Tornado Damage Risk Assessment

Dallas-Fort Worth Metroplex

A Regional Exercise in Demographic, Environmental, and Urban Analysis
January, 2000

Potential Damage Impact of the May 3, 1999 Oklahoma Tornado Outbreak if it had Occurred over North Central Texas

Study Summary
Performed as a Public Service for the National Weather Service And the Emergency Management Community

North Central Texas Council of Governments
616 Six Flags Drive, Suite 200, Centerpoint Two
P.O. Box 5888
Arlington, Texas 76005-5888
Tornado Damage Risk Assessment
Dallas-Fort Worth Metroplex

North Central Texas Council of Governments
616 Six Flags Drive
Arlington, Texas 76005
Phone: (817) 640-3300

National Weather Service Forecast Office
3401 Northern Cross Blvd
Fort Worth, Texas 76137
Phone: (817) 429-2631

An analysis of detailed urban geographic data to estimate the potential impacts of a major tornado outbreak on the Dallas Fort-Worth Metroplex. Features the application of Geographic Information System (GIS) Technology.

Fujita Scale Wind Velocity contours from the Moore, Oklahoma tornado of May 3, 1999 projected atop color aerial digital photography for eastern Arlington, Texas.

Front Cover: Computer model of the path of the Moore, Oklahoma projected upon structure data for North Dallas. Path colors differentiate between different Fujita Scale wind velocities. Structures are given 3-D perspectives through the use of Geographical Information System software.
Data Analysis and Geographic Information System Data Compilation

Scott Rae
Senior Research Associate
Department of Research and Information Services
North Central Texas Council of Governments

Advisory Group

Jim Stefkovich
Warning Coordination Meteorologist
National Weather Service Forecast Office
Fort Worth, Texas

Gary Woodall
Warning Coordination Meteorologist
Meteorological Services Division
National Weather Service Southern Region Headquarters

Bob O’Neal
Director
Department of Research and Information Services
North Central Texas Council of Governments

Rocky Gardiner
Manager of Research
Department of Research and Information Services
North Central Texas Council of Governments

Jack Tidwell
Senior Environmental Planner
Department of Environmental Resources
North Central Texas Council of Governments

Special Thanks for Data Contributions and Suggestions

Greg Stumpf, National Severe Storms Laboratory
Dr. Charles A. Doswell III, National Severe Storms Laboratory
Tim Marshall, Haag Engineers
Amy Wyatt, North Central Texas Council of Governments
Angi Young, North Central Texas Council of Governments
Tamara Schells, North Central Texas Council of Governments
Arash Mirzaei, North Central Texas Council of Governments
Mitch Lestig, North Central Texas Council of Governments
Ken Cervenka, North Central Texas Council of Governments
Introduction

The series of tornadoes which struck the Oklahoma City area on May 3, 1999 were the most damaging tornadoes in U.S. history, causing over 1 billion dollars in damage and completely destroying over 2500 structures. While loss of life was kept to a minimum due to advances in weather forecasting technology and the preparedness of the media, the impact of this tornadic event was augmented by the fact that the tornadoes struck a densely populated metropolitan area.

What if a tornado or outbreak of this magnitude struck the Dallas-Fort Worth Metroplex? With nearly 5 million people, 1.1 million houses, and 60,000 commercial structures, the effect would be devastating at best. Losses would likely exceed the cost impact to Oklahoma City by an order of magnitude. The climatology of Dallas-Fort Worth is prime for such weather systems, and it is only a matter of time before the odds bring one of these events to the heart of the Metroplex.

A joint research project between the North Central Texas Council of Governments (NCTCOG) and the National Weather Service Fort Worth (NWS) examines the potential impact such a weather event would have on the Metroplex. By utilizing many of the same tools and data sets typically used in regional urban planning for North Central Texas, the problem of tornado risk is demonstrated through demographic, environmental, and urban analysis.

