes of this plan, we will define flash flooding as flooding that occurs due to localized drainage and is outside the boundaries of the FIRM floodplain."

Madison County further states:

> "The risks associated with flash flooding are the same as riverine flooding. One clear distinction is the element of surprise. Flash flooding, as the name implies, occurs quickly and without much warning. In riverine flooding, the time and height of the crest can be accurately predicted, and warnings can be issued several hours in advance."

A floodplain is the land adjacent to a channel, stream, river or other body of water that is prone to flooding. Because floods result from many different circumstances, not all floods are equal in magnitude, duration, or effect. Floodplain maps are the spatial representation of the land areas susceptible to a flood event. This assessment uses the Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Map [1] (FIRM) floodplain maps with 1% (100-year) and 0.2% (500-year) annual exceedance probability.

FEMA-generated floodplain maps consist of several zones (see Table 4.3) based on information level and location. For the purpose of this study Zones A and AE were combined into a single 100 year (1%) event zone and Zones B/X and C/X were combined as a single zone of 500 year (0.2%) flood events.

Table 4.3: Flood zone table with description used in FEMA floodplain and FIRM maps

ZONE	ANNUAL PERCENT CHANCE OF FLOOD		DESCRIPTION
Z0NE V	1%	High Risk Coastal Area	Coastal areas are prone to 1% inundation. No hydraulic analysis therefore no flood depths
ZONE VE (formerly V1-30)	1%		Coastal areas are prone to 1% inundation. Hydraulic analysis is performed therefore flood depths data available.
ZONE A	1%	High Risk Non-Coastal Area	Areas with 1% chance of annual flooding and 26% chance over 30 year lifetime. No detailed analysis, no depths or BFEs (base flood elevations)
ZONE AE	1%		Areas with 1% chance of annual flooding and 26% chance over 30 year lifetime. Detailed analysis, hence depths or BFEs data available.
ZONE AH	1%		Areas with 1% annual flooding (pond like) with shallow depths (1-3 ft)
ZONE AO	1%		Areas with 1% annual flooding (sheet like) with shallow depths (1-3 ft)
ZONE B and X (Shaded)	0.2%	Moderate to Low Risk Area	Area of moderate flood hazard, usually the area between the limits of the 100-year and 500-year floods.
Zone C and X (Unshaded)	0.2%		Area of minimal flood hazard, usually depicted on flood plain map as above the 500-year flood level

*(**Source:** http://www.fema.gov/floodplain-management/flood-zones)*

In this study, floods from all relevant sources such as heavy rainfall events, tornadoes, hurricanes, and dam/levee failure are considered isolated natural hazards. The flood types (riverine flood, stream flood, and flash flood) are not individually studied for the purposes of this analysis. The types are grouped together into the flood category.

4.5.2 Severity and Extent of Floods. Floods are one of the most frequent natural hazards in north Alabama. The National Weather Service (NWS) issues official flood watches and warnings prior to and during such events. Distinct warning levels indicate the severity of the event; Table 4.4 describes such warnings in detail.

Table 4.4: NWS Flood warning types and their description

Type	Description
Flood Advisory	Thunderstorms have produced heavy rainfall that may result in ponding of water on roadways and in low-lying areas, as well as rises in small stream levels, none of which pose an immediate threat to life and property
Flood Watch	Atmospheric and hydrologic conditions are favorable for long duration areal or river flooding
Flash Flood Watch	Indicates that conditions are favorable for the particular weather event in and near the Watch area, and which may pose a risk to life and property. Watches are issued up to 48 hours in advance with forecaster confidence around 50%.
Flood Warning	Long duration areal or river flooding is occurring or is imminent, which may result from excessive rainfall, rapid snow melt, ice jams on rivers or other similar causes
Flash Flood Warning	Excessive rainfall producing thunderstorms have developed, leading to short duration flash flooding. A warning may also be issued if a dam break has occurred

(***Source:*** *http://www.erh.noaa.gov/okx/wwa_definitions_new.html*)

The UAH campus is expected to be effected by both 500 and 100 year flood events as shown by the analysis of floodplain maps (see Figure 4.3). Flooding can potentially cause a great deal of damage to both property and personnel. UAH assets on the south side of campus are typically more susceptible to a flood event; however, flooding from heavy rain runoff may occur in any low-lying area on campus.

4.5.3 Flood History Profile. A total of 333 flood events have been recorded for the selected five counties for the period 1993 through 2012 by the National Storm Database, a NCDC product. There has been an average of 17.5 flood events per year. These floods resulted in one death (June 1999 in Huntsville) and a total of six injuries. During this period, property damage was estimated to be $6.8 million and crop damage $52,000 in the five counties. Marshall County, on August 10, 2001, experienced a countywide flood which resulted in four injuries, the maximum during this period. Floods of June 28, 1999 (Madison Co.) and May 6, 2003 (Madison and Jackson Cos.) had the highest property damages, estimated to be $4.2 million. Apart from direct impacts on properties and crops, floods can have both short- and long-term erosion effects on roads, soil, landscaping, and walkways.

A summary of flood events in the Huntsville city limits (1999-2012) is listed in Table 4.5. All of the floods in Huntsville are considered flash floods. A total of 26 flood events in the Huntsville city limits resulted in an annual average of 2 floods per year, and a total of one (1) fatality, six (6) injuries, and property damage of almost $1.5 million.

One multi-day flood event not listed above occurred May 4-8, 2003. During this event, the Cummings Research Park area of Huntsville, of which the UAH campus is a part, had a five-day total of 6.57 inches of rain. During this event, on May 6, 2003 the UAH campus experienced a flash flood affecting a large section of campus along the southern part of John Wright Drive. The storm water runoff covered roadways and parking lots along this section of John Wright Drive. The heavy rainfall washed landscape mulch into the loading dock area of the UAH National Space Science Technology Center (NSSTC) building resulting in a clogged storm drain and subsequent flooding to parts of the first floor of the building. There was also heavy soil erosion caused by storm water runoff around one bridge and parking lot entrance along John Wright Drive.

Table 4.5: Recorded flood events in Huntsville city limits (1999-2012)

DATE	TIME	LOCATION	EVENT TYPE	DTH	INJ	PDG ($M)
06/28/1999	0045	HUNTSVILLE	FLASH FLOOD	1	1	1.500
06/28/1999	0145	HUNTSVILLE	FLASH FLOOD	0	0	0.008
02/22/2003	0330	HUNTSVILLE	FLASH FLOOD	0	0	0.000
07/10/2003	1640	HUNTSVILLE	FLASH FLOOD	0	0	0.000
07/14/2004	1538	HUNTSVILLE	FLASH FLOOD	0	0	0.000
02/21/2005	1900	HUNTSVILLE	FLASH FLOOD	0	0	0.000
02/21/2005	1500	HUNTSVILLE	FLASH FLOOD	0	0	0.000
07/12/2005	2042	HUNTSVILLE	FLASH FLOOD	0	0	0.000
08/15/2005	1519	HUNTSVILLE	FLASH FLOOD	0	0	0.000
04/07/2006	2136	HUNTSVILLE	FLASH FLOOD	0	0	0.000
04/07/2006	2055	HUNTSVILLE	FLASH FLOOD	0	0	0.000
04/07/2006	2100	HUNTSVILLE	FLASH FLOOD	0	0	0.000
04/07/2006	2115	HUNTSVILLE	FLASH FLOOD	0	0	0.000
07/25/2007	1751	HUNTSVILLE	FLASH FLOOD	0	0	0.000
08/29/2007	1800	HUNTSVILLE	FLASH FLOOD	0	0	0.020
08/29/2007	1830	HUNTSVILLE	FLASH FLOOD	0	0	0.001
11/14/2008	1900	HUNTSVILLE	FLASH FLOOD	0	0	0.000
04/02/2009	1730	HUNTSVILLE	FLASH FLOOD	0	0	0.000
05/01/2009	1625	HUNTSVILLE	FLASH FLOOD	0	0	0.000
07/12/2009	2240	HUNTSVILLE	FLASH FLOOD	0	0	0.000
09/08/2009	1431	HUNTSVILLE	FLASH FLOOD	0	0	0.000
09/08/2009	1454	OAKWOOD	FLASH FLOOD	0	0	0.000
09/08/2009	1600	HUNTSVILLE	FLASH FLOOD	0	0	0.000
08/08/2011	1423	HUNTSVILLE	FLASH FLOOD	0	0	0.000
01/11/2012	0956	HUNTSVILLE	FLASH FLOOD	0	0	0.000
09/02/2012	1640	HUNTSVILLE	FLASH FLOOD	0	0	0.005
TOTAL				**01**	**06**	**$1.5M**

Source: *NCDC Storm Database (1950-2012) - NOAA*

4.5.4 Probability of future occurrences.

4.5.4.1 Temporal probability. Since floods are the result of phenomena extending over large spatial regions, the temporal analysis is performed over an area much larger than just the UAH campus or Huntsville, AL city limits. There has been an average of 17.5 floods per year between 1993 and 2012 in the five-county area included in this study. It should be noted that between 1993 and 2002 the annual mean was 7.6 flood events per year, and between 2003 and 2012 the average increased to 26.4 flood events per year. The highest per-year flooding was recorded in 2009 with 59 flood events. In 2003, 2004, and 2012, high flood rates were also recorded, with 28, 23, and 25 flood events respectively. An annual flood event distribution also shows a gradual, increasing trend over the years studied (see Figure 4.1). It should be noted that without detailed climatological studies it is unclear whether future rainfall events will follow the same trends.

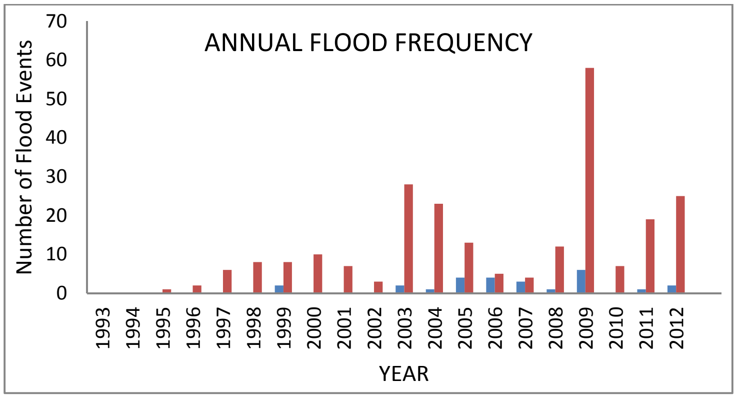


Figure 4.1: Annual flooding frequency chart for 5 Counties (red) and Huntsville City Limits (blue) (1993-2012)

Along with annual distributions, monthly distributions were also analyzed over the same period. Flood events were not distributed uniformly each month (see Figure 4.2). Approximately 66% (219) of the total 333 flood events occurred between the months of December and May. It is also important to note that most of the annual precipitation is distributed during these months, and the southeastern United States is known to be more susceptible to storm events during this period each year. Therefore, the threat of flooding for the UAH campus and surrounding areas is highest from December through May.

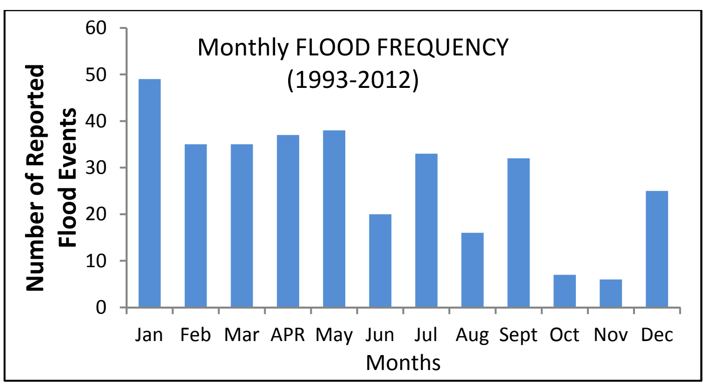


Figure 4.2: Monthly long term flood distribution

4.5.4.2 Spatial probability. Analysis of FIRM floodplain maps for the UAH campus indicates that during a 100-year rainfall event, five roads on campus will be affected. The total combined length of these road sections is estimated at approximately 2.1 miles. These five roads would be affected during a 500 year rainfall event resulting in an increase to approximately 3.5 miles of roadway (see Table 4.6).

South and south-western side roads leading to the campus will be severely affected. Approaches and parking areas for buildings including Olin B. King Technology Hall, Propulsion Research Laboratory, WLRH Radio Station, Business Services Building, Shelbie King Hall, Johnson Research Center, Von Braun Research Hall, Shelby Center for Science & Technology, Engineering Building are more prone to flood events (see Table 4.8).

Table 4.6: UAH campus roads affected by 100 year and 500 years flood events floodplains

Road	Type	100 year flood event	Length (miles)	500 year flood event	Length (miles)
Technology Drive	Public	YES	0.275	YES	0.451
Sparkman Drive	Public	YES	1.106	YES	1.97
Knowledge Drive	Private	YES	0.226	YES	0.277
John Wright Drive	Private	YES	0.453	YES	0.733
Charger Way	Private	No	N/A	No	N/A
Ben Graves Drive	Private	No	N/A	No	N/A
Holmes Avenue	Public	No	N/A	No	N/A
University Drive	Public	No	N/A	No	N/A
Bradford Drive	Public	YES	0.035	YES	0.102
	Total affected miles		**2.095**		**3.533**

The UAH campus is a place where many students, employees, contractors, and guests commute in order to learn and work; thus, it is important to analyze not only the campus floodplain areas but also the adjacent community and surrounding counties' floodplains as well. Flood events affecting the surrounding communities could have indirect adverse effects on UAH's ability to conduct regular business or to obtain critical supplies (such as food, fuel, and medical supplies). Analysis of floodplain maps of adjacent counties, including Limestone, Morgan, Marshall, and Jackson, indicate that almost 150 miles of major roads (class 1-Interstate Highways, class 2-US highways, and class 3-major state roads) will be affected by a 100-year rainfall event, and 167 miles of road will be affected if a 500-year rainfall event occurs. A floodplain map for the adjacent counties with major roads is shown in Figure 4.4, and the inundation summary of major roads leading to the UAH campus from these adjacent counties is listed in Table 4.7.

Table 4.7: Prominent roads leading to UAH under the floodplains

ROAD NAME	100 Year Flood Effect (miles)	500 Year Flood Effect (miles)
US Highway 431	8.117	9.331
US Highway 231/ Memorial PKWY	3.183	3.846
Interstate 565	5.250	5.908
US Highway 72/University Dr.	15.135	16.93
Alabama State Highway 20	4.706	4.706
Old Madison Pike	0.911	0.977
Research Park Boulevard	0.709	0.739
TOTAL	**38.010**	**42.435**

Table 4.8: UAH campus buildings and flood effects

Building and Primary Building Use	**Class room**	**Research Center**	**Administration**	**Facility**	**Auditorium**	**Residence**	**100 Yr Flood Effect**	**100 yr Building Approach**	**500 yr Flood Effect**	**500 yr Building Approach**
North Campus Residence Hall						✓				
Frank Franz Hall						✓				
Morton Hall	✓	✓								
Union Grove Gallery & Meeting Hall					✓					
Spragins Hall				✓						
Roberts Hall	✓	✓			✓					
University Center			✓		✓					
Central Campus Residence Hall						✓				
Tom Bevill Center					✓	✓				
Nursing Building	✓	✓								
Salmon Library			✓	✓						
Amphitheater					✓					
Wilson Hall	✓	✓								
Business Administration Building	✓		✓		✓					
University Fitness Center				✓						
Intermodal Parking Facility				✓						
Charger Village						✓				
Shelby Center for Science & Tech	✓	✓								
Fraternity/Sorority Housing						✓				
Southeast Campus Housing						✓				
Charger Union			✓	✓						
Alabama Credit Union				✓						
Madison Hall			✓				✓	Mod	✓	Mod
Robert Cramer Research Hall / NSSTC	✓	✓					✓	Mod	✓	Mod
Optics Building	✓	✓								
Materials Science Building	✓	✓			✓					
Engineering Building	✓	✓					✓	Mod	✓	Mod
Solar Energy Research Laboratory		✓					✓	Mod	✓	Mod
Von Braun Research Hall	✓	✓					✓	Mod	✓	Mod
Physical Plant Building				✓			✓	Mod	✓	Mod
Central Receiving & Shipping				✓			✓	Mod	✓	Severe
Johnson Research Center	✓	✓					✓	Mod	✓	Severe
Propulsion Research Lab		✓					✓	Mod	✓	Severe
WLRH radio Station				✓			✓	Severe	✓	Severe
Business Service Building			✓				✓	Severe	✓	Severe
Shelbie King Hall			✓						✓	Mod
Olin B. King Technology Hall	✓	✓					✓	Mod	✓	Severe

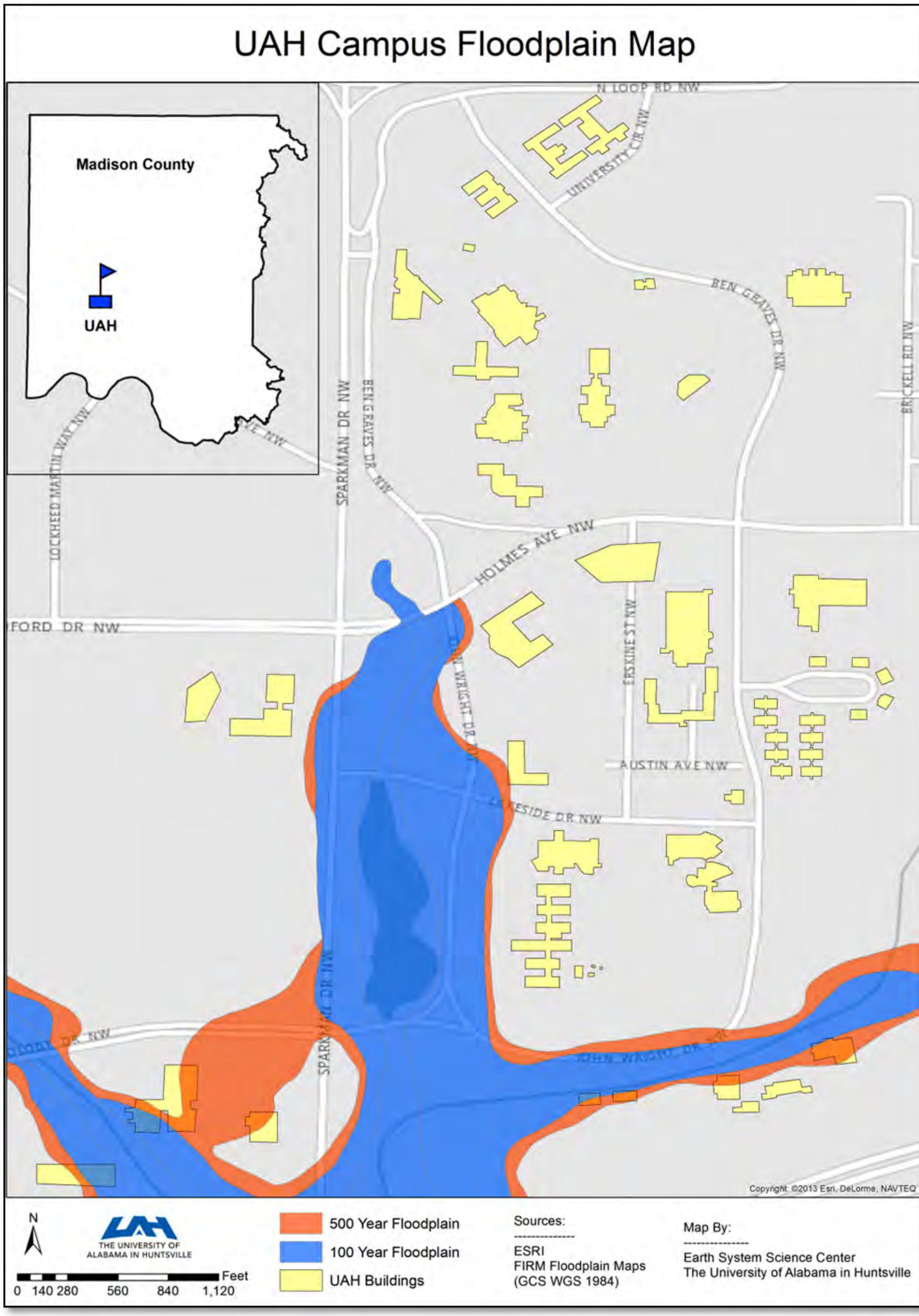


Figure 4.3: UAH floodplain map

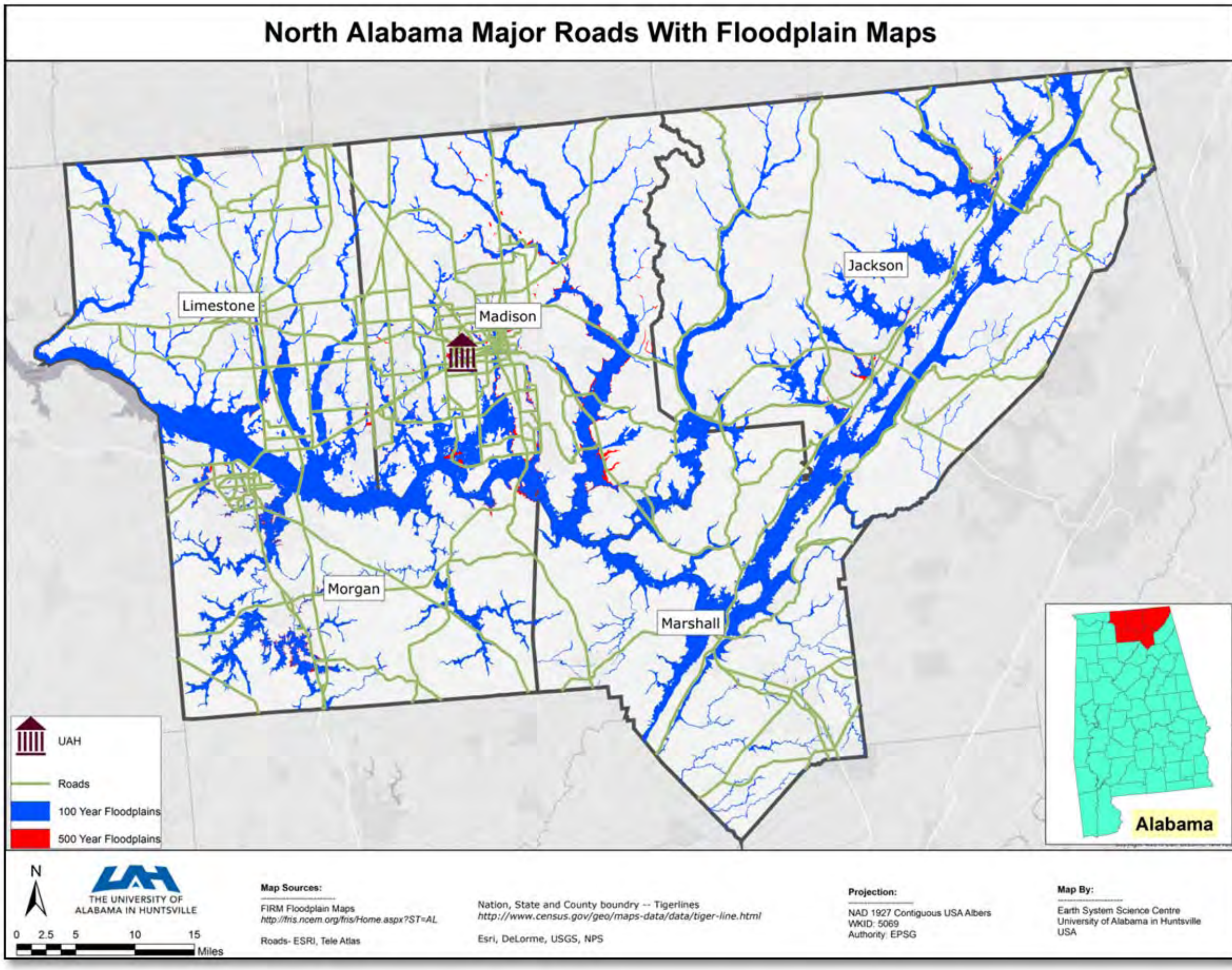


Figure 4.4: Adjacent Counties floodplain map with major roads

4.5.6 Impacts. Floods are capable of undermining roads, buildings, and bridges, eroding stream banks, washing out access routes, destroying landscaping and trees, damaging and washing away automobiles, and causing injuries and loss of life. Floods occur in all 50 states and other U.S. territories and FEMA estimates that 9 million households and $390 billion of property are at risk from flooding.

Flooding may block access to areas of campus, strand motorists and pedestrians, and jeopardize the safety and health of those caught in flood waters. Flooding may also cause ground and water contamination from overflowing sewer systems, underground fuel storage tanks, and other hazardous materials released by flood water damage. Debris from fast-moving flood waters poses additional risks to lives and property.

In addition to natural flooding events, possibilities of man-made floods exist. Man-made floods are caused by events such as pipe bursts and drain blockages. These floods are much smaller in spatial extent as compared to natural flooding events and mostly affect a particular building or block. However, for campus operations, a man-made flood may be as devastating as a natural flood. Furthermore, man-made flooding can occur at any time with no prior warning.

Indirect impact from flooding may include financial loss, operational interruption, and increased insurance premiums.

4.6 Hazard: Hurricanes

4.6.1 Nature of hazard. A tropical cyclone is a relatively large and long-lasting cyclonic low pressure system which develops over tropical and subtropical regions. Typically, tropical cyclones with wind speeds less than 39 mph are termed tropical depressions. With wind speeds between 39 and 73 mph they are termed tropical storms, and with wind speeds greater than 74 mph they are termed hurricanes [2].

A hurricane is a type of tropical cyclone or severe tropical storm that forms in the tropics and subtropics (i.e. southern Atlantic Ocean, Caribbean Sea, Gulf of Mexico, and northeastern Pacific Ocean). Hurricanes are typically accompanied by thunderstorms and tornadoes [3]. All Atlantic and Gulf of Mexico coastal areas are subject to hurricanes. The Atlantic hurricane season lasts from June to November, with the peak season taking place between mid-August and late October [4].

4.6.2 Severity and extent of hurricanes. Hurricanes are known to cause catastrophic damage to coastlines as well as areas several hundred miles inland. Hurricanes can produce winds exceeding 155 mph and can lead to the formation of tornadoes. Hurricanes can create storm surges along the coast and may cause extensive damage from heavy rainfall. Slow moving hurricanes traveling into mountainous regions tend to produce especially heavy rain. Excessive rain can trigger landslides or mud slides as well as flash flooding. Floods and flying debris, from the excessive winds, are often the deadly and destructive results of these weather events. The Saffir-Simpson hurricane wind scale (Table 4.9) is a categorical scale that relates the wind speed associated with a hurricane to the possible damage that it could cause.

Table 4.9: Saffir-Simpson hurricane wind scale

Category	Wind Speed (MPH)	Comment
1	74-95	Very dangerous winds, will produce some damage
2	96-110	Extremely dangerous winds, will cause extensive damage
3	111-129	Devastating damage will occur
4	130-156	Catastrophic damage
5	157+	Catastrophic damage

Source: *www.nhc.noaa.gov/aboutshs.shtml*

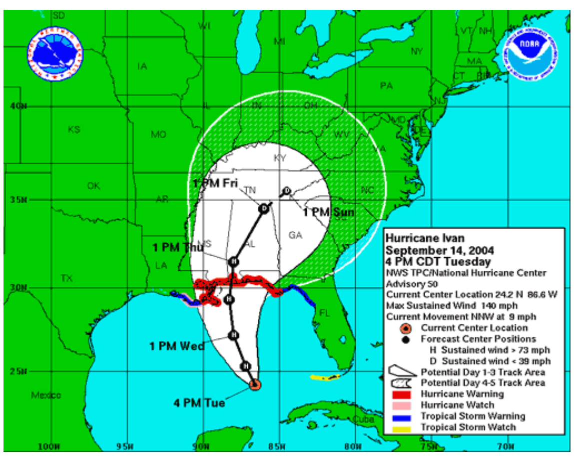
4.6.3 Hurricane history profile. A total of 11 hurricane tracks have had a direct impact on the five counties surrounding the UAH campus since 1950 (29 tracks since 1879). The most significant hurricanes that have directly impacted the region resulted in fatalities and combined property and crop damage in excess of $3.7 billion. Hurricane Katrina (2005) is known to have caused a total of $1 billion in property damage, while Ivan (2004) caused $2.5 billion in property damage and $25 million in crop damage throughout the state. Hurricane Opal (1995) resulted in two fatalities, $100 million in property damage, and almost $10 million in crop damage, as reported by NOAA's NCDC for the state of Alabama. Table 4.10 lists all 11 hurricanes known to have had a significant impact upon northern Alabama since 1950. It should be noted that since the radius of hurricanes can range up to 100 miles, the region may have experienced excessive rainfall and high winds etc. from other hurricanes but with a less severe effect.

Table 4.10: Summary of all hurricanes whose tracks crossed north Alabama since 1950

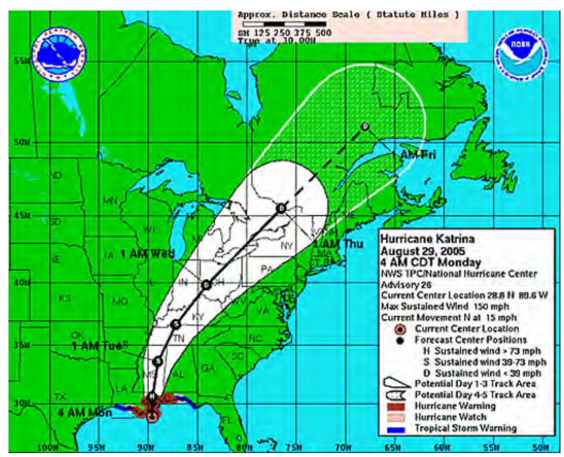
SEREAL NO.	YEAR	MONTH	TIME	NAME
1950244N19276	1950	9	6:00	EASY
1970200N19277	1970	7	0:00	BECKY
1977246N27274	1977	9	12:00	BABE
1979241N11335	1979	9	18:00	FREDERIC
1985224N19279	1985	8	6:00	DANNY
1985299N25270	1985	11	6:00	JUAN
1992230N11325	1992	8	0:00	ANDREW
1995271N19273	1995	10	6:00	OPAL
2002258N10300	2002	9	0:00	ISIDORE
2004247N10332	2004	9	0:00	IVAN
2008229N18293	2008	8	12:00	FAY

***(Source:** International Best Track Archive for Climate Stewardship (IBTrACS))*

The NOAA-generated hurricane tracks for Katrina (2005) and Ivan (2004) (the two most destructive hurricanes of the region in recent times) are shown below in Figure 4.5. Both storms impacted north Alabama, including the Huntsville and Madison County, Alabama areas.



(a) IVAN on 09/14/2004



(b) KATRINA on 08/29/2005

Figure 4.5: Hurricane track of two most destructive hurricanes of region**.** ***(Source:*** *http://www.nhc.noaa.gov/archive/2005/KATRINA_graphics.shtml*
http://www.nhc.noaa.gov/archive/2004/IVAN_graphics.shtml)

4.6.4 Probability of Future Occurrences. Historical tropical cyclone data, available from the National Storm Database (NOAA), for north Alabama is limited. Based on this limited data, the probability of a hurricane or significant tropical cyclone affecting the UAH campus is one in every two years. Damage assessment at the county level is not possible since all damage is reported in terms of hurricanes which extend several counties. Historical records suggest that all major hurricanes were greatly reduced in strength by the time they impacted Huntsville (more than 300 miles from the nearest coast); therefore, the risk was significantly reduced.

4.6.5 Impacts. The UAH campus is susceptible to the effects of hurricanes; however, the storms are typically significantly reduced in strength and may be considered tropical storms or tropical depressions by the time their affects are felt in the Madison County area. The UAH campus and surrounding community is far enough inland that the primary hurricane threat is from high winds, tornadoes, and flooding. It should be noted that an estimated ten percent of hurricane-associated deaths in the United States are due to tornadoes.

Indirect impact from hurricane-related damage can include financial loss, operational disruption, and increased insurance premiums.

4.7 Hazard: Severe Thunderstorm

4.7.1 Nature of hazard. The National Weather Service (NWS) considers a thunderstorm severe if it produces hail at least one inch in diameter, has winds of 58 miles per hour (50 Knots) or higher, and/or produces a tornado. Lightning is an associated risk with severe thunderstorms. Thunderstorms may occur in isolation, clusters, or in a line. Severe thunderstorm may consist of more than one or all of the following events:

- Lightning
- Tornadoes
- Straight-line Winds
- Flash Floods and Floods
- Hail

Tornadoes and floods, because of their nature and extent in the region, are studied separately; lightning, straight-line winds, and hail are analyzed in the current section.

4.7.2 Severity and extent. Typically, thunderstorms average 15 miles in diameter and last approximately 30 minutes. Approximately ten (10) percent of the 100,000 thunderstorms that occur in the United States each year are classified as severe by the NWS. Some facts (for the Unites States) related to each thunderstorm's constituents [5] are:

- Lightning
  - Causes an average of 55-60 fatalities and 400 injuries each year
  - Occurs with all thunderstorms
  - Costs more than $1 billion in insured losses each year
- Tornadoes
  - Cause an average of 60-65 fatalities and 1,500 injuries each year
  - Can produce wind speeds in excess of 200 mph

  - Can be 1 mile wide and stay on the ground over 50 miles
- Straight-line Winds
  - Can exceed 125 mph
  - Can cause destruction equal to a tornado
  - Are extremely dangerous to aviation
- Hail
  - Can be larger than a softball (5 inches in diameter)
  - Causes more than $1 billion in crop and property damage each year

4.7.3 History profile.

4.7.3.1 Straight-line wind. A total of 1,395 high winds were recorded for the counties around UAH, of which more than 55% reached speeds above 50 knots. Between 1950 and 2012, $24.5 million in property damage and $0.8 million in crop damage were caused by high speed winds. A total of 12 fatalities and 32 injuries due to high winds were also reported during this period.

A summary of all high wind events from 1950-2012 for each county is tabulated in Table 4.11. This data shows that the maximum damage due to high winds in terms of fatalities (all 12), injuries (20 out of 32), and property damage ($7.8 million maximum) was recorded for Madison County. Table 4.12 lists all the high wind events (50 knots or more) for the Huntsville city region. A total of 52 high wind events were recorded for Huntsville between 1995 and 2012. All of these events together resulted in 2 injuries and $0.9 million in property damage.

Table 4.11: Summary of the major thunderstorms and high wind events for each county (1950-2012)

County	EVTYPE	Frequency	FATALITIES	INJURIES	PROPDMG (x1000)
Madison	**TSTM**	**539**	**12**	**20**	**7863.1**
Marshall	TSTM	309	0	0	3411.6
Limestone	TSTM	292	0	3	7364.5
Morgan	TSTM	27	0	2	321
Jackson	TSTM	218	0	4	2477.2
Multiple County	TSTM	10	0	3	3077
TOTAL		**1395**	**12**	**32**	**24514.4**

Source: *Severe Weather Database Files (1950-2012) - NOAA*

4.7.3.2 Lightning. A total of 145 significant lightning events were recorded in the storm database for the counties surrounding the UAH campus. It should be noted that the storm database includes only those lightning events which resulted in reported injury, fatality, or property/crop damage. Table 4.13 summarizes these lightning events for each county. Lightning events with no casualties or property damage being reported to NOAA are not included in this list.

Since 1950, there have been a total of 4 fatalities and 22 known injuries in the region due to lightning. In Huntsville/Madison County there have been a total of 44 reportable lightning events since 1995. These 44 events resulted in 1 fatality (1997) and 5 injuries;

property damage was assessed to be $1.5 million and crop damage of $7,000 was reported. Table 4.14 lists all lightning events that have occurred in Huntsville since 1995.