Above: Wichita Falls, Texas F-4 Tornado of April 10, 1979. This tornado, like the one in "Moore" Oklahoma, is the type of violent class tornado that would be extremely dangerous in a dense urban area like Dallas-Fort Worth.

Above: Computer Model of Large Tornado following Scenario Four path into Downtown Dallas. This scenario would likely impact over 30,000 structures and create estimated appraised structural losses of over $2.8 Billion.
# Table of Contents

- **Study Overview**  
  Page 7
- **Data Sources**  
  Page 8
- **Study Area**  
  Page 11
- **Computer Application Methodology**  
  Page 12
- **Tornado Fujita Scale Damage Mapping**  
  Page 13
- **The Tornadoes**  
  - The Big Tornado “A9”  
    Page 14
- **The Scenarios**  
  Page 18
- **Summarizing Data By Fujita Damage Contour**  
  Page 20
- **Summary of Study Findings**  
  Page 21
- **People and Traffic In Tornado Paths**  
  - Estimating Traffic in the Path of Tornadoes  
    Page 22
- **Structural Damage Estimates**  
  - Estimation of Damage Dollar Totals  
    Page 23
  - Structure Values  
    Page 26
  - Analysis by Structure Category  
    Page 32
- **The Series 50 Summary** (50 Tornadoes Across the Metroplex)  
  - The Most Damaging Path  
    Page 33
  - A Downtown Dallas Path  
    Page 36
- **Detailed Summary Of Each Scenario (1-5)**  
  Page 39

**Aerial Image Maps Courtesy of VARGIS LLC**

North Central Texas Council of Governments/National Weather Service Fort Worth  
Study Summary - Page 6
Study Overview

This study features the use of digitally mapped tornado path information from a real tornado outbreak laid atop Dallas-Fort Worth urban and demographic data. It uses some of the best regional geographic data available to help answer the unavoidable meteorological and emergency management questions that arise after a big storm event in a nearby geographical area:

- What if it had happened here?
- What would have been our toll?
- Would we have been prepared?

Modern computer technology can help estimate the magnitude that the tasks of warning, rescue, and recovery would require. If we make the very likely assumption that *Dallas-Fort Worth would see comparable damage in the same portions of the tornadoes that caused damage in Oklahoma*, we can then model this same event across the Dallas-Fort Worth Metroplex and assess how susceptible the area is to large tornado damage potential.

Five (5) separate distributions (scenarios) of the same Oklahoma tornado paths are modeled with the output including:

- The number of structures in the path
- Potential dollar damages to structures and contents
- Residents living in the path
- Employees working in the path
- Utility lines in the path
- The distribution of land use in the path
- Estimated roadway miles and vehicles travelling in the path

A second analysis looks at the largest tornado of the outbreak across 50 different paths through the Metroplex. Residents, structures, and values in the path are calculated and compared.

A tornadic outbreak like the one in Oklahoma would cover an amazing amount of North Central Texas territory, and this study will help identify and quantify the features that lie in the paths.

Right: *Tornado scenario five path through 3-D graphical representations of apartment complex density*. Dallas County is closest, with the view looking directly west towards Tarrant County.
Data Sources

• Dallas County Appraisal District Data – June 1999
• Tarrant County Appraisal District Data – June 1999
• Collin County Appraisal District Data – June 1999
• Denton County Appraisal District Data – June 1999

• North Central Texas Regional Population and Housing Estimates 1998
• North Central Texas Employment and Household Estimates 1995-1999
• Landiscor Aerial Photography 1999
• North Central Texas Regional Basemap
• Vargis 2 meter resolution Aerial Photography 1999
• North Texas GIS Consortium 0.5 meter resolution Aerial Photography 1997

* For this project, several databases were either utilized or constructed to provide the best-possible guess of what geographic features would be impacted by a specific alignment of one or more tornadoes. These included:

• A 400,000 record database identifying geographic distribution of:
  • Land use – Functional use of land areas
  • Structure Category - Commercial, Industrial, Single-Family, Apartment, and Mobile Home
  • Structure Density – The number of individual structures existing in an area
  • Structure Value – The appraised value of structures in an area

• A regional employment distribution data set showing the distribution of employees in relationship to their local transportation survey zone and land use.

• A regional data set showing the point location of major employers in the Dallas-Fort Worth Metroplex.

• A regional apartment complex distribution data set.

• A regional school distribution data set.

• An address-matched file of all commercial properties in the Metroplex.

• A regional transportation system data set.

• Modeled roadway volume data sets for primary freeways, arterials, and collectors in the region.
• Distribution of major electrical power lines in Dallas, Tarrant, Collin, and Denton Counties.

• Detailed mapping of the May 3, 1999 tornado outbreak in Oklahoma. Mapping boundaries for the Moore, Oklahoma tornado were adapted from the damage survey performed by the National Severe Storms Laboratory (NSSL). Other tornadoes in the event were mapped using general mapping from the National Weather Service in Norman, Oklahoma and post-event damage survey descriptions. Widths and velocities were assigned from mapping and descriptions of each tornado provided by either the National Weather Service or the National Severe Storms Laboratory.

The 400,000 record database featured the merging of several data sets:

• 1995 North Central Texas Land Use
• North Central Texas City and County Jurisdiction Boundaries
• Census Block Group Boundaries
• MAPSCO Grid Cell Boundaries
• Trinity River Corridor Engineering Scale Mapping --76,000 Building Footprints
• Select City Parcel Mapping

Above: Schools and major electrical utility lines in the path of the biggest tornado of scenario five. Overall, 43 utility line routes and 11 schools would be in the paths of tornadoes.
Oklahoma Moore Tornado Detailed Damage Delineation acknowledgement:

Provided by: Greg Stumpf, NSSL

Damage Survey Info
- Greg Stumpf, NSSL
- Jim LaDue, NWS
- Don Burgess, NWS
- Mike Magsig, NWS
- Mike Branick, NWS
- Tim Marshall, Texas Tech U. and Haag Engineering

The delineation information provided was digitized into Arc/Info GIS by the North Central Texas Council of Governments using tiger mapping data in Oklahoma and translated to the Texas State Plane Coordinate System. Display maps were generated by Arcview GIS Version 3.1.

Above: North Dallas Damage Path in Arcview GIS
The Study Area

The North Central Texas region is made up of 16 counties and encompasses 12,797 square miles. The population of this area is estimated to be over 4.9 million (1999), and most of this population resides in the 1.14 million single family homes and 622,000 apartment units found in the region.

The analysis area specifically used in this study is a large subset of the North Central Texas region. The study area includes:

- All of Dallas, Tarrant, Denton, Collin, Rockwall and Parker Counties
- All of Johnson and Ellis Counties
- Portions of and Wise and Kaufman counties

Any tornadoes placed across these areas were analyzed using a detailed foundation of land use, population, housing, and employment data. Detailed appraisal data was available for Dallas, Tarrant, Denton, and Collin Counties. Tornadoes or portions of tornadoes falling outside of the analysis area did not have sufficient data available and calculations were not performed. Portions of tornadoes falling partially in the study area were analyzed, but only those included portions were calculated for damages.
Computer Application Methodology

The goal of this study was to use urban analysis computer technology to estimate the threat to North Central Texas people and property that a major tornado outbreak could pose. The continuing growth and advancement of Geographic Information System (GIS) technology is making studies like this possible. GIS is utilized by the North Central Council of Governments and many North Central Texas cities as a primary tool to analyze, prioritize, and evaluate urban planning needs. It’s role is prevalent in transportation, demographic, environmental, and emergency planning – and important geo-referenced databases continue to grow in detail and sophistication. The impact of a major tornado outbreak depends greatly on the characteristics of the area that it strikes, and GIS provides a way to analyze an area in detail.