Table 4.12: List of thunderstorm winds (above 50 knots) at Huntsville city since 1995

DATE	TIME	EVENT TYPE	LOCATION	MAG (Knots)	DTH	INJ	PRD ($K)
03-Jul-95	1647	TSTM	Huntsville	56	0	0	42
27-May-96	1525	TSTM	Huntsville	55	0	0	15
27-May-96	1612	TSTM	Huntsville	55	0	0	10
24-Jan-97	1706	TSTM	Huntsville	75	0	0	5
21-Feb-97	0717	TSTM	Huntsville	54	0	0	18
13-Jun-97	1540	TSTM	Huntsville	52	0	0	6
13-Jun-97	1540	TSTM	Huntsville	75	0	0	3
20-Jul-98	1320	TSTM	Huntsville	60	0	0	25
20-Jul-98	1320	TSTM	Huntsville	55	0	0	10
22-Jan-99	1740	TSTM	Huntsville	55	0	0	25
22-Jan-99	1740	TSTM	Huntsville	75	0	0	0
03-Jun-99	1300	TSTM	Huntsville	75	0	0	0
24-Jul-99	1700	TSTM	Huntsville	55	0	0	8
29-Jul-99	1715	TSTM	Huntsville	55	0	0	15
13-Aug-99	1930	TSTM	Huntsville	60	0	0	20
03-JAN-00	2210	TSTM	Huntsville	55	0	0	2
03-JAN-00	2210	TSTM	Huntsville	55	0	0	10
10-AUG-00	1612	TSTM	Huntsville	55	0	0	0
10-AUG-00	1612	TSTM	Huntsville	88	0	0	0
13-FEB-00	1928	TSTM	Huntsville	65	0	2	250
13-FEB-00	1942	TSTM	Huntsville	65	0	0	20
13-FEB-00	1928	TSTM	Huntsville	75	0	0	100
13-FEB-00	1942	TSTM	Huntsville	100	0	0	2
17-AUG-00	1600	TSTM	Huntsville	60	0	0	5
13-Jun-02	1520	TSTM	Huntsville	55	0	0	8
30-Jul-02	1635	TSTM	Huntsville	59	0	0	15
01-May-03	1630	TSTM	Huntsville	60	0	0	0
10-Jul-03	1535	TSTM	Huntsville	60	0	0	0
22-Jul-03	0910	TSTM	Huntsville	70	0	0	150
18-Nov-03	1230	TSTM	Huntsville	80	0	0	20
05-Mar-04	2225	TSTM	Huntsville	70	0	0	0
13-Jan-05	0958	TSTM	Huntsville	60	0	0	0
04-Dec-05	0119	TSTM	Huntsville	60	0	0	0
09-Mar-06	1725	TSTM	Huntsville	60	0	0	0
09-May-06	1640	TSTM	Huntsville	60	0	0	0
30-May-06	1550	TSTM	Huntsville	60	0	0	5
01-Jun-06	1620	TSTM	Huntsville	58	0	0	0
28-Jul-06	1333	TSTM	Huntsville	65	0	0	0
25-Jul-07	1740	TSTM	Huntsville	52	0	0	0
14-Nov-07	1940	TSTM	Huntsville	55	0	0	0
09-Jul-08	1717	TSTM	Huntsville	56	0	0	2
28-Mar-09	1753	TSTM	Huntsville	52	0	0	1
02-Apr-09	1910	TSTM	Huntsville	56	0	0	45
09-Jun-10	1815	TSTM	Huntsville	52	0	0	0
09-Jul-10	1708	TSTM	Huntsville	52	0	0	10
09-Jul-10	1700	TSTM	Huntsville	52	0	0	15
09-Jul-10	1705	TSTM	Huntsville	52	0	0	1
11-Apr-11	1743	TSTM	Huntsville	52	0	0	5
26-Jun-11	1305	TSTM	Huntsville	52	0	0	2
02-Sep-12	1628	TSTM	Huntsville	52	0	0	10
02-Sep-12	1625	TSTM	Huntsville	52	0	0	15
10-Dec-12	0338	TSTM	Huntsville	61	0	0	2

*(**Source:** NCDC severe weather storm Database)*

Table 4.13: List of all the lightning events at Huntsville, Alabama (1995-2012)

DATE	TIME	EVENT TYPE	LOCATION	DTH	INJ	PRD ($K)
15-Feb-95	1800	LIGHTNING	Huntsville	0	0	50
15-Feb-95	2320	LIGHTNING	Huntsville	0	0	50
03-Jul-95	1715	LIGHTNING	Huntsville	0	0	200
25-Jul-95	2239	LIGHTNING	Huntsville	0	0	25
14-Jul-96	1930	LIGHTNING	Huntsville	0	0	10
20-Jul-96	1311	LIGHTNING	Huntsville	0	0	20
24-Jan-97	1700	LIGHTNING	Huntsville	0	1	10
24-Jan-97	1705	LIGHTNING	Huntsville	0	0	14
18-Mar-97	2315	LIGHTNING	Huntsville	0	0	8
18-Mar-97	2355	LIGHTNING	Huntsville	0	0	4
18-Jul-97	1247	LIGHTNING	Huntsville	0	0	50
18-Jul-97	1247	LIGHTNING	Huntsville	0	0	35
18-Jul-97	1303	LIGHTNING	Huntsville	0	0	3
02-Sep-97	1509	LIGHTNING	Huntsville	0	0	15
02-Sep-97	1510	LIGHTNING	Huntsville	0	0	6
06-May-98	1724	LIGHTNING	Huntsville	0	0	100
06-May-98	1724	LIGHTNING	Huntsville	0	0	0
20-Jul-98	1315	LIGHTNING	Huntsville	0	1	75
20-Jul-98	1315	LIGHTNING	Huntsville	0	0	25
05-May-99	2145	LIGHTNING	Huntsville	0	0	30
05-May-99	2145	LIGHTNING	Huntsville	0	0	0
03-Jun-99	1230	LIGHTNING	Huntsville	0	0	15
03-Jun-99	1230	LIGHTNING	Huntsville	0	0	2
07-Jul-99	1800	LIGHTNING	Huntsville	0	0	3
07-Jul-99	1800	LIGHTNING	Huntsville	0	0	150
24-Jul-99	1700	LIGHTNING	Huntsville	0	0	2
24-Jul-99	1700	LIGHTNING	Huntsville	0	0	8
12-Aug-99	1530	LIGHTNING	Huntsville	0	0	5
19-Aug-99	1715	LIGHTNING	Huntsville	0	0	30
19-Aug-99	1715	LIGHTNING	Huntsville	0	0	100
04-Apr-01	1430	LIGHTNING	Huntsville	0	0	45
18-Aug-02	1505	LIGHTNING	Huntsville	1	1	100
07-Apr-06	2200	LIGHTNING	Huntsville	0	0	5
26-May-06	1515	LIGHTNING	Huntsville	0	1	0
26-May-06	2220	LIGHTNING	Huntsville	0	1	0
30-May-06	1545	LIGHTNING	Huntsville	0	0	20
28-Jul-06	1423	LIGHTNING	Huntsville	0	0	0
21-Aug-10	2040	LIGHTNING	Huntsville	0	0	0
08-Aug-11	1420	LIGHTNING	Huntsville	0	0	10
14-Sep-11	2338	LIGHTNING	Huntsville	0	0	50
11-Jan-12	0923	LIGHTNING	Huntsville	0	0	1
05-Apr-12	1800	LIGHTNING	Huntsville	0	0	0
03-Jun-12	2200	LIGHTNING	Huntsville	0	0	250
02-Sep-12	1636	LIGHTNING	Huntsville	0	0	25
TOTAL				**1**	**5**	**$1.5M**

*(**Source:** NCDC severe weather storm Database)*

Table 4.14: Summary of lightning events since 1950–2012 for each of the concerned counties in the region

County	EVTYPE	Frequency	FATALITIES	INJURIES	PROPDMG (x1000)
Madison	**LIGHTNING**	**71**	**2**	**5**	**3394.5**
Marshall	LIGHTNING	26	1	7	323.5
Limestone	LIGHTNING	32	0	4	1467.5
Morgan	LIGHTNING	05	0	1	16
Jackson	LIGHTNING	11	1	6	240
TOTAL		**145**	**04**	**22**	**$5.4 M**

Source: *Severe Weather Database Files (1950-2012) - NOAA*

4.7.3.3 Hail. Hail is frozen precipitation in the form of balls or irregular lumps of ice. Hail can damage buildings, roofs, and automobiles, and can be deadly to livestock and people. Hail is usually pea-sized to marble-sized, but large thunderstorms are capable of producing much larger hail (Table 4.15). The storm database defines a weather event as a hailstorm if the hail size is greater than one inch or hail accumulations of smaller size result in property and/or crop damage, or casualties.

The largest hail reported in the counties surrounding UAH was 3 ¾ inches and was recorded in the city of Athens in Limestone County (1995). For a map of all hail events in the region see Figure 4.6 below. The highest damage-causing hail events in the five-county area occurred in 1998: $20,000 of crop damage was reported in Jackson County, and a property loss of $382,000 was reported for Huntsville. A total of 962 prominent hail storms have been recorded for the region since 1950. These storms have resulted in 3 injuries and a total of almost $2.5 million in property damage (Table 4.16).

Table 4.15: Hail size division table (*based on NOAA*)

Pea	¼ in diameter
Marble/mothball	½ in diameter
Dime/Penny	¾ in diameter
Nickel	7/8 in diameter
Quarter	1 in diameter
Ping-Pong Ball	1 ½ in diameter
Golf Ball	1 ¾ in diameter
Tennis Ball	2 ½ in diameter
Baseball	2 ¾ in diameter
Tea Cup	3 in diameter
Grapefruit	4 in diameter
Softball	4 ½ in diameter

Table 4.16: Summary of hail events recorded by NCDC Storm Database for each county (1950-2012).

County	EVTYPE	Frequency	FATALITIES	INJURIES	PROPDMG (x1000)
Madison	**HAIL**	**349**	**0**	**1**	**955**
Marshall	HAIL	169	0	1	483
Limestone	HAIL	212	0	1	484
Morgan	HAIL	119	0	0	155
Jackson	HAIL	113	0	0	442
TOTAL		**962**	**00**	**03**	**$2.5 M**

*(**Source:** NCDC severe weather storm Database)*

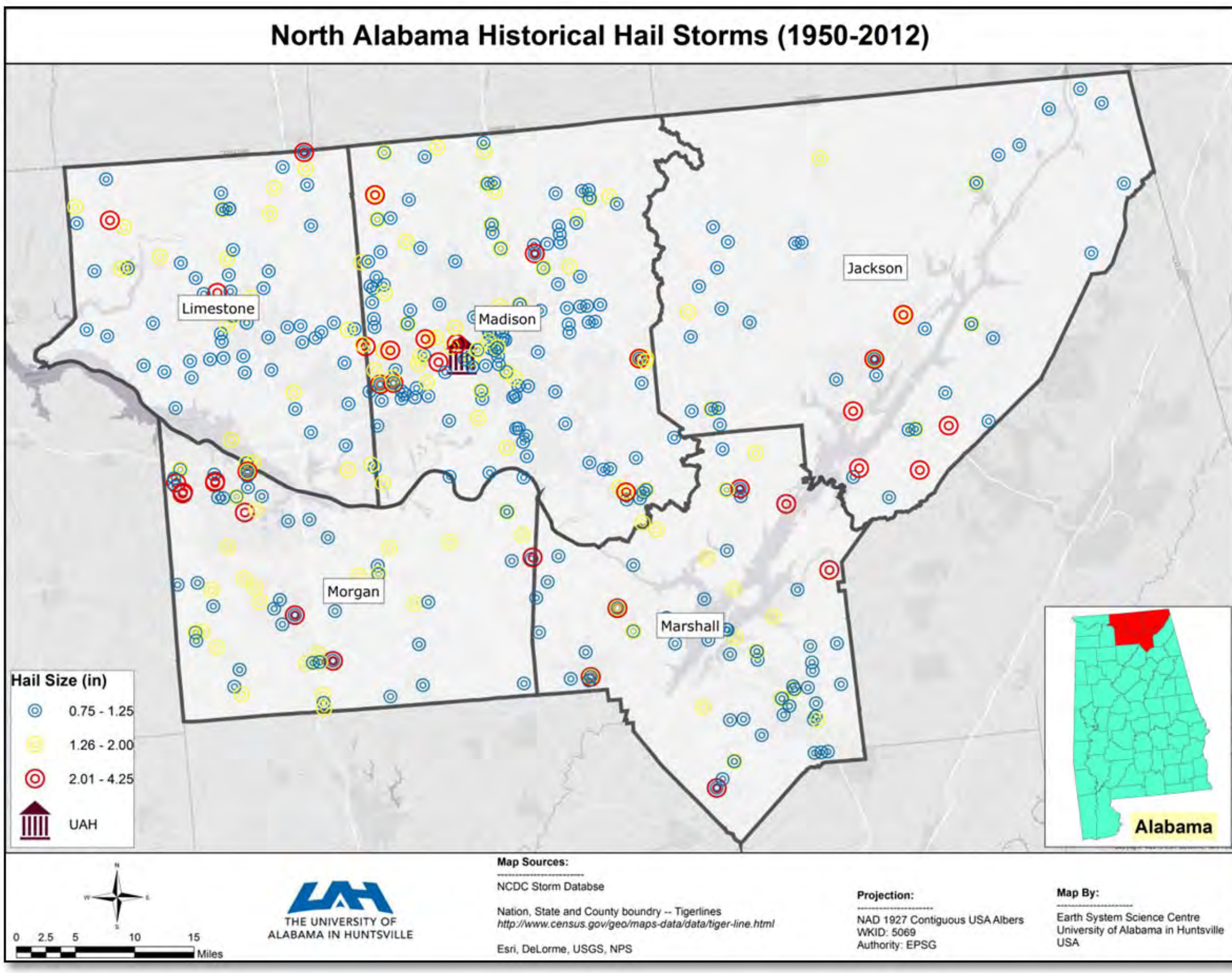


Figure 4.6: Historical hail events in North Alabama (1950-2012)

4.7.4 Probability of future occurrences. Since 1950 high winds, lightning, and hail have caused 16 fatalities and 57 injuries in the region. High winds have caused most of the fatalities and injuries (12 and 32, respectively). Hail and severe winds have been the major sources of property and crop damage. The extent of thunderstorms is usually wide and often covers multiple counties. Thus, assessing possible damage to the UAH campus has to be viewed at a higher spatial resolution.

Almost 56% of the winds in the region had a speed of at least 50 knots (i.e., capable of producing thunderstorms). Extremely high winds (80 knots or more) were not very common, comprising less than 2% of the total events. Hail size distribution shows that almost 87% of the total recordable hail events in the region were nearly 1 inch in diameter, but heavy hail storms in the region are also not a common phenomenon. Figure 4.7 shows the intensity distribution of high winds and hail in the region since 1950.

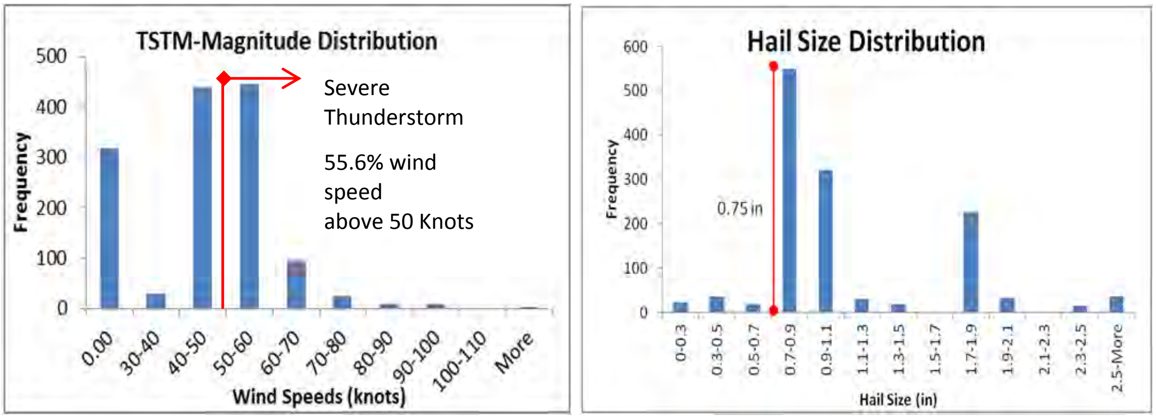


Figure 4.7: *(a) Thunderstorm intensity distribution (1950-2012); (b) Hail size distribution (1950-2012)*

4.7.4.1 Temporal probability. The probability of future severe thunderstorm events depends upon multiple atmospheric and climatic conditions. Although exact long term prediction of severe thunderstorms is not possible, based on historical events it is clear that the UAH campus is in a zone regularly impacted by severe thunderstorms. Annual distributions show an increasing trend in the number of thunderstorms and high winds. In the year 2011, the greatest number of high wind events (174) was recorded, with 2009 having the second highest occurrence (96). The long-term annual average of high straight-line winds shows more than 21 such events per year. However, since 1990 the average has increased to almost 50 events per year.

Monthly distributions clearly indicate that the months April through August are most susceptible to thunderstorms in the region, with 74.6% of the total thunderstorms occurring during these months. Similarly, annual distribution of hail events shows an increasing trend with the greatest number of hail events occurring in the 2012. Statistics based on historical records indicate the greatest probability of hail events affecting the UAH campus during the months of March through August (see Figure 4.8).

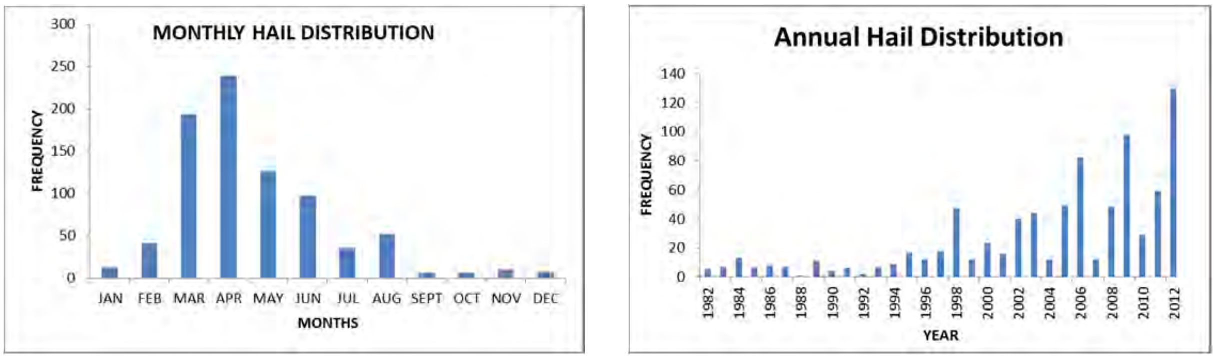


Figure 4.8: Annual and Monthly distributions of hail in the region (1980-2012)

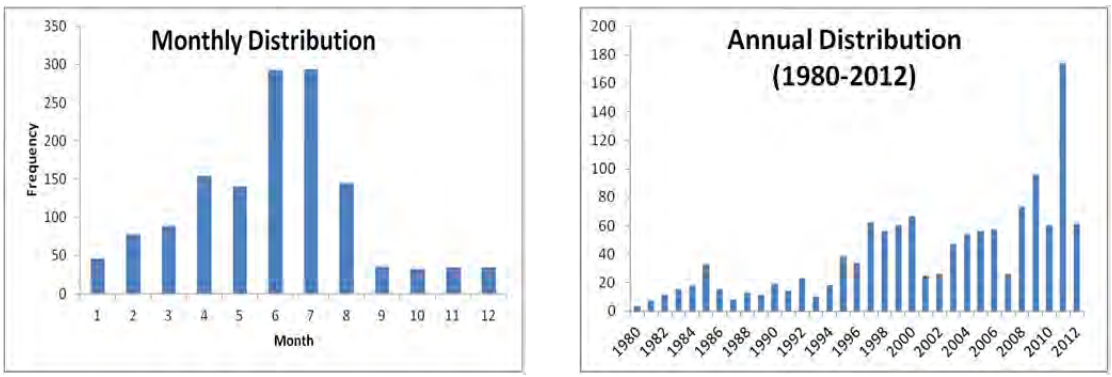


Figure 4.9: Annual and Monthly distributions of straight line winds in the region (1980-2012)

4.7.4.2 Impacts. Since 1975, Madison County has experienced over 400 severe thunderstorms. High winds and lightning associated with severe thunderstorms frequently cause property damage and loss of life. Winds can uproot or damage trees, damage electrical poles and transmission lines, tear roofing material from buildings, and blow deadly and damaging debris. Lightning can cause injury or death from electrocution and can cause wild fires, structural fires, and damage or destroy electrical equipment.

Indirect impacts of severe thunderstorms can include financial loss and increased insurance premiums. Secondary impacts also may include hazards to motorists and pedestrians from fallen debris and downed power lines.

4.8 Hazard: Tornadoes

4.8.1 Nature of hazard. NOAA describes a tornado as "a narrow, violently rotating column of air that extends from the base of a thunderstorm to the ground." This column of air, commonly referred to as a funnel, consists of dust particles, water droplets, and debris. Tornadoes are considered the most violent of all atmospheric storms.

Typical characteristics and facts related to a tornado (source: *NOAA*):

- Tornadoes cause an average of 70 fatalities and 1,500 injuries in the U.S. each year.
- The strongest tornadoes have rotating winds of more than 250 mph.
- Tornadoes can be up to one mile wide and stay on the ground for over 50 miles.
- Tornadoes may appear nearly transparent until dust and debris are picked up or a condensation cloud forms within the funnel.
- The average forward speed is 30 mph but may vary from nearly stationary to 70 mph.

4.8.2 Severity and extent of tornadoes. Studies show that approximately 78% of tornadoes in north Alabama occur between March and August [6]. However, tornadoes can occur at any time during the year. In terms of timing, they tend to occur between noon and midnight. Almost 80% of all tornadoes in north Alabama happen during this time period. The path followed by a tornado is called a tornado track, and while exact track extent varies with the strength and geographic location of the tornado, these tracks usually extend a few miles in length and several meters in width.

The severity of a tornado can be assessed using the estimated wind speed. The NWS typically incorporates damage severity and extent as a key factor in determining wind speed. Tornado severity prior to 2007 was measured in terms of the Fujita (F) scale [7]. The Enhanced Fujita (EF) scale became the standard in 2007 [8]. The F scale provided six categories for classifying tornadoes; classification was based on the associated wind speed and ranged from F0 to F5 (where F0 was the minimum and F5 was the maximum). The EF Scale was implemented by the NWS to rate tornadoes in a more consistent and accurate manner and incorporates more parameters for the strength assessment than the original F scale. It is important to note that in this threat assessment tornado data prior to 2007 is still categorized using the F scale. A comparison of the wind speeds for both scales is shown in Table 4.18 below.

4.8.3 Tornado history profile. The effect of tornadoes in north Alabama is assessed at two levels: Madison and adjacent counties level and UAH campus level. Historically, only the tornadoes of 1974 (ID-102) and 1967 (ID-925) are known to have tracks across the UAH campus. A total of 221 tornadoes, at an average rate of 3.2 per year from 1950-2012, are reported in the NOAA severe weather database files for Madison and the adjacent counties. See Table 4.17 for a list of tornados that have struck within the Huntsville city limits.

A total of ten tornadoes with a magnitude of F3 or greater have struck within the Huntsville city limits between 1950 and 2012. Of these tornadoes, three (1952, 1989, and 1995) were of F4 and one (2011) of EF5 magnitude. The 2011 tornado outbreak resulted in a multi-day, county-wide power failure in Madison County and Huntsville (27th April – 1st May, 2011). Some portions of the county were without power for as many as seven (7) days. UAH was without power for almost seven (7) days. This outage resulted in a complete inability to conduct normal operations on the UAH campus, as well as in the surrounding city and county.

Table 4.17: List of all tornadoes withing the Huntsville city limits (1950-2012)

TORN_ID	YEAR	MONTH	DAY	TYPE	**F**-SCALE	INJ	FAT	PR_DMG*
82	1952	3	22	TORNADO	F4	50	4	4
23	1952	2	13	TORNADO	F3	26	1	5
26	1954	3	13	TORNADO	F3	20	2	7
627	1957	6	28	TORNADO	F2	0	0	4
168	1958	5	25	TORNADO	F2	1	0	4
862	1967	11	24	TORNADO	F2	7	0	5
898	1967	12	18	TORNADO	F2	27	2	6
925	1967	12	21	TORNADO	F1	1	0	5
1049	1973	11	27	TORNADO	F3	42	0	6
102	1974	4	1	TORNADO	F3	6	1	6
225	1974	4	3	TORNADO	F3	7	2	6
559	1977	7	8	TORNADO	F2	0	0	5
562	1985	8	16	TORNADO	F1	0	0	4
578	1986	7	28	TORNADO	F0	0	0	2
816	1989	11	15	TORNADO	F4	463	21	8
641	1989	7	2	TORNADO	F2	0	0	5
623	1994	6	26	TORNADO	F1	0	0	5
481	1995	5	18	TORNADO	F4	55	1	6
221	1997	5	3	TORNADO	F0	0	0	0
1210	2003	5	6	TORNADO	F0	0	0	0
734	2004	3	5	TORNADO	F0	0	0	0
1421	2004	7	14	TORNADO	F0	1	0	4
173	2009	4	2	TORNADO	F0	0	0	4
449	2009	5	6	TORNADO	F2	0	0	6

1168	2010	10	26	TORNADO	F0	0	0	3
302252	2011	4	27	TORNADO	F1	0	0	0
302308	2011	4	27	TORNADO	F1	0	0	0
302230	2011	4	27	TORNADO	F1	0	0	0
309488	2011	4	27	TORNADO	F5	145	72	9
302325	2011	4	27	TORNADO	F1	0	0	0
361096	2012	3	2	TORNADO	F3	0	0	0
TOTAL						**851**	**106**	

*1 $1-$50
2 $50-$500
3 $500-$5,000
4 $5,000-$50,000
5 $50,000-$50, 0000
6 $500,000-$5,000,000
7 $5,000,000-$50,000,000
8 $50,000,000-$5, 00,000,000
9 $5,00,000,000-$50,000,000,000

Source: *Severe Weather Database Files (1950-2012) - NOAA*

(NOTE: The injuries/fatalities mentioned here are for the entire tornado track not for the particular location)

Table 4.18: Fujita F scale and new EF scale wind gusts and damage comparisons:

F-SCALE	WIND SPEED (MPH)	EF-SCALE	WIND SPEED (MPH)	COMMENT
F0	45-78	EF0	65-85	Minimal Damage
F1	79-117	EF1	86-109	Moderate Damage
F2	118-161	EF2	110-137	Considerable Damage
F3	162-209	EF3	138-167	Severe Damage
F4	210-261	EF4	168-199	Devastating Damage
F5	262-317	EF5	200-234	Incredible Damage

Source: *http://www.spc.noaa.gov/faq/tornado/ef-scale.html*

4.8.4 Probability of future occurrence.

4.8.4.1 Temporal probability. The annual distribution of tornadoes indicates an increasing trend over the last 60 years, with an average of 3.2 tornadoes occurring each year. This apparent trend is greatly affected by the more than 35 tornado events occurring in the region in 2011. Analysis of historical tornado events indicates that the months from March through June are the most susceptible to tornadic activity. Almost 74% of the total tornadoes in the region have occurred during these months, with a 60-year combined average of 37.3

tornado events per month during these months. The largest number of tornadoes (72) occurred in the month of April. Tornadoes can occur in the months from July to February, but the total is much lower than during March through June. Only 53 tornado events (26%) of the total 202 events occurred during these months, with an average of 6.7 tornadoes per month. This clearly indicates that the months from March to June have the highest probability of tornado events occurring (the probability is greater than 1). While the probability of a tornado occurring during the other months is much less, the chances cannot be ruled out completely (see Figure 4.10).

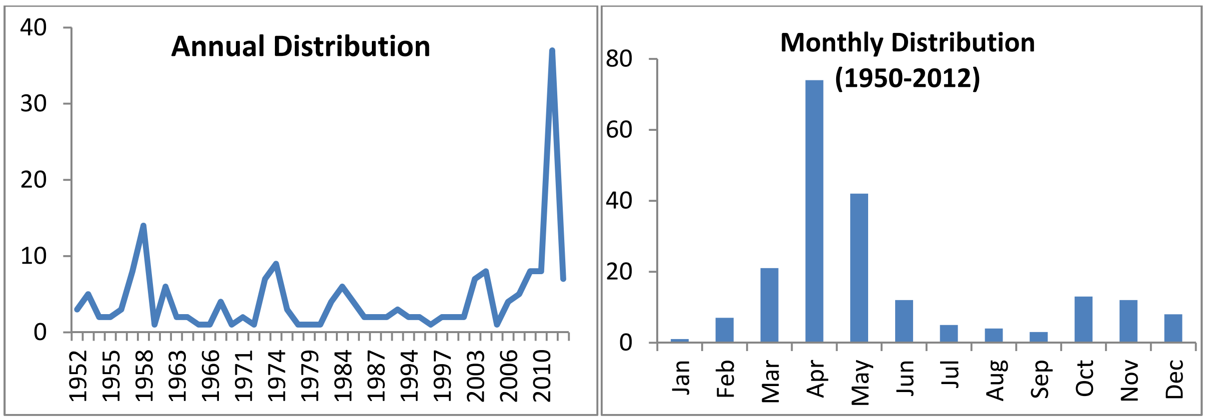
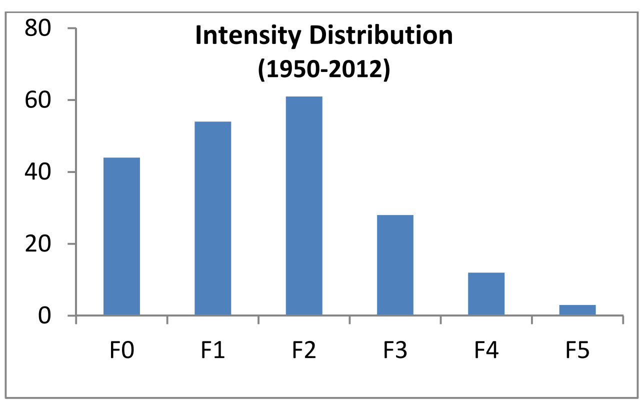


Figure 4.10: Monthly and Annual tornado event distributions in the region (1950-2012)

The average number of tornadoes per year is 3.21, with a maximum of 37 tornadoes in 2011. Only 7.5% percent of these tornadoes are of EF4 or EF5 magnitude (see Figure 4.11 (a). A total of 851 injuries and 106 fatalities are recorded for the tornadoes that have struck Huntsville since 1950. Box plots of the injuries and fatalities for each of the tornado types are given below, Figure 4.11 (b) and (c), for the five counties. The distribution clearly indicates that the maximum number of casualties is recorded for F4 and F5 tornadoes. The 2011 F4 tornado (ID 314625) resulted in an extremely high number of injuries (nearly 1500).



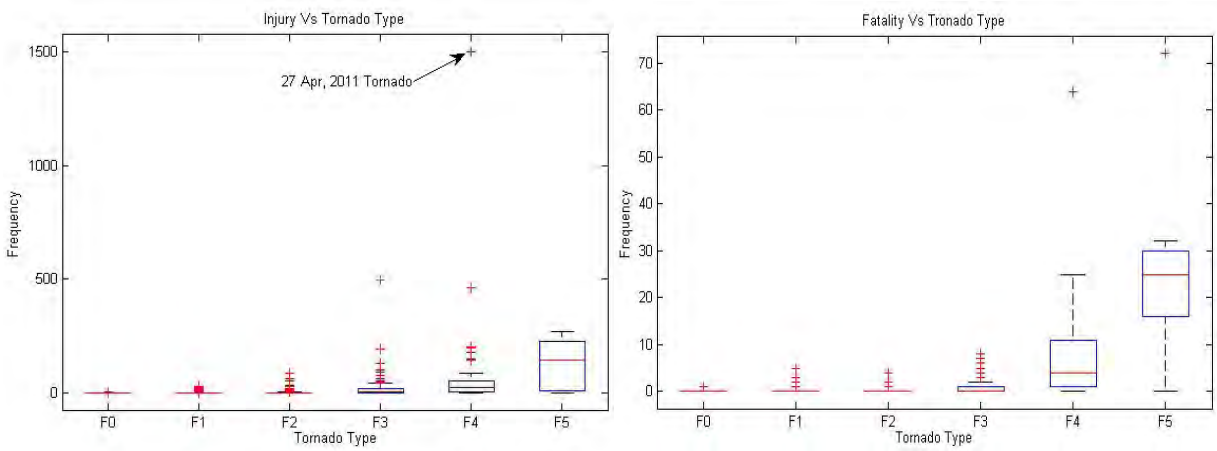


Figure 4.11: (a) Tornado type historical frequency distribution (b) box plot Fatalities per tornado type over the years and (c) Injuries per tornado type (1950-2012)

4.8.4.3 Spatial probability. The UAH campus has experienced only two tornadoes directly impacting the campus. These occurred in 1967 and 1974. The 1974 tornado (F3) passed directly across the campus causing more than half of the UAH campus to be in its direct or indirect impact zone. The tornado of 1967 (F1) passed just south of the campus, and only the southernmost part of the campus was impacted. Figure 4.12 shows the two tornado tracks and their impact zones.

As mentioned above, a total of 202 tornadoes have been recorded in the five-county region around the UAH campus since 1950. These tornadoes, as shown in Figure 4.13, are more or less uniformly distributed throughout the region. Therefore, at this spatial scale, an accurate spatial distribution of an atmospheric event (such as a tornado), which is the result of a large scale meteorological phenomenon, is not possible. However, at larger spatial scales such as the continental scale, spatial variability is easily studied. Additionally, studies by Ashley (2008) and others show that the various regions of northern Alabama are more or less equally susceptible to a tornado event.

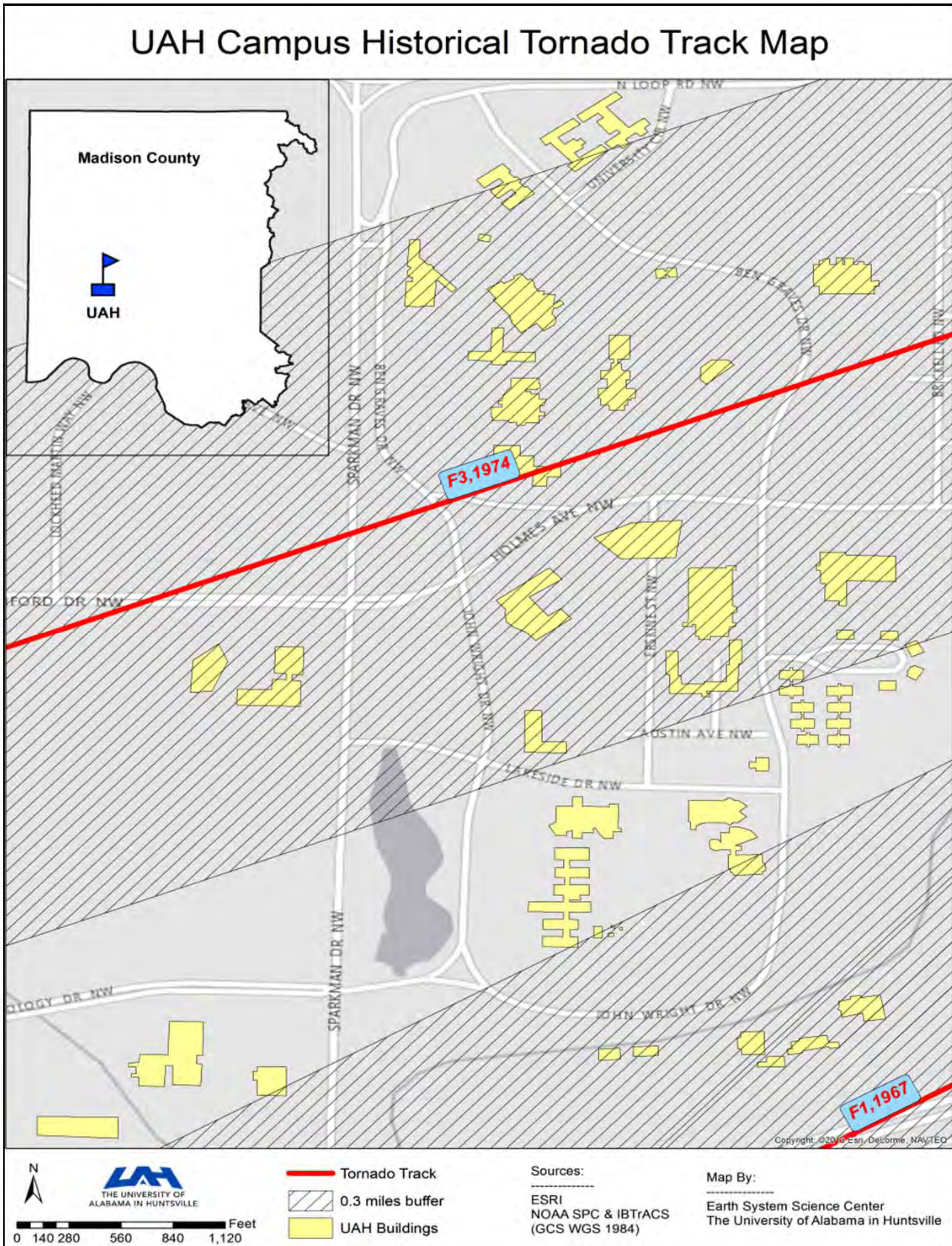


Figure 4.12: UAH historical tornado tracks with 0.3 miles buffer zone

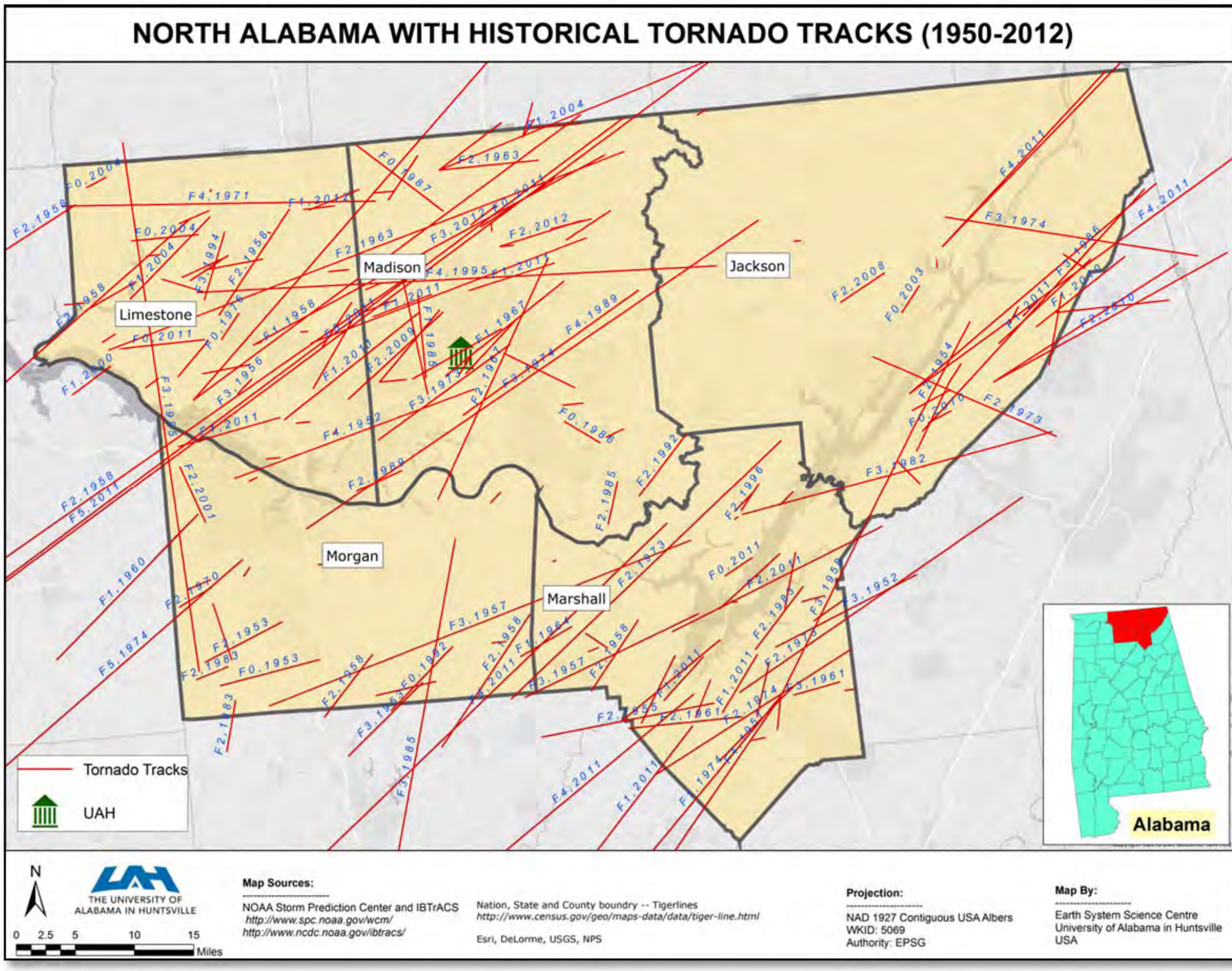


Figure 4.13: Adjacent counties tornado tracks (1950-2012)

4.8.5 Impacts. Tornado damage results from high wind speed and wind-blown debris. Tornado winds can reach as high as 300 miles per hour and travel over 100 miles on the ground. Tornado damage is directly correlated to the strength of a particular tornado and is quantified using the EF scale as outlined above. Tornadoes may be anywhere from several yards to over one mile in width. It should be noted that tornado strength as measured by the EF scale does not necessarily have a direct correlation to the width of a given tornado.

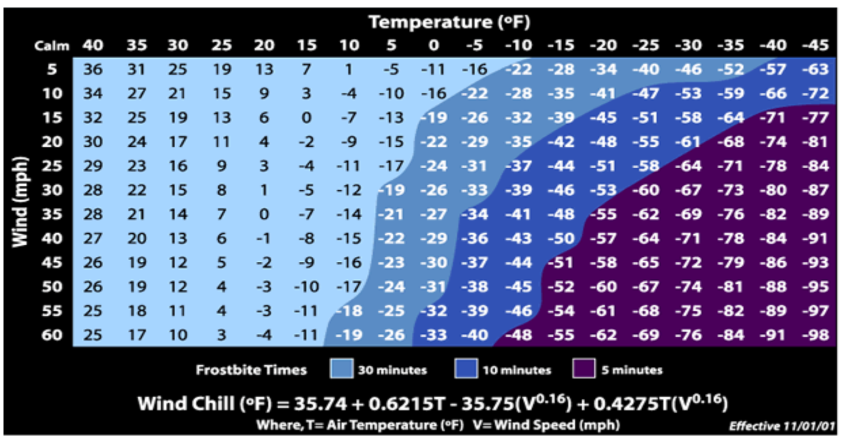
Tornado damage may result in casualties, property damage, financial losses, increased insurance premiums, and/or brand and institutional reputation damage.