In order to provide the most representative analysis, the actual tornado damage paths from the Oklahoma City tornado event were mapped and transposed across the North Central Texas geography. This mapping included 53 different tornadoes of varying size and strength. Five (5) separate geographic scenarios for the transposed tornadoes were chosen. The tornado paths maintained the precise size, length and direction of motion that they had in Oklahoma. The mid-point of the outbreak was shifted to North Texas and adjusted slightly North, South, East and West to make up the five scenarios. The scenarios were largely recommended by the National Weather Service Forecast Office in Fort Worth. The paths were chosen based upon both intuitive risk potential and apparent potential based on data trends. Note again that the relative geographical positioning of the various tornadoes and their direction of movement is the same as the Oklahoma outbreak. Thus, this is a real event transposed upon North Central Texas data.
The Tornadoes used in this analysis were mapped using a distinct delineation of the Fujita Scale (F-Scale) damage regions as they occurred in Oklahoma. The F-Scale corresponds to the magnitude of damage occurring to structures. Information available from the Oklahoma event provided significant information on the tornado path widths, length, and F-Scale ratings and this information was used to re-construct aerial distributions and geographic extents of the tornadoes in the May 3rd outbreak. In cases where the data was too general, the tornado F-Scale boundaries were constructed by the computer using mathematical intervals. For the largest of the tornadoes, detailed damage path mapping was acquired from the National Severe Storms Laboratory, and the F-Scale boundaries were digitized into the Geographic Information System. In the Metroplex scenarios, the F-Scale regions represent areas where a certain level of damage is likely. In essence, it represents an expectation. Structures in a particular F-Scale zone in Oklahoma experienced a predominant category of damage that we are expecting would occur to Metroplex structures if subject to the same conditions in those zones. For this study, single family structures and apartment units were considered destroyed if in the F-2 level contour and mobile homes at F-1. The dollar values calculated for damages assumed an 80% loss of the appraised structure values at these levels. Commercial structures were expected, on average, to be more durable.
The Tornadoes

Fifty-three (53) tornado damage paths were mapped and included in this study. These ranged from very small and weak tornadoes, with paths as short as .1 mile and a Fujita rating of F-0, to very large tornadoes, with paths as long as 37.5 miles and a Fujita rating of F-5. The **prefix letter** in the tornado system (ie. A or B or C, etc…) refers to the **parent storm** producing the tornado. For instance, all of the tornadoes with A in the prefix (A1,A2,A3…A14) were all produced from the same tornadic thunderstorm at different times along the storm’s path. These are referred to as tornado “families” and represent multiple stages in each thunderstorm’s evolution and life. The family system codes were developed by damage surveyors with the National Weather Service in Norman, Oklahoma following the May 3 outbreak.

As the paths were together moved slightly east/west and north/south for each of the five North Central Texas scenarios, some of the tornadoes would shift to either intersect the outer study boundary or lie completely outside of it. In these cases, only the portion of the tornadoes that fit in the study area received calculations for damages. The chart below lists all of the tornadoes, their strength, size, hour of primary impact, and the proportion of each tornado’s damage path that fell within the study area during each of the scenarios.

<table>
<thead>
<tr>
<th>Tornado</th>
<th>Impacted Area</th>
<th>Time</th>
<th>Percentage of Tornado Path Falling in Study Area by Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>System</td>
<td>Fujita Scale</td>
<td>Width (Feet)</td>
<td>Acres</td>
</tr>
<tr>
<td>A1</td>
<td>0</td>
<td>75</td>
<td>5.49</td>
</tr>
<tr>
<td>A2</td>
<td>0</td>
<td>75</td>
<td>1.01</td>
</tr>
<tr>
<td>A3</td>
<td>3</td>
<td>300</td>
<td>356.06</td>
</tr>
<tr>
<td>A4</td>
<td>0</td>
<td>25</td>
<td>1.39</td>
</tr>
<tr>
<td>A5</td>
<td>0</td>
<td>75</td>
<td>0.81</td>
</tr>
<tr>
<td>A6</td>
<td>3</td>
<td>2640</td>
<td>1234.95</td>
</tr>
<tr>
<td>A8</td>
<td>2</td>
<td>1500</td>
<td>366.78</td>
</tr>
<tr>
<td>A9</td>
<td>5</td>
<td>5280</td>
<td>12242.4</td>
</tr>
<tr>
<td>A11</td>
<td>0</td>
<td>180</td>
<td>7.44</td>
</tr>
<tr>
<td>A12</td>
<td>2</td>
<td>660</td>
<td>344.94</td>
</tr>
<tr>
<td>A13</td>
<td>0</td>
<td>150</td>
<td>44.77</td>
</tr>
<tr>
<td>A14</td>
<td>1</td>
<td>150</td>
<td>48.36</td>
</tr>
<tr>
<td>B2</td>
<td>0</td>
<td>75</td>
<td>40.78</td>
</tr>
<tr>
<td>B3</td>
<td>1</td>
<td>450</td>
<td>374.92</td>
</tr>
<tr>
<td>B4</td>
<td>0</td>
<td>75</td>
<td>1.68</td>
</tr>
<tr>
<td>B5</td>
<td>0</td>
<td>75</td>
<td>16.92</td>
</tr>
<tr>
<td>B6</td>
<td>0</td>
<td>75</td>
<td>1.47</td>
</tr>
<tr>
<td>B7</td>
<td>0</td>
<td>75</td>
<td>15.91</td>
</tr>
<tr>
<td>B8</td>
<td>1</td>
<td>900</td>
<td>245.12</td>
</tr>
<tr>
<td>B9</td>
<td>1</td>
<td>150</td>
<td>88.32</td>
</tr>
</tbody>
</table>

Chart Continued on Page 16
Above: Tornadoes from the May 3 1999 Outbreak Included in this Study. The map above shows the positions as they were mapped in central Oklahoma. This data set was moved south over the Dallas-Fort Worth Metroplex and merged with local data.

Above: Actual tornado damage in downtown Fort Worth due to a significant tornado on March 28, 2000. The right image shows the relative path sizes of the Fort Worth event (in purple) and the largest of the Oklahoma tornadoes through downtown (multi-contoured).
### Tornado Damage Risk Assessment - Dallas-Fort Worth