4.9 Hazard: Winter Storms and Extreme Winter Weather

4.9.1 Nature of hazard. Winter storms can be multi-day events and typically consist of strong winds, freezing rain or sleet, heavy snowfall, and extreme cold temperatures. Winter storms can result in hazardous driving and walking conditions, utilities interruptions, public services interruption, and public safety services (such as police, fire, and emergency medical) interruptions or delays. Winter storms in the southeastern United States are typically caused by Canadian and Arctic cold fronts from northern and mid-western states along with tropical cyclonic weather in the Gulf of Mexico [9].

Extreme cold often accompanies or is a by-product of a winter storm. Prolonged exposure to the cold may cause frostbite or hypothermia and can become life-threatening. Strong winds along with intense storms can knock down trees, utility poles, and power lines. All UAH buildings and assets are equally subject to the severe winter storm hazard.

4.9.2 Severity and extent of winter storms. Heavy accumulations of ice can bring down trees, electrical wires, telephone poles and lines, and communication towers. Even small accumulations of ice may cause extreme hazards to motorists and pedestrians. Heavy snow can immobilize a region and paralyze a city, stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. The Wind Chill Temperature (WCT) index developed by the NWS is a chart that shows the relationship between temperature (F) and wind speed (mph) to deduce the possible winter risks. The index is divided into four parts; each part denotes the time within which skin might be frozen if exposed to air (Figure 4.14).



Wind (mph) \ Temperature (°F): Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

Wind Chill (°F) = $35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$

Where, T= Air Temperature (°F) V= Wind Speed (mph) *Effective 11/01/01*

Figure 4.14: National Weather Service Wind Chill calculation chart

4.9.3 Winter storm and extreme winter weather history profile. North Alabama historically has experienced a total of 22 extreme winter weather events, including winter storms (14), ice storms (5), snow/ice (5), and record cold temperatures (2) (see Table 4.19). These extreme winter weather events have resulted in a total property loss of nearly $5.02 billion, and a total of five fatalities and two injuries have been reported since 1993 in the region. The storm of March 12, 1993 is considered the worst winter storm to date (13 inches of snow fell within 24 hours); it resulted in four deaths and $5.0 billion in property damage.

> *"What most called the worst winter storm in Alabama history struck Friday afternoon and lasted until mid-day Saturday. Snow began falling over north Alabama Friday afternoon, then spread southward overnight, reaching all the way to the Gulf Coast. The storm was caused by a strong and massive low pressure system that moved from the Western Gulf of Mexico into the Florida*

panhandle, and up the Eastern Seaboard. The heaviest snow began after midnight when northerly winds of 40 to 55 mph became common. Frequent lightning discharges occurred of several hours giving an eerie blue-tinged glow to the atmosphere. By mid-day Saturday snow had accumulated to 6 to 12 inches over North Alabama. It was estimated that 400,000 homes were without electricity, and many remained so for several days. Only 4-wheel drive vehicles could barely maneuver roads, and some roads in north Alabama remained impassable until the following Tuesday. As if the snow, high winds, and extreme cold were not enough, many large trees fell onto homes and businesses."- NCDC Storm Data 1993 record.

Table 4.19: Recorded severe winter conditions in north Alabama (1993-2011)

DATE	LOCATION	EVTYPE	FAT	INJ	PRDMG
12-Mar-93	State wide	WINTER STORM	4	0	5.0B
09-Feb-94	N. AL	ICE STORM	0	2	0
06-Feb-95	N./C. AL	SNOW/ICE	0	0	0
11-Feb-95	N./C. AL	SNOW/ICE	0	0	0
10-Dec-95	N./C. AL	RECORD COLD	0	0	0
06-Jan-96	N./C. AL	WINTER STORM	0	0	380K
01-Feb-96	N./C. AL	WINTER STORM	0	0	595K
16-Feb-96	N. AL	WINTER STORM	0	0	195K
10-Jan-97	N. AL	WINTER STORM	0	0	64K
29-Dec-97	N./C. AL	WINTER STORM	0	0	0
04-Feb-98	N. AL	WINTER STORM	0	0	27K
23-Dec-98	N. AL	ICE STORM	1	0	14.4M
06-Jan-99	N. AL	WINTER STORM	0	0	0
21-Dec-99	N. AL	ICE STORM	0	0	0
28-JAN-00	N. AL	WINTER STORM	0	0	75K
28-JAN-00	N. AL	ICE STORM	0	0	1.11M
28-JAN-00	N./C. AL	WINTER STORM	0	0	2.27M
05-Feb-02	N. AL	WINTER STORM	0	0	30K
26-Feb-04	N. AL	WINTER STORM	0	0	0
28-Jan-05	N. AL	ICE STORM	0	0	0
08-Feb-10	Limestone	WINTER STORM	0	0	0
08-Feb-10	Madison	WINTER STORM	0	0	0
10-Jan-11	N. AL	SNOW/ICE	0	0	0
06-Jan-14	N. AL	RECORD COLD	0	0	0
26-FEB-15	N./C. AL	SNOW/ICE	0	0	0
05-MAR-15	N./C. AL	SNOW/ICE	0	0	0
TOTAL			**5**	**2**	**5.02B**

4.9.4.4 Probability of future occurrence. North Alabama, particularly Huntsville, experiences a minimum mean winter temperature of 37.14^{o}F and two snow days per year based on long term winter snow and temperature records maintained by NWS. NCDC storm database records show that Huntsville has experienced 22 extreme winter weather events since 1993, an average of at least one such event per year. Therefore, the temporal probability of extreme winter events in Huntsville or on the UAH campus is moderate.

4.9.5 Impacts. Impacts from winter storms and extreme cold weather events are directly correlated to the strength and duration of a given storm and the campus' ability to handle the affects. Risks include casualties, disruption of electricity for extended periods, disruption of transportation routes, and structural and/or landscape damage from ice or snow loading.

Extreme winter weather, including winter storms, ice storms, and heavy snowfall typically results in interruptions to normal UAH operations. Classes and operations are usually suspended during extreme winter weather events. Health and safety hazards to student residents and critical staff exist during extreme winter weather. These include exposure to extreme cold, potential for slips and falls, potential loss of heating, and other related hazards. Financial loss and increased insurance premiums may result if building or property damage occurs or if operations are disrupted for an extended period of time.

4.10 Hazard: Drought and Heat Waves

4.10.1 Nature of hazard.

4.10.1.1 Drought. A drought is a period of abnormally prolonged dry weather that may cause serious problems to agriculture, hydrology, meteorology, or the socioeconomics of a region. The severity of the drought depends upon the degree of moisture deficiency, the duration, and the size of the affected area.

There are four different ways that a drought can impact an area:

- Agricultural: A situation in which the amount of available soil moisture cannot meet the needs of a particular crop (i.e., moisture is below the wilting point for a long enough period to affect the crop's growth and development).
- Hydrological: Occurs when surface and subsurface water supplies are below long term norms for a watershed, which tends to affect the local ecology and water balances.
- Meteorological: A measure of departure of precipitation from the long term mean (normal) of a region. Due to different climatic conditions, this is measured regionally since what is considered a drought in one location of the country may be normal in another location.
- Socio-economic: Occurs when physical water shortages, especially for drinking and daily needs, begin to affect people and industry.

4.10.1.2 Heat wave. North Alabama summers are typically hot and humid. Summertime weather that is abnormally hot (usually 10 degrees or more above the regional average) and/or humid is termed an extreme heat condition. A combination of high temperature and humidity increases the level of discomfort for people and can potentially lead to an increase in mortality and morbidity. A heat wave combined with drought is a very dangerous situation for a region and its people.

4.10.2 Severity and extent of extreme heat events. Heat is one of the leading weather-related causes of fatalities in the United States, resulting in hundreds of deaths each year. Generally, extreme heat events are defined by high humidity, temperatures ten (10) degrees or more above the average high for the region, and such conditions lasting for prolonged periods of time.

Humid conditions occur when a dome of high atmospheric pressure traps hazy, damp air near the earth's surface. A heat wave is an extended period of extreme heat and is often accompanied by high humidity. These conditions can be dangerous and even life-threatening for people who do not take the proper precautions.

NOAA's heat alert procedures are based on heat index values. The heat index is given in degrees Fahrenheit and is a measure of how hot it really feels when relative humidity is factored into the actual air temperature. The heat index as a combination of temperature and relative humidity conditions is given below in Figure 4.15.

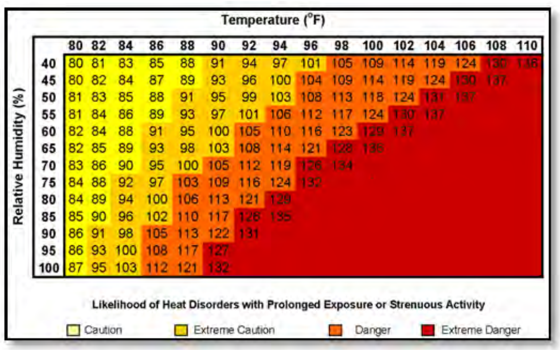


Figure 4.15: Heat Index chart *(Source: http://www.nws.noaa.gov/os/heat/images/heatindex.png*)

On average, more than 1,500 people die in the United States annually due to the direct or indirect effects of extreme heat. This number is greater than the annual average of deaths from tornadoes, hurricanes, floods, and lightning combined. Extreme heat tends to cause severe health related hazards such as those listed in Table 4.20.

Table 4.20: Health effects and their symptoms caused by excessive heat event

TYPE	Danger Category	Temperature (°F)	SYMPTOMS
Heat Cramps	III Danger/II Extreme Caution (depending upon duration of exposure)	90-105 (II) 105-130 (III)	Painful muscle cramps and spasms usually in legs and abdomen; Heavy sweating
Heat Exhaustion	III Danger/II Extreme Caution (depending upon duration of exposure)	90-105 (II) 105-130 (III)	Heavy sweating; Weakness; Cool, pale, clammy skin; Weak pulse; Possible muscle cramps; Dizziness; Nausea and vomiting; Fainting.
Heat Stroke (Sunstroke)	IV Extreme Danger	>130	Altered mental state; Possible throbbing headache, confusion, nausea, dizziness, shallow breathing; High body temperature (106°F or higher); Skin may be hot and dry, or patient may be sweating; Rapid pulse; Possible unconsciousness.

Source: National Weather Services (http://www.nws.noaa.gov/os/heat/index.shtml#firstaid)

4.10.3 History Profile. North Alabama has experienced a total of 93 excessive heat events since 1996, which have resulted in two (2) fatalities (June 24, 2000 and July 28, 2005) and ten (10) injuries 2008 (see Table 4.21 and Figure 4.16). However, there is no record of any kind of property damage due to excessive heat events in the region.

Since 1998, a total of 29 droughts were recorded in the NCDC storm database for north Alabama. There were no fatalities or injures due to droughts, though crop damage of $100,000 was recorded during September 1998.

Table 4.21: **Summary of extreme heat events in North Alabama (1993-2012)**

EVENT TYPE	LOCATION	FAT	INJ	DAMAGE ($K)
Extreme Heat	North Alabama	02	10	00
Drought	North Alabama	00	00	100

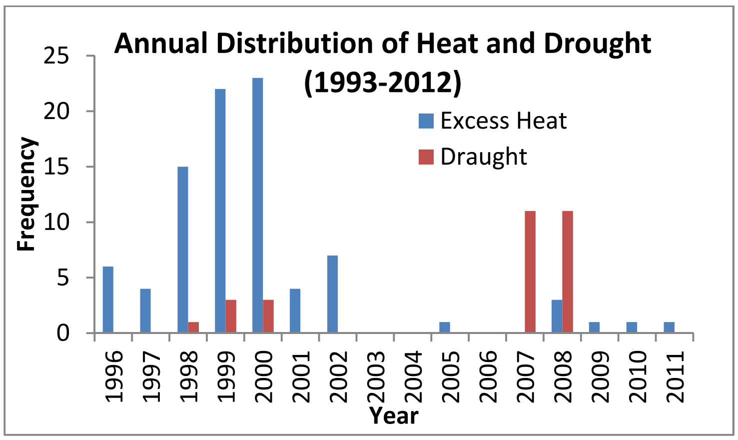


Figure 4.16: Frequency distribution of excess heat and drought events in North Alabama (1993-2012)

4.10.4 Future probability and impact. Based on limited historical data for north Alabama and Huntsville the probability of extreme heat events and drought events is moderate for the UAH campus.

4.10.5 Impacts

Extreme heat and drought may impact UAH community members, properties, and finances (economic impact). Drought that cause shortages of or forced rationing of water for irrigation purposes can result in damage to lawns, landscaping, and other grounds and land features. In addition to lawn and plant damage, drought-related grounds damage may include soil erosion and resulting sediment problems, sinkhole formation, and soil shrinkage which can lead to building settling and structural and foundation damage.

There are some indirect effects as well: 1) prolonged drought can cause water scarcity that can lead to problems acquiring water for drinking and/or reduced water availability for critical campus operations; 2) lack of potable water may lead to civil unrest; 3) extreme heat events can lead to direct health hazards as described above; 4) financial loss and insurance cost increases may occur if property damage or disruption of operations results. Therefore, based on historical records, extreme heat events pose a slight risk for the UAH community and a moderate risk for campus property.

4.11 Hazard: Earthquakes

4.11.1 Nature of hazard. USGS describes an earthquake as the vibration of the earth's surface typically produced by shock waves from the rupturing of rocks under either friction or stress at or beneath the Earth's surface. The process releases a tremendous amount of energy which is termed an earthquake. Earthquakes can be caused by landslides, rockslides, meteor impacts, friction between moving rocks within the core of the Earth, or fracturing of rock materials along fault lines.

4.11.2 Severity and extent of earthquakes. Earthquake intensity is measured either on the Richter scale, which measures the amplitude of the largest seismic wave, or the Modified Mercalli Intensity (MMI) scale, which combines people's observations and the severity of physical damage caused to assess the intensity [11]. Richter scale intensity measurements are considered more scientific and thus more accurate when compared to the MMI scale [12]. Table 4.22 gives a comparison between both Richter and MMI intensity levels and damage associated.

Table 4.22: Comparison of Richter scale and MMI scale with their typical effects

Richter Scale Magnitude	Typical Maximum MMI	Typical Effect
1.0 – 3.0	I	Not felt except by very few
3.0 – 3.9	II – III	II - Felt only by few III – Felt noticeably
4.0 – 4.9	IV – V	IV – Very noticeable, walls make cracking sound V – Nearly everyone feels, unstable object overturn
5.0 – 5.9	VI – VII	VI – Felt by all, Slight property damage VII – slight damage to well-built ordinary structures, significant damage to poorly built structures
6.0 – 6.9	VIII – IX	VIII – Slight damage in well-built structure, fall of chimneys, factory stacks etc. IX – Great damage in majority of buildings with partial collapses
7.0 and More	X and higher	High scale destruction

Source: *http://earthquake.usgs.gov/learn/topics/mag_vs_int.php*

Northern Alabama falls within three frequently active seismic zones: the New Madrid Seismic Zone, the Southern Appalachian Seismic Zone, and the South Carolina Seismic Zone (see Figure 4.17). The UAH campus, according to the USGS's Geohazard tool, falls into the 4-6% Peak Ground Acceleration (PGA) category with a 10% probability of 50 years exceedance [13]. This means that there is a 10% chance of a 50 year earthquake event with 4-6% maximum horizontal ground movement. A 4-6%g PGA is associated with level IV-V on the MMI scale, indicating low to moderate damage probability.

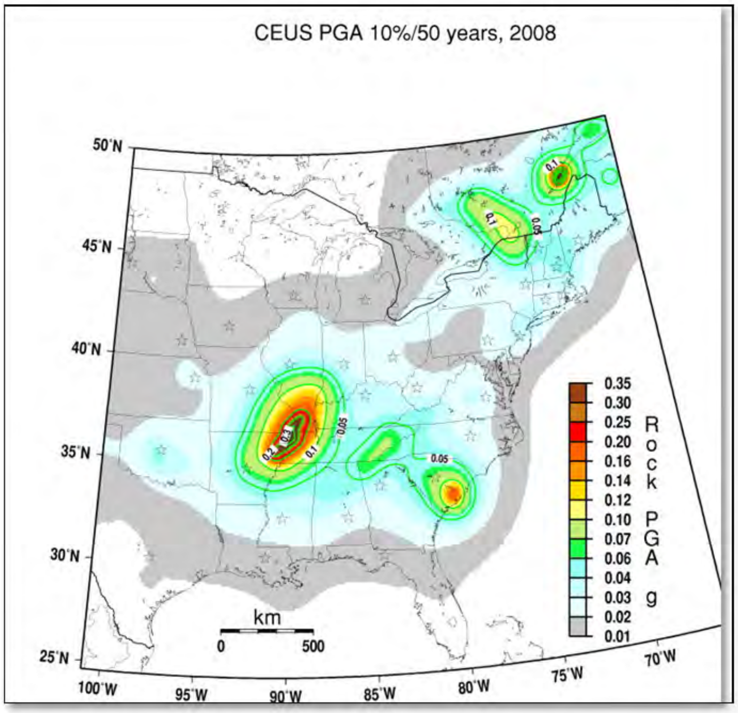


Figure 4.17: A 10% 50 years USGS Geohazard map for Southeast United States, displaying 3 notable active seismic zones. (***Source:*** *https://geohazards.usgs.gov/hazards/apps/cmaps/)*

4.11.3 Earthquake history profile. Historically, according to the Geological Survey of Alabama's records, a total of 66 earthquakes with epicenters in Limestone, Madison, Marshall, Morgan, and Jackson counties have been recorded since 1927. Of these earthquakes, six fell in Madison County (details in Table 4.23). Roughly 88% of these earthquakes were between magnitudes one (1) and three (3) on the Richter scale. The Huntsville earthquake of 1939 had a magnitude of 4.2 and is the only earthquake event to exceed magnitude 4 in this area. This earthquake's epicenter was approximately 3.5 miles south of the current UAH campus.

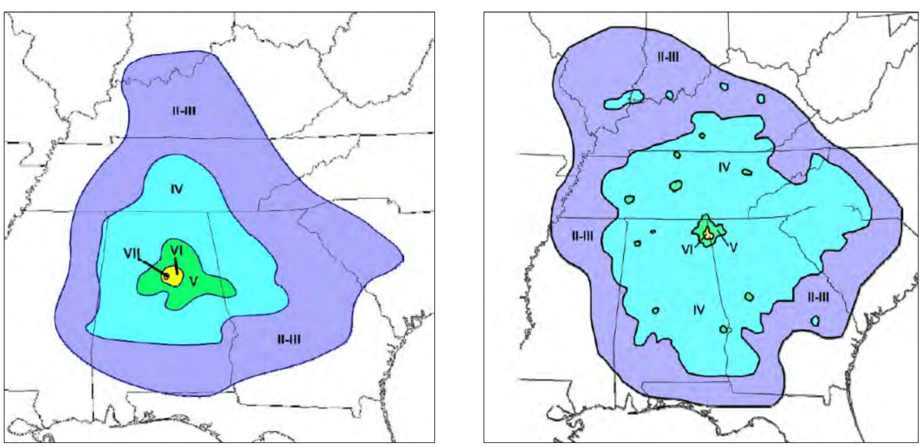


Figure 4.18: (LEFT) Intensity map of Irondale Earthquake (10/18/1916); (RIGHT) Intensity map of Fort Payne Earthquake (4/29/2003). **Source:** *Geological Survey of Alabama*

Tremors have been felt in the region on multiple occasions due to earthquakes with epicenter miles away. For instance, the area now comprising the UAH campus experienced a MMI level VII intensity tremor due to the earthquake of Oct. 18, 1916 (Irondale Earthquake) centered at Shelby County and level VI on Apr. 29, 2003 at Fort Payne, Alabama. The Irondale earthquake is the strongest earthquake recorded for Alabama (approximately 5.1 magnitude on the Richter or level VII on the MMI scale). A seven-state area totaling approximately 100,000 square miles felt the tremor. The 2003 Fort Payne earthquake had a Richter magnitude of 4.9. The UAH campus was under level VI intensity (based on MMI scale) during the Fort Payne earthquake, which is typically characterized as felt by many people, walls make cracking sounds, and pictures hanging may fall. No major damage from these earthquakes has been reported on campus. Figure 4.18 shows intensity maps for both of these earthquakes.

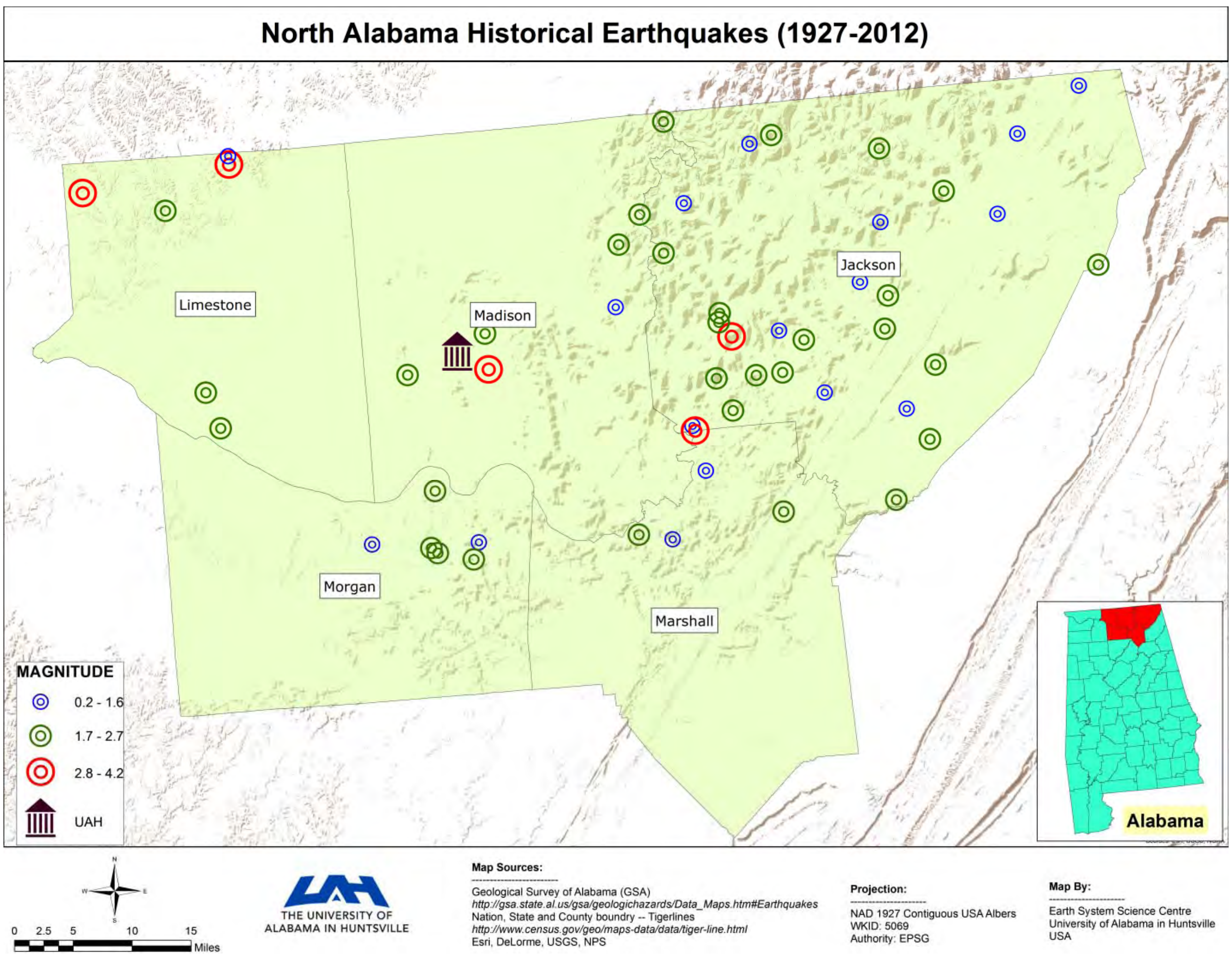


Figure 4.19: Historical Earthquake epicenters in North Alabama (1927-2012)

Table 4.23: List of Earthquakes with epicenter in Madison County (1927-2013)
***(Source:** Geological Survey of Alabama)*

Year	Richter Scale	Depth (km)	Location
1939	4.2	NA	Huntsville
1957	0.2	NA	Farley
1984	2.7	1.3	Huntsville
1988	1.9	14.4	Madison
1989	1.3	17.9	Huntsville
1992	2.1	8.2	New Market
2011	2.5	9.8	New Market
2013	2.3	21.8	Triana

4.11.4 Probability of future occurrences. From the analysis of historical events and PGA probability assessment from USGS, it seems that north Alabama frequently experiences earthquakes but of a very mild nature (88% are under magnitude 3.0). Only three (3) earthquakes were recorded in 53 years (1927-1980) in north Alabama; however, since 1980, 63 earthquakes have been recorded for the region at an average of almost two (2) earthquake events per year (Figure 4.19). A monthly distribution for the region shows approximately 4.2 earthquakes in the months of September through January 6.4 from February through August.

As noted above, the UAH campus is within three active seismic zones. This makes the campus highly susceptible to an earthquake event. Although recent historical records indicate numerous tremors around the campus, almost all of them were of mild intensity. However, based on the historical events and proximity of UAH to both the New Madrid and the Southern Appalachian Seismic Zones, the probability of major earthquake events in the region is of a moderate nature (7-10% chance of magnitude 7.5 and higher; 25-30% chance of magnitude 6 and higher). Yet, in the case of a major earthquake event, the economic loss is estimated to be in the billions of dollars, and the possibility of fatalities and injuries cannot be ignored.

4.11.5 Impacts. Potential impacts to the campus include casualties, loss of potable water supply, natural gas service interruption, utilities interruption, structural damage, property and roadway damage, increased insurance costs, and disruption of operations.

4.12 Hazard: Landslide

4.12.1 Nature of hazard. Landslides are typically described as any down and outward slope movement of soil and rock under the direct influence of gravity. Landslides consist of up to five modes of slope movement: falls, topples, slides, spreads, and flows. Landslides can consist of soil, rocks, and artificial fills. There are multiple factors that may contribute to a landslide. These can include rainfall, snowmelt, changes in water level, stream erosion, soil erosion, changes in ground water levels, earthquakes, volcanic activity, disturbance by human activities, or any combination of these factors [14].

4.12.2 Severity and extent of landslide. Landslides can move slowly, (millimeters per year) or can move quickly and disastrously, as is the case with debris flows (generally 30-50 mph) depending on the slope angle, water content, volume of debris, and type of earth and debris in the flow. Landslides constitute a major geologic hazard because they occur throughout the United States and cause $1-2 billion in damages and more than 25 fatalities on average each year [15].

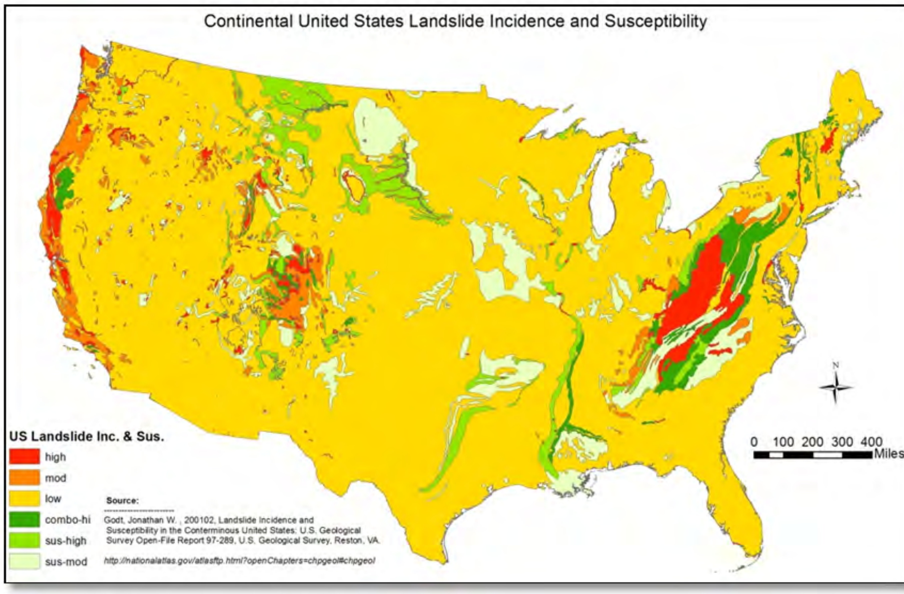


Figure 4.20: Continental United States landslide incidence and susceptibility map

Figure 4.20 shows landslide incidence and susceptibility in the continental United States. In the above graphic, "combo-hi" indicates areas with high susceptibility to landslides but where there are only a moderate number of incidents; "high" indicates areas with a high number of landslide occurrences (more than 15% of the area experience landslides); "low" indicates areas with landslide incidents impacting less than 1.5% of the involved land; "mod" indicates areas with 1.5-15% of involved land experiencing landslides; "sus-high" indicates areas with a high susceptibility to landslides but where few incidents occur, and "sus-mod" indicates areas with moderate susceptibility and low incident rates.

4.12.3 Landslide history profile. Historically, there have been a total of 70 landslide events in north Alabama since 1950. Almost all the counties of the region are susceptible to landslides based on these historical events. The maximum (34) landslide events were recorded in Madison County. A summary of landslides for each county is tabulated in Table 4.24 below.

Table 4.24: Summary of historical landslide events in 5 Counties of North Alabama (1950-2012)

County	Number of Landslides
Madison	***34***
Limestone	02
Jackson	19
Morgan	10
Marshall	02

***Source**: Geological survey of Alabama (GSA)*

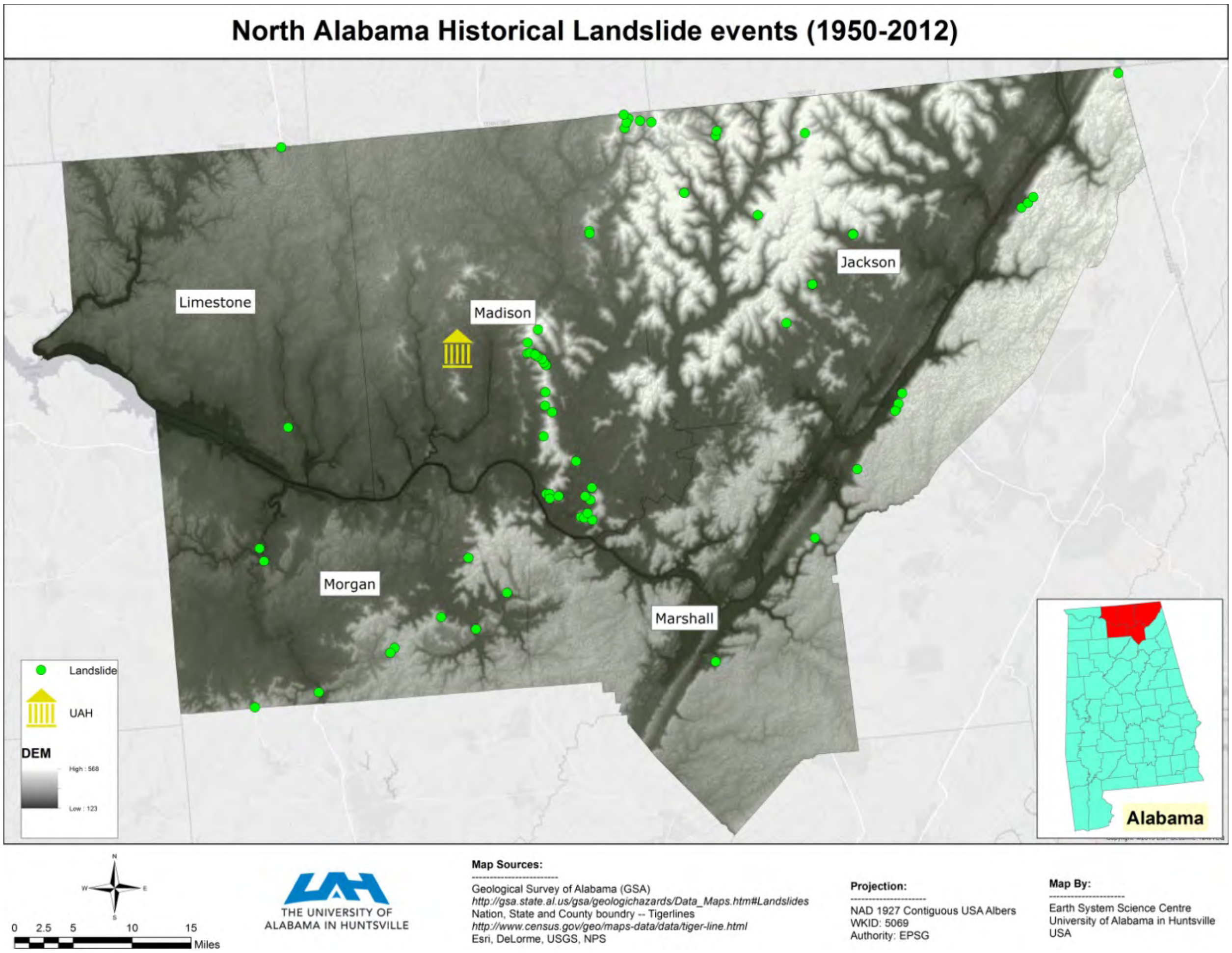


Figure 4.21: North Alabama historical landslide event locations with respect to UAH campus.

4.12.4 Probability of future occurrence. As Figure 4.21 shows, the UAH campus has not experienced any reported landslide events historically, and since the campus is situated mostly on a plane surface, the future probability of landslides at the UAH campus is negligible.

4.12.5 Impacts. Impacts to UAH assets, personnel, or property from landslides are unlikely. However, landslides in the surrounding region could cause damage to roads and communities, thus indirectly affecting UAH.

4.13 Hazard: Sinkholes and land subsidence.

4.13.1 Nature of hazard. The USGS defines a sinkhole as "an area of ground that has no natural external surface drainage--when it rains, all of the water stays inside the sinkhole and typically drains into the subsurface . . . Some are shaped like shallow bowls or saucers whereas others have vertical walls; some hold water and form natural ponds. Typically, sinkholes form so slowly that little change is noticeable, but they can form suddenly when a collapse occurs. Such a collapse can have a dramatic effect if it occurs in an urban setting."

Sinkholes may be naturally occurring or human-induced. Construction and land development practices may lead to human-induced sinkholes where groundwater and rock and soil composition is conducive to formation or where karst conditions are already present. Changes to water drainage patterns, added weight of new construction, interruption of underground streams by excavation, and other construction-related activities may contribute to the formation of sinkholes.

Naturally occurring sinkholes may occur as the result of drought or heavy rains. Drought can cause a lowering of water tables, and groundwater fluid pressure often helps support soil covering underground cavities in and around aquifer systems. Reduced pressure can result in underground soil and rock structural failures, thus creating sinkholes. Heavy rains can result in over-pressurization and increased water flow in aquifer systems, and where weaknesses exist, the increase in groundwater pressure and potential underground soil and rock erosion may combine to result in the formation of sinkholes.

4.13.2 Severity and extent of sinkholes. The USGS states “sinkholes can vary from a few feet to hundreds of acres and from less than 1 to more than 100 feet deep.” According to scientific studies and the USGS, almost 20% of the United States area is susceptible to sinkholes (Figure: 4.22). Historically, the most damaging sinkholes have been found in Alabama, Florida, Texas, Missouri, Kentucky, Tennessee, and Pennsylvania.

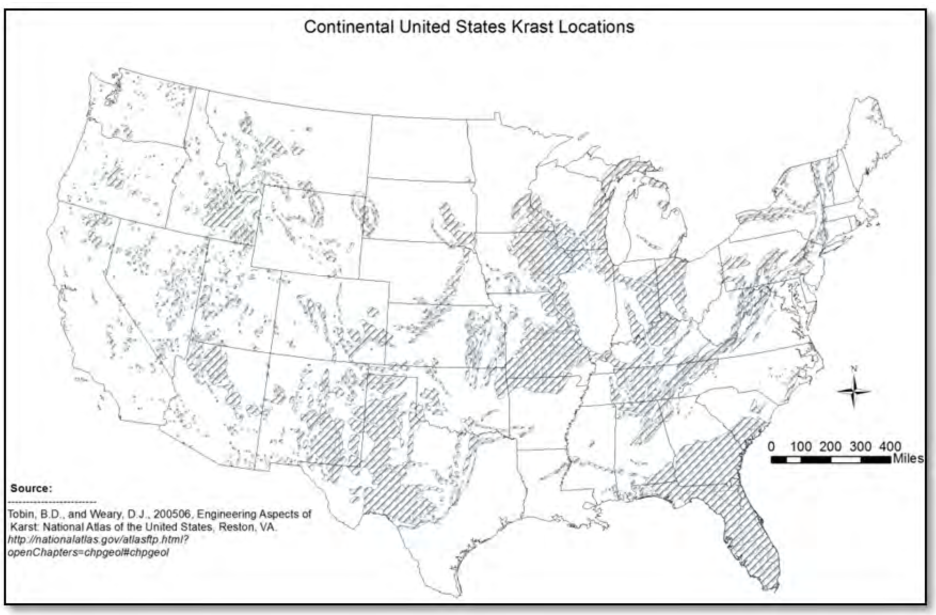


Figure 4.22: Continental United States karst location map

4.13.3 Sinkholes history profile. Sinkholes are holes on the ground surface which form due to a hole (or more specifically a void, cavity, or cave) in the rock below which are formed over a period of time. A number of sinkholes are present in Huntsville and the surrounding areas. A total of 2,878 sinkholes have been reported since 1950 for the region. A summarized list of sinkholes per county is tabulated in Table 4.25 and a map of historical sinkhole events can be seen in Figure 4.23 below.

Table 4.25: Summary of historical sinkholes in North Alabama

County	Sinkholes
Madison	***453***
Limestone	278
Jackson	393
Marshall	178
Morgan	963
Lawrence	608

Source: *GSA*

UAH experienced one moderate-sized sinkhole in 1967, estimated to have been roughly 30 feet in diameter with an unknown depth. This sinkhole occurred over an underground aquifer and is believed to have been the result of heavy rains creating higher than normal groundwater pressures, which in turn caused erosion and collapse of an underground cavity.

A small sinkhole approximately 2.5 feet in diameter and one to two feet in depth occurred on the campus in December 2013. This sinkhole occurred at the Nursing Building expansion project construction site following installation of a foundation caisson a few feet away.