#### Summary

<table>
<thead>
<tr>
<th>Tornado</th>
<th>Impacted Area</th>
<th>Time</th>
<th>Percentage of Tornado Path Falling in Study Area by Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Width (Feet)</td>
<td>Acres Sq. Miles</td>
<td>Path Miles</td>
</tr>
<tr>
<td>B10</td>
<td>100</td>
<td>97.02 0.15</td>
<td>4.49 7 P.M.</td>
</tr>
<tr>
<td>B11</td>
<td>150</td>
<td>2.41 0.01</td>
<td>0.12 7 P.M.</td>
</tr>
<tr>
<td>B12</td>
<td>75</td>
<td>3.19 0.01</td>
<td>0.19 8 P.M.</td>
</tr>
<tr>
<td>B13</td>
<td>300</td>
<td>28.45 0.04</td>
<td>0.74 8 P.M.</td>
</tr>
<tr>
<td>B14</td>
<td>225</td>
<td>26.07 0.04</td>
<td>0.99 8 P.M.</td>
</tr>
<tr>
<td>B15</td>
<td>75</td>
<td>1.94 0.01</td>
<td>0.16 8 P.M.</td>
</tr>
<tr>
<td>B16</td>
<td>450</td>
<td>352.19 0.55</td>
<td>6.40 8 P.M.</td>
</tr>
<tr>
<td>B18</td>
<td>450</td>
<td>543.48 0.85</td>
<td>9.91 9 P.M.</td>
</tr>
<tr>
<td>B19</td>
<td>300</td>
<td>570.07 0.89</td>
<td>1.00 9 P.M.</td>
</tr>
<tr>
<td>B20</td>
<td>3960</td>
<td>9524.33 14.88</td>
<td>20.67 9 P.M.</td>
</tr>
<tr>
<td>B21</td>
<td>2640</td>
<td>5198.37 8.12</td>
<td>16.16 10 P.M.</td>
</tr>
<tr>
<td>C1</td>
<td>300</td>
<td>155.97 0.24</td>
<td>4.25 7 P.M.</td>
</tr>
<tr>
<td>C2</td>
<td>75</td>
<td>1.40 0.01</td>
<td>0.15 6 P.M.</td>
</tr>
<tr>
<td>D1</td>
<td>90</td>
<td>88.68 0.14</td>
<td>9.73 8 P.M.</td>
</tr>
<tr>
<td>D2</td>
<td>750</td>
<td>623.18 0.97</td>
<td>6.75 9 P.M.</td>
</tr>
<tr>
<td>D3</td>
<td>300</td>
<td>357.24 0.56</td>
<td>11.02 9 P.M.</td>
</tr>
<tr>
<td>D4</td>
<td>2250</td>
<td>4191.53 6.55</td>
<td>15.03 10 P.M.</td>
</tr>
<tr>
<td>E1</td>
<td>75</td>
<td>0.98 0.01</td>
<td>0.11 8 P.M.</td>
</tr>
<tr>
<td>E2</td>
<td>450</td>
<td>508.06 0.79</td>
<td>9.26 8 P.M.</td>
</tr>
<tr>
<td>E3</td>
<td>1350</td>
<td>2043.50 3.19</td>
<td>12.15 8 P.M.</td>
</tr>
<tr>
<td>E6</td>
<td>2640</td>
<td>4934.37 7.71</td>
<td>15.03 9 P.M.</td>
</tr>
<tr>
<td>E7</td>
<td>1320</td>
<td>595.34 0.93</td>
<td>3.52 9 P.M.</td>
</tr>
<tr>
<td>G1</td>
<td>150</td>
<td>17.30 0.03</td>
<td>1.00 9 P.M.</td>
</tr>
<tr>
<td>G2</td>
<td>1050</td>
<td>2587.08 4.04</td>
<td>20.34 10 P.M.</td>
</tr>
<tr>
<td>G3</td>
<td>450</td>
<td>142.44 0.22</td>
<td>2.55 10 P.M.</td>
</tr>
<tr>
<td>G4</td>
<td>150</td>
<td>9.11 0.01</td>
<td>0.51 10 P.M.</td>
</tr>
<tr>
<td>G5</td>
<td>2640</td>
<td>4203.04 6.57</td>
<td>12.92 11 P.M.</td>
</tr>
<tr>
<td>G6</td>
<td>1320</td>
<td>354.83 0.55</td>
<td>2.02 11 P.M.</td>
</tr>
<tr>
<td>H1</td>
<td>150</td>
<td>14.19 0.02</td>
<td>0.80 9 P.M.</td>
</tr>
<tr>
<td>H2</td>
<td>90</td>
<td>3.14 0.01</td>
<td>0.28 9 P.M.</td>
</tr>
<tr>
<td>H3</td>
<td>450</td>
<td>60.05 0.09</td>
<td>1.03 9 P.M.</td>
</tr>
<tr>
<td>H4</td>
<td>1320</td>
<td>1356.54 2.12</td>
<td>8.28 10 P.M.</td>
</tr>
<tr>
<td>I1</td>
<td>600</td>
<td>79.71 0.12</td>
<td>1.01 10 P.M.</td>
</tr>
</tbody>
</table>
Above: Thirty-Six (36) of the 53 tornadoes from the May 3, 1999 outbreak overlaid atop North Central Texas. The tornadoes are positioned at the beginning of each of their ultimate damage paths. Similar colors represent tornadoes generated from the same thunderstorm.