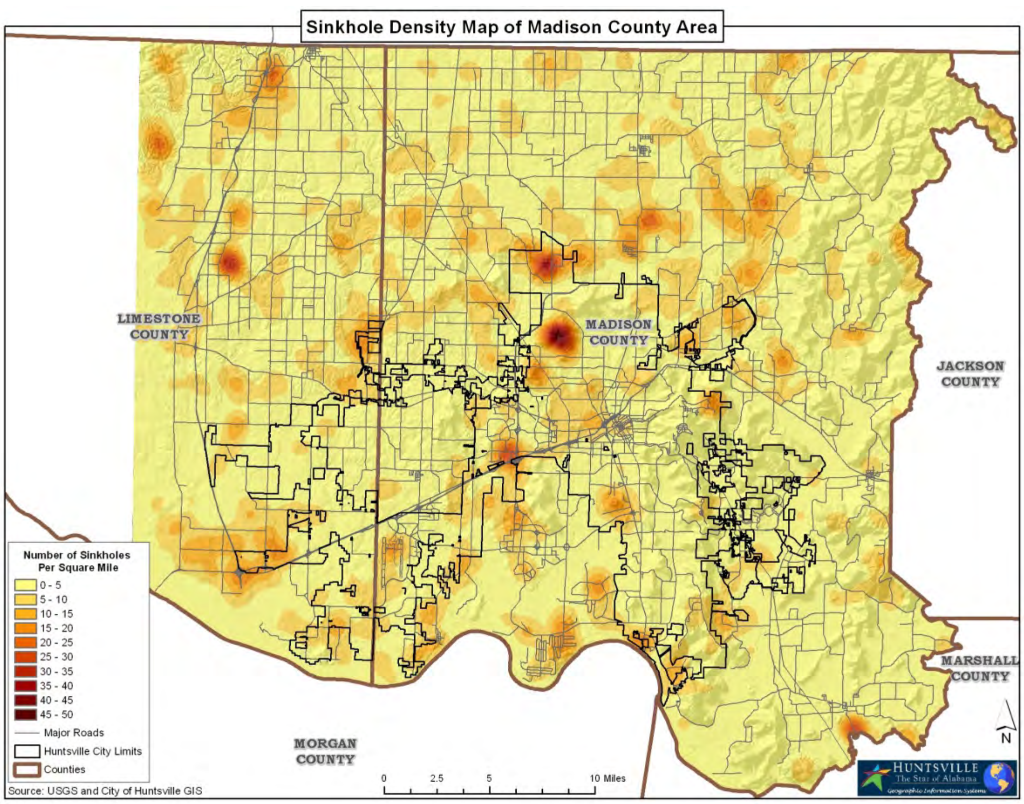


Figure 4.23 Sinkhole Density Map of Madison County Area (source: City of Huntsville)

4.13.4 Probability of future occurrences. Huntsville is situated in a region where land subsidence is a frequent phenomenon. The area is underlain by carbonate rocks, primarily limestone. The area is characterized by the presence of subsurface cavities and underground aquifers. These characteristics render the area highly susceptible to land subsidence and sinkholes.

It should be noted that Madison County has many areas with high sinkhole densities per square mile (see Figure 4.23). Therefore, the possibility of future sinkhole events on UAH grounds is high, especially since the campus is located over identified karsts zones (areas more susceptible to sink holes) in north Alabama (Figure 4.22).

Adding to the future probability is the large amount of recent construction, excavation, and changes in land use across the campus. Anecdotal reports (unverified but from reliable sources) indicate that a small underground stream was encountered during excavation for caissons for the Shelby Center for Science and Technology building construction. It is believed additional fill material was used to support the caisson. It is unknown how the underground stream was impacted or how the possible diversion of the stream may impact the campus in the future.

4.13.5 Impacts. Subsidence occurring in developed areas of the campus may have significant impact including property damage, structural damage, increased insurance costs, and potential casualties.

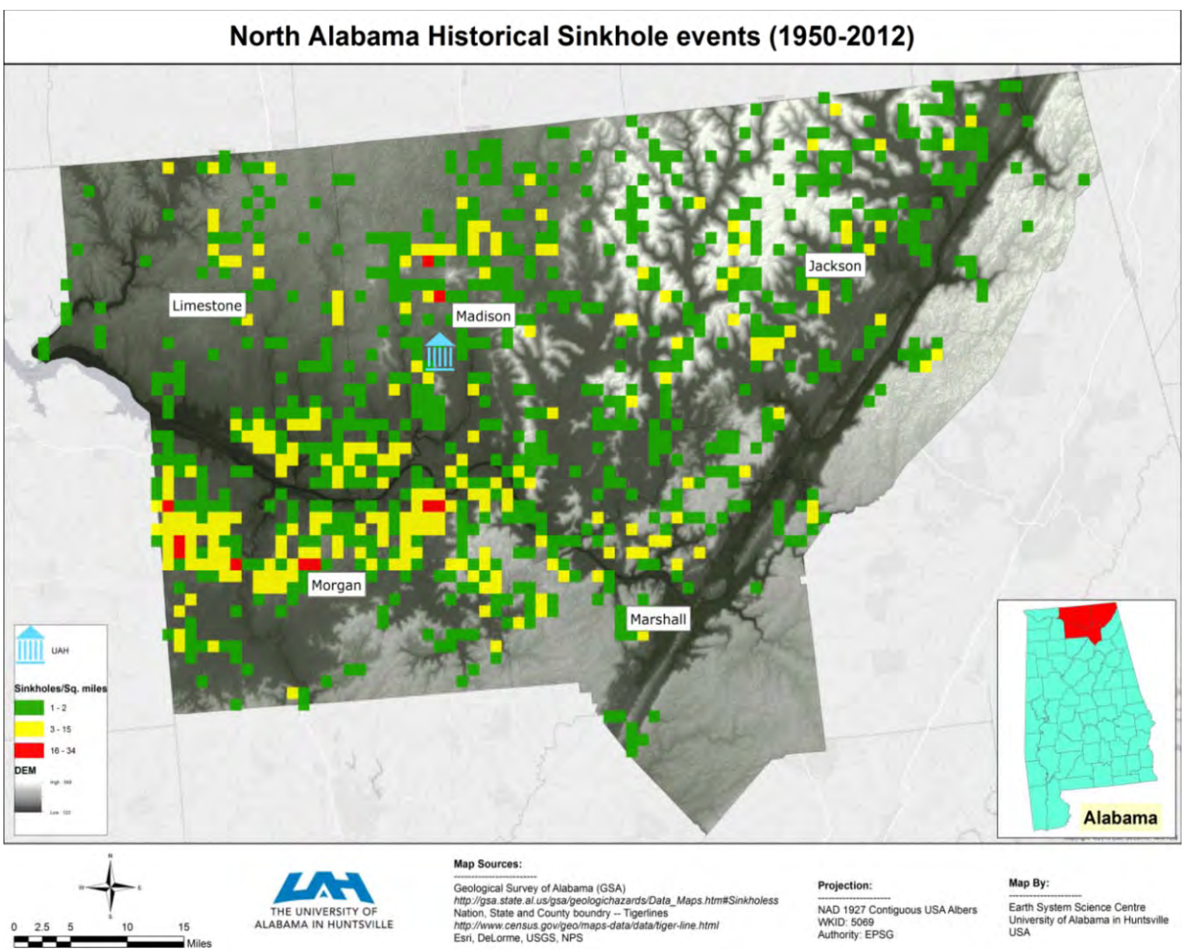


Figure 4.24: North Alabama historical sinkhole event locations with respect to UAH campus.

4.14 Hazard: Criminal Activities

4.14.1 Nature of the hazard. Criminal activities are man-made hazards. The University of Alabama in Huntsville is a relatively safe place; however, crime can occur anywhere. Criminal activities considered during this hazard analysis include incidences such as theft, vandalism, sexual offence, murder, non-negligent manslaughter, negligent manslaughter, and arson. UAH offers safety services with the help of the UAH Police Department (UAHPD). The UAHPD is located in the Intermodal Facility off John Wright Drive (Figure 4.24) and operates 24/7/365 including weekends and holidays. UAHPD consists of a force of sworn officers with state police powers. UAHPD's primary responsibilities include reporting/investigating criminal cases on-campus and in nearby public spaces around campus, as well as organizing several crime awareness and prevention programs such as:

- Sexual Assault Program
- Illegal Drug and Alcohol Policy
- Missing Student Report
- Emergency Response Procedures

4.14.2 Extent and severity. According to the Huntsville Police Department's annual reports (2011 & 2012) [16][17], a total of more than 48,000 crime events have been reported within the Huntsville city limits from 2010-2012; this results in an annual mean of nearly 16,000 reports. The crimes included are: homicide, rape, robbery, assault, burglary, larceny, and auto thefts. This has resulted in 11,263 total arrests in 2010, 12,498 in 2011, and 11,296 in 2012. This report does not include alcohol and drug related violations. The highest percentage of crime activities are larceny (39% of total) and burglary (36% of total) whereas homicide and sex-offences are both reported less than 1% each (0.08% and 0.6%, respectively).

According to the Federal Bureau of Investigation's (FBI) Uniform crime report, in 2011 there were 2,696 identified violent crime incidents and 87,160 property crime incidents in and around campuses in the United States. UAH reported 46 violent crime incidents (1.7% of US) and 896 property crime incidents (1% of US).

4.14.3. Criminal activities history profile. Historically, UAH is a relatively safe place; however a shooting occurred at the Shelby Center in 2010. In addition to the above mentioned incident, there have been cases of reported minor criminal activities on and around the UAH campus. A total of 220 on-campus and 13 off-campus criminal reports were filed between 2007 and 2012. [18] [19] **It should be noted that these numbers are only reports of incidences, and the actual number of incidents identified as actual crimes after thorough investigations may be less than the number reported.** Higher education institutions receiving federal monies are required by the Higher Education Opportunity Act (HEOA) and the Jeanne Clery Act (Clery Act) to report and track all instances of reported crimes listed in Table 4.26, regardless of whether the reports are later determined to be unfounded (meaning no crime occurred).

During the 2007-2012 period, a total of 53 arrests were made on campus and an additional 44 arrests off campus related to alcohol and drug violations. Further, a total of 280 student disciplinary referrals were made during 2007-2012. Tables 4.26, 4.27, and 4.28 below show the details for each of these reports, arrests, and disciplinary referrals in the categories required to be tracked under the HEOA and Clery Act.

Table 4.26: On-campus (Off-campus) criminal activities reported to UAHPD (2007-2012)*

TYPE	2007	2008	2009	2010	2011	2012	TOTAL
Murder and Non-negligent Manslaughter	00 (00)	00 (00)	00 (00)	03 (00)	00 (00)	00 (00)	**03 (00)**
Negligent Manslaughter	00 (00)	00 (00)	00 (00)	00 (00)	00 (00)	00 (00)	**00 (00)**
Sex offence - Forcible	05 (00)	00 (00)	03 (00)	00 (00)	04 (02)	03 (00)	**15 (02)**
Sex offence - Nonforcible	01 (00)	01 (00)	00 (00)	00 (00)	00 (00)	00 (00)	**02 (00)**
Robbery	00 (00)	00 (00)	00 (02)	01 (01)	01 (00)	00 (00)	**02 (03)**
Aggravated Assault	00 (00)	01 (00)	05 (00)	03 (01)	01 (00)	01 (00)	**11 (01)**
Burglary	40 (00)	23 (00)	33 (00)	24 (00)	38 (03)	22 (00)	**180 (03)**
Motor Vehicle Theft	00 (00)	00 (00)	02 (01)	03 (02)	02 (01)	00 (00)	**07 (04)**
Arson	00 (00)	00 (00)	00 (00)	00 (00)	00 (00)	00 (00)	**00 (00)**

Table 4.27: On-campus (Off-campus) criminal activities that resulted in arrests (2007-2012)*

	2007	2008	2009	2010	2011	2012	TOTAL
Liquor-Law Violations	00 (00)	02 (00)	00 (00)	04 (02)	00 (00)	00 (00)	**06 (02)**
Drug Abuse Violations	00 (01)	08 (07)	10 (07)	14 (09)	09 (07)	03 (09)	**44 (40)**
Illegal Weapons Possession	00 (00)	00 (01)	00 (00)	02 (00)	01 (00)	00 (01)	**03 (02)**

Table 4.28: On-campus disciplinary referrals to UAH (2007-2012)*

	2007	2008	2009	2010	2011	2012	TOTAL
Liquor-Law Violations	24	43	29	54	62	28	**240**
Drug Abuse Violations	00	05	09	13	07	06	**40**

Illegal Weapons Possession	00	00	00	00	00	00	**00**

***Source:** *UAHPD Annual Security Reports 2010-2013*

Figure 4.25: UAHPD coverage map

4.14.4 Probability of future occurrences. Based on historical records (2007-2012), 37 criminal activities (Table 4.26) are reported on average every year. However, 85% of these reports are property related which, according to UAHPD, are typically determined to be incidents of "borrowed without intimation". Moreover, in alcohol and drug related issues, approximately 8 arrests and 47 disciplinary referrals occur annually.

Analysis of short term crime reports does not provide sufficient data to make long term predictions; however, it can be inferred from the last 6 years of crime logs that violent crimes are relatively rare on campus. There have been no reported cases of hate-induced crime on campus.

The greatest criminal threat to the university has historically been theft and burglary. However, future occurrence of one or more major crimes cannot be completely ruled out. Because these occurrences may depend largely upon the emotional state of a person, the university provides free stress related counsel to its personnel. University functionality is only minimally affected by non-violent, minor crimes. Increases in minor crimes may negatively impact UAH's brand image and institutional reputation and result in negative economic impact from decreased enrollment and other related financial losses.

Major, violent crimes can greatly affect university functioning. Following a February 2010 workplace violence shooting on campus, the University ceased full operations for one week. The impact of violent crimes could include casualties, property damage, operational interruption, decreased enrollment, economic loss, brand and reputational injury, and increased insurance premiums.

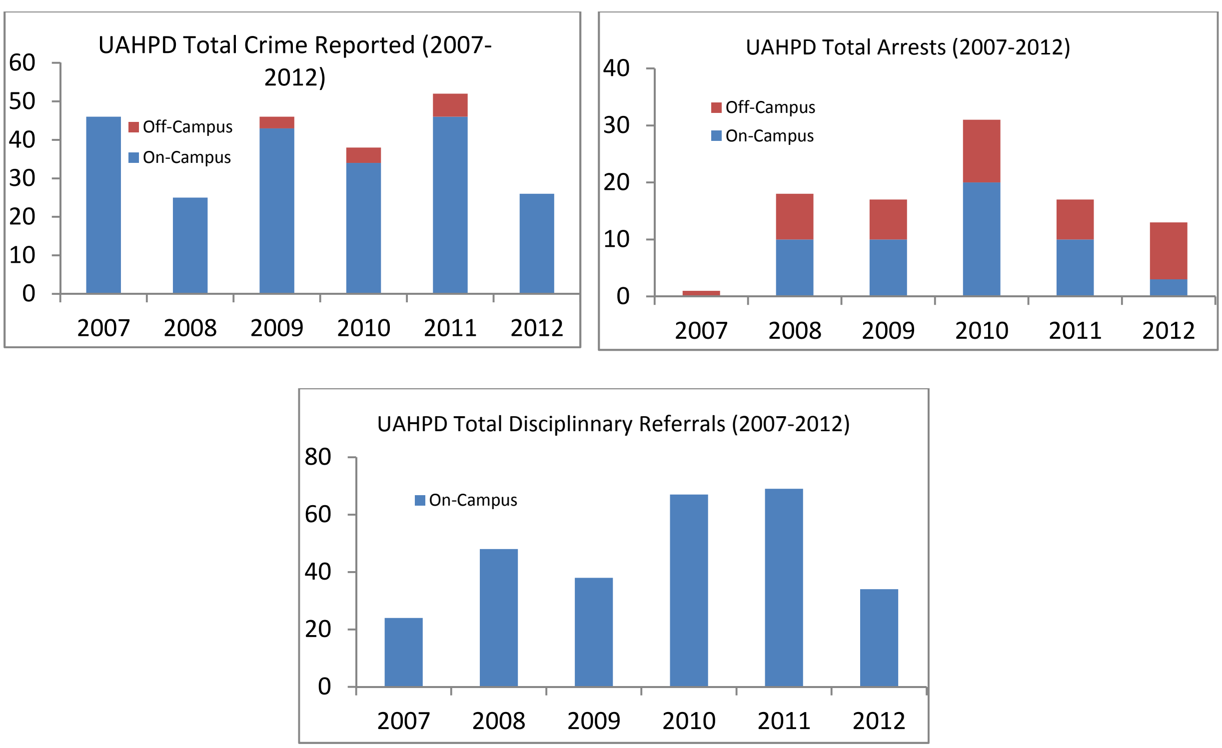


Figure 4.25: UAH total reported arrests and disciplinary referrals annual distribution

4.15 Hazard: Communicable Diseases

Diseases that FEMA and/or the Centers for Disease Control and Prevention (CDC) recognize as sources of large scale pandemic hazard are included in this study. These include: Pandemic Influenza (PI), Tuberculosis (TB), Pertussis, and Hepatitis. Other contagious diseases with frequent outbreaks but relatively not as severe as those mentioned above are also included in this study and include: measles, mumps, rubella, meningitis, and norovirus. These communicable diseases are a potential threat to healthy working and learning environments of the campus.

4.15.1 Pandemic influenza.

4.15.1.1 Nature of hazard. Influenza, a viral respiratory disease, can cause high morbidity and mortality in humans and is also known to affect some animal species[20]. Health impacts of influenza can range from mild to severe and in some cases results in death. Influenza is a viral infection usually affecting the nose, throat, bronchi and lungs. Infection is characterized by sudden high fever, aching muscle, headache, and sore throat, among other symptoms.

According to the CDC, an influenza pandemic occurs when a novel (non-human) influenza virus gains the ability for efficient and sustained human-to-human transmission and then spreads globally [21] .

4.15.1.2 Severity and extent. Influenza pandemics are unpredictable but can have significant global consequences. Over the past century pandemic influenza has resulted in millions of deaths worldwide. Some of the most severe past pandemics are summarized in Table 4.29.

Table 4.29: Summary of historical pandemic influenza outbreaks

Name	Year	Origin	Estimated Fatality Worldwide	Age Group Most Affected
Spanish Flu (H1N1)	1918-19	Unclear	20-50 M	Young Adults
Asian Flu (H2N2, Avian)	1957-58	Southern China	1-4 M	All age groups
Hong Kong Flu (H3N2, Avian)	1968-69	Southern China	1-4 M	All age groups
Influenza A(H1N1, swine)	2009-10	North America	100-400 K	Children and young adults

Source: *Pandemic Influenza Risk Management - WHO Interim Guidance (2013) WHO/HSE/HEA/HSP/2013.3*

It should be noted that a particular strain of pandemic influenza, and influenza in general, may affect certain age groups more or less severely than others. This fact is in part related to the evolution of the influenza strain in question. For example, a strain mutated from some earlier widespread or prevalent strain may have less effect on older individuals exposed to the earlier version and thus have some level of immunity or resistance to the mutated strain. Conversely, the mutated strain may disproportionately affect younger people who were not born at the time of the original strain's prevalence.

4.15.1.3 Pandemic influenza history profile. In 2009, the Alabama Department of Public Health (ADPH) noted unusual instances while dealing with influenza. Most influenza cases usually occur during the traditional flu season. However, in the summer of 2009 multiple influenza cases were detected at a time of the year when few influenza cases were typically reported. This unusual influenza activity was due to the 2009 H1N1 virus. A summary of the Alabama 2008-2009 influenza season is shown in Figure 4.27 below.

2009 H1N1 is the most recent in the history of pandemic influenzas. The CDC reported approximately 60.8 million cases, 274,304 hospitalizations, and 12,469 deaths associated with this pandemic influenza outbreak in the United States. Eighty-seven percent of deaths are believed to have occurred among persons under age 65. Hospitalization and death rates were four to seven times more likely for children than with typical seasonal influenza. Hospitalization and death rates for working-age adults were estimated to be eight to twelve times more likely than with typical seasonal influenza. Hospitalizations and fatalities among persons 65 years or older were lower than typical seasonal rates. These estimates were based on historical information from 1976 through 2001.

2009 H1N1 is not a pandemic now but has become a seasonal influenza. Due to this it ceases to appear in the section of pandemic influenza after 2009. The WHO February 2014 influenza report indicated no significant pandemic influenza currently being reported anywhere around the globe.

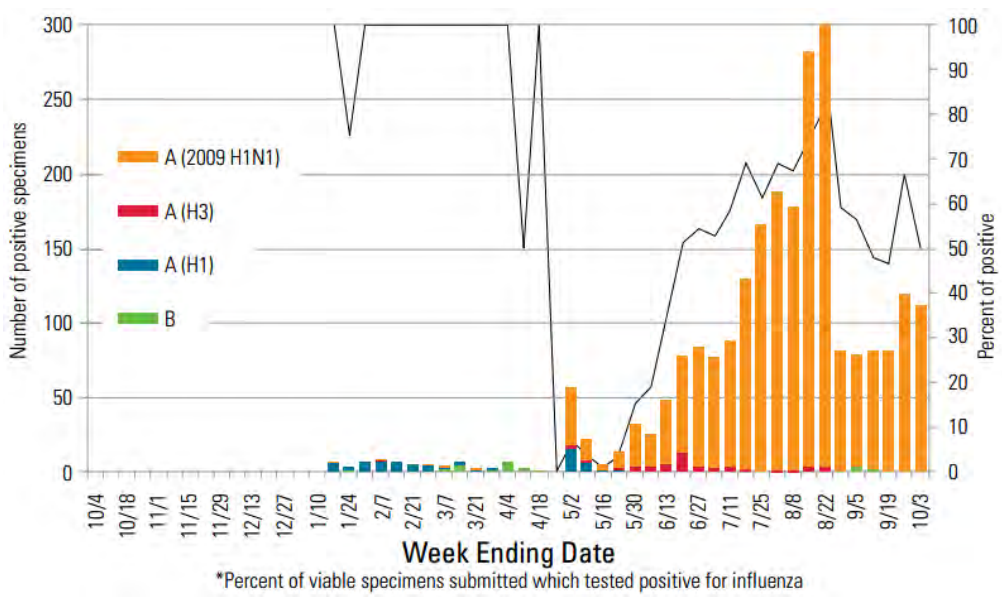


Figure 4.26: Alabama summary of Influenza season (2008-2009). **Source:***ADPH Annual Report - 2009*

4.15.1.4 Probability of future occurrence. History suggests the probability of future occurrence of any such pandemics cannot be neglected. In the last one hundred years, the world has witnessed at least 4 major pandemic viruses; this trend is slightly skewed towards the later part of the century. However, the nature and extent of such pandemic cannot be precisely predicted.

Campus diversity may also contribute to the impact of a pandemic influenza outbreak. Considerations in this area include campus populations of international students, scholars, faculty, and invited guests.

Future pandemic influenza strains that may affect persons 18-64 would have the greatest impact on UAH. Almost all age groups typically found in a higher education environment would potentially be impacted. In a university setting, social interaction among young adults is typically more frequent and of longer duration than among young adults outside of a university environment. High levels of social interaction among young adults and classroom interactions with faculty and staff have the potential to create an environment conducive to the rapid spread of influenza among the student population as well as the employee population.

4.15.1.5 Impacts. Impacts to the University may include, but are not limited to, high rates of student and employee absenteeism, interruption of academic activities, cancellation of meetings, gatherings, and conferences, lost revenue from cancellations, loss of revenue resulting from student withdrawals (where students become too ill to continue educational activities), loss of contract and grant revenue (resulting from employee absenteeism), and a general interruption of educational and other mission critical services.

In the event of widespread illness within the campus community it may become necessary to limit or cancel activities where social interactions occur in order to reduce potential exposure to a virus.

4.15.2 Tuberculosis (TB)

4.15.2.1. Nature of hazard. Tuberculosis is caused by a bacterium called *Mycobacterium tuberculosis*. It typically affects the lungs (pulmonary TB) but can affect other body organs as well (extrapulmonary TB) [24]. The disease is spread through the air when people who are sick with pulmonary TB expel bacteria, for example, by coughing, sneezing, or spitting. Pulmonary TB is a contagious bacterial infection that may cause symptoms such as a bad cough that lasts three (3) weeks or longer, chest pain, coughing up blood or sputum, weakness, weight loss, fever, chills, loss of appetite, etc.

4.15.2.2. Severity and extent. TB is one of the major global health problems that cause ill-health among millions of people each year and ranks as the second leading cause of death from an infectious disease worldwide, after the human immunodeficiency virus (HIV) [25]. The latest estimates from WHO indicate there were 8.6 million new TB cases in 2012 and 1.3 million TB deaths globally. The CDC estimates a total of 9,945 TB cases reported in the U. S. in 2012. This estimate represents a TB incidence rate of 3.2 cases per 100,000 persons in the

U.S.

4.15.2.3 TB history profile. Historically a total of 1,951 cases of TB have been reported in Alabama between 2003 and 2013, at an average of almost 177 cases per year [22][23]. Madison County during the same period reported 157 cases at an average of almost 14 per year. Table 4.30 provides the details of TB cases for the five-county area of north Alabama included in this hazard analysis.

Table 4.30: Summary of TB cases in 5 counties of North Alabama (2003-2013)

County	Number of TB Cases (Mean) 2003-2013
Madison	*157 (14.2)*
Limestone	23 (2.1)
Morgan	60 (5.5)
Marshall	79 (7.2)
Jackson	17 (1.5)

Source: *ADPH (http://www.adph.org/TB/Default.asp?id=1194)*

4.15.2.4 Prevention and cure. Tuberculosis can be treated by taking several drugs for 6 to 9 months. There are 10 drugs currently approved by the U.S. Food and Drug Administration (FDA) for treating TB. According to the CDC, the first-line anti-TB agents that form the core of treatment regimens include:

- Isoniazid (INH)
- Rifampin (RIF)
- Ethambutol (EMB)
- Pyrazinamide (PZA)

4.15.2.5 Probability of future occurrence. Based on the historical events, future probability of cases of TB is high for Madison County. Although TB becomes fatal only in extreme cases, due to its contagious nature it becomes very harmful for an otherwise healthy environment. Figure 4.27 shows the number of total reported cases for Alabama for the north Alabama region. TB cases have been declining, but several cases are reported in north Alabama every year. The regional population, including that of the UAH campus, is at a low risk to be affected by the disease.

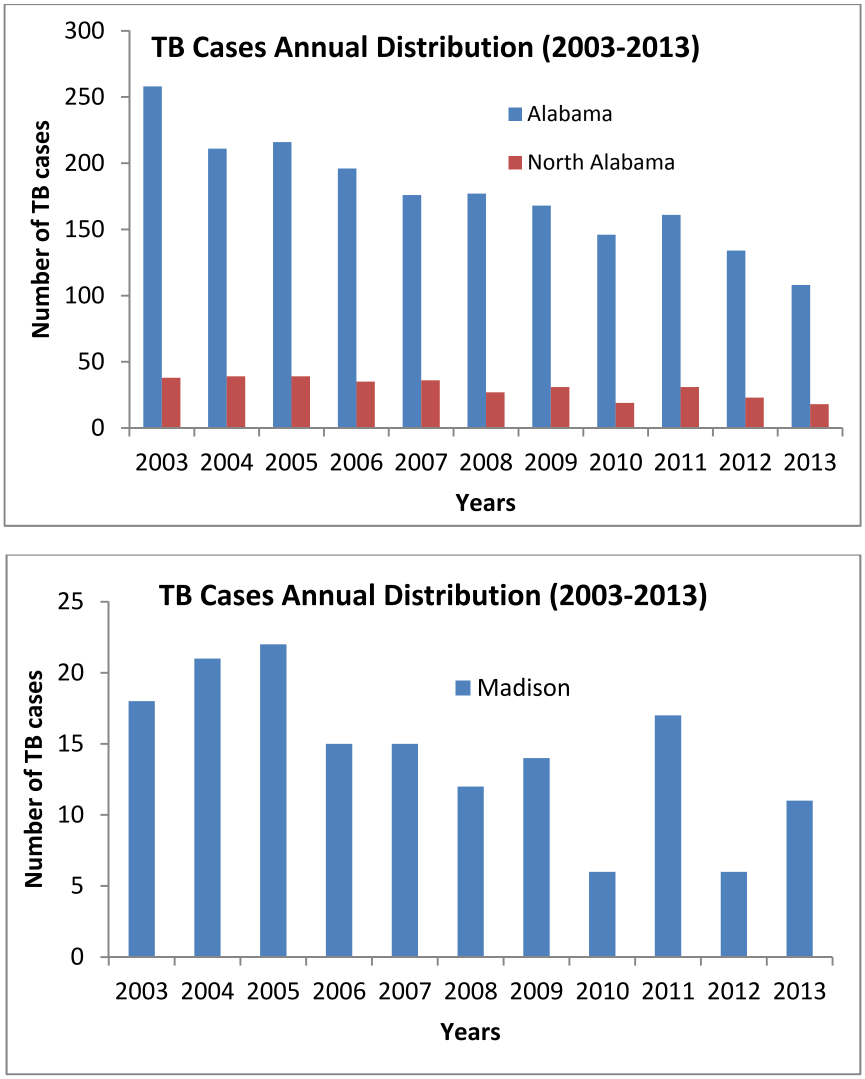


Figure 4.27: Annual distribution of the cases of TB (2003-2013) in Alabama, Madison County and North Alabama. **Source:** *ADPH (http://www.adph.org/TB/Default.asp?id=1194)*

Spatial probability of any disease is strongly dependent on the population density and the environment of people. Huntsville is one of the more densely populated parts of the state and thus outbreak of any contagious diseases can spread extremely fast among the population.

4.15.3 Pertussis (whooping cough).

4.15.3.1 Nature of hazard. Pertussis, also known as whooping cough, is a highly contagious respiratory tract infection. It is caused by the bacterium Bordetella pertussis [26]. It occurs mainly in infants and young children, and is easily transmitted from person to person. The first symptoms generally appear seven (7) to ten (10) days after infection, and may include mild fever, runny nose, nasal congestion, and cough. In typical cases the cough gradually develops into a paroxysmal cough followed by whooping sound (hence the name whooping cough) [27].

4.15.3.2 Severity and extent. Pertussis is an endemic (common) disease in the United States. According to the CDC fast facts -worldwide, there are an estimated 16 million cases of pertussis and about 195,000 deaths per year. In 2012 48,277 cases of pertussis (whooping cough) were reported in the U.S., but many more go undiagnosed and unreported. This is the second most number of pertussis cases reported in the U.S. since 1955, when 62,786 cases were reported.

4.15.3.3 History profile. According to the ADPH, the state of Alabama had more than 1,700 cases of pertussis reported from 1993 to 2013 at an average of almost 82 cases per year. Madison County reported 96 cases between the years 2007-2013, an average of almost 14 cases per year. The five counties of north Alabama reported a total of 210 such cases during the same period at an average of 30 cases per year. Table 4.31 summarizes the number of cases reported in each of the 5 counties of north Alabama from 2007 to 2013 [22,23].

Table 4.31: Summary of Pertussis cases in 5 Counties of North Alabama (2007-2013)

County	Total (Mean)
Madison	96 (13.7)
Limestone	18 (2.5)
Morgan	52 (7.4)
Marshall	31 (4.4)
Jackson	13 (1.8)

Source: *ADPH* *(http://adph.org/Immunization/Default.asp?id=557)*

4.15.3.4. Prevention and cure. The best way to prevent pertussis (whooping cough) among infants, children, teens, and adults is to get vaccinated. In the United States the recommended pertussis vaccine for infants and children is called **DTaP** [28]. This is a combination vaccine that protects against three diseases: diphtheria, tetanus, and pertussis. For maximum protection against pertussis children should get 5 doses (shots) of the vaccine. One dose should be received at each of the following ages: 2 months; 4 months; 6 months; 15 through 18 months; and 4 through 6 years. The whooping cough booster vaccine for adolescents and adults is called **Tdap** (Tetanus, Diptheria, and Pertussis)

4.15.3.5. Probability of future Occurrences. Based on the historical cases, the probability of future occurrences of pertussis cases in Alabama is very high. As mentioned earlier, the annual mean since 1993 is nearly 82 cases per year across the state. However, the distribution is highly skewed towards the later part of the years because of the years 2009, 2010, 2012 and 2013, which reported extremely high numbers of cases (305, 205, 172, and 199 respectively). This is evident from the analysis of the average number of cases per year;

between the years 1993 to 2004 the average was only 34, whereas between 2005 and 2013 it jumped to 146.5 per year which is more than 4 times the earlier mean. Figure 4.28 shows the annual distribution of pertussis cases in Alabama since 1993.

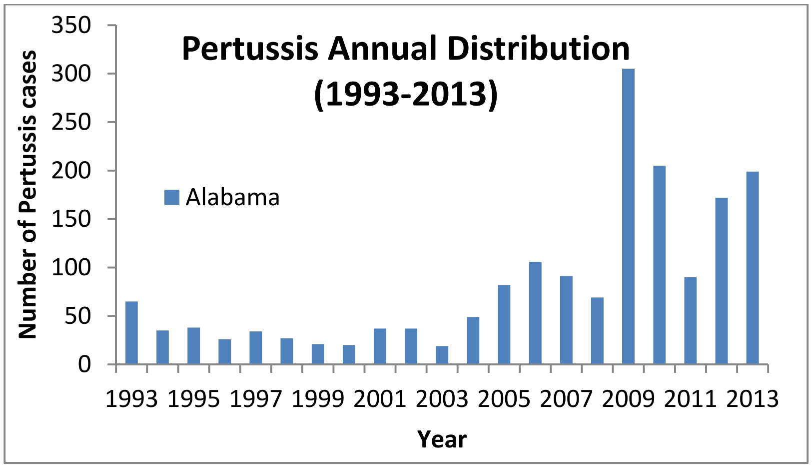


Figure 4.28: Annual distribution of pertussis cases in Alabama (**Source:** *ADPH* *http://adph.org/Immunization/Default.asp?id=557*)

Further analysis of cases in Madison and surrounding counties reveal that Madison County has reported the maximum number of cases (96) since 2007, whereas Jackson County had the fewest cases (13) during the same period. Madison County's high frequency of cases has strong relation with its relatively dense population, and therefore the probability of occurrences of such cases at UAH cannot be neglected.

4.15.4 Hepatitis.

4.15.4.1 Nature of hazard. The term hepatitis refers to a group of viral infections that affect the liver. There are five main hepatitis viruses, referred to as types A, B, C, D, and E. Most liver damage is caused by 3 hepatitis viruses: hepatitis A, hepatitis B, and hepatitis C. In particular, types B and C lead to chronic disease in hundreds of millions of people and, together, are the most common cause of liver cirrhosis and liver cancer [29].

Hepatitis A and E are typically caused by ingestion of contaminated food or water. Hepatitis B, C, and D usually occur as a result of parenteral contact with infected body fluids. Common modes of transmission for these viruses include receipt of contaminated blood or blood products and invasive medical procedures using contaminated equipment. Hepatitis B can be transmitted from infected mother to baby at birth, from family member to child, and also by sexual contact. Acute infection may occur with limited or no symptoms, but possible symptoms may include jaundice (yellowing of the skin and eyes), mild fever, dark urine, extreme fatigue, loss of appetite, nausea, vomiting, and abdominal pain [30].

4.15.4.2 Severity and extent of hepatitis. Viral hepatitis is a global public health problem affecting millions of people every year; this disease can cause disability and death.

Typically around 500 million people are chronically infected with hepatitis B virus (HBV) or hepatitis C virus (HCV) around the world [31]. Approximately one (1) million people die each year (~2.7% of all deaths) from causes related to viral hepatitis, most commonly liver disease, including liver cancer.

In the USA, according to the CDC's study of mortality data from 2006-2010, the serious health consequences associated with viral hepatitis (chronic liver disease, including cirrhosis) was ranked 12th in 2010. Viral hepatitis associated death rates in 2010 were highest among persons infected with HCV (4.65 deaths per 100,000 population), followed by HBV (0.52 deaths per 100,000 population), and HAV (0.03 deaths per 100,000 population). *(http://www.cdc.gov/hepatitis/Statistics/2011Surveillance/Commentary.htm#disc)*

4.15.4.3 Hepatitis history profile. ADPH records indicate that Alabama had a total of 1,277 investigations of hepatitis (A, B, C and other viruses related to hepatitis) in the years 2012 and 2013. Of these, 116 were confirmed as actual incidences of Hepatitis. According to CDC Surveillance Data for Acute viral Hepatitis reports, Alabama has, on average, 1.35 cases of acute hepatitis A per 100,000 people, 2.33 cases of acute hepatitis B per 100,000 people, and 0.25 cases of hepatitis C per 100,000 people from 1990-2011. During the same period, the national mean rate of the United States was 5.6, 3.32, and 0.93 per 100,000 people for hepatitis A, B and C respectively. Figure 4.29 shows the annual distribution of acute hepatitis cases in Alabama since 1990.

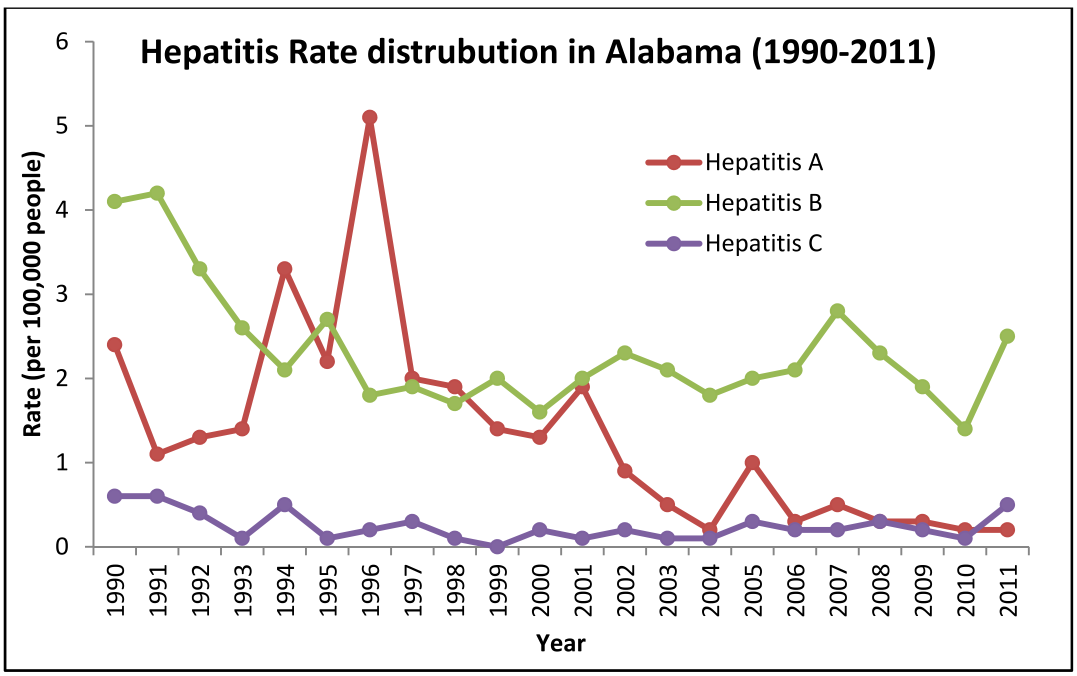
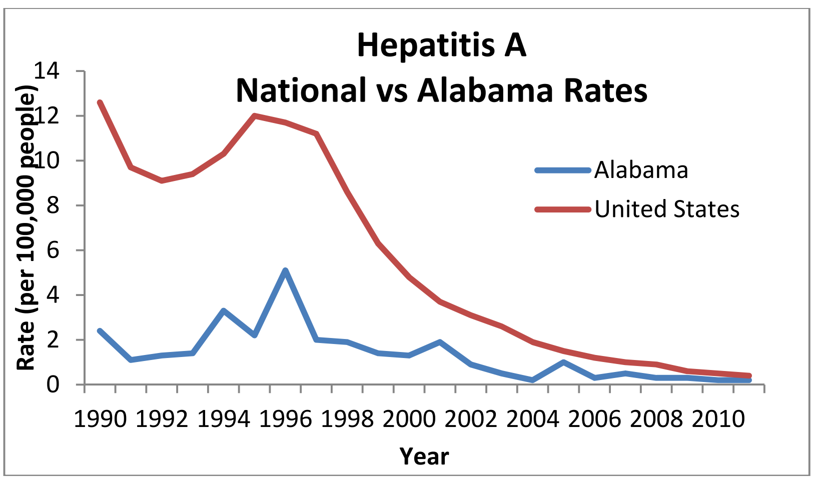


Figure 4.29: Annual distribution of hepatitis cases in Alabama (**Source:** *CDC Surveillance Data for Acute Viral Hepatitis reports 2006 and 2011)*

4.15.4.4 Prevention and cure. Hepatitis can be prevented using vaccines such as HAV (for hepatitis A) and HBV Vaccines (for hepatitis B). HBV can prevent the serious consequences of hepatitis B infection, including liver cancer and cirrhosis. Vaccination gives long-term protection from hepatitis B infection, possibly lifelong. The WHO recommends that all infants receive the hepatitis B vaccine as soon as possible after birth, preferably within 24 hours. Babies normally get 3 doses of hepatitis B vaccine: the first dose at birth, a second dose at 1-2 months of age, and a third dose at 6-18 months of age. However, anyone through 18 years of age who did not receive the vaccine when they were younger should also be vaccinated. No vaccines are available for hepatitis C infection. Research into the development of its vaccine is under way. If treatment is necessary, hepatitis C is typically treated with a combination of drugs and treatment may continue for several months [30].

4.15.4.5 Probability of future occurrences and impacts. Based on the historical cases, the probability of future occurrences of hepatitis (A, B, and C) cases in Alabama is very high. As mentioned earlier, the annual mean (for A, B, and C combined) since 1990 is nearly 2 in every 100,000 people in the state. However, the annual distribution indicates a slight reduction in the number of cases in recent years. Based on historical events, the future probabilities of incidences of hepatitis (A, B, and C) are of mild concern for Alabama including Madison County, but the risk cannot be completely neglected.

Figure 4.30 shows the comparison between the overall United States and the state of Alabama rates of hepatitis (A, B, and C) cases over the years. All the comparisons clearly indicate that the national rates have come down considerably over the years, especially for hepatitis A cases. However, the state rates have generally remained static (except for hepatitis B) over the years. During earlier years, Alabama rates were significantly lower than the national rates; however, during recent years these rates are more or less similar.



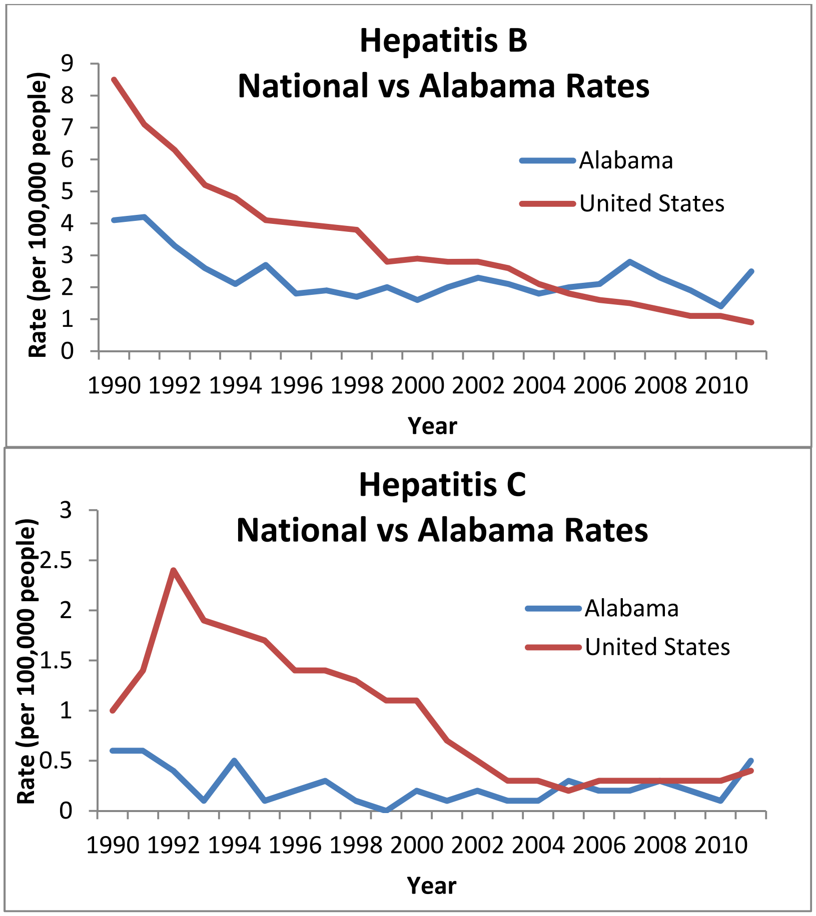


Figure 4.30: Figure shows the comparison between the national and state hepatitis rates 1990-2011.
Data Source: *CDC Surveillance Data for Acute Viral Hepatitis reports 2006 and 2011*

4.15.5 Other contagious diseases. The United States, through successful routine immunization programs and policies, has minimized the rate of vaccine preventable diseases to extremely low levels among the general population. Some cases are reported each year, due in part to a large number of immigrant populations and persons entering the U.S. from countries where a given disease may still occur or where there is an active outbreak. Brief descriptions of some of these diseases are as follows:

4.15.5.1 Measles. Measles is a highly contagious respiratory disease caused by the measles virus. This disease is also known as Rubeola. Measles can be prevented by a combination of MMR (Measles Mumps and Rubella) vaccine [32]. According to CDC observations, widespread use of this MMR vaccine has led to a more than 99% reduction in measles cases throughout the United States. However, as of June 2014, the United States is experiencing the highest number of cases since measles elimination was documented in the year 2000. According to data presented by the CDC, as of June 27, 2014, there were 539 confirmed measles cases reported in the U.S. This is nearly five (5) times more than the mean number of cases between the years 2001-2013. (source: http://www.cdc.gov/measles/cases-outbreaks.html) Recorded cases from 2001 through June 2014 are summarized in Figure 4.31. According to CDC reports, many of the cases in 2014 have been associated with travel to and from the Philippines, which was undergoing a large measles outbreak during 2014.

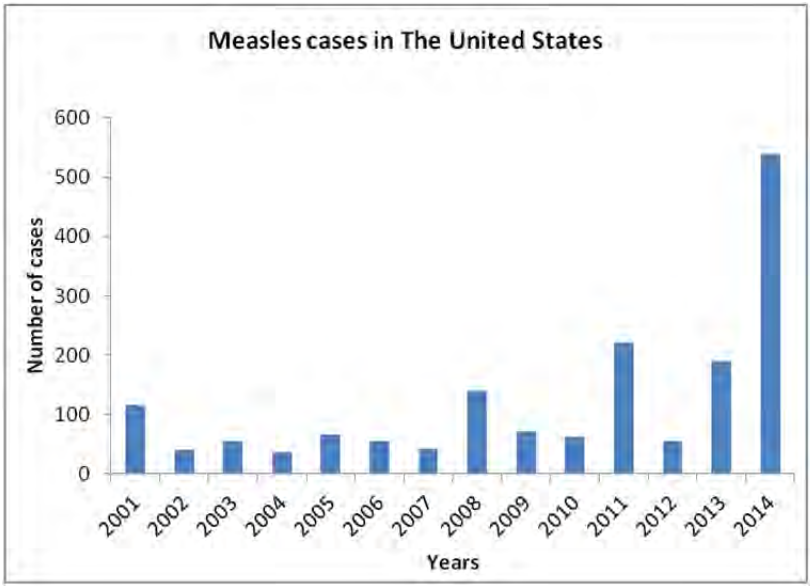


Figure 4.31: Number of reported measles cases in the United States (2001-2014)
Source: CDC (http://www.cdc.gov/measles/cases-outbreaks.html)

***4.15.5.2 Mumps*.** Mumps is an acute viral illness characterized by fever and inflammation of salivary glands. Vaccination is the best way to prevent mumps. This vaccine is included in the combination Measles-Mumps-Rubella (MMR) and Measles-Mumps-Rubella-Varicella (MMRV) vaccines. Two doses of mumps vaccine are estimated to be 88% effective at preventing the disease [33].

The MMR vaccine is effective against mumps prevention and there are normally only a few hundred cases of mumps each year in the United States. The reported cases of previous years (2006-2013) are presented in figure 4.32. However, outbreaks still occur and may involve a larger number of cases than usual. In 2006, 2009 and 2010, the United States experienced a multi-state mumps outbreak in which 6584, 1991 and 2611 cases were reported, respectively. This resurgence mainly affected college students living in different Midwestern college campuses. There was an increase of mumps outbreaks in the U. S. again in 2014. According to CDC reports, a total 845 cases were reported as of June 27, 2014. Of these, 453 cases are related to an outbreak in an Ohio community and 243 cases were linked to The Ohio State University (http://www.cdc.gov/mumps/outbreaks.html).

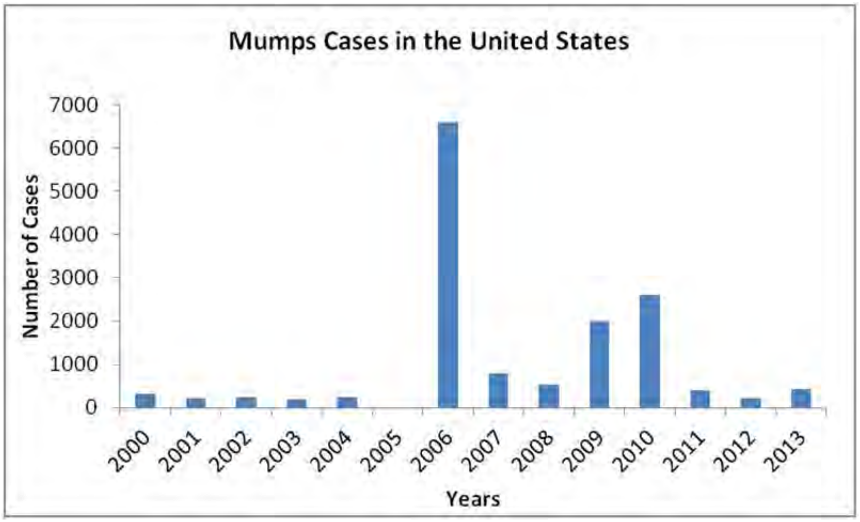


Figure 4.32: Graph showing the number of cases of mumps in the United States (2000-2013)
Source: WHO/UNICEF (http://www.who.int/immunization/monitoring_surveillance/resources/en/)

4.15.5.3 Rubella. Rubella, also known as German measles or Three Day Measles, is a contagious disease caused by the rubella virus. It is characterized by low fever, mild rashes and swollen glands. The measles-mumps-rubella (MMR) vaccine, usually given to children in the United States twice before they reach school age, is highly effective in preventing rubella [34]. As a result of widespread immunization, the CDC has already declared rubella eliminated in the United States. There are no recent major outbreaks of Rubella cases reported in United States.

4.15.5.4 Meningitis. Meningitis is a disease involving acute inflammation of protective membranes present around the brain and spinal cord. These membranes are known as meninges. The inflammation may be caused by infection with virus, bacteria, or some other microorganisms and less commonly, by some non-infectious factors like cancer, physical injury or some drugs [35]. Bacterial and viral meningitis are the most common contagious form of meningitis. Meningitis caused by bacterium *Neisseria meningitides* is commonly known as meningococcal diseases. The CDC recommends routine meningococcal vaccination for adolescents because this age group is at higher risk than others for meningococcal disease. Adolescents should receive an initial vaccination at age 11-12 and a booster dose at the age of 16.

Rates of meningococcal diseases have been declining in the United States since the late 1990s. There are fewer than 1,000 cases reported annually. Vaccination offers the best protection against meningococcal disease. Current vaccines provide immunity against four out of five strains of the bacteria *Neisseria meningitides.* These strains are referred to as A, C, Y, and W-135. No vaccine is currently available in the U.S. to protect against the fifth strain, which is known as type B. The type B meningococcal vaccine is licensed for Europe, Canada, and Australia. The Food and Drug Administration (FDA) briefly allowed the use of this vaccine for outbreaks that occurred at Princeton University and the University of California in Santa Barbara, where nine (9) and four (4) cases, respectively, were reported during 2013 [36, 37].

4.15.5.5 Norovirus. Noroviruses are a group of viruses that cause inflammation of the stomach and large intestine lining (gastroenteritis). Symptoms of Norovirus often start with sudden onset of vomiting and/or diarrhea accompanied by abdominal cramps [38]. Symptoms may also include fever, headache, and malaise. The norovirus was originally referred to as the "Norwalk virus" after the town of Norwalk, Ohio, the location of the first confirmed outbreak in 1972.

Noroviruses are highly contagious in nature. They are usually found in contaminated food and water but they may also be spread through contact with an infected person or surface [39]. According to the CDC, "Norovirus can spread quickly in closed places like daycare centers, nursing homes, schools, and cruise ships. Most norovirus outbreaks happen from November to April in the United States". Noroviruses cause 19-21 million illnesses and result in 56,000-71,000 hospitalizations and 570-800 deaths annually in the U.S. Noroviruses are the most common cause of food-borne disease outbreaks in the U.S. (source: cdc.gov/norovirus/trends-outbreaks.html).

4.15.5.6 Chikungunya. Chikungunya is a viral disease transmitted to humans by infected mosquitoes. The major symptoms included severe joint pain and fever. Other symptoms include muscle pain, nausea, fatigue, headache, and rash. There is no vaccine or medication to prevent or cure Chikungunya virus infection [40]. Some existing medications are effective in reducing Chikungunya-related fever and joint pain.

Because of a recent outbreak in the Caribbean and Pacific Island areas, the number of cases of Chikungunya has increased among travelers visiting or returning to the United States from affected areas. These imported cases could result in additional local spread of the virus in the continental United States. According to CDC statistics, as of July 22, 2014, there have been 497 cases of Chikungunya reported by states and territories in the U.S. As of this same date, ADPH had reported three confirmed cases of Chikungunya in Alabama and two (2) preliminary positive test results. In each case, the infected person had traveled to parts of the Caribbean. (https://www.adph.org/news/assets/140718.pdf)

4.15.5.7 Ebola. Ebola, a rare and often fatal disease, was first discovered in 1976 near the Ebola River in the Democratic Republic of Congo. The disease is caused by infection from one of the Ebola virus strains (Ebola virus, Sudan virus, Tai Forest virus, and Bundilbugy virus) and can affect humans as well as nonhuman primates.

The 2014 Ebola outbreak is the largest in recorded history, affecting multiple countries in West Africa. The outbreak was ongoing as of December 4, 2014, and a total of 17,256 cases were reported for Guinea (2,186), Liberia (7,650), and Sierra Leone (7,420). Of these cases, 10,793 were laboratory confirmed and resulted in 6,113 deaths. One death and three healthcare worker infections have been reported in the U.S. Affected countries including Nigeria, Senegal, and Spain declared their outbreaks over on October 17, October 19, and December 2, 2014, respectively.

4.15.6 UAH immunization policies. There are a large number of international students arriving at UAH from different overseas countries each year. To help ensure the health and safety of the University campus there are several immunization requirements for all international students. These immunization policies are a necessary step for protection of students, employees, and guests from the spread of various contagious diseases. The implementation of these policies is the responsibility of the Student Health Center (SHC) of UAH. Key immunization policy requirements are outlined below:

1. Documentation requirements: All students must submit a completed vaccination form and supporting materials to the SHC. If any required vaccinations have not been completed, or if supporting documentation is not available, students must obtain the necessary vaccination(s) at least 30 days before the first day of classes.

2. Required vaccinations: Measles, Mumps, Rubella (MMR) and Meningococcal/Meningitis vaccinations are required for all admitted students. International students must be immunized against TB. The SHC facilitates TB screening and testing for all international students and some international visitors upon arrival at the campus.

4.16 Hazard: Hazardous Material Incidents

4.16.1 Nature of hazard. Hazardous materials are substances that can cause injury, death, chronic health impacts, property damage, and environmental damage if released or misused. Hazardous materials may include industrial chemicals, laboratory chemicals, hazardous waste (byproducts of the use of one or more hazardous chemicals), cleaning products, fertilizers, gasoline, other fuel oils, and radiological materials.

UAH utilizes hazardous materials in a number of locations and for a variety of purposes and are routinely stored in various campus facilities. This includes research-oriented use in laboratory environments, teaching aids in laboratory environments (such as a chemistry laboratory), building systems (HVAC, etc.), and maintenance operations (paints, solvents, fuels, etc.).

Hazardous materials are also shipped on local highways, thoroughfares, and railways on a daily basis. If released during transport, these materials can spread quickly into surrounding areas in the form of liquids, solids, and/or vapors. Human error is the typical cause of most transportation incidents resulting in the release of hazardous materials.

Incidents such as accidental or intentional releases of chemical, biological or radiological substances that are explosive, corrosive, reactive, flammable/combustible, or toxic in nature are categorized as hazardous material incidents. Hazardous material incidents are technological events (*i.e.*, created and influenced by human activities).

4.16.2 Severity and extent of hazardous material incidents. According to the Pipeline and Hazardous Materials Safety Administration (PHMSA), a total of 163,459 incidents related to hazardous material handling and transportation occurred between 2004 and

2013 in the United States. These incidents have resulted in a total of 129 fatalities and 2,772 injuries, as well as a loss of nearly $745 million (an average of almost $7.4 million per year). In Alabama, a total of 8,212 incidents involving hazardous materials were reported from 1971 to April 2014, an average of nearly 195 events per year. These incidents have resulted in 23 fatalities and damages totaling $34 million. Most available reports for hazardous material incidents are centered on incidents occurring at a scale or quantity which mandates reporting under state and/or Federal regulations. It is therefore difficult to determine the actual number of hazardous materials incidents since many small incidents do not require reporting to authorities.

Toxic Release Inventory (TRI) [41], a unit under the United States Environmental Protection Agency (EPA), keeps records of the management of certain toxic chemicals that may pose a threat to human health and the environment. More than 650 chemicals are monitored by TRI which include:

- Chemicals that may cause cancer or other chronic human health effects
- Chemicals that may cause significant adverse acute human health effects
- Chemicals that may result in significant adverse environmental effects

In 2012, a total of 21,024 facilities handling such chemicals reported to TRI that there were a total of almost 10.6 billion kg of TRI identified chemicals currently in use in the U.S. These chemicals were reportedly managed as waste through either the process of recycling (35%), energy recovery (12%), treatment (38%), and the other 15% (nearly 1.6 billion kg) was disposed of or released to air, water or land bodies [42].

4.16.3 Hazmat history profile. According to PHMSA, historically, there have been a total of 218 hazardous material incidents in Huntsville (1971-Apr. 2014) which have resulted in eight (8) fatalities and seven (7) injuries. A total of 88 evacuations were also reported along with a total $0.5 million in damage.

There are 198 facilities currently reporting to TRI in the north Alabama region (see Figure 4.32). Of these, 59 are within the Huntsville city limits. In addition, 1,157 waste management facilities (both active and non-active) are listed under the Resource Conservation and Recovery Act Information (RCRA) (Figure 4.33) [43]. Of these, 468 are within the Huntsville city limits. Table 4.32 lists the number of TRI and RCRA facilities in each county in north Alabama.

In addition to the above-mentioned TRI and RCRA facilities around the University of Alabama in Huntsville campus, there is also an operational nuclear power plant within a 50 mile radius (approximately 28 nautical miles away). Browns Ferry Nuclear Power Plant is located on the Tennessee River near the Limestone and Morgan County boundary. All three units of the plant are maintained and operated by the Tennessee Valley Authority (TVA), with a total capacity of nearly 3300 MW. More than 900,000 people are estimated to be residing within a 50 mile radius of the plant. Spragins Hall on the UAH campus is designated as a backup processing center location for Limestone County evacuees in the event of a nuclear emergency evacuation involving the Browns Ferry nuclear facility.

Bellefonte Nuclear Generation Station in Hollywood, AL was proposed more than 40 years ago and is still incomplete at present. However, TVA has again proposed to complete the construction of the first reactor unit of this plant, which is almost 40 miles from the UAH campus. Figure 4.35 shows the location of these power plants with respect to UAH.

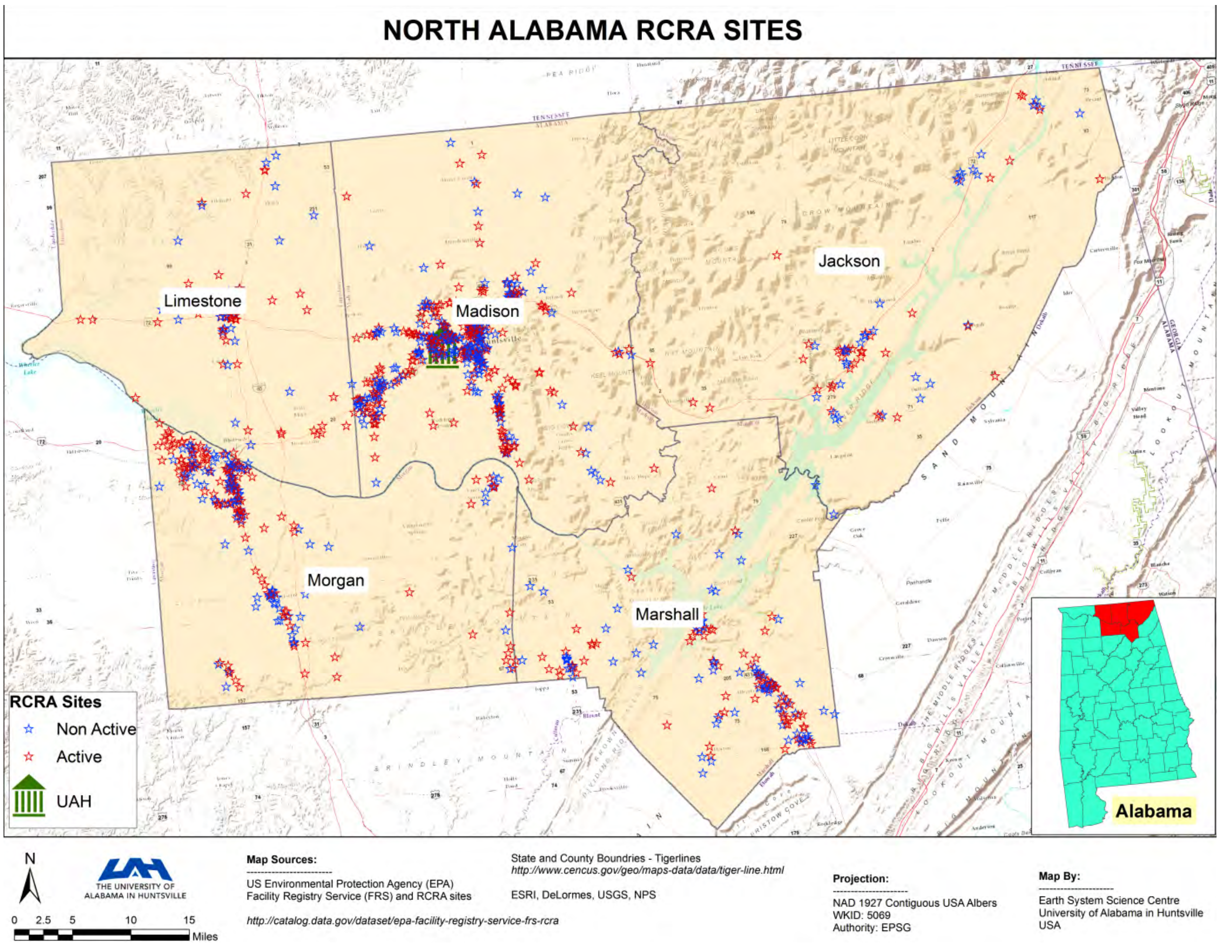


Figure 4.33: North Alabama EPA recognized Facility Registry Services (FRS) based sites

Table 4.32: Number of TRI and RCRA facilities in North Alabama

COUNTY	TRI	RCRA
Madison	*65*	*564*
Limestone	20	96
Jackson	21	78
Marshall	35	160

Morgan	57	259

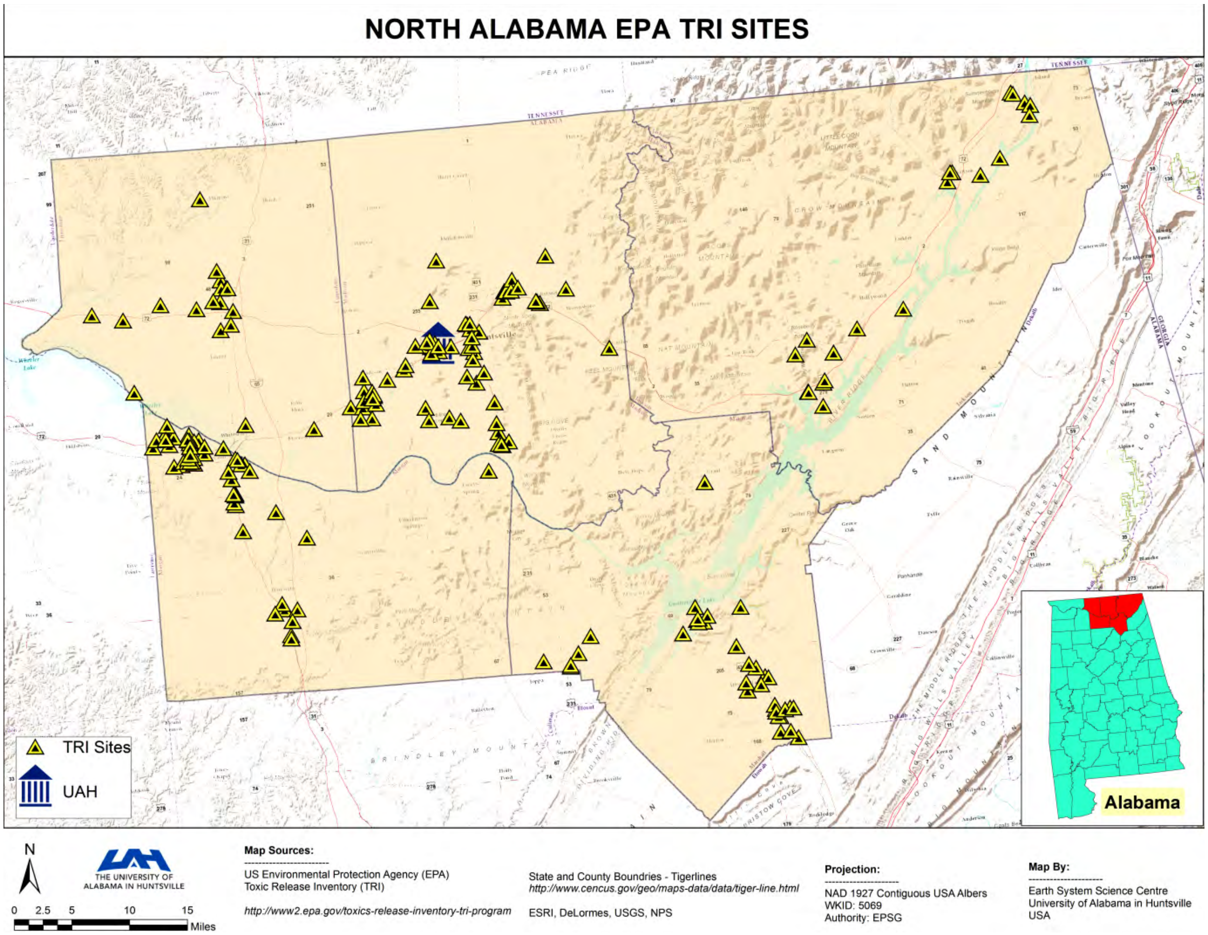


Figure 4.34: North Alabama EPA recognized Toxic Release Inventory (TRI) sites

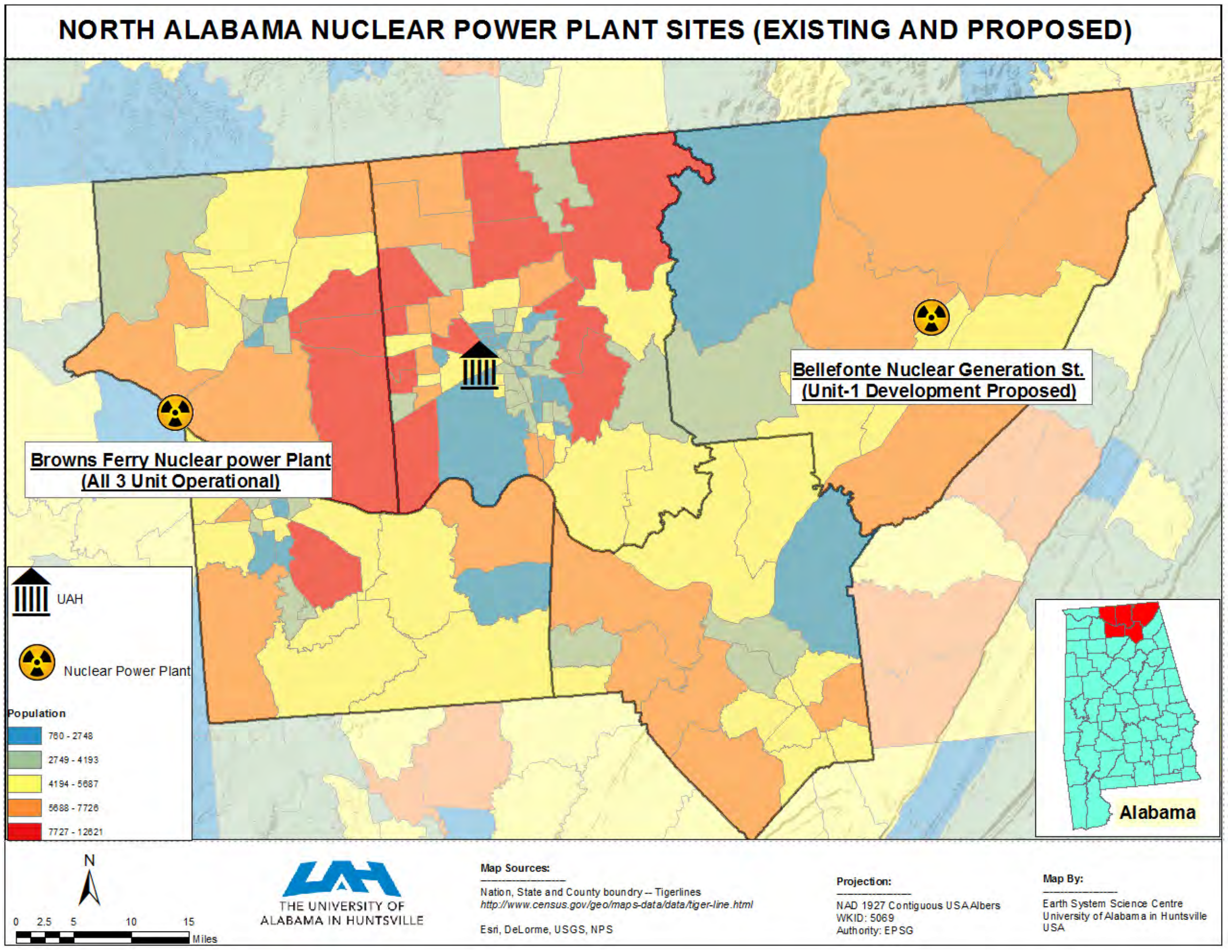


Figure 4.35: North Alabama proposed and existing nuclear power plants and 50 mile impact radius with total population (2010 census tracks)

4.16.3.1 Hazardous materials at UAH. Many research laboratories, teaching laboratories, and maintenance groups at UAH regularly work with hazardous materials. UAH maintains an Office of Environmental Health and Safety (OEHS) which is an advisory and service oriented division charged with promoting occupational safety programs, chemical hygiene programs, and hazardous waste disposal services. OEHS oversees HAZMAT-related activities including safety procedures and training, hazard assessment and testing, purchase, and regulated disposal for the University.

There are currently eleven (11) campus buildings with known hazardous materials storage and/or use. In addition, one off-campus facility is located on Redstone Arsenal. The Redstone Arsenal facility uses explosives as well as chemicals in some of their research activities. A total of 291 labs within these 12 buildings use hazardous materials (chemical, biological, explosive, and radiological). Table 4.33 provides a brief summary of these buildings and type of HAZMAT in each of them. These 291 facilities currently contain a total of approximately 500 gallons of liquid, 50 kg of solid, and 124.7 mCi of radioactive hazardous materials.

Table 4.33: UAH buildings that contain HAZMAT in labs and/or other work environments

Building	Chemical	Biological	Radioactive	Machine	TOTAL
Wilson Hall	07	00	00	02	**09**
Von Braun Research Hall	11	00	02	12	**25**
Technology Hall	11	00	01	06	**18**
Shelby Center for Science and Technology	39	28	01	01	**69**
Roberts Hall	03	00	00	04	**07**
Propulsion Research Center	05	02	03	04	**14**
Physical Plant Building	05	00	00	04	**09**
Optics Building	19	00	13	00	**32**
Material Science Building	29	06	02	03	**40**
Engineering Building	11	01	00	02	**14**
Cramer Hall	17	01	11	20	**49**
Aerospace Research Center (Off Campus)	02	00	01	02	**05**
	159	**38**	**34**	**60**	**291**

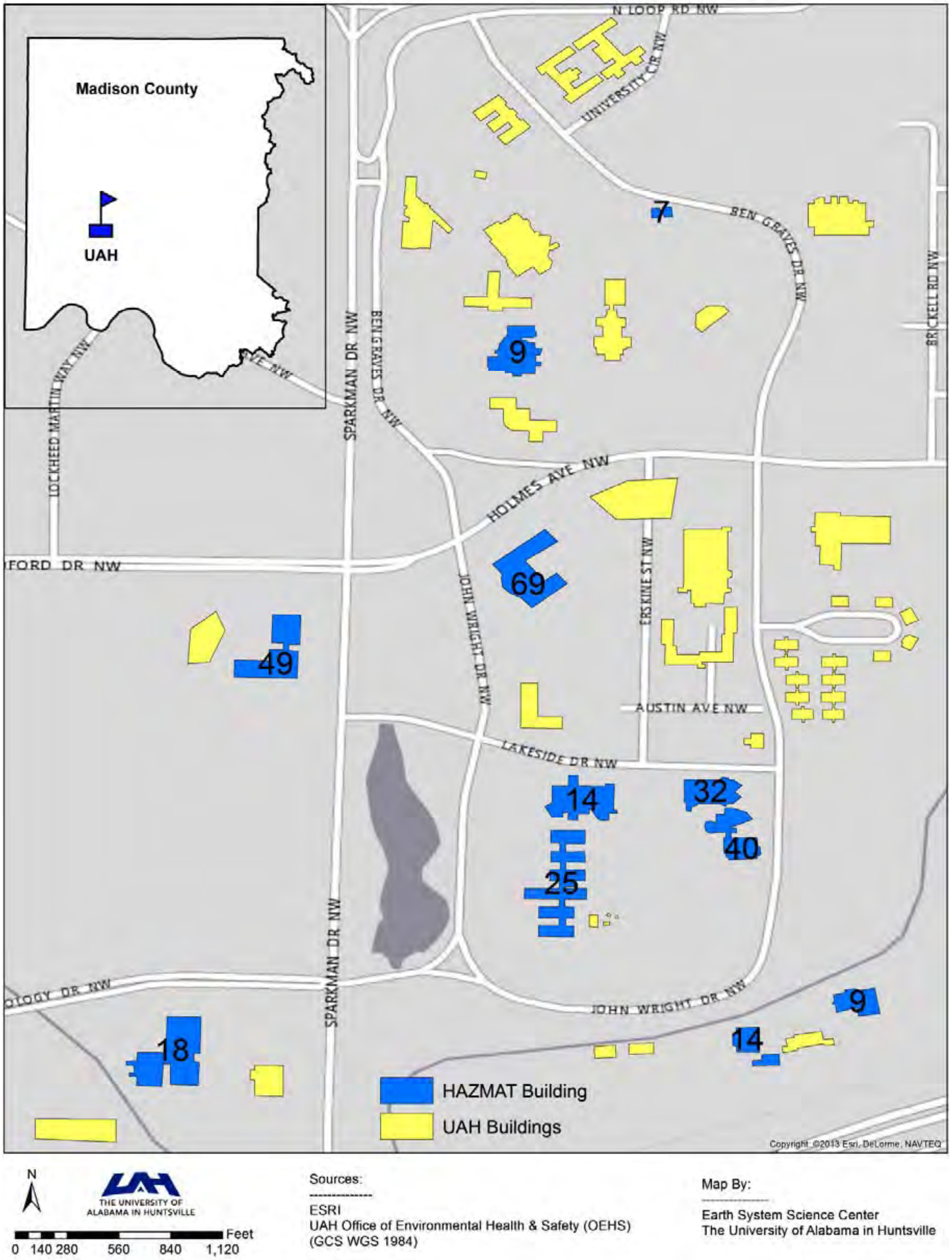
Figure 4.36 shows the location of these facilities on campus. There have been four incidents related to HAZMAT reported to OEHS in last two years: one incident at Engineering Building (EB), one at Von Braun Research Hall (VBRH), and two incidents at Physical Plant Building (PPB). A brief description of each incident is as follows:

EB — Suspicious activities in the lab resulted in a chemical spill. The chemical spill was identified as not related to the manufacture of illegal drugs. The lab supervisor did not know who used the lab or what produced the spill, in the fume hood. A small quantity of burned or otherwise reacted chemicals was found on fume hood surface. The spill cleanup material was disposed of as chemical waste.

VBRH — Historical mercury contamination. The area was contaminated from research conducted a number of years before. The area was used as a storage area following the research activities. OEHS contracted a company to clean the area so it can be used safely. Clean up debris was disposed of as hazardous waste.

PPB
1) A spill resulted from a broken hydraulic line on the trash truck. Resulted in the release on the parking lot of approximately 10 gallons of hydraulic fluid. This spill was cleaned on site and did not enter any water ways. The spill cleanup material was non-regulated.
2) Spill of approximately 20 gallons of rinse water from a Grounds pesticide delivery vehicle. It was cleaned according to spill protocol by the Grounds Department. The spill material was non-regulated.

UAH Campus Buildings With HAZMAT



Sources:

ESRI
UAH Office of Environmental Health & Safety (OEHS)
(GCS WGS 1984)

Map By:

Earth System Science Center
The University of Alabama in Huntsville

Figure 4.36: UAH buildings containing HAZMAT

4.16.3.2 Railway Transportation of Hazardous Materials. A potential source of hazardous materials release which would directly impact the campus is the Norfolk Southern railroad line running along the extreme southern border of the campus. Railroads are frequently utilized to transport large quantities of hazardous materials.