Above: Computer representation of the largest of the tornadoes from the May 3, 1999 outbreak entering Downtown Fort Worth. Simple GIS 3-Dimensional renderings allowed some basic visualization of the region’s urban environment and its interaction with computer-generated phenomena.

Tornado paths across Dallas-Fort Worth. GIS technology provided a means to estimate the number of structures and their appraised value beneath the tornado paths.
The Big Tornado “A9”

Tornado “A9” was arguably the largest of the outbreak. The trajectory of this large tornado into the Oklahoma City area certainly made it the most damaging. It is often referred to as the “Moore” tornado -- named after the southern suburb of Oklahoma City that received intense damage from the storm. It covered a 37 mile track and impacted almost 20 square miles of land. The study for North Central Texas uses this tornado as the focus for centering the entire outbreak. It is assumed to be the greatest threat to the metropolitan area. All of the scenarios include the entire length of this tornado in the study area, and most of its path impacts Tarrant or Dallas counties. This tornado also had the best mapping of its damage path through Oklahoma available. Fujita-scale damage contours for this storm were mapped in the Geographic Information System, and potential threats were identified with greater accuracy.

Above: Computer simulated image of the path of tornado “A9” through the center of Tarrant County in scenario three. The tornado passes through 8 different jurisdictions along this route.
Above: Radar Image of the Moore Tornado. The storm was a mile wide at some points along its Oklahoma path. The “Doppler on Wheels” project collected the above radar data on the storm, and identified a wind velocity peak of over 300 miles per hour.

Above: Projection of the Moore tornado path towards downtown Dallas in Scenario Four of the Study. The storm was at a Fujita level of F-3 at this point, but quickly reaches F-5 beyond Central Expressway. The tornado would cause an estimated $2.8 billion in structural damage.
The Scenarios

The 53 tornadoes that were mapped for this study were distributed across the Metroplex in 5 different alignment groups. All tornadoes maintained their exact length, width, and angle of direction. The variation in the scenarios was accomplished by moving the center point of the outbreak to 5 different locations. In all cases, the biggest tornado of the outbreak ("A9") took a path that was primarily over either Dallas or Tarrant counties.

Scenario One

Scenario Two

Scenario Three

Scenario Four

Scenario Five
Summarizing Data By Fujita Damage Contour
Just How Much DFW Property Falls Inside of the Zones?

<table>
<thead>
<tr>
<th>Area</th>
<th>F-Scale</th>
<th>Homes</th>
<th>Apartment Units</th>
<th>Commercial Properties</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>60</td>
<td>24</td>
<td>6</td>
<td>$11,220,000</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>55</td>
<td>76</td>
<td>5</td>
<td>$12,080,014</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>142</td>
<td>36</td>
<td>11</td>
<td>$23,336,216</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>4</td>
<td>114</td>
<td>22</td>
<td>$28,314,274</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>95</td>
<td>38</td>
<td>7</td>
<td>$18,890,422</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>112</td>
<td>22</td>
<td>6</td>
<td>$20,544,422</td>
</tr>
</tbody>
</table>

GIS computer software allows databases to be summarized by the geographic positioning of their features. As the tornado path is directed across the DFW Metroplex geographic data, structures and attributes falling within the various Fujita mapping contours of the tornado can be identified and described. Although there is no direct correlation between how structures in Oklahoma reacted in these same zones and how DFW structures would react, there is little reason to suspect that DFW structures would fare significantly better. Over 90% of the structures falling in the paths in DFW are residential -- following similar building code, densities and neighborhood layouts.

Most of the data tables presented in this document are designed to provide a summary of property quantity, types, and total value located within the mapped Fujita contours. Similarly, residential population, employment, and traffic are summarized by these zones. In terms of individual damage ratings, not every structure in these zones in Oklahoma was rated with the Fujita scale of the contour, but the occurrence of that level of damage was significant and much repeated. The Fujita scale rating may vary somewhat, but the average dollar loss throughout the contour may not change much when applied to multiple structures. For every structure that fares better than expected within a contour, another may fare worse.