The Federal Railroad Administration, through its Office of Safety Analysis, maintains a railway accident database. This database shows that there were approximately 257 railway incidents involving hazardous materials in the U.S. from January 2005 through October 2014. There were a total of 30,629 railway accidents reported during this period. These accidents lead to a total of 44,390 persons reported to have required evacuation from at or near the accident scenes.

The UAH campus would be at significant risk should a railway incident occur adjacent to campus that involves hazardous materials. Impacts could include casualties, property and environmental damage, operational interruption, and economic loss.

4.16.3.3 Roadway Transportation of Hazardous Materials. Immediately adjacent to and running parallel with the railroad is Interstate 565, which is a main transportation route through the City of Huntsville. Numerous truckloads of hazardous materials are transported via this roadway on a daily basis.

The Federal Motor Carrier Safety Administration reported a total of 12,863 hazardous materials cargo releases involving large trucks from January 2009 through September 2013. This data yields an annual average of approximately 2,573 hazardous material releases resulting from commercial transportation on large trucks.

4.16.4 Probability of Future Occurrences.

4.16.4.1 Temporal Probability. Given the number of incidents in recent history, the temporal probability of hazardous material incidents in Huntsville is low. PHMSA reported an annual average of 5 incidents in the area during the period from 1971 through 2014. As mentioned in section 4.16.3, these incidents resulted in eight (8) fatalities and nearly $0.5 million in damage. Based on historical events, the probability of a future occurrence having significant impact on the campus is low.

4.16.4.2 Spatial Probability . There are more than 600 facilities (65-TRI; 564-RCRA) in Madison County that deal with hazardous materials. There are a total of 26 TRI and 331 RCRA facilities within a 5 mile radius of the UAH campus. Superfund sites are the designated sites for maintaining and disposing the most hazardous materials and are part of a national priority list. There are 3 superfund sites to the south of the campus. Further, the proximity to Browns Ferry Nuclear Plant (26 miles; 3 operational units) and Bellefonte Nuclear Generation Station (70 miles; proposed) also adds the danger of radiological material release.

For probability analysis, major roads (including interstate highways, U.S. highways, and state highways) and railways are considered to be transportation corridors where hazardous materials are primarily transported and where hazardous material releases could result in adverse impacts to the UAH community.

Taking into consideration these facts, historical records, the campus proximity to the Norfolk Southern Railway, Interstate 565, and U.S. Highway 72, spatial probability is high for the UAH campus to be impacted by a hazardous materials incident.

4.16.5 Impact. The extent of a hazardous material incident depends in part on whether the release is from a mobile or fixed site and the quantity and nature of the material released. Factors to be considered include material, toxicity, duration of the release, and environmental conditions such as weather.

Impacts to the campus may include casualties, grounds or structural contamination, fire, explosion, other property damage, and/or operational interruption. Indirect results may include financial loss, increased insurance premiums, brand and reputation harm, and loss of grounds or facilities use. Likely, more than one impact would be present because of the nature of hazardous materials incidents and the potential for them being wide-area incidents and/or long duration events (containment, decontamination, etc.).

4.17 Hazard: Technological Hazards.

4.17.1 Cyber Crimes.

4.17.1.1 Nature of Threat. Electronic crimes, or cybercrimes, are crimes that use computers and networks as the main tool or that have computer or network assets as a primary target. The U.S. Bureau of Justice Statistics divides cybercrime into three types:

- Cyber attacks: crimes in which the computer system is the target. These crimes may consist of computer viruses, denial of service attacks, and electronic vandalism or sabotage.
- Cyber theft: crimes in which a computer is used to steal money or something of value. These crimes include intellectual property theft, personal data theft (identity theft), financial data theft, embezzlement, and fraud.
- Other cyber security incidents: crimes involving malware, unauthorized keylogging software, social engineering (phishing), unauthorized or attempted unauthorized access of computer systems, website spoofing, website redirection (pharming), and theft of other information.

Cybercrime is noted by the U.S. Department of Justice (DOJ) Offices of the United States Attorneys as “one of the greatest threats facing our country, and has enormous implications for our national security, economic prosperity, and public safety.” According to the F.B.I., cybercrime threats can come from domestic or international sources. International sources include foreign governments, foreign adversaries, foreign companies, crime syndicates, and individual operators. Universities face the added threat of international students and faculty who may be in the U.S. for duplicitous reasons such as cyber espionage and theft of sensitive or intellectual property.

One additional type of cybercrime to consider is cyber terrorism or cyber warfare. Foreign nations, foreign adversaries, and other groups and individuals who are adversaries to the United States may attempt to compromise computer systems and networks in order to disrupt critical infrastructure (military systems, power grids, power generation operations, public water supply systems, traffic control systems, railroad control systems, etc.) with the intent of creating wide-scale disruptions of critical and governmental services, confusion, and terror among the general population.

4.17.1.2 Severity and extent of cybercrime. Cyber security threats are increasing exponentially with the increase in usage of cyber technologies across the globe. The International Telecommunication Union (ITU) provides a comprehensive definition of cyber security as "the collection of tools, polices, security concepts, security safeguards, guidelines, risk management approaches, actions, training, best practices, assurance and technologies that can be used to protect the cyber environment and organization and user's assets. Organization and user's assets include connected computing devices, personnel, infrastructure, applications, services, telecommunication systems, and totality of transmitted and/or stored information in the cyber environment." [44]

Research universities such as UAH frequently use information of high value and work closely with both government and private research and technological agencies. There have been multiple cyber-related attacks against universities in the United States in recent years. The attack on the University of Maryland in February 2014, is reported to have exposed identities of more than 300,000 people including students, staff, and alumni. Similar attacks have been reported at the University of Indiana and Delaware recently.

In 2013, according to the Federal Bureau of Investigation's (FBI) Internet Crime Complaint Center's (IC3) annual report, a total of 3,105 cyber-related complaints from Alabama were registered with a total reported dollar loss of $6.1 million. Of these, hacking and identity theft accounts for nearly 20 percent with a median loss per complaint of $346.71 and $750 respectively. Additionally, almost five percent of the reported cases related to "spam" emails, accounting for nearly $0.3 million in losses. At the national level, IC3 received 238,189 cyber-related complaints from within the U.S. with total dollar losses reported at $574,276,422. On the international level, IC3 reported 262,813 cyber-related complaints in 2013 with an adjusted dollar loss of $781,841,611. This dollar amount represents a 48.8 percent increase over 2012.

UAH is known to work with agencies such as the Department of Defense, Department of Energy, United States Army, National Aeronautics and Space Administration (NASA), Department of Homeland Security, and other government agencies and thus may be seen by cyber criminals, including organized crime and foreign governments, as a resource for sensitive information. UAH is constantly at risk from cyber threats.

The UAH Office of Information Technology (OIT) is responsible for maintaining cyber security on campus. According to OIT, phishing (attempts to acquire sensitive information electronically through social engineering means) and scam emails are the primary threats. However, there have been some attempts to compromise and gain unauthorized access into University systems. The University currently maintains a centralized data center. Damage to the data center from natural or man-made hazards could disrupt the entire University information technology network and cyber functioning and/or result in the release of confidential and/or sensitive or classified data.

Password security is another area of concern. The University must balance cyber security needs with user experience and satisfaction. Balancing the user expectations against best practices in password security (such as password complexity and password expiration) is an ongoing challenge. Whereas separate, unlinked login and password credentials for campus systems might prove more secure, the University's students, employees, and other key stakeholders expect simplicity when it comes to digital credentials. Therefore, UAH is moving towards "single sign-on" where a user has one master credential that may be used to access multiple systems. The central credentialing service is linked to multiple systems and presents a potential vulnerability for compromised user credentials.

Another vulnerability facing many institutions of higher education (IHE) is aging cyber infrastructure. Much of the existing UAH campus network infrastructure was put into place before cybercrime, particularly infrastructure-related attacks, were as prevalent as they are today. Aging network and computer equipment and software create added vulnerabilities to network intrusion, denial of service attacks, network equipment compromise, and theft or destruction of critical and sensitive data.

4.17.1.3. Temporal Probability. In contrast to government and industry, university networks have historically been open and inviting in order to appeal to students, faculty, and staff. IHEs often strive to make it relatively easy for campus community members, alumni, and donors to connect to and communicate with them. IHEs are typically more vulnerable than government and businesses to some forms of cybercrime.

IHEs continue to be targets for cyber criminals at both the domestic and international levels. Government and industry-sponsored research, the presence of foreign nationals (international students, scholars, and faculty), and university-owned intellectual property can present enticing targets to adversarial foreign nations and organizations. Intellectual property, personal and financial data, and other opportunities for criminal financial gain make the UAH network and computer systems potential targets for corporate and individual groups and persons.

UAH is in the process of upgrading critical cyber infrastructure. However, many technologies are outdated within 18 months of product release. Vulnerabilities in software, computer operating systems, and other cyber equipment are found and exploited by criminals daily. Therefore, the likelihood of cybercrime affecting UAH is moderate.

4.17.1.4 Impact. The impacts of cybercrime may vary with the extent, severity, and nature of a given cybercrime. Possible effects include:

- Loss of intellectual property
- Theft of sensitive and classified data
- Reputational harm and loss of competitiveness
- Fines and penalties
- Legal fees and compensatory payments to affected individuals or organizations
- Financial loss from interruption of contracts and grant work
- Opportunity costs including disruption of operations
- Cost of additional mitigation measures

The education sector in the U.S. is reported to have a per capita data breach cost substantially above the overall mean. Data from 2014 indicates that the education sector has the third highest per capita cost in the United States. Nationally, the total average organizational cost (all sectors) for a data breach was $5.85 million. This represents a 7.4-percent increase over 2013. With roughly 9,000 students and employees, at the 2014 per capital average for the education sector of $259, a data breach might be expected to cost the University in excess of $2.3 million.

4.17.2 Electrical Utility Outage

4.17.2.1 Nature of hazard. An electrical utility outage (power outage) involves the interruption of electrical service to the University from the Huntsville Utilities public utility organization's electricity distribution system. Power outages can be caused by natural hazards or may be human related. Causes include: wind, snow, ice, severe weather, earthquake, vehicle crashes, equipment failure, and short circuits caused by wild animals. Other human-related causes include criminal acts (vandalism, sabotage) and terrorism (physical sabotage or destruction, cyber-related attacks).

Sources of outages may include excessive electrical demand from heating or cooling needs during periods of extreme cold or hot weather, respectively. Peak demand during these weather events can exceed the capacity of the electrical transmission infrastructure resulting in unplanned outages (circuit protection or equipment failure) or forced outages intended to prevent transmission infrastructure damage.

Over 90 percent of the campus electrical transmission infrastructure is above ground (power lines, poles, and transformers). At least 75 percent of the surrounding community's electrical infrastructure is above ground as well. These infrastructure components are susceptible to damage from severe weather, ice, falling trees, vehicle crashes, vandalism, sabotage, and other natural and human-caused sources.

4.17.2.2 Severity and Extent of Power Outages. Power outages can be categorized as brief outages, extended outages, or catastrophic outages. Brief outages last only a few minutes or less; extended outages last less than one day, and catastrophic outages can last days or weeks. Weather-related outages are typically the greatest in duration because of large areas affected by weather systems.

Power outages may vary greatly in scope. They may be localized to a small area, such as a single building or structure or a single street. An outage may also affect a larger area such as a few city blocks, or be extensive and impact an entire city, county, or region.

4.17.2.3. History of Power Outages on the UAH Campus. Historically, the UAH campus experiences one to two power outages annually. These outages typically last less than one hour and do not always affect the entire campus. The UAH campus receives electrical service from two separate Huntsville Utilities power substations. The campus is divided roughly in half (north and south sections) between the two, with Holmes Avenue serving as the dividing line. Interruptions to one area of campus typically do not affect the other area.

Outages affecting the entire campus are rare but do occur and tend to be related to instances of severe or winter weather in the area. The University has not kept historical records of power outages; however, there is information regarding two catastrophic outages – both weather related – and two extended outages that significantly impacted campus operations.

In April 2011, a tornado outbreak affecting the north Alabama region resulted in a seven (7) day interruption of electrical service to the campus. The outage was extensive and affected most of Madison County and other areas in surrounding counties. Huntsville Utilities purchases most of its electricity from the Tennessee Valley Authority (TVA). At the time of the tornado outbreak, TVA maintained three primary power transmission pathways into Madison County. Interruption of one or even two of the transmission pathways would not have resulted in a county-wide outage. However, tornadoes severely damaged all three transmission pathways, resulting in a complete interruption of the electrical supply for the county. TVA, Huntsville Utilities, and other utilities disaster response teams from unaffected areas required three days before power began to be restored to the area and one week to restore power to the UAH campus.

An ice storm in the winter of 1985 also resulted in a multi-day power outage on campus. The exact duration of the outage is not known but is believed by long-time employees to have lasted two days. The ice storm caused widespread outages throughout the region, and some areas were without electricity for several days.

In 2013, the southern portion of campus experienced an approximately two (2) hour outage which resulted from substation equipment damage caused when a squirrel created a short circuit at the transmission substation facility. Classes were disrupted in several buildings during the power interruption.

In 2014, electrical service to Morton Hall was interrupted for several hours because of a faulty power transformer. Classes scheduled in that building were dismissed for the full day.

4.17.2.4 Probability of future occurrence.

*4.17.2.4.1 Temporal probability***.** Power outages may be caused by a wide range of factors and may also be a secondary effect of another event impacting the area or region. Because of these widely varying causes and contributing factors, it is not possible to predict specific outage times or events. Outage risk increases during the severe weather season for north Alabama, which extends from March through May each year. Risk also increases during the winter weather season, though not to the extent of severe weather season.

Brief power outages affecting only one of the transmission substations and infrastructure feeding a single section of campus will occur, and the outages have been observed to average one to two instances annually. Temporal risk of brief outages is moderate. Campus-wide extended power outages have historically impacted the campus less frequently and are typically the result of major natural hazard events, which themselves cannot be predicted with any certainty. However, anecdotal evidence seems to indicate one such event every three to five years. Temporal risk of extended outages is deemed low to moderate. Catastrophic outages are rare and again are typically a secondary result of a major natural hazard event. Anecdotal evidence suggests one such event every 10-15 years. Temporal risk of catastrophic outage is considered to be low.

*4.17.2.4.2 Spatial probability***.** The UAH campus is located in an area regularly impacted by severe storms and occasional winter storms (snow, ice). These events typically impact a large geographical area and can cause extensive damage to power transmission infrastructure. Additionally, because of the exposed nature of most power transmission infrastructure (lines, poles, substations, transformers, etc.) the overall likelihood of human-caused damage to Huntsville Utilities and/or UAH-owned equipment providing campus electrical supplies is significant. Spatial probability for a brief outage is moderate. Spatial probability is low for an extended outage, as these events generally tend to be geographically isolated, and thus, the risk is spread over a much wider area. Spatial probability for a catastrophic event is slight to low, as these events tend to be triggered by major natural hazards and are infrequent in nature.

4.17.2.5 Impact. Campus operations are very susceptible to power outages. Most campus buildings have emergency generators that are only capable of handling egress lighting needs and in many instances, life safety equipment (fire alarms, security systems, etc.) power needs. With only a few campus exceptions, primary lighting, heating and cooling systems, and most building electrical distribution systems are not generator protected, and thus, not powered during an outage.

Normal campus operations cannot continue during a power outage. Duration and extent of a power outage have a direct effect on the severity of impact to University operations. Short-duration or brief outages typically have minimal impact on operations. Academic, research, and business operations may experience small interruptions or delays but are generally able to resume in a few minutes to an hour. UAH does not usually cancel classes or close the campus for brief outages.

Extended outages can result in significant operational interruptions lasting from two hours to one day. During an extended outage, normal campus operations are suspended. Extended outages can result in lost wages for hourly employees, loss of academic instructional time, interruption or disruption of research activities, and moderate generator fuel expenses (diesel, natural gas). Normal operations can generally resume as soon as power is restored;

however, because of the required commute time for students and employees, delays in receipt of notifications regarding operational status, and other factors, the University will typically suspend normal operations for as much as one-half day.

Catastrophic outages will result in the complete disruption of all but public safety and emergency campus operations. Catastrophic outages cause the disruption of academic instruction, research activities, contracts and grants activities, business operations, residence hall operations, food service operations, heating and cooling systems, many building life-safety systems (fire alarms, security systems), and most other non-emergency campus activities.

Catastrophic outages can lead to significant financial losses (contracts and grants income, auxiliary services income, etc.). If more than one week in duration, a catastrophic outage has the potential to completely disrupt the academic semester. Such a disruption could lead to a cancelling of classes for the remainder of a semester and require tuition reimbursements to students. Canceling the semester and the resulting academic interruption would have a negative impact on students and faculty and could lead to enrollment loss and lower faculty retention. It would create economic hardships for many employees as well as for the University.

Also at risk during a catastrophic power outage is critical research. Loss of heating, cooling, and/or refrigeration capabilities would lead to the loss of years of research, much of which cannot be or cannot easily be duplicated. In some instances, this would result in the loss of research spanning decades and representing the bulk of a researcher's life's work.

Public safety concerns are also present during a catastrophic power outage. In some buildings, life safety systems are protected only by battery backup power. These systems may remain online for 12 hours or less. Once battery power is exhausted there would be no fire alarm or electronic physical security systems active in some buildings.

Residential facilities that remain occupied during a catastrophic outage may not be able to provide hot water for bathing. Students would be unable to prepare their own meals, and campus food services would be severely constrained because of the loss of use of food preparation equipment and lack of available food refrigeration. Heating and cooling systems would not be functional and thus student residents having to remain on campus (in cases where international and domestic students are unable to return home or make other accommodations) would not have environmentally controlled living quarters.

A secondary impact of power outages can include mechanical equipment damage. Commercial heating, ventilation, and air conditioning (HVAC) systems, as well as other physical plant systems, are susceptible to damage during power interruptions, particularly if the interruptions include instances of closely-spaced interruption/resumption cycles. Motors and other electrical components can be damaged by these uncontrolled power cycles.

5. Mitigation Strategies

5.1 Purpose of Mitigation Strategies

Risk management involves identifying potential and actual hazard threats to The University of Alabama in Huntsville (UAH), understanding how a hazard may impact organizational objectives, and developing and implementing strategies to manage those risks and mitigate their impact.

The goal of these mitigation strategies is to reduce potential impacts to the campus community from the hazards identified in the previous section. These mitigation measures provide a long-range set of goals and objectives intended to provide for a more resilient UAH community and support the University in its missions of teaching, research, and service.

5.2 Steps in Developing the Mitigation Strategies

Each member of the UAH inter-disciplinary Emergency Management Operations Group (EMOG) was asked to complete a risk assessment for their operational units. The assessment utilized the Campus Safety Health and Environmental Management Association's (CSHEMA) Hazard Vulnerability Assessment Tool. This tool is based on a Federal Emergency Management Agency (FEMA) model which in turn is based on a higher education example.

HAZARD RISK ASSESSMENT MODEL

THREAT EVENT/ HAZARD	PROBABILITY	SEVERITY = MAGNITUDE of IMPACTS: HUMAN IMPACT		FACILITIES IMPACT		INSTITUTIONAL IMPACT		SEVERITY IMPACTS	UNMITIGATED RISK	PREPAREDNESS	RELATIVE RISK
	Relative likelihood this will occur	*Potential deaths or injuries*		*Physical damage and costs*		*Interruption of research & teaching Impact reputation/image*		*Overall Impact (Average)*	*Probability x Severity Impacts*	*Level of Preparedness*	*Unmitigated Risk/Preparedness*
Natural Hazards Technological Human Terrorism	*P1:Likelihood*	*H1:Extent*	*H2:Number*	*F1:Extent*	*F2:Cost*	*I1:Duration*	*I2PR*	*S1:Severity*	*U1:Unmitigated*	*R1:Preparedness*	**To sort results, Unprotect sheet, GoTo (F5) "ResultSort" then use Sort function**
Threat	*Probability*	*HumanExtent*	*HumanNumber*	*FacilExtent*	*FacilCost*	*InstDuration*	*InstPR*	*Severity*	*RawRisk*	*Preparedness*	**RelativeRisk**
Sample	2.00	1.00	3.00	1.00	1.00	2.00	2.00	**1.67**	**3.33**	3.00	**1.111**
AVERAGE SCORE											

Figure 5.1 CSHEMA Hazard Vulnerability Assessment Tool version 2.0

The risk assessment responses were combined with detailed information of past hazard events and reviewed by the Planning and Public Safety groups of the Hazard Mitigation

Planning Committee. Past hazard event lists were compiled through the evaluation of available data including: National Weather Service records, news reports, campus damage reports, interviews with long-time University employees, Committee members' recollections, and anecdotal evidence from the UAH maintenance management database.

Following the risk assessment, the Planning Group reviewed information on capabilities and potential impacts. The capabilities and impact information was obtained directly from campus operational units and from unit-level continuity of operations plans (COOP) during the Business Impact Analysis. The Planning and Public Safety groups examined regulatory and compliance issues, resource availability, possible funding sources, and other capabilities of the University.

Major challenges facing each segment of the campus community were derived from the hazard analysis, business impact analysis, public participation, and inter-departmental discussions. These challenges form the basis for determining appropriate mitigation measures based on existing risks, capabilities, statutory requirements, and funding.

The Public Safety Group and the Planning Group, with input from EMOG members, reviewed a range of possible mitigation alternatives for UAH. Each of the alternatives was evaluated to determine its suitability and feasibility to advance the goals of this Plan. The mitigation measures selected were those determined to best address each vulnerability. FEMA's STAPLEE (social, technical, administrative, political, legal, economic, environmental) method was incorporated into the mitigation alternatives review process. (See Table 5.1)

S	Social	Community members and other stakeholders support the implementation strategy and specific mitigation actions. Projects must be evaluated in terms of acceptance by the community.
T	Technical	Proposed actions must be technically feasible, must help to reduce long-term losses, and have minimal secondary impacts. Actions should be identified as a whole or partial solution, or not viable.
A	Administrative	A determination should be made as to whether the community has the anticipated staffing, funding, and maintenance requirements needed to implement a mitigation action, or whether the community will need outside assistance.
P	Political	Proposed actions should be reviewed from the perspective of understanding how University leadership will respond to and support issues related to environment, safety, emergency management, and economic impact.

L	Legal	A determination should be made as to whether the University has the legal authority to implement the action, and to what extent the action can be enforced from both a statutory and policy perspective.
E	Economic	Proposed actions should be evaluated for cost effectiveness and whether funding sources, either internal or external, are or are expected to be available.
E	Environmental	Proposed actions should be evaluated to determine whether they are environmentally sustainable and healthy, or would result in negative environmental impact.

Table 5.1 – FEMA's STAPLEE mitigation action analysis method

The Committee completed a mitigation implementation program to schedule the implementation of mitigation measures. The implementation program assigns implementation responsibility, sets a timeline, identifies funding needs, and establishes an implementation priority.

5.2.1 Mitigation strategy development. The following steps were utilized in developing mitigation strategies:

1. **Identify vulnerable locations/critical assets.** For each of the threat events, vulnerable campus locations or critical/high-value facilities were identified.
2. **Identify mitigation measures.** For each of the threat events, potential interim and long-term mitigation measures were evaluated, taking into consideration site-specific vulnerabilities and critical assets. Existing and ongoing mitigation measures were also identified.
3. **Develop mitigation strategy.** Institutional priorities, goals, objectives, operational experience, and business impact analysis were used to develop an overall mitigation strategy. A list of all high-priority short- and long-term mitigation measures were recommended for implementation.
4. **Develop implementation strategy for mitigation measures.** An implementation strategy was developed for identified mitigation priorities. Potential funding sources, implementation responsibilities, and implementation timelines were identified.

5.3 The Planning Approach

The planning approach outlined below utilizes six program categories recommended by FEMA for managing a mitigation program. These categories were used by the Committee for identifying and selecting alternative mitigation measures.

- **Prevention.** Administrative actions that influence land use and building use and development in order to minimize risks of loss from hazards.

- **Property protection.** Actions that modify existing buildings or infrastructure to protect them from a hazard or remove them from the hazard area.

- **Public education and awareness.** Actions to inform and educate UAH community members and other affected stakeholders about potential risks from hazards and potential ways to mitigate the hazards.

- **Natural resource protection.** Actions that minimize hazard losses and also preserve or restore the functions of natural systems.

- **Structural projects.** Actions that involve the construction of new structures or the modification of existing structures and natural systems to reduce the impact of a hazard.

- **Emergency services.** Actions to develop, sustain, or enhance existing hazard recognition, emergency notification, and emergency response capabilities.

Not included in this Plan are mitigation action alternatives considered by the Committee that were determined to be cost prohibitive, of a low cost-to-benefit ratio, environmentally unsound, or politically or legally unfeasible.

Mitigation actions also consider campus institutional priorities and operational experience, highly valued or irreplaceable assets identified to be vulnerable, and business impact analysis. Mitigation actions focus on the greatest campus vulnerabilities and establish prioritized interim and long-term actions to reduce campus risks.

5.4 Mitigation Action Considerations

The mitigation actions in this Plan respond to the considerations outlined in this section. These considerations summarize the principal hazard issues and mitigation opportunities. Moreover, the considerations are based on the risk assessment, business impact analysis, community input, coordination among interested agencies, and participation by the Committee members.

5.4.1 Prevention considerations. UAH maintains a five-year campus master plan. The master planning process provides a clear and compelling vision of a unique, attractive, and functional setting for all the activities that occur on the UAH campus. To fulfill its purpose, this physical planning process is coordinated with the University's strategic plan.

UAH does not have a full-time planning department. Long-range planning, such as the campus master plan, is typically accomplished through ad-hoc committees and/or the Facilities and Operations Department. Facilities and Operations maintains an Office of Campus Architect which is responsible for providing guidance to the University's growth consistent with the mission and goals of the administration, campus master plan, state and local building codes, and established campus construction standards. The UAH Office of Emergency Preparedness is responsible for maintenance and development of campus-level emergency preparedness plans, exercises, and drills. Other offices with direct responsibility for public safety planning include the UAH Police Department and the Office of Environmental Health and Safety. These offices are a part of Facilities and Operations.

Other prevention considerations:

- UAH is located within the City of Huntsville, which maintains a full-time planning department.
- Land improvements, roadwork, and other such modifications made by the City of Huntsville may have direct impact on the campus or areas immediately adjacent to campus.
- The City of Huntsville Police Department has concurrent jurisdiction on the UAH campus.
- The City of Huntsville provides emergency fire response services for the campus through Huntsville Fire and Rescue.
- Remote cameras enhance the monitoring capabilities of law enforcement and aid in crime deterrence.

5.4.2 Property protection considerations. Structures on the UAH campus have been constructed over a period of 60 years and were designed to meet building codes and safety standards required at the time of construction. Building code requirements evolve on a continual basis, but as newer standards are adopted by various jurisdictions, existing construction must generally only meet the codes and standards in place at time of construction.

Other property protection considerations:

- Property insurance policies do not typically cover damage from natural flood, sinkholes, and earthquakes.
- UAH owns a significant amount of intellectual property.
- Some buildings on the UAH campus do not have fire sprinkler systems.
- UAH considers its primary threat to be human- or technology-caused fires.
- UAH is located in a geographic area prone to frequent severe weather and tornadoes.
- Some campus buildings have fire alarm systems that are not centrally monitored but do report via telephone line directly to the fire department in the event of system activation.

5.4.3 Public education and outreach considerations. The UAH community is composed of domestic and international students, faculty, staff. invited guests, contractors, and other visitors. For many students, this may be their first time away from home without the support of parents, other family, and friends.

International students, scholars, and faculty may be visiting the north Alabama region for the first time. These groups and new employees recruited from outside the north Alabama geographic region may be unfamiliar with hazards inherent to the area and to higher education campus environments.

Other public education and outreach considerations:

- The UAH Office of Emergency Preparedness maintains campus-level preparedness plans and emergency action guidelines and is an emergency preparedness technical resource for University operational units, colleges, and departments.
- The UAH Office of Environmental Health and Safety offers programs, guidance, and training in occupational health and safety, chemical hygiene, laboratory safety, fire safety, first aid, and cardiopulmonary resuscitation.
- The UAH Police Department is a fully empowered state law enforcement agency dedicated to protecting the campus community. The department offers crime prevention services and programs to facilitate the safe movement of pedestrians and vehicles on campus.
- Federally funded higher education institutions are required by law to develop and maintain emergency response and evacuation procedures (Higher Education Opportunity Act of 2008 [HEOA])
- Higher education institutions receiving federal funding are required by law to maintain programs to prevent dating violence, domestic violence, sexual assault, and stalking (section 485[f][8] of the Higher Education Act [HEA])

5.4.4 Natural resources protection considerations. The 400-acre UAH campus is located in a combination of urban business and residential settings. The campus has a diverse variety of natural flora and fauna including undeveloped wooded areas, a man-made lake, and naturally occurring streams. Parts of the campus are located directly above what is believed to be an extensive underground natural aquifer system.

Other natural resources protection considerations:

- Accidental or intentional release of hazardous materials into a waterway or storm drainage system can negatively impact the campus environment as well as downstream environments.
- Streams and natural drainage paths help manage rain and floodwater runoff.
- Debris from storm-damaged trees can block streets and restrict water flow in streams and drainage paths.
- Storm-related debris and fallen trees can disrupt electrical service, create property damage, increase hazard recovery times, and increase hazard-related recovery costs.
- The five-year campus master plan includes relocation of one major campus thoroughfare on the north end of campus.

5.4.5 Structural projects considerations. The UAH *Campus Master Plan* twenty-year projections indicate the number of buildings on the existing UAH campus will increase by over fifty percent. (See Figure 5.2) Since 2006 the University has constructed ten (10) new buildings, completely renovated two (2) others, and built an athletic complex consisting of two ball fields, a locker room building, and a ticket/concessions building. Construction began on one additional building in December 2014 and UAH purchased an adjacent elementary school (building and grounds) in the fall of 2014.

Other structural projects considerations include:

- UAH is located in a geographic region prone to frequent severe weather and tornadoes.
- Parts of the UAH campus are located above what is believed to be an underground aquifer system. One major sinkhole occurred in this aquifer system and impacted an area on the western edge of campus in 1967.

Figure 5.2. UAH Twenty-year Illustrative Master Plan – 2010 through 2030

5.4.6 Emergency services considerations. A comprehensive emergency notification system can tie a variety of stand-alone notification systems into a single, centrally-controlled mass notification system (MNS). UAH has invested in a voice-capable MNS for in-building and exterior emergency voice notification. This system is capable of real-time live and recorded voice notifications. Not all buildings are currently equipped with an indoor MNS. The extreme western portions of the campus are not covered by the outdoor MNS.

UAH uses a third-party emergency notification solution to provide emergency information via telephone, text/SMS, email, and some social media types (*e.g.*, Facebook, Twitter). This third-party system cannot disseminate information in real time (*i.e.*, live). Because of telephone and internet network delays beyond the control of the service provider and UAH, these notifications may experience delays in delivery. Other delays in message receipt may include the recipient not having access to telephone and/or internet service, not being subscribed to the notification service, and conscious decision not to read or listen to a notification message.

Other emergency services considerations include:

- The UAH Police Department is a fully empowered state law enforcement agency dedicated to protecting the campus community.
- The City of Huntsville Police Department has concurrent jurisdiction on the UAH campus.
- The City of Huntsville provides emergency fire response services for the campus through Huntsville Fire and Rescue.
- Emergency medical services are provided on campus though Huntsville Emergency Medical Services, Inc. (HEMSI).
- Remote cameras can enhance the monitoring capabilities of law enforcement and aid in crime deterrence.
- The Huntsville-Madison County Emergency Management Agency maintains and operates two (2) tornado warning sirens on the UAH campus.
- Weather radios in offices, meeting spaces, and residential suites provide a readily accessible means for advance warning of severe weather.

5.5 Existing Hazard Mitigation Activities

This Plan expands upon and improves existing campus-level mitigation activities, as described in this section.

5.5.1 Hazard Mitigation Grant Program (HGMP). UAH is developing this plan as a sub-grantee of the Alabama Emergency Management Agency (AEMA) through the Pre-Disaster Mitigation program of the FEMA Hazard Mitigation Grant Program. UAH will implement the mitigation activities listed in this Plan as resources and funding allow and based on the priorities and implementation strategies set forth herein.

5.5.2 Severe weather protective area program. Since 2012, new construction on the UAH campus is being designed to include designated severe weather protective areas. These areas are intended to provide protective areas for peak building occupancy loads in the event of severe weather.

5.5.3 Mass notification system project. Since 2010, new campus building fire alarm systems are required by policy to have voice capability. In 2013, phase one of a two-phase campus mass notification installation project was begun. This project ties buildings with existing voice-capable fire alarm systems into a centrally monitored and controlled MNS. Buildings included in phase one that were without voice-capable fire alarm systems were retrofitted with new speaker and speaker/strobe hardware to convert to voice. The system ties separate building systems together via a central control station using secure radio frequency communications between the points.

Buildings and MNS implementation types included in phase one are shown in table 5.2.

Building Name	System Type	Building Name	System Type
Administrative Science	Converted	North Campus Residence Hall	Converted
Bevill Center	Converted	Roberts Hall	Converted
Central Campus Residence Hall	Voice capable	Salmon Library	Converted
Charger Union	Voice capable	Spragins Hall	Converted
Charger Village	Voice capable	SWIRLL	Voice capable
Frank Franz Hall	Converted	University Center	Converted
Morton Hall	Converted	University Fitness Center	Converted
Materials Science	Voice capable	Wilson Hall	Voice capable

Table 5.2 – MNS implementation, phase one.
Converted = converted from traditional fire alarm system to voice-capable
Voice capable = system originally installed as voice-capable fire alarm system

Phase one of the project also included two outdoor high-power speaker arrays (HPSA). One array is located on the north end of campus atop Roberts Hall. The other is located on the southern portion of campus atop Materials Science Building. These speaker arrays are intended to provide real-time emergency notification to pedestrians, bicyclists, and others moving between campus buildings or engaged in outdoor activities on campus. They are tied into the centrally-controlled MNS via secure radio frequency communications.

5.5.4 Continuity of operations planning. In April 2009, former Alabama Governor Bob Riley issued a directive requiring all state entities to develop continuity of operations plans (COOP). UAH adopted an online planning tool and former UAH president David Williams issued a directive to all University colleges and units to develop unit-specific continuity of operations plans. Since October 2009, 23 UAH departments/units have developed some level of continuity plan using the online tool. Not all key units have fully developed continuity plans.

5.5.5 Crime prevention and awareness training. UAHPD officers maintain several crime prevention, deterrence, and awareness programs specific to a higher education environment. These initiatives include but are not limited to:

- Rape Aggression Defense (RAD) training
- Domestic violence awareness campaigns
- Theft prevention talks and publications
- Property registration and identification services
- Security escort services
- Stranded motorist assistance
- Special event security planning
- Training for Campus Security Authorities (required by HEOA)
- Campus physical security services

5.5.6 Existing strategic planning capabilities and regulatory tools. UAH maintains a University-level Strategic Plan that outlines goals, objectives, and priorities intended to guide all University activities. Supporting the Strategic Plan are other mission- and goal-oriented plans, including:

- Annual Capital Development Plan
- Five Year Facilities Development Plan
- Campus Master Plan
- Emergency Management Plan

Regulatory tools include building codes and standards, environmental regulations, occupational health and safety regulations, Federal and State laws and regulations, University of Alabama System directives, and UAH policies and procedures. Regulatory examples include:

- National Fire Protection Association (NFPA) standards
- International Building Code (IBC) standards
- State-adopted building codes
- Local municipality building codes (City of Huntsville)
- Americans with Disabilities Act (ADA) (42 U.S.C 12101 et seq.)
- Occupational Safety and Health Administration (OSHA) regulations
- Higher Education Act (HEA) of 1965 (20 U.S.C. 1001 et seq.)
- Higher Education Opportunity Act (HEOA) (34 C.F.R. 600 et seq.)
- Jeanne Clery Disclosure of Campus Security Policy and Campus Crime Statistics Act (20 U.S.C. § 1092[f])
- Title IX of the Education Amendments of 1972 (20 U.S.C. 1681 et seq.)
- Code of Alabama 1975
- Homeland Security Presidential Policy Directive 5: Management of Domestic Incidents
- Homeland Security Presidential Policy Directive 8: National Preparedness

5.5.7 Student resident safety training. The UAH Housing and Residence Life office conducts regular safety orientations and training for both staff and student residents. Staff training includes

5.5.8 Public health. UAH currently requires all incoming students to provide proof of immunization for the following infectious or communicable diseases: measles (2 doses, one of which must also include mumps and rubella [MMR]), and meningitis (if residing in on-campus housing). Tuberculosis screening is required for all incoming students.

UAH operates a Student Health Center and a Faculty and Staff Clinic, both staffed with licensed nursing professionals. Both clinics offer basic health screening services.

The UAH Student Health Center offers required immunizations to admitted students who have not previously been inoculated or are unable to provide proof of immunization.

The UAH Communicable Diseases Management Team (CDMT) handles reports or confirmed instances of communicable diseases on campus or which may threaten campus. The CDMT uses a case-management approach to each incident and works closely with University and local/state public health officials to monitor potential threats.

5.6 Comprehensive Mitigation Strategies

This section presents the long-term strategies for mitigation of natural and man-made hazards. UAH derives its five-year mitigation action program from the program goals, objectives, and available long-term mitigation measures presented here.

5.6.1 Land and building use and resource conservation and protection. Manage the development of land and buildings to minimize risks of loss due to natural or man-made hazards.

5.6.1.1 Comprehensive plans. Incorporate mitigation planning measures into active comprehensive planning programs that guide future campus development. These measures would ensure campus planning duly considers the vulnerability of areas exposed to natural hazards and the vulnerability of campus areas to man-made hazards.

Mitigation measures:

5.6.1.1.1 Maintain up-to-date comprehensive plans for all aspects of campus development. This includes the Campus Master Plan, Capital Development Plan, Emergency Management Plan, and others.

5.6.1.1.2 Where appropriate, integrate findings and recommendations of this Plan into comprehensive plan amendments for existing plans. This should include relevant plans not scheduled for review within the next 18 months.

5.6.1.1.3 Review and amend existing planning documents to be certain the vulnerability and environmental sustainability of lands for future development are clearly *addressed.* Plans should include open-space planning to create amenities for recreation and conservation of natural resources.

5.6.1.2 Geographic information systems (GIS). Maintain a comprehensive database of hazards locations, infrastructure, and facilities inventories.

Mitigation measures:

5.6.1.2.1 Maintain risk assessment data in GIS, including flood zones, tornado tracks, sinkhole locations, Clery Act reportable crimes. This will include locations of hazardous materials (laboratories, storage areas, fuel storage tanks, etc.).

5.6.1.2.2 Maintain a comprehensive inventory of campus facilities and critical infrastructure. This will include information on interior and exterior shut-off points for utilities (electricity, water, natural gas). This would include links to electronic copies of building floor plans for each facility. (See *5.7.1.2.3.)*

5.6.1.2.3 Review and update as needed existing floor plans to ensure they are current and include all modifications and improvements. This will include implementation of a quality assurance process to ensure that plans are updated as changes are made during the construction/renovation project management process.

5.6.1.2.4 Conduct comprehensive study of campus to identify areas with potential for sinkholes or land subsidence. No current study exists that identifies possible sinkhole threats on campus. It is believed that western parts of central campus are located above underground aquifers and/or natural cave systems.

5.6.1.2.5 Integrate emergency information into the Virtual Alabama GIS tool to allow sharing of information with community first responders (e.g., fire, police, EMS). Work with Alabama Department of Homeland Security, Huntsville Fire and Rescue, Huntsville Police, and Huntsville Emergency Medical Services, Inc. to integrate critical campus emergency information into Virtual Alabama and make it available to first responders. Information to be integrated would include building floor plans, emergency evacuation locations, hazardous materials storage locations, utilities shut-off points, and other information critical to responders during an emergency situation.

5.6.1.3 Building codes. Review local and State building codes for effectiveness and proper application of standards to protect buildings and infrastructure from natural and man-made hazard damage.

Mitigation measures:

5.6.1.3.1 Evaluate building code standards for roof construction to ensure standards are included in appropriate construction projects. Evaluation will include a roof design review process for construction projects and will encourage the use of hurricane storm clips in structures with trusses. Will examine existing structures to identify structures lacking storm clips and retrofit those roof systems to include storm clips.

5.6.1.3.2 Evaluate building code standards for fire protection system to ensure applicable standards are met or exceeded in appropriate construction projects. Evaluation will include fire protection system review and will also include examination of existing structures to identify structures lacking fire suppression systems and those structures where systems meet codes applicable at time of construction but may be improved upon by retrofitting or renovation of the system.

5.6.2 Property protection. Protect structures and their occupants and contents from the damaging effects of natural and man-made hazards.

Mitigation measures:

5.6.2.1 Property insurance. Maintain adequate structure and contents insurance coverage through the Alabama State Insurance Fund and other appropriate sources. Maintain a Risk Management Committee to conduct the annual review. Review and modify committee membership at least every two years to ensure representatives from all major campus operations and risk management groups are included (academics, research, business operations, facilities, public safety, planning and preparedness, inventory management, risk management, auxiliary services, student housing).

5.6.2.1.1 Annual coverage review. Risk Management Committee will conduct annual insurance coverage review for structure and contents coverage in coordination with the Alabama Division of Risk Management. Committee will ensure compliance with subsection 41-15-4(b) of the Code of Alabama 1975 requirements for all University-owned buildings. Annual coverage reviews will additionally include thorough review and updating as needed of the UAH property schedule prior to submission to the Division of Risk Management.

5.6.2.1.2 Flood insurance. Maintain insurance riders for flood-related damages. Risk Management Committee will review the most current FEMA floodplain maps and ensure that all structures at risk from 100- or 500-year flood events have flood insurance coverage.

5.6.2.1.3 Sinkhole / land subsidence insurance. Conduct cost/benefit study to determine feasibility of insurance riders for sinkhole and land subsidence damages for campus structures and facilities identified as being at risk in a sinkhole and land subsidence study. (see *5.6.1.2.4.)*

5.6.2.1.4 Earthquake insurance. Conduct cost/benefit study to determine feasibility of earthquake coverage for campus structures and infrastructure. If determined to be feasible, secure coverage through the State Insurance Fund or other appropriate source(s).

5.6.2.2 Land use policies. Implement written policies to prevent construction of structures or other vulnerable developments within hazard areas. Incorporate policies into all strategic planning activities.

5.6.2.2.1 Develop and implement formal policies to prohibit construction of facilities *vulnerable to flood damage within campus floodplains.*

5.6.2.2.2 Develop and implement policies to prohibit construction of facilities vulnerable to land subsidence in areas identified in activity 5.6.1.2.4.

*5.6.2.2.3 Develop and implement grounds vegetation and landscape management policies to minimize wildfire risk to structures and persons. (*e.g., *fire breaks, vegetation setback/buffer zones, etc.)*

5.6.2.3 Flood proofing. Evaluate and, where feasible and cost effective, retrofit existing buildings located in floodplains to reduce the potential for flood-related damages. This method should be utilized for buildings where it is not feasible to relocate or elevate the structure.

5.6.2.4 Power generation. Evaluate critical facilities for current emergency power generation capabilities.

Mitigation measure:

5.6.2.4.1 Conduct a gap analysis for each facility to identify shortfalls and determine additional emergency power generation requirements, if any. Review facility critical functions and determine whether current emergency power generation capabilities meet the requirements to maintain those functions during a power outage.

5.6.2.4.2 Evaluate, design, and implement cost-effective emergency power generation improvements. Where additional emergency power generation needs are identified and it is feasible to do so, upgrade and/or implement emergency power generation equipment to meet requirements for maintaining critical functions at the facility.

5.6.2.4.3 Install debris guards on emergency generator equipment. Evaluate, design, and implement feasible, cost-effective debris guards for emergency generator equipment. Debris guards should include protection of generator cooling systems and fuel storage tanks from airborne debris, such as may be present during a tornado or straight-line wind event.

5.6.2.5 Fire suppression systems. Assess existing campus buildings that do not have an automatic fire suppression system (sprinkler system, chemical agent system, etc.) for feasibility of retrofitting with an automatic suppression system.

Mitigation measures:

5.6.2.5.1 Conduct study of campus buildings not currently equipped with automatic fire suppression systems to determine feasibility and cost effectiveness of retrofitting with such systems.

5.6.2.5.2 Where feasible for buildings identified in 5.6.2.5.1, evaluate, design, and implement cost-effective automatic fire suppression systems for currently unprotected *buildings.*

5.6.3 Public Education and Outreach. Educate and inform the public about the risks of hazards and the techniques available to reduce threats to life and property.

5.6.3.1 Outreach projects. Conduct regular public events to inform the UAH community of hazards and mitigation measures.

Mitigation measures:

5.6.3.1.1 Establish an annual campus-wide severe weather awareness event. Coordinate with National Weather Service (NWS) to coincide with the annual NWS Severe Weather Awareness Week.

5.6.3.1.2 Identify other environmental awareness events to integrate public information on hazard exposure risks and protection measures.

5.6.3.1.3 Invite subject matter experts to present on specific hazard topics upon request by campus organizations, departments, etc.

5.6.3.1.4 Provide hazard awareness and mitigation information via brochures for distribution to students, employees, and guests.

5.6.3.1.5 Maintain and publicize hazard awareness and mitigation information on the UAH web site. Provide readily accessible links to hazard information such as natural hazards, crime hazards, and occupational hazards.

5.6.3.1.6 Conduct, sponsor, or host public training classes specific to certain hazards. This should include SKYWARN storm spotter training, Rape Aggression Defense (RAD) training, first aid, cardiopulmonary resuscitation (CPR), automated electronic defibrillator (AED), fire extinguisher use, and other hazard-specific courses including occupational health and safety.

5.6.3.1.7 Require new employees receive mandatory safety awareness training. This should include familiarizing employees with natural hazards to which the campus or their assigned work area is vulnerable, including man-made and technological hazards inherent to their job location and responsibilities.

5.6.4 Emergency services. Improve the efficiency, timing, and effectiveness of response, recovery, planning, and mitigation efforts for natural and man-made disasters.

5.6.4.1 Emergency notification. Improve public warning systems.

Mitigation measures:

5.6.4.1.1 Upgrade and/or install mass notification systems within all UAH buildings to *include recorded and live voice alert capabilities.*

5.6.4.1.2 Upgrade and/or install outdoor mass notification (giant voice) systems sufficient to cover all UAH campus grounds with recorded and live voice capabilities.

5.6.4.1.3 Weather radios. Improve UAH community access to weather alert radios.

5.6.4.1.4 Ancillary notification systems. Improve voluntary participation in ancillary notification systems such as UAlert (text, email, telephone, social media) within the UAH community.

5.6.4.2 Law enforcement services. Improve the efficiency, response capabilities, and effectiveness of UAHPD.

5.6.4.2.1 Response capabilities. Conduct gap analysis to identify potential response capability limitations. Analysis will include examination of concurrent jurisdiction with Huntsville Police Department and how that relationship impacts response capabilities.

5.6.4.2.2 Staffing and equipment. Conduct cost/benefit analysis to determine feasibility of increased staffing (sworn officers, dispatchers, and/or administrative staff) and/or emergency response equipment purchases (e.g., vehicles, barricades, non-lethal weapons, body armor, body cameras, first aid equipment, etc.).

5.6.4.3 Hazardous materials release response. Improve UAH's capabilities for responding to hazardous materials incidents.

Mitigation measures:

5.6.4.3.1 Response capabilities. Conduct gap analysis to identify response capability limitations. Analysis will include examination of UAH response capabilities (staffing, equipment, and training) and response times as well as Huntsville Fire and Rescue capabilities and response times.

5.6.4.3.2 Staffing and equipment. Conduct cost/benefit analysis to determine feasibility of increased staffing (e.g., hazardous materials specialists, occupational safety and compliance specialists, fire safety specialists, radiological specialists, etc.) and/or equipment (e.g., level A hazardous materials suits, self-contained breathing apparatus [SCBA], radiological monitoring tools, spill containment kits, air quality monitoring, etc.).

5.6.4.4 Emergency management and emergency responder training. Maintain a formal emergency response training program for UAH emergency response personnel and emergency and crisis management staff.

Mitigation measures:

5.6.4.4.1 Exercises and drills. Evaluate, design, and implement a formalized, cost-effective annual exercise and drill program, including, but not limited to: tabletop exercises, functional exercises, full-scale exercises, evacuation drills, and emergency communications drills. The exercise and drill program should be developed using the Homeland Security Exercise and Evaluation Program (HSEEP) guidelines. It is recognized that functional and full-scale drills typically require significant resources (funding, planning, staffing, evaluation, etc.). These type of exercises may be developed and implemented in cooperation and conjunction with other local, regional, and other agencies, institutions, and organizations.

5.6.4.4.2 Incident Command System (ICS) and National Incident Management System (NIMS). Review and evaluate existing ICS and NIMS training requirements for UAH emergency responders and emergency and crisis management personnel. Review current training levels achieved by each and identify any additional individual training needs.

5.6.4.5 Asset inventory and categorization. Maintain a categorize inventory of response resources that may be deployed in a disaster or crisis response situation. Utilize FEMA/NIMS Integration Center resource typing criteria.

Mitigation measures:

5.6.4.5.1 Initial inventory and categorization. Conduct a comprehensive response asset inventory of all UAH resources that may be deployed during a disaster or crisis response. Utilize FEMA/NIMS resource typing criteria.

5.6.4.5.2 Establish program for maintenance and updating of response asset inventory and categorization information. Evaluate, design, and implement a formalized, cost-effective continuous process for review and updating of response asset inventory and categorization. Process would include, at a minimum, annual review and updates.

5.6.5 Structural projects. Apply engineered structural modifications to natural systems, buildings, and infrastructure to reduce the potentially damaging impacts of hazards where feasible, cost effective, and environmentally suitable.

5.6.5.1 Drainage system maintenance. Maintain drainage systems, streams, lakes, and storm water runoff systems for reduction of flood risk.

Mitigation measures:

5.6.5.1.1 Storm drainage systems - campus. Evaluate, design, and implement cost-effective flood control structural projects, including, but not limited to: channel expansions, pipes and culverts, detention basins, and bridge modifications on and around the UAH campus. Evaluation should include consultation with City of Huntsville to identify potential municipal projects in the surrounding area that could reduce the risk of flooding.

5.6.5.1.2 Storm drainage systems – building specific. Evaluate, design, and implement cost-effective building-specific flood control structural projects, including, but not limited to: installation of mechanical pumping systems, water flow diversion systems, drainage systems, landscaping modifications, and flood/moisture monitoring equipment.

5.6.5.2 Fresh air intake systems. Evaluate, design, and implement cost-effective structural modifications to relocate fresh air intakes to upper floors or rooftops for ventilation systems on structures where current intake systems are at or near ground level.

5.6.5.3. Severe weather protective areas. Provide for the improved protection of the UAH community from tornadoes and severe thunderstorms.

Mitigation measures:

5.6.5.3.1. Protective areas – new construction. Ensure future campus facilities, where feasible, are designed with designated severe weather protective areas capable of accommodating the maximum anticipated building occupant load. Where feasible, design to meet FEMA safe room standard P-320 or P-361 as appropriate to the building construction type. Work with local and State EMAs to identify potential grant funding sources for protective area (safe room) construction.

5.6.5.3.2. Protective areas – existing structures. Examine and assess existing structures to ensure that suitable protective areas, if available in the facility, are identified and designated on building floor plans and posted on building evacuation and emergency action maps. Where no protective area exists, examine feasibility through a cost/benefit analysis of retrofitting the structure to include a protective area(s). Work with local and State EMAs to identify potential grant funding sources for protective area (safe room) construction and retrofitting.

5.6.5.4 Physical security. Conduct facility and grounds security assessments. Evaluate, design, and implement cost-effective physical security measures to existing structures and new construction where feasible.

Mitigation measures:

5.6.5.4.1 Access control systems – exterior doors. Evaluate, design, and implement cost-effective building access control systems where feasible, including, but not limited to: electronic door locks, key and/or card entry systems, and electronic master door lock controllers.

5.6.5.4.2 Access control systems – interior doors. Identify and assess physical access to sensitive areas, hazardous materials storage areas, restricted areas, and areas with physical hazards (e.g., high voltage, mechanical equipment, elevator equipment, etc.). Where the need for additional access control measures are identified, evaluate, design, and implement cost-effective access control systems where practicable and feasible, to include, but not limited to: electronic door locks, key and/or card entry systems, and electronic master door lock controllers.

5.6.5.4.3 Building perimeter and interior security systems. Identify and assess high-security, restricted, and hazardous locations to determine need for monitored security systems (e.g., intrusion alarms, etc.). Where needs are identified and it is feasible to do so, evaluate, design, and implement cost-effective security systems.

5.6.5.4.4 Surveillance systems. Assess and identify campus areas where surveillance systems (e.g., closed-circuit television [CCTV]) may be effectively implemented for crime deterrence. Areas to be assessed include, but are not limited to: building interior common areas, building entrances, parking areas, public gathering areas, point-of-sale locations, and high-security/restricted areas. Where needs are identified and it is feasible to do so, evaluate, design, and implement cost-effective surveillance systems and equipment solutions.

5.6.5.4.5 Vehicle access barriers. Assess campus locations for vulnerabilities to vehicular hazards, including, but not limited to: vehicle-borne improvised explosive devices and run-away vehicles. Where significant hazard exposure exists, evaluate, design, and implement cost-effective vehicle access barrier systems (e.g., bollards).

5.6.5.4.6 Site security design. For new construction, landscape renovation projects, and building renovation projects, conduct needs assessment for enhanced physical security elements, including counterterrorism elements. Where needs are identified and it is deemed feasible to do so, evaluate, design, and implement cost-effective counterterrorism and/or crime deterrence elements which do not impede or compromise normal operations, undermine the UAH community vitality, or negatively impact the surrounding environment. The U.S. General Services Administration (GSA) Site Security Design Guide and security design guidelines from professional organizations such as the American Institute of Architects (AIA) will be employed where appropriate and feasible.

5.6.6 Operational Continuity. Examine current Continuity of Operations Plans (COOP) for all campus critical functions, critical equipment and supplies, and critical processes. Conduct gap analysis to identify strengths and areas for development. Identify, research, recommend, and implement feasible, cost-effective solutions to develop or improve capabilities to resume normal operations following an incident which interrupts one or more campus critical functions or campus operations as a whole.

5.6.6.1 Recovery of information technology services. Conduct central information technology systems capabilities review and gap analysis. Evaluate, design, and implement feasible, cost-effective information technology solutions to improve systems redundancy and/or systems recovery time.

Mitigation measures:

5.6.6.1.1 Develop and maintain off-site "hot" recovery site for central information technology server and data storage systems. Evaluate, design, and implement feasible, cost-effective, geographically dispersed off-site "hot" failover and recovery site for central information technology application and database equipment and services.

5.6.6.1.2 Develop and maintain redundant campus-level networking and internet *connectivity infrastructure.* Evaluate, design, and implement feasible, cost-effective secondary or redundant network infrastructure to provide redundant or fail-over networking and internet (external) connectivity capabilities.

5.6.6.1.3 Conduct campus-level assessment to identify critical records that only exist in hardcopy format. Evaluate, design, and implement cost-effective process to convert records to electronic format, where practicable and feasible, and identify redundant data storage processes to ensure survivability of records. Where conversion to electronic format is not feasible or cost effective, evaluate and implement cost-effective secure storage protocols if such protocols are not already in place.

5.6.6.2 Emergency finance and procurement procedures and processes. Conduct capabilities review and gap analysis for critical finance and procurement operations. Evaluate, design, and implement cost-effective emergency procedures and processes that are in compliance with applicable state and/or Federal laws, meet applicable contractual agreements, and provide for redundancy and/or rapid recovery of critical finance services in support of ongoing response, recovery, or other continuity efforts.

5.6.6.3 Departmental/unit operational continuity. Develop and maintain COOP for all critical and mission-essential campus departments and units. Where plans currently exist, review, evaluate, test, and update as necessary. Where plans do not currently exist, create, review, implement, and test new plans.

Mitigation items:

5.6.6.3.1 Academic continuity – loss of academic building or instructor capabilities and/or resources. Evaluate, design, and implement cost-effective academic recovery and continuity program resources at the University level, including, but not limited to: distance learning resources, alternate facility agreements (e.g., memorandums of agreement for facility use with other area higher education institutions, businesses, and/or municipalities), and identification of alternate instructor resources (e.g., instructor sharing memorandums of agreement with other higher education institutions, identification of qualified instructor resources in the surrounding and nearby communities.

5.6.6.3.2 Research and contracts and grants continuity – loss of facility, equipment, and/or research staff. Evaluate, develop, and implement cost-effective research and contracts and grants operations recovery and continuity programs for critical research and contracts and grants operations and functions. (e.g., research facility use memorandums of agreement with other higher education institutions, research centers, and/or private industry).

5.6.6.4 Facilities reoccupation. Evaluate, develop, and implement a formalized, cost-effective facility safety inspection and reoccupation program/process.
Mitigation measures:

5.6.6.4.1 Building safety evaluations following significant damage event. Evaluate, develop, and implement a cost-effective building safety evaluation program for responding to structures which suffer significant physical damage. Program/process should include, but is not limited to, incorporation of the Applied Technology Council (ATC)-45 Safety Evaluation of Buildings After Wind Storms and Floods guidelines and the ATC-20 Procedures for Post-earthquake Safety Evaluation of Buildings guidelines. The evaluation process for fire-related damage should be developed in coordination and consultation with the local fire marshal's office. The evaluation process for significant hazardous materials-related incidents should be developed in coordination and consultation with the Huntsville Fire and Rescue hazardous materials response unit and the UAH Office of Environmental Health and Safety.

5.6.6.4.2 Facility restoration and reoccupation process. Evaluate, develop, and implement a cost-effective, formalized facility restoration and reoccupation process. The process should involve, but not be limited to, displaced department/unit representatives, Facilities and Operations (architect, maintenance, construction), Registrar (if academic building), Academic Affairs (if academic building), Procurement, Risk Management (insurance, liability), Student Housing (if residential or residence life facility), and Finance and Accounting (budgets, accounting).

5.6.6.5 Business interruption protection. Evaluate, develop, and implement comprehensive business interruption protection programs, including, but not limited to, business interruption insurance coverage. Coverage should include normal business and academic operations as well as research and contracts and grants operations.

5.6.7 Public Health. Evaluate, develop, and implement cost-effective mitigation measures to reduce the threat of infectious and communicable disease among the UAH general population.

Mitigation measures:

5.6.7.1 Public education regarding communicable diseases. Review and evaluate current campus public education programs relating to communicable disease prevention and conduct a gap analysis. Where areas for improvement are identified, evaluate, develop, and implement feasible, cost-effective public educational programs intended to raise awareness of potential public health communicable disease threats and preventive measures.

6. Mitigation Action Programs Prioritization and Responsibility

6.1 Purpose of the Mitigation Action Program

This section represents the five-year mitigation action program for The University of Alabama in Huntsville (UAH). The section provides a listing of proposed priority project to be considered for funding and implementation over the five-year hazard mitigation planning cycle for this Plan. The mitigation action program assigns priority, responsibility for implementation, and time frame for implementation for each proposed activity. For each mitigation measure, the program goal, program objectives, hazard(s) addressed, and the possible funding sources are noted in the tables. The overall intent of these mitigation action programs and priority projects is to reduce the effects of each hazard.

6.2 Prioritization of Mitigation Actions

This Plan establishes the prioritization of recommended mitigation action programs outlined in Section 5. Each mitigation action item was evaluated for consistency with the long-term vision, goals, and objectives of this Plan. These mitigation action items are fully consistent with UAH established goals and plans currently in place and with comments and concerns presented through public participation and interagency coordination efforts of this planning process.

6.2.1 Prioritization criteria. Each proposed action program was evaluated using several factors in order to determine priority. These criteria included, but were not limited to:

6.2.1.1 Economic considerations. Economic considerations included, but were not limited to:

- *Availability of funds.* Will the measure require Federal, State, or other outside funding sources? Are University funds available? Can in-kind services reduce UAH obligations? What is the projected availability of required funds during the timeframe for implementation? Where funding sources cannot be readily identified, should the project still be considered but at a lower priority?
- *Benefits to be derived from the proposed measure.* Will the measure likely reduce dollar losses from property damage or operational interruption in the event of a hazard occurrence? To what degree? Will the measure likely reduce the likelihood of casualties in the event of a hazard occurrence? To what degree?
- *Costs.* Are the costs reasonable in relation to the likely benefits? Do economic benefits to the UAH community outweigh estimated project costs? What cost-reduction alternatives might be available?
- *Economic feasibility.* Have the costs and benefits of the preferred measure been compared against other alternatives? What is the economic impact of the no-action alternative? Is this the most economically effective solution?
- *Impact on UAH academic, research, and business activities.* Will the proposed

measure improve operational capabilities? What impact might the measure have on these activities?

- *Growth and development goals.* Will the proposed activity advance UAH's overall growth and development goals and objectives?

6.2.1.2 Social considerations. Social considerations included, but were not limited to:

- *Environmental justice.* Will the proposed measure be socially equitable to minority, disadvantaged, and special needs populations?
- *Community impact.* Will the measure disrupt established campus social functions or improve quality of campus life for affected areas? Will the measure disrupt the surrounding neighborhoods and business community?
- *Community support.* Is the measure consistent with UAH and/or neighboring community values? Will the campus community and/or neighboring community support the measure?
- *Impact on social and cultural resources.* Will the measure adversely affect or enhance valued campus and neighboring community social and cultural resources?

6.2.1.3 Environmental considerations. Environmental considerations included, but were not limited to:

- *Federal environmental policies and regulations.* Will the measure be consistent with existing Federal environmental regulations? How will the measure affect environmental resources such as land, water, air, wildlife, vegetation, etc.? Can potentially adverse impacts be sufficiently mitigated through reasonable, cost-effective methods?
- *State and local environmental regulations.* Will the measure be in compliance with State and local environmental laws, such as floodplain management regulations, water quality standards, air quality standards, etc.?
- *Environmental conservation goals.* Will the measure advance or hinder the overall environmental goals and objectives of the University?

6.2.1.4 Administrative, legal, and political considerations. Administrative, legal, and political considerations included, but were not limited to:

- *Staffing.* Does UAH have adequate staff resources and expertise to implement the measure? Will additional staff, training, or consultants be necessary? Can UAH funds support staffing demands? Will the measure overburden existing staff loads?
- *Maintenance.* Does UAH have the capabilities to maintain the proposed project once it is implemented or completed? Are staff, funds, and facilities available for long-term project maintenance?
- *Timing.* Can the measure be implemented in a timely manner? Are the timeframes for implementation and/or completion reasonable?

- *Legal authority*. Does UAH have the legal authority to implement the measure? Does the measure require approval from the University of Alabama System Board of Trustees (BOT)? What are the legal consequences of implementing the measure as opposed to an alternative action or taking no action? Will a BOT resolution be required? Will local, State, or Federal authority approval be required?
- *Political support.* Does the UAH administration support the proposed measure? Does the UAH community support the measure? Do other stakeholders support the measure? What advocates might facilitate implementation of the proposal?

6.2.1.5 Technical considerations. Technical considerations included, but were not limited to:

- *Technical feasibility*. Is the proposed measure technically possible? Are there technical issues that must be resolved prior to implementation? Does the measure effectively solve the problem or create new problems? Are there secondary impacts that might be considered? Have professional experts been consulted?
- *Technical complexity*. Is the proposed measure technically complex? Will it require special training for staff in order to maintain or implement? Does UAH have technical expertise available internally or must a professional expert be consulted or engaged in order to maintain or implement?

6.2.1.6 Likelihood of associated hazard occurrence. How likely is the hazard(s) associated with the proposed mitigation item to occur? What level of impact will the associated hazard have on the campus community and/or infrastructure? A risk prioritization matrix was applied based on the International Organization for Standardization (ISO) 31000:2009 risk prioritization map. (see table 6.1).

Risk prioritization map – ISO 31000:2009

Likelihood					
5 Certain	Low	Moderate	High	Extreme	Extreme
4 Likely	Low	Moderate	High	High	Extreme
3 Possible	Low	Moderate	Moderate	High	High
2 Unlikely	Low	Low	Moderate	Moderate	Moderate
1 Rare	Low	Low	Low	Low	Low
Significance	1 Insignificant	2 Minor	3 Significant	4 Major	5 Catastrophic

Table 6.1 – ISO 31000 Risk Prioritization Map (source: http://www. ISO.org)

Proposed mitigation programs for hazards with a high risk of occurrence and potential severe impacts were given top priority. Conversely, hazards with a low risk of occurrence and low impact were given lowest priority.

The general order of prioritization is in order from highest to lowest as follows:

- *Extreme.* Certain likelihood of occurrence, catastrophic or major impact to campus community and/or infrastructure.
- *High.* Certain or likely to occur with significant, major, or catastrophic impact to campus community and/or infrastructure.
- *Moderate.* Certain, likely, or possible to occur, with significant, major, or catastrophic impact to campus community and/or infrastructure.
- *Low.* Low or unlikely probability of occurrence with low minimal impact to campus community or infrastructure.

6.2.2 Cost-benefit review. Priority mitigation projects will only be implemented if the benefits are maximized and outweigh the associated costs of the proposed projects. Each mitigation measure was evaluated, weighing the estimated costs for each mitigation measure against the projected benefits to be derived. For example, a project to modify a storm drainage system might provide the following benefits: (1) the elimination of flood damages to a structure or facility, (2) reduction of flood response costs, (3) reduction of flood insurance claims. A more detailed cost-benefit analysis will be required for each priority project to determine economic feasibility during the project planning phase. Projects will also require a more detailed evaluation for eligibility and feasibility including social impact, environmental impact, technical feasibility, and other criteria that measure project effectiveness. This detailed evaluation of projects will be performed in the pre-application phase of a grant response, or during the initial project planning phase where UAH funding is the sole funding source. Further, project implementation will be subject to the availability of FEMA grants and other sources of external and internal funding from year to year.

6.3 Available Mitigation Measures

The Mitigation Measures tables below reference mitigation measures by number to the comprehensive mitigation strategies contained in **Section 5.6** of this Plan. All of the available mitigation measures presented in **Section 5** are listed in this section in the same order for ease of reference.

Implementation times are estimated for the purposes of this plan. Actual implementation times may differ and will be more accurately projected during the initial project planning phase or during the pre-application phase of a grant response.

Table 6.2 – Mitigation Measures

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.1.1.1	Prevention	Comprehensive Plans	Maintain up-to-date comprehensive plans scheduled for review in the next 18 months for all aspects of campus development.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
High	18-24 months	April 2015	Facilities and Operations, Executives
Funding Source(s):		Internal operating funds	
Hazards addressed:		ALL	

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.1.1.2	Prevention	Comprehensive Plans	Integrate findings and recommendations of this Plan into comprehensive plan amendments for existing plans not currently scheduled for review in the next 18 months.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	18-24 months	August 2015	Facilities and Operations, Executives
Funding Source(s):		Internal operating funds, Master Planning budget	
Hazards Addressed:		ALL	

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.1.1.3	Prevention	Comprehensive Plans	Review and amend existing planning documents to address vulnerability and environmental sustainability of lands for future development.

Priority	Implementation Time	Start Date	Implementation Responsibility
Moderate	18-24 months	April 2015	Facilities and Operations, Executives
Funding Source(s):		Internal operating funds	
Hazards Addressed:		ALL	

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.1.2.1	Prevention	Geographic Information Systems	Maintain risk assessment data in GIS, including flood zones, tornado tracks, sinkhole location, Clery Act reportable crimes, haz-mat locations.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	24 months	TBD	Emergency Preparedness, Facilities, Campus Architect, OIT (supporting role)
Funding Source(s):		Internal, Grants (*e.g.*, PDM, HMGP), Academic partnership	
Hazards Addressed:		ALL	

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.1.2.2	Prevention	Detailed Plans and Targeted Studies	Maintain a comprehensive inventory of campus facilities and critical infrastructure.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	24 months	TBD	Emergency Preparedness, Facilities, Campus Architect

Funding Source(s):	Internal operating funds, PDM/HMGP grants, other grants
Hazards addressed:	ALL

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**
5.6.1.2.3	Prevention	Detailed Plans and Targeted Studies	Review and update as needed existing floor plans to ensure they are current with all modifications and improvements are included.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	Prevention	Detailed Plans and Targeted Studies	Campus Architect, Facilities
Funding Source(s):		Internal operating funds	
Hazards Addressed		ALL	

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**
5.6.1.2.4	Prevention	Geographic Information Systems	Conduct comprehensive study of campus to identify areas with potential for sinkholes or land subsidence.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Low	TBD	TBD	Facilities, Campus Architect, Emergency Preparedness
Funding Source(s):		Internal operating funds, academic partnership	
Hazards Addressed:		Sinkholes/Land Subsidence	

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**

5.6.1.2.5	Prevention	Geographic Information Systems	Integrate emergency information into the Virtual Alabama GIS tool to allow sharing of information with community first responders.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	24 months	TBD	Office of Emergency Preparedness
Funding Source(s):		Internal operating funds, academic partnership, State funding	
Hazards Addressed:		Fire, hazardous materials, earthquake, criminal acts, terrorism	

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**
5.6.1.3.1	Prevention	Building and Technical Codes	Evaluate building code standards for roof construction to ensure standards are included in appropriate construction projects.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	Ongoing	April 2015	Campus Architect, Facilities
Funding Source(s):		Internal operating funds	
Hazards Addressed:		Severe Thunderstorms/High Winds/Tornados	

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**
5.6.1.3.2	Prevention	Building and Technical Codes	Evaluate building code standards for fire protection systems to ensure applicable standards are met or exceeded in appropriate construction projects.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**

High	Ongoing	April 2015	Campus Architect, Facilities
Funding Source(s):		Internal operating funds	
Hazards Addressed:		Fire	

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**
5.6.2.1.1	Property protection	Insurance	Conduct annual property insurance coverage review.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	Annually	September 2015	Risk Management, Facilities and Operations, Business Services
Funding Source(s):		Internal operating funds	
Hazards Addressed:		ALL	

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**
5.6.2.1.2	Property protection	Insurance	Maintain insurance riders for flood-related damages for structures located in FEMA-designate floodplain areas. Review annually.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	Annually	September 2015	Risk Management, Facilities and Operations, Business Services
Funding Source(s):		State funding, internal operating funds	
Hazards Addressed:		Flood	

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**

5.6.2.1.3	Property protection	Insurance	Conduct cost/benefit study to determine feasibility of insurance riders for sinkhole and land subsidence damages for campus structures and facilities identified as being at risk in a sinkhole and land subsidence study.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Low	TBD	TBD	Risk Management, Facilities and Operations, Business Services

Funding Source(s):	State funding, internal operating funds
Hazards Addressed:	Sinkholes/Land Subsidence

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.2.1.4	Property protection	Insurance	Conduct cost/benefit study to determine feasibility of earthquake coverage for campus structures and infrastructure.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Low	TBD	TBD	Risk Management, Facilities and Operations, Business Services

Funding Source(s):	State funding, internal operating funds
Hazards Addressed:	Earthquake

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.2.2.1	Prevention	Flood Plain Management, Land Use Policies	Develop and implement formal policies to prohibit construction of facilities vulnerable to flood damage within campus floodplains.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**

Low	12 months	October 2015	Facilities and Operations, Executives, Risk Management

Funding Source(s):	Internal operating funds
Hazards Addressed:	Flood

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.2.2.2	Prevention	Land Use Policies	Develop and implement formal policies to prohibit construction of facilities vulnerable to land subsidence in areas identified in activity 5.6.1.2.4.

Priority	Implementation Time	Start Date	Implementation Responsibility
Low	12 months	TBD	Facilities and Operations, Executives, Risk Management

Funding Source(s):	Internal operating funds
Hazards Addressed:	Sinkholes/Land Subsidence

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.2.2.3	Prevention	Land Use Policies	Develop and implement grounds vegetation and landscape management policies to minimize wildfire risk to structures and persons.

Priority	Implementation Time	Start Date	Implementation Responsibility
Low	12 months	TBD	Facilities, Campus Architect,

Funding Source(s):	Internal operating funds
Hazards Addressed:	Wildfire / Fire

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.2.3	Prevention	Flood Proofing	Evaluate and where needed retrofit existing buildings located in floodplains to reduce the potential for flood-related damages (for buildings where not feasible to relocate or elevate structure).
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Low	60 months	TBD	Facilities, Campus Architect

Funding Source(s):	Federal grants (*e.g.*, HGMP), State funding, capital improvement funding
Hazards Addressed:	Flood

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.2.4.1	Property Protection	Power Generation	Conduct a gap analysis for each to identify shortfalls and determine additional emergency power generation requirements, if any.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	12-18 months	January 2017	Facilities, Campus Architect, VP for Research (for Research facilities), OIT (for IT infrastructure)

Funding Source(s):	Internal operating funds, Research overhead funds
Hazards Addressed:	Utilities Interruption

Mitigation Measure #	Goal	Program Objective	Mitigation Measure

5.6.2.4.2	Property Protection	Power Generation	Where additional emergency power generation needs are identified and it is feasible to do so, evaluate, design, and implement emergency power generation improvements.

Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	18-24 months	TBD (following completion of 5.6.2.4.1)	Facilities, Campus Architect, VP for Research (for Research facilities), OIT (for IT infrastructure)

Funding Source(s):	Federal grants (*e.g.*, HMGP), State funds, capital development funds, Research grants (Federal, State, Private)
Hazards Addressed:	Utilities Interruption

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**
5.6.2.4.3	Property Protection	Power Generation	Install debris guards on emergency generator equipment.

Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	18-24 months	TBD	Facilities and Operations

Funding Source(s):	Federal grants (*e.g.*, HMGP), State funds, capital development funds, Research grants (Federal, State, Private)
Hazards Addressed:	Utilities Interruption

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**
5.6.2.5.1	Property Protection	Fire Prevention	Conduct study of campus buildings not currently equipped with automatic fire suppression systems to determine feasibility and cost effectiveness of retrofitting with such systems.

Priority	Implementation Time	Start Date	Implementation Responsibility
High	12-18 months	January 2016	Facilities, Campus Architect

Funding Source(s):	Federal grants (*e.g.*, FEMA Fire Prevention & Safety Grants), capital improvement funds, internal operating funds
Hazards Addressed:	Fire

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.2.5.2	Property Protection	Fire Prevention	Where feasible and practicable for buildings identified in 5.6.2.5.1, evaluate, design, and implement cost-effective automatic fire suppression systems for currently unprotected buildings.

Priority	Implementation Time	Start Date	Implementation Responsibility
High	24-36 months	TBD (following completion of 5.6.2.5.1)	Facilities, Campus Architect, Executives

Funding Source(s):	Federal grants (*e.g.*, FEMA Fire Prevention & Safety Grants), State funds, capital improvement funds
Hazards Addressed:	Fire

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.3.1.1	Public Education and Outreach	Outreach Projects	Establish an annual campus-wide severe weather awareness event.

Priority	Implementation Time	Start Date	Implementation Responsibility
High	Annually	March 2016	Emergency Preparedness

Funding Source(s):	Federal grants (*e.g.*, FEMA preparedness grants), internal operating funds, private organization funds (*e.g.*, local weather associations) or grants
Hazards Addressed:	Severe Thunderstorms/Tornados

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**
5.6.3.1.2	Public Education and Outreach	Outreach Projects	Identify other environmental awareness events to integrate public information on hazard exposure risks and protection measures.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	Ongoing	October 2017	Emergency Preparedness, UAH Police, UAH Environmental Health and Safety

Funding Source(s):	Federal grants (*e.g.*, FEMA preparedness grants), internal operating funds, private organization funding or grants
Hazards Addressed:	ALL

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**
5.6.3.1.3	Public Education and Outreach	Outreach Projects	Provide subject matter experts to present on specific hazard topics upon request by campus organizations, departments, etc.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	Ongoing	October 2016	Emergency Preparedness, UAH Police, UAH Environmental Health and Safety

Funding Source(s):	Federal grants (*e.g.*, FEMA preparedness grants), internal operating funds, private organization funding or grants
Hazards Addressed:	ALL

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.3.1.4	Public Education and Outreach	Outreach Projects	Provide hazard awareness and mitigation information via brochures for distribution to students, employees, and guests.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
High	Ongoing	June 2015	Emergency Preparedness, UAH Police, UAH Environmental Health and Safety, Student Affairs, Human Resources
Funding Source(s):		Federal grants (*e.g.*, FEMA preparedness grants), State funds, internal operating funds, private organization funding or grants	
Hazards Addressed:		ALL	

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.3.1.5	Public Education and Outreach	Outreach Projects	Maintain and publicize hazard awareness and mitigation information on the UAH web site.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	Ongoing	October 2015	Emergency Preparedness, UAH Police, Environmental Health and Safety, Marketing and Communications
Funding Source(s):		Internal operating funds, open-source and public online resources, private organization funding or grants	
Hazards Addressed:		ALL	

Mitigation Measure #	Goal	Program Objective	Mitigation Measure

5.6.3.1.6	Public Education and Outreach	Outreach Projects	Conduct, sponsor, or host public training classes specific to certain natural and man-made hazards. (*e.g.*, NWS SKYWARN, ICS/NIMS, Rape Aggression Defense)
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	Ongoing	October 2016	Emergency Preparedness, UAH Police, Environmental Health and Safety, Student Affairs, Human Resources

Funding Source(s):	FEMA/DHS preparedness grants, State funds (AEMA), local community funds (HMCEMA, police, fire, EMS, etc.), private organization direct funding or grants
Hazards Addressed:	ALL

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**
5.6.3.1.7	Public Education and Outreach	Outreach Projects	Require new employees to receive mandatory safety and hazard awareness training.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
High	Ongoing	January 2016	Emergency Preparedness, Environmental Health and Safety, UAH Police, Human Resources, Academic Affairs, VP for Research (for Research staff)

Funding Source(s):	Internal operating funds, Research grants (Federal, State, private) and contracts
Hazards Addressed:	ALL

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**
5.6.7.1.1	Emergency Services	Emergency Notification	Upgrade and/or install building mass notification systems in all UAH buildings to include recorded and live voice alert capabilities.

Priority	Implementation Time	Start Date	Implementation Responsibility
High	18 months	TBD	Facilities and Operations, Emergency Preparedness, UAHPD

Funding Source(s):	Internal operating funds, capital improvement funds, State funds, Federal grants (*e.g.*, HMGP)
Hazards Addressed:	ALL

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.4.1.2	Emergency Services	Emergency Notification	Install outdoor mass notification systems sufficient to cover all UAH campus grounds with recorded and live voice capabilities.

Priority	Implementation Time	Start Date	Implementation Responsibility
Moderate	18 months	TBD	Facilities and Operations, Emergency Preparedness, UAHPD

Funding Source(s):	Internal operating funds, capital improvement funds, State funds, Federal grants (*e.g.*, HMGP)
Hazards Addressed:	ALL

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.4.1.3	Emergency Services	Emergency Notification	Improve UAH community access to weather alert radios.

Priority	Implementation Time	Start Date	Implementation Responsibility
Moderate	Ongoing	TBD	UAH departments/units, Emergency Preparedness

Funding Source(s):	Internal operating funds, State funds, Federal grants, private grants

Hazards Addressed:	Severe weather, tornado, winter weather

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.4.1.4	Emergency Services	Emergency Notification	Improve voluntary participation in ancillary notification systems (*e.g.*, text, email, telephone voice, social media)
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	Ongoing	April 2014	Emergency Preparedness, Student Affairs, Human Resources, Academic Affairs

Funding Source(s):	Internal operating funds
Hazards Addressed:	ALL

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.4.2.1	Emergency Services	Response Capabilities	Conduct gap analysis to identify potential law enforcement response capability limitations
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	6-12 months	TBD	UAH Police, Huntsville Police

Funding Source(s):	Federal grants (*e.g.*, DoJ, DHS), State funding, local operating funds, Huntsville police operating funds
Hazards Addressed:	Man-made/Crime/Terrorism

Mitigation Measure #	Goal	Program Objective	Mitigation Measure

5.6.4.2.2	Emergency Services	Response Capabilities	Conduct cost/benefit analysis to determine feasibility of increased staffing (sworn officers, dispatchers, and/or administrative staff) and/or emergency response equipment purchases (*e.g.*, vehicles, barricades, non-lethal weapons, body armor, body cameras, first aid equipment, etc.).

Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	12-24 months	TBD	Facilities and Operations Admin., UAH Police

Funding Source(s):	Federal grants (*e.g.*, DoJ, DHS), State funding, local operating funds
Hazards Addressed:	Man-made/Crime/Terrorism

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**
5.6.4.3.1	Emergency Services	Response Capabilities	Conduct gap analysis to identify hazardous materials incident response capability limitations. Analysis will include examination of UAH response capabilities as well as Huntsville Fire and Rescue capabilities.

Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	12-18 months	TBD	Environmental Health and Safety, Emergency Preparedness, Huntsville Fire & Rescue

Funding Source(s):	Federal grants, State funds, local operating funds, Huntsville Fire operating funds
Hazards Addressed:	Hazardous Materials Release

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**

5.6.4.3.2	Emergency Services	Response Capabilities	Conduct cost/benefit analysis to determine feasibility of increased staffing (*e.g.*, hazardous materials specialists, radiological specialists, etc.) and/or equipment (*e.g.*, self-contained breathing apparatus [SCBA], radiological monitoring tools, spill containment kits, air quality monitoring, etc.).
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	12-18 months	TBD	Environmental Health and Safety
Funding Source(s):	Federal grants, State funds, local operating funds		
Hazards Addressed:	Hazardous Materials Release		

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**
5.6.4.4.1	Emergency Services	Response Capabilities	Evaluate, design, and implement a formalized, cost-effective annual HSEEP exercise and drill program, including, but not limited to: tabletop exercises, functional exercises, full-scale exercises, evacuation drills, and emergency communications drills.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
High	Ongoing	August 2015	Emergency Preparedness
Funding Source(s):	Federal grants (FEMA, DHS, DoJ), State funds, operating funds, other agency funds (EMA, HPD, HF&R, etc.)		
Hazards Addressed:	ALL		

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**
5.6.4.4.2	Emergency Services	Response Capabilities	Review and evaluate NIMS/ICS training requirements, identify additional training needs, update policies to incorporate.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**

Moderate	6 months	TBD	Emergency Preparedness, EMOG

Funding Source(s):	Local operating funds
Hazards Addressed:	ALL

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.4.5.1	Emergency Services	Response Capabilities	Conduct response asset inventory and categorize assets using FEMA/NIMS resource typing criteria.

Priority	Implementation Time	Start Date	Implementation Responsibility
Low	12 months	TBD	Facilities, UAHPD, OEHS, Emergency Preparedness

Funding Source(s):	Internal operating funds, State funds, Federal grants
Hazards Addressed:	ALL

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.4.5.2	Emergency Services	Response Capabilities	Evaluate, design, implement a continuous review and update process for NIMS asset inventory and categorization.

Priority	Implementation Time	Start Date	Implementation Responsibility
Low	Ongoing	TBD (following 5.6.4.5.1)	Facilities, UAHPD, OEHS, Emergency Preparedness

Funding Source(s):	Internal operating funds, State funds, Federal grants
Hazards Addressed:	ALL

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.5.1.2	Structural Projects	Flood Conveyance Improvements	Evaluate, design, and implement cost-effective flood control structural projects, including, but not limited to: channel expansions, pipes and culverts, detention basins, and bridge modifications on and around the UAH campus.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Low	36-60 months	TBD	Facilities, Campus Architect, City of Huntsville Public Works and Engineering
Funding Source(s):		Federal grants (*e.g.* FEMA HMGP, Flood mitigation), State funds, capital improvement funds	
Hazards Addressed:		Flood/Flash Flood	

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.5.1.2	Structural Projects	Flood Conveyance Improvements	Evaluate, design, and implement cost-effective building-specific flood control structural projects, including, but not limited to: installation of mechanical pumping systems, water flow diversion systems, drainage systems, landscaping modifications, and flood/moisture monitoring equipment.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Low	24-36 months	TBD	Facilities, Campus Architect
Funding Source(s):		Federal grants (*e.g.* FEMA HMGP, Flood mitigation), State funds, capital improvement funds	
Hazards Addressed:		Flood/Flash Flood	

Mitigation Measure #	Goal	Program Objective	Mitigation Measure

5.6.5.2	Structural Projects	Indoor Air Quailty	Evaluate, design, and implement cost-effective structural modifications to relocate fresh air intakes to upper floors or rooftops for ventilation systems where current intake systems are at or near ground level.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Low	36-48 months	TBD	Facilities, Campus Architect
Funding Source(s):	Federal grants, State funds, capital improvement funds		
Hazards Addressed:	Hazardous Materials Release/Terrorism		

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**
5.6.5.3.1	Structural Projects	Protective Areas	Ensure future campus facilities, where feasible, are designed with designated severe weather protective areas capable of accommodating the maximum anticipated building occupant load. Where feasible and practicable, design to meet FEMA safe room standard P-320 or P-361 as appropriate
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
High	Ongoing	April 2015	Campus Architect, Facilities, Emergency Preparedness
Funding Source(s):	Federal grants (*e.g.*, FEMA HGMP/PDM, construction grants), State funds (*e.g.*, AEMA, construction grants), capital improvement funds		
Hazards Addressed:	Tornados		

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**
5.6.5.3.2	Structural Projects	Protective Areas	Examine and assess existing structures to ensure that suitable protective areas, if available in the facility, are identified and designated on building floor plans and posted on building evacuation and emergency maps.

Priority	Implementation Time	Start Date	Implementation Responsibility
High	18-24 months	October 2015	Campus Architect, Facilities, Emergency Preparedness

Funding Source(s):	Federal grants (*e.g.*, FEMA HGMP/PDM, construction grants), State funds (*e.g.*, AEMA, construction grants), capital improvement funds
Hazards Addressed:	Tornados

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.5.4.1	Structural Projects	Physical Security	Evaluate, design, and implement cost-effective building exterior access control systems where feasible and practicable, including, but not limited to: electronic door locks, key and/or card entry systems, and electronic master door lock controllers.

Priority	Implementation Time	Start Date	Implementation Responsibility
High	12-18 months	In progress	Facilities

Funding Source(s):	Capital improvement funds (funding identified and reserved)
Hazards Addressed:	Crime/Terrorism

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.5.4.2	Structural Projects	Physical Security	Evaluate, design, and implement cost-effective interior access control systems where practicable and feasible, to include, but not limited to: electronic door locks, key and/or card entry systems, and electronic master door lock controllers.

Priority	Implementation Time	Start Date	Implementation Responsibility
Moderate	12-18 months	April 2015	Facilities

Funding Source(s):	Capital improvement funds (funding identified)
Hazards Addressed:	Crime/Terrorism

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**
5.6.5.4.3	Structural Projects	Physical Security	Evaluate, design, and implement cost-effective monitored security systems for high-security, restricted, and hazardous locations.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Low	18-24 months	TBD	Facilities, UAH Police, Research Security Office, Academic Affairs

Funding Source(s):	Capital improvement funds, local operating funds, Research funding
Hazards Addressed:	Crime/Terrorism/Hazardous Materials Release

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**
5.6.5.4.4	Structural Projects	Physical Security	Assess and identify campus areas where surveillance systems may be effectively implemented for crime deterrence. Where feasible and practicable to do so, evaluate, design, and implement cost-effective surveillance systems solutions.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	36 months	May 2015	Emergency Preparedness, UAH Police, Facilities, Campus Architect

Funding Source(s):	Federal funds (*e.g.*, DoJ, DHS), Research funds, local operating funds, capital improvement funds
Hazards Addressed:	Crime

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.5.4.5	Structural Projects	Physical Security	Assess campus locations for vulnerabilities to vehicular hazards, including, but not limited to: vehicle-borne improvised explosive devices and run-away vehicles. Where significant hazard exposure exists, evaluate, design, and implement cost-effective vehicle access barrier systems (*e.g.*, bollards).

Priority	Implementation Time	Start Date	Implementation Responsibility
Low	36-48 months	TBD	Facilities, Campus Architect, UAH Police

Funding Source(s):	Construction grants, capital improvement funds, local operating funds
Hazards Addressed:	Crime/Terrorism

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.5.4.6	Structural Projects	Physical Security	Conduct needs assessment for enhanced physical security elements, including counterterrorism elements. Where needs are identified and it is deemed practicable and feasible to do so, evaluate, design, and implement cost-effective counterterrorism and/or crime deterrence elements

Priority	Implementation Time	Start Date	Implementation Responsibility
Low	36 months	TBD	Facilities, Campus Architect, UAH Police

Funding Source(s):	Construction grants and funding, capital improvement funds, local operating funds
Hazards Addressed:	Crime/Terrorism

Mitigation Measure #	Goal	Program Objective	Mitigation Measure

5.6.6.1.1	Response and Recovery	Operational Continuity	Evaluate, design, and implement cost-effective, geographically dispersed off-site "hot" failover and recovery site for central information technology application and database equipment and services.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
High	TBD	TBD	Office of Information Technology
Funding Source(s):		Federal funds, State funds, local operating funds	
Hazards Addressed:		ALL	
Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**
5.6.6.1.2	Response and Recovery	Operational Continuity	Evaluate, design, and implement cost-effective secondary or redundant network infrastructure, where practicable and feasible, to provide redundant or fail-over networking and internet (external) connectivity capabilities.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
High	TBD	TBD	Office of Information Technology, Campus Architect, Facilities
Funding Source(s):		Federal funds, State funds, Construction funding, local operating funds	
Hazards Addressed:		ALL	

Mitigation Measure #	**Goal**	**Program Objective**	**Mitigation Measure**
5.6.6.1.3	Response and Recovery	Operational Continuity	Conduct campus-level assessment to identify critical records that only exist in hardcopy format. Convert such records to digital format.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**

Moderate	36 months	TBD	Human Resources, Academic Affairs, Student Affairs, Research, Counsel

Funding Source(s):	Internal operating funds
Hazards Addressed:	Fire, flood, hazardous materials, criminal acts, terrorism

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.6.2	Response and Recovery	Operational Continuity	Evaluate, design, and implement cost-effective emergency procedures and processes that are in compliance with applicable state and/or Federal laws, that meet applicable contractual agreements, and provide for redundancy and/or rapid recovery of critical finance services in support of ongoing response, recovery, or other continuity efforts.

Priority	Implementation Time	Start Date	Implementation Responsibility
Moderate	TBD	TBD	Finance and Administration, Procurement, Counsel

Funding Source(s):	Local operating funds
Hazards Addressed:	ALL

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.6.3.1	Response and Recovery	Operational Continuity	Evaluate, design, and implement cost-effective academic recovery and continuity program resources and agreements

Priority	Implementation Time	Start Date	Implementation Responsibility
Moderate	TBD	TBD	Academic Affairs, Office of Information Technology

Funding Source(s):	TBD
Hazards Addressed:	ALL

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.6.3.2	Response and Recovery	Operational Continuity	Evaluate, develop, and implement cost-effective research and contracts and grants operations recovery and continuity programs for critical research and contracts and grants operations and functions.
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	TBD	TBD	VP for Research, Office of Information Technology, Academic Affairs

Funding Source(s):	Federal funds/grants, Research grant funding, other funding TBD
Hazards Addressed:	ALL

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.6.4.1	Response and Recovery	Operational Continuity	Evaluate, develop, and implement a cost-effective building safety evaluation program for responding to structures which suffer significant physical damage. (*e.g.,* ATC-45, ATC-20 guidelines)
Priority	**Implementation Time**	**Start Date**	**Implementation Responsibility**
Moderate	12 months	TBD	Facilities, Campus Architect, Environmental Health and Safety, UAH Police, Risk Management

Funding Source(s):	Local operating funds TBD
Hazards Addressed:	Earthquake/Fire/Tornado/Land Subsidence/Hazardous Materials

Mitigation Measure #	Goal	Program Objective	Mitigation Measure

5.6.6.4.2	Response and Recovery	Operational Continuity	Evaluate, develop, and implement a cost-effective, formalized facility restoration and reoccupation process.

Priority	Implementation Time	Start Date	Implementation Responsibility
Moderate	12 months	TBD	Facilities, Campus Architect, Environmental Health and Safety, UAH Police, Risk Management

Funding Source(s):	Local operating funds TBD
Hazards Addressed:	ALL

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.6.5	Response and Recovery	Operational Continuity	Evaluate, develop, and implement comprehensive business interruption protection programs, including, but not limited to, business interruption insurance coverage.

Priority	Implementation Time	Start Date	Implementation Responsibility
Moderate	Ongoing	TBD	Academic Affairs, Finance and Administration, VP for Research, Risk Management, Business Services

Funding Source(s):	Research funding (contracts & grants), local operating funds TBD
Hazards Addressed:	ALL

Mitigation Measure #	Goal	Program Objective	Mitigation Measure
5.6.7.1	Public Health	Outreach Projects	Evaluate, develop, and implement cost-effective, practicable, and feasible public educational programs intended to raise awareness of potential public health communicable disease threats and preventive measures.

Priority	Implementation Time	Start Date	Implementation Responsibility
Moderate	Ongoing	TBD	Student Health Center, Faculty/Staff Clinic, Emergency Preparedness

Funding Source(s):	Local operating funds TBD, Federal/State grant programs
Hazards Addressed:	Public Health (Pandemic, Communicable Diseases)

7. Plan Maintenance

7.1 The Planning Cycle

This section presents a continuous cycle for monitoring, evaluating, and updating the Plan. This includes incorporating mitigation strategies into other, ongoing planning activities and methods for continuing community involvement. Continual plan maintenance ensures an active and relevant hazard mitigation planning process.

7.2 Procedures

The DRUC will oversee plan maintenance during the each five-year maintenance cycle of the Plan. The Emergency Management Coordinator (EMC) will serve as the DRUC's facilitator, responsible for holding regularly-scheduled meetings, assigning specific tasks necessary to monitor and update the plan to DRUC members, and serving as the DRUC's liaison with those assigned implementation responsibilities in the Plan. The facilitator will also serve as the DRUC's liaison with the surrounding community, municipalities, first responders, and other stakeholders. DRUC membership will be reviewed annually.

The DRUC will meet once each year during the five-year planning cycle to perform the following activities:

- Evaluate the effectiveness of previously implemented mitigation actions
- Explain why any actions are not completed or behind schedule
- Address changing land use patterns and new campus development
- Identify any changes in risk assessment and/or hazard vulnerability
- Address changing campus population and/or demographics
- Review DRUC membership

The facilitator will schedule the annual meeting at a time and location convenient to a majority of the DRUC members. All annual meetings will be advertised in relevant campus publications and open to the campus community and the general public.

In the event modifications to the Plan are warranted as a result of the annual review or other circumstances, the DRUC will oversee the revision process and make change recommendations to the EMOG. The EMOG will approve all revisions to the Plan and make recommendations to the Policy Group for incorporation of those proposed changes. Conditions which might warrant revisions to this Plan would include, but not be limited to, special opportunities for funding and/or response to a natural or man-made disaster. A public meeting will be held before adoption of any major revisions. Minor revisions require only approval by the DRUC, EMOG, and University president. A copy of the Plan revisions will be submitted to all holders of the original Plan in a timely manner.

At the end of each five-year cycle, the DRUC will oversee a major update to the plan that follows the federal planning criteria in effect at the time of the update. The updated plan will again be submitted to AEMA and FEMA for approval.

7.3 Implementation Through Existing Programs

During each five-year planning cycle, this Plan will serve as a starting point for all current and future mitigation activities. New mitigation measures identified by the DRUC and/or EMOG will be incorporated into this Plan using the process discussed above.

Capital budgeting requirements for implementation of mitigation items contained in this Plan will be incorporated into the campus budgeting process. Where appropriate, these budgeted items will be recognized and provided for in annual the capital development planning process, strategic planning process, and campus master planning process.

7.4 Continuing Public Involvement

A critical part of maintaining an effective and relevant hazard mitigation plan is ongoing community involvement, including public review and comment. Therefore, the DRUC is dedicated to direct involvement of the UAH community and surrounding communities in providing feedback and comments on the Plan throughout the five-year implementation cycle.

To this end, an electronic copy of the Plan will be available for download and viewing on the UAH Emergency Preparedness and Emergency Information web pages. Comments and feedback will be directed to the EMC who will in turn provide these to the DRUC members.

Public meetings will be held when deemed necessary by the DRUC. The public will be able to express their concerns, ideas, and opinions at these meetings. Public meetings will be held during the drafting stage of each five-year Plan update and to present the final revised Plan to the public before adoption.

7.5 Ongoing Planning Needs

Beginning in 2015, the mitigation planning program detailed in this Plan will become a continuous process of profiling new natural and man-made hazard events, assessing vulnerabilities and new information arises and conditions change, monitoring changing assets and affected populations, and keeping current on evolving mitigation measures. UAH will use this Plan as a starting point for any future mitigation actions or discussion of new mitigation ideas.

UAH will begin updating its Campus Master Plan in 2015. This plan provides a guideline for short- and long-term campus development. The master plan will incorporate mitigation activities from this Plan where appropriate. The master planning process will likely last into 2016.

UAH maintains an Annual Capital Development Plan, a Five Year Facilities Development Plan, and publishes a Deferred Maintenance & Facility Renewal Report annually. This Plan will be incorporated into those ongoing annual planning and reporting processes as appropriate.

The UAH community will continue to refer to this plan for all natural and man-made hazard mitigation planning purposes and will incorporate this plan into future mitigation agendas.

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Appendix A: Business Impact Analysis Process

A.1 Introduction

Knowing the potential consequences of disaster events on mission critical university departments is very important for successful disaster preparation. A business impact analysis (BIA) can help predict the consequences of a disaster on the critical functions of a business (or university department) and can aid in developing strategies for recovery. The BIA of the University of Alabama in Huntsville was compiled using data from the Charger Ready continuity planning tool, which was completed by each campus department.

This BIA report for will include our methodology for collecting and analyzing the data, a brief summary of the survey results for each department, an analysis of potential impacts resulting from a disaster event, and an analysis of preparedness for a disaster.

A.2 Methodology

Data was collected from the ChargerReady continuity planning system. This system was acquired from the University of California System and is designed for operational continuity planning for institutions of higher education. The planning group had originally intended to conduct a new BIA survey, but we did not use this survey since most of the questions we planned to ask could be answered with data already in Charger Ready. The Planning Committee did, however, use the web based survey software Survey Monkey to record and organize the responses from ChargerReady. The data was exported from Survey Monkey to a spreadsheet, and the complete responses can be seen in this appendix.

The following questions are used in the ChargerReady tool to gather and categorize critical functions, recovery time objectives, potential impacts from loss of critical functions, and whether or not the responsible unit has a contingency plan in place:

1. **Department name:**
2. **Number of people working in the department:**
3. **Briefly describe your department's mission statement and/or give an overview of what your department does.**
4. **List and briefly describe any peak volume or critical timeframes of your department.**
   (Complete the following information for each critical function.)
5. **Critical Function:**
6. **Briefly describe the critical function:**
7. **Identify and briefly describe any dates, date ranges, or times of day that are particularly critical to this function:**
8. **How long can the critical function be unavailable before negative impacts occur?**
   A. Cannot be unavailable (must continue at normal or increased service load)
   B. Cannot be unavailable (must continue if at all possible, perhaps in reduced mode)

C. Can be unavailable for 1 to 8 hours
D. Can be unavailable for up to 24 hours
E. Can be unavailable for between 24 to 72 hours
F. Can be unavailable for no more than one week
G. Can be unavailable for no more than 30 days
H. Can be unavailable until conditions permit resumption

9. **What is the severity of the loss of the critical function 1 as time progresses:**
   A. None
   B. Moderate
   C. Severe
   D. Catastrophic
10. **Which of these operational impacts could result from the critical function being unavailable:**
   A. Regulatory/Compliance Issues
   B. Damage to Reputation
   C. Embarrassment
   D. Loss of research data
   E. Disruption of teaching
   F. Disruption of research
   G. Disruption of patient care
   H. Loss of faculty
   I. Loss of staff
   J. Loss of students
   K. Well-being of faculty/staff harmed
   L. Well-being of students harmed
   M. Legal obligations unmet by campus
   N. Legal harm to the university
   O. Impact on other campus unit(s)
   P. Impact on important business partner(s)
   Q. None
   R. Other (please specify)
11. **Which of these financial impacts could result from the critical function being unavailable:**
   A. Reduced Productivity
   B. Increased Expenses
   C. Delayed Collection of Funds
   D. Reduced Income/Revenues
   E. Breach of Contract
   F. Lateness Penalties
   G. Loss of future business
   H. Loss of research funding
   I. Payment deadlines unmet
   J. Loss of revenue to campus
   K. None
   L. Other (please specify)
12. **List all upstream dependencies which the critical function relies on.**

13. List all downstream dependencies which rely on the critical function:

14. What is a reasonable recovery time objective for the critical function?

A. 0 - 4 Hours
B. 4 - 24 Hours
C. 1 - 4 Days
D. 4 - 7 Days
E. 1 - 2 Weeks
F. 2+ Weeks

15. Does your department have a work-around plan in case the critical function is unavailable?

16. Briefly describe the workaround for the critical function:

17. When was the work-around for the critical function last tested?

18. What additional hardware, personnel, and supplies are required to use the work-around for the critical function?

19. How long will it take to implement the work-around for the critical function?

A. 0 - 4 Hours
B. 4 - 24 Hours
C. 1 - 4 Days
D. 4 - 7 Days
E. 1 - 2 Weeks
F. 2+ Weeks

20. How long can the work-around for the critical function be used?

A. 0 - 4 Hours
B. 4 - 24 Hours
C. 1 - 4 Days
D. 4 - 7 Days
E. 1 - 2 Weeks
F. 2+ Weeks

21. What percentage of full production can this alternative provide?

A. 0 - 25%
B. 25 - 50%
C. 50 - 75%
D. 100%

22. Please rank the critical functions you listed from most to least important.

The following survey questions were forwarded to college, department, and other unit heads for critical academic, operational, and research areas. These questions were used to obtain, clarify, and/or quantify data needed for the impact analysis and obtained from ChargerReady.

Department Name: *click here to enter department name*

Peak volume or critical timeframes for department:

Jan☒ Feb☐ Mar☐ Apr☐ May☐ Jun☐ Jul☐ Aug☐ Sep☐ Oct☐ Nov☐ Dec☐

Critical Function 1

Critical Function:

Description:

Identify point in time when interruption of the function would have greater impact (i.e., a specific season or month, end of month/quarter, etc.):

How long can the function be unavailable:

Identify the point in time when negative impact(s) will begin to occur:

0 – 1 hour
1 – 8 hours
8 – 24 hours
24 - 72 hours
> 72 hours
> 1 week
> 1 month

Identify negative impacts that could occur if the function is still unavailable at the time indicated above:

Disruption of teaching ☐
Disruption of research ☐
Disruption of patient care ☐
Departure of faculty ☐
Departure of staff ☐
Departure of students ☐
Well-being of faculty/staff ☐
Well-being of students ☐
Payment deadlines unmet ☐
Loss of revenue ☐
Legal obligations unmet ☐
Legal harm to the University ☐
Impact on other unit(s) ☐
Impact on important business partner(s) ☐

Quantify impacts in financial terms (assume worst case scenario): $

Does your department have a work-around plan in case this function is unavailable: yes ☐ no ☐

If there is anything you would like to add or clarify please do so here: *click here to give more information/clarification*

For the purposes of the business impact analysis, information specific to the impacts from the interruption of critical functions was examined. The impact analysis was not intended to evaluate the strengths of operational continuity plans or to examine recovery time objectives.

A.3 Survey Results Summary

The following table identifies mission-essential university departments:

Mission Essential Departments/Units
Academic Affairs
Admissions & Recruitment
Auxiliary Services (includes dining services)
Budget Office
Business Services (procurement, asset inventory, insurance)
College of Business Administration
College of Education
College of Engineering
College of Liberal Arts
College of Nursing
College of Science
Contracts and Grants Accounting
Distance Learning
Emergency Preparedness
Environmental Health and Safety
Facilities
Finance and Accounting
Human Resources

Office of Information Technology
International Student and Scholar Office
Office of Counsel and Risk Management
Office of VP for Research
Office of Sponsored Programs
Payroll Services
Professional and Continuing Studies
Records and Registration
Student Financial Services
Student Health Center
Telecommunications Services
University Advancement (communications, public information)
University Housing
University Police Department

Table A.1 – Mission Essential Departments/Units

This list includes departments/units that listed critical functions in their respective ChargerReady continuity plans and/or were identified by the DRUC Planning Committee as having a critical role in university operations.

Appendix B: Risk Assessment Process

B.1 Introduction

A risk assessment process was used to identify potential hazards for the UAH campus and assess the level of vulnerability to those potential events. Conducting a risk assessment allowed UAH to determine:

- Which natural, man-made, and technological hazards could affect the campus.
- What areas of the campus are vulnerable to the hazards.
- What assets would be affected.
- To what degree these assets would be affected, as measured in dollar losses.

B.2 Risk Assessment Workgroup

An inter-disciplinary group completed a comprehensive and measured analysis that captured critical campus perspectives. Senior department representatives from the EMOG and DRUC were asked to complete the risk assessment portion.

B.3 Risk and Vulnerability Assessment Model

The risk assessment model utilized by UAH was developed by the Campus Safety Health and Environmental Management Association (CSHEMA) in collaboration with FEMA. The model was developed for use by higher education institutions and is designed to quantify and document the probability and overall severity of various types of threat events or hazards. This was calculated using formulas developed by CSHEMA. Microsoft Excel spreadsheets were used to gather each individual assessment and automatically calculate the group consensus using the preset formulas.

For each threat event, participants answered one question representing probability of occurrence, then evaluated six impact questions across three different categories (human impact, facilities impact, and institutional impact), and then assessed their unit's preparedness level. All six impact estimates were averaged to produce an overall severity score.

The assumption is that threat events that affect all three categories would have greater overall impact to campus than events whose impacts are limited to just facilities or people. The overall severity score and the probability were then combined to create a relative risk score for each threat event.

Once all the threat events were evaluated, the results were sorted from high to low to produce a relative risk ranking of threat exposures. The results were discussed to determine reasonableness and validity. The results provided a basis to evaluate adequacy of campus mitigation measures and recovery planning for the most significant campus threats.

The CSHEMA risk assessment work sheet provided to workgroup participants in shown in figure B1.

Figure B.1 – Risk Assessment Worksheet

THREAT EVENT/ HAZARD	PROBABILITY	SEVERITY = MAGNITUDE of IMPACTS						SEVERITY IMPACTS	UNMITIGATED RISK
		HUMAN IMPACT		FACILITIES IMPACT		INSTITUTIONAL IMPACT			
	Relative likelihood this will occur	Potential deaths or injuries		Physical damage and costs		Interruption research & teaching Impact reputation/image		Overall Impact (Average)	Probability x Severity Impacts
Natural Hazards Technological Human Terrorism	1 = Not occur 2 = Doubtful 3 = Possible 4 = Probable 5 = Inevitable	Question 1	Question 2	Question 1	Question 2	Question 1	Question 2	1 = Lowest 5 = Highest	1 = Lowest 25 = Highest
NATURAL HAZARDS									
Tornado	4.25	1.00	4.00	3.00	3.00	2.00	2.00	2.75	11.69
Severe Thunderstorm	5.00	1.00	2.00	2.00	1.00	1.00	1.00	1.86	9.29
High Winds	5.00	1.00	1.00	1.00	1.00	1.00	1.00	1.57	7.86
Flood	5.00	1.00	1.00	1.00	1.00	1.00	1.00	1.57	7.86
Flood - 100 yr.	4.00	1.00	1.00	1.00	1.00	1.00	1.00	1.43	5.71
Flood - 500 yr.	3.00	1.00	1.00	2.00	1.00	1.00	1.00	1.43	4.29
Earthquake - minor	3.00	1.00	1.00	1.00	1.00	1.00	1.00	1.29	3.86
Earthquake - major	2.00	1.00	1.00	2.00	3.00	2.00	1.00	1.71	3.43
Winter Storm	4.00	1.00	1.00	2.00	1.00	2.00	1.00	1.71	6.86
TECHNOLOGICAL									
Power Failure	4.00	1.00	1.00	1.00	1.00	2.00	1.00	1.57	6.29
Natural Gas Disruption	3.00	1.00	1.00	1.00	1.00	1.00	1.00	1.29	3.86
Water Supply Disruption	3.00	1.00	1.00	1.00	1.00	2.00	1.00	1.43	4.29
Telecommunications Failure	3.00	1.00	1.00	1.00	1.00	2.00	2.00	1.57	4.71
IT Systems Disruption	3.00	1.00	1.00	1.00	1.00	2.00	2.00	1.57	4.71
Residence Hall Fire	3.00	1.00	2.00	1.00	1.00	1.00	3.00	1.71	5.14
Building Fire - Major	3.00	1.00	1.00	2.00	2.00	1.00	2.00	1.71	5.14
Building Fire - Minor	3.00	1.00	1.00	1.00	1.00	1.00	1.00	1.29	3.86
HAZMAT Incident - Lab	3.00	1.00	2.00	2.00	1.00	1.00	2.00	1.71	5.14
HAZMAT Incident - Transportation (Roadway)	3.00	1.00	1.00	2.00	1.00	2.00	1.00	1.57	4.71
Flood - Plumbing/sprinkler	3.00	1.00	1.00	1.00	2.00	1.00	1.00	1.43	4.29
Loss of Central Plant	2.00	1.00	1.00	2.00	2.00	2.00	2.00	1.71	3.43
HAZMAT Incident - Railway	3.00	1.00	3.00	2.00	1.00	2.00	2.00	2.00	6.00
HUMAN-RELATED									
Public Health Emergency	4.00	2.00	2.00	1.00	1.00	3.00	1.00	2.00	8.00
Sports/Public Event Disturbance	2.00	1.00	2.00	1.00	1.00	1.00	2.00	1.43	2.86
Workplace Violence	2.00	5.00	4.00	1.00	1.00	2.00	4.00	2.71	5.43
Civil Disturbance	2.00	1.00	2.00	1.00	1.00	1.00	3.00	1.57	3.14
Mass Casualty Event	2.00	5.00	4.00	1.00	1.00	2.00	3.00	2.57	5.14
Active Shooter	2.00	1.00	4.00	1.00	1.00	2.00	5.00	2.29	4.57
TERRORISM									
Vehicle Bomb	2.00	1.00	4.00	2.00	2.00	2.00	4.00	2.43	4.86
Mail/Package Bomb	2.00	1.00	3.00	1.00	1.00	2.00	4.00	2.00	4.00
Biological Agent Release	1.00	1.00	4.00	1.00	1.00	3.00	4.00	2.14	2.14
Radiological Material Release	1.00	1.00	4.00	1.00	1.00	3.00	4.00	2.14	2.14
								#DIV/0!	#DIV/0!
								#DIV/0!	#DIV/0!
AVERAGE SCORE	2.95	1.28	1.97	1.38	1.25	1.66	2.03	1.79	5.26

B.4 Risk Assessment Instructions to Workgroup Participants

Risk assessment workgroup participants were provided with detailed examples and instructions for completing the risk assessment worksheets. These instructions were included as part of the CSHEMA risk assessment model:

Instructions: How to use the Risk and Vulnerability Assessment Model

The Risk Assessment model is designed to quantify and document the probability and overall severity of various types of threat events or hazards (natural, technological, human, and terrorism). This is calculated on a Microsoft Excel spreadsheet preset with formulas to automatically calculate the workgroup consensus.

For each threat event, participants will answer one question representing probability of occurrence, then evaluate six impact questions across three different categories (human impact, facilities impact and institutional impact) and then assess their preparedness level. All six estimates for impact are averaged to produce an overall severity score.

The assumption is that threat events that affect all three categories would have greater overall impact to a campus than events whose impacts are limited to just facilities or people. The overall severity score and the probability are then combined to create a relative risk score for each threat event.

Once all the threat events have been evaluated, the results can be sorted from high to low to produce a relative risk ranking of threat exposures. The results should be discussed with the group to determine reasonableness and validity. The results of this risk assessment can provide a basis to evaluate adequacy of campus mitigation measures and recovery planning for the most significant campus threats.

Consensus can be reached in a variety of ways:

1. Using one of the various ‘option calculator’ tools.
2. Calculating that score manually—dividing the sum of the opinions by the number of participants.

		SEVERITY = MAGNITUDE of IMPACTS									RELATIVE RISK
THREAT EVENT/ HAZARD	PROBABILITY	HUMAN IMPACT		FACILITIES IMPACT		INSTITUTIONAL IMPACT		SEVERITY IMPACTS	UNMITIGATED RISK	PREPAREDNESS	
	Relative likelihood this will occur	*Potential deaths or injuries*		*Physical damage and costs*		*Interruption research & teaching Impact reputation/image*		*Overall Impact (Average)*	*Probability x Severity Impacts*	*Level of Preparedness*	*Unmitigated Risk/Preparedness*
Natural Hazards Technological Human Terrorism	*1 = Not occur 2 = Doubtful 3 = Possible 4 = Probable 5 = Inevitable*	*Question 1*	*Question 2*	*Question 1*	*Question 2*	*Question 1*	*Question 2*	*1 = Lowest 5 = Highest*	*1 = Lowest 25 = Highest*	*1 = None 2= Poor 3= Fair 4=Good 5=Prepared*	
Animal/ Crop Eco-terrorism	3.2	1.4	2.5	3	2.3	2.9	1.4	**2.25**	**7.2**	2	3.6
Workplace Violence	4.4	3.4	4.3	1.4	1.1	1.4	3.7	**2.55**	**11.22**	3	3.74

In the example in the table above, there are 12 participants from campus departments

Threat: Animal/Crop Eco-terrorism

Probability – 3.2

1. To calculate the possibility you will need to tally all of the responses in the following way:

   10 participants rate it as 3-possible—30 points
   2 participants rate it as 4-probable—8 points
   Total score is 38, divided by 12 participants = 3.17 rounded up to 3.2

   The other questions are manually calculated in a similar manner.

2. To calculate the **Severity,** take the average of the human impact, facilities impact, and institutional impact scores.

   In this example the calculations would be:
   (1.4+2.5+3.0+2.3+2.9+1.4)/6=2.25

3. To calculate the **Unmitigated Risk,** take the probability and multiply it by the Severity.

   In this example, the calculation would be: 3.2*2.25=7.2

4. To calculate **Relative Risk**, take the unmitigated risk and divide it by the level of preparedness.

In this example, the calculation would be: 7.2/2= 3.6

In this example shown here, Workplace Violence is a greater relative risk to the campus than Flood.

Hazard & Risk Assessment Instructions

Probability and Severity Metrics

I. Probability Metric

1. Consider the number of occurrences on your campus over the past 15 years, the number of similar events at other Universities, and any changes or trends that could affect the frequency of this event on your campus.

Estimate the likelihood this event will occur in next 15 years.

1. Not applicable (will not occur)
2. Doubtful (not likely)
3. Possible (could occur)
4. Probable (very likely to occur)
5. Inevitable (will occur)

II. Severity Metrics

A. Human Impact

1. If this event has occurred in the past on your campus, what was the extent of injuries and deaths that occurred?

    1. None or this event has never occurred on campus
    2. Few or minor injuries
    3. Multiple minor injuries or a major injury
    4. Multiple major injuries or a death
    5. Multiple deaths and major injuries

2. Consider the potential for injuries or deaths from this event on your campus or from similar events at other universities, and any changes or trends that would affect future injuries and deaths from this type of event.

    Estimate the number of injuries and deaths that could result from this event:

1. None
2. Few minor injuries
3. Multiple minor injuries or possible death
4. Multiple deaths and major injuries
5. Multiple deaths and major injuries

B. <u>Facilities Impact</u>

1. Consider the vulnerability of your central campus facilities to this event. (See the attached page for a list of typical campus facilities.)

   <u>Estimate the extent of damage to campus-wide facilities:</u>

   1. Little or no damage
   2. Mild damage to several facilities
   3. Moderate damage to multiple facilities
   4. Severe damage to multiple facilities
   5. Extensive damage to most facilities

2. Considering the extent of damage to the central campus facilities, <u>estimate the total cost to respond to the event and repair or replace all damaged facilities.</u>

   1. Less that $1 million
   2. Between $ 1 million and $10 million
   3. Between $10 million and $100 million
   4. Between $100 million and $500 million
   5. More than $500 million

C. <u>Institutional Impact</u>

1. If this event were to/did occur on your campus, <u>estimate the duration of interruption to campus-wide teaching and research activities, and business operations:</u>
   1. Hours
   2. Days
   3. Weeks
   4. Months
   5. Years or longer

2. <u>To what extent would this event negatively impact the campus reputation or public image over the long term?</u>
   1. None
   2. Minor
   3. Moderate

4. Significant
5. Severe

III. Preparedness

1. Consider what the level of preparedness is for each threat/hazard.
    1. None: Plan/Policy is not developed and no training/exercises have occurred.
    2. Poor: Plan/Policy is not developed and no training/exercises have occurred. However, some resources have been expended/identified to start the process.
    3. Fair: Plan/Policy is developed but needs to be updated or training/exercises need to occur to test the plan/policy.
    4. Good: Plan/Policy is developed and training/exercises have occurred, but after action items need to be addressed and minor improvements need to be made to the plan/policy.
    5. Prepared: Plan/Policy is developed, written and current. Training and exercises are conducted on a routine basis to test the plan/policy. Plan/Policy is shared with stakeholders.