Tornado Losses Avoided Through Hazard Mitigation

September 2011 **Joint Field Office, Hazard Mitigation, Oklahoma City, Oklahoma**

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FEMA

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Tushka, Oklahoma Community Safe Room

September 2011

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1.0 Executive Summary

In 2005 a Community Safe Room was completed in the Town of Tushka, Oklahoma. The Safe Room was funded partially by Federal (FEMA) funds and the remaining amount by State and local funds.

On Sunday April 14th, 2011 an EF3 tornado swept through Atoka County, Oklahoma and hit the Town of Tushka, Oklahoma. The National Weather Service (NWS) had provided a 59 minute advanced warning and this was enough time for people to seek shelter in the Tushka Safe Room, even if they lived miles away. The Tushka safe room was filled to capacity along with another community storm bunker that had been built in 1947. The EF3 tornado passed over the Safe Room and resulted in extensive damage to the Tushka community, the Tushka K-12 School and to homes and businesses in the surrounding area.

A family, a town, or a community impacted by a severe tornado event experiences extreme destruction, financial and emotional distress, often injuries and even loss of family members, friends or neighbors.

The Federal Emergency Management Agency (FEMA), working with State and local officials provide mitigation funding initiatives to offset the losses of such devastating events. The Tushka School Safe Room Mitigation Project was one of many Community Safe Room initiatives completed over the past decade in various communities in Oklahoma and throughout the Midwest "tornado alley" regions.

This tornado losses avoided study (LAS) examined the impact of this EF3 tornado event and determined that had the mitigation project (Tushka Safe Room) not been in place at the time of the event, there would have been many more injuries and losses of life.

The Tushka Community Safe Room sheltered approximately 350 people that would have had nowhere else to go had the shelter not been in place. We confirmed that at least 19 people were in the safe room whose homes were severely damaged, partially collapsed or totally destroyed (see Appendix A).

Avoided casualties and injuries are the only losses avoided for a tornado safe room and therefore a dollar amount must be determined for various injuries and even for the loss of life.

Using a very conservative methodology (see Section 1.2) the Oklahoma City Joint Field Office FEMA Mitigation Assessment Team (OKCMAT) determined that there were at least sixteen million nine hundred thousand dollars ($16,900,000) in losses avoided. This translates into fewer injuries and loss of life as a result of the mitigation project in place.

A Losses Avoided Ratio was also determined where any number greater than one represents a positive investment. A ratio of 2 would suggest that for every dollar invested in a mitigation project you avoid 2 dollars in potential losses. The Losses Avoided ratio for the Tushka Community Safe Room was 57, indicating our mitigation return on investment was well over 100 percent.

In summary, this Losses Avoid Study demonstrates that Federal, State and local funds used to construct Community Safe Rooms provides a cost effective long term mitigation measure that helps reduce injuries and loss of life during a severe tornado event.

1.1 Introduction

Tushka, Oklahoma Community Safe Room

On Sunday April 14, 2011 a series of storms moved north and east over southeastern Oklahoma out of which developed an EF3 tornado that tore through Atoka County and the Town of Tushka, Oklahoma. A tornado warning was issued for Atoka County by the National Weather Service at 6:15 PM and 59 minutes later at 7:14 PM the tornado touched down west of the Town of Tushka and moved toward town.

Fortunately, being Sunday, the schools and many of the businesses were closed; however, the tornado was extremely violent, contained multiple vortexes, averaged a mile wide and was moving toward the town. People west of town took shelter in a variety of ways; personal storm shelters; their neighbor's storm shelters; they huddled in the middle of their homes or in bathrooms; they drove away from the storm or headed into town to shelter in the Town's New Safe Room or the Tushka School's 1947 Storm Bunker. The tornado, ripped through homes, fields, the town, and directly over the two Tushka Community Shelters. Both shelters were completely filled with men, women, children, and local first responders, shoulder to shoulder.

Tushka School 1940's Storm Bunker

Thirty six minutes later the event was over, leaving hundreds of homes destroyed, the Tushka school in ruins, dozens injured and two dead.

Over the past 12 years the State of Oklahoma, various counties, communities, and individual homeowners, with the support of FEMA and the Oklahoma State Emergency Management Division, have invested over 20 Million dollars to design and install both individual and community safe rooms to provide shelter from extreme high wind events like the one described above. With the expenditure of these large amounts of public and private funds the question is often asked: How well are these mitigation initiatives working? Are we able to quantify the losses avoided as a result of our investment dollars and grant programs?

The April 24, 2011 Tushka tornado gives us the opportunity to measure the losses avoided as a result of the Mitigation Project (Tushka Storm Shelter) that was in place.

1.2 Methodology

We have focused our study on a community safe room (Tushka Storm Shelter) built in 2005 with both state, community and federal funding. This project was funded under FEMA's *Hazard Mitigation Grant Program* (HMGP) following several major tornado events, specifically, Presidentially Declared Disaster 1401. The *Hazard Mitigation Grant Program* is a part of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (The Stafford Act) and provides grants for states and communities to implement hazard mitigation measures after presidentially declared disasters. Hazard Mitigation is defined as a *sustained action taken to reduce or eliminate long-term risk to people and their property from hazards and their effects.* This Loss Avoidance Study (LAS) is intended to answer the question, "How much loss was avoided from a tornado event due to the completion of the safe room mitigation project?"

FEMA completed nine Loss Avoidance Studies for riverine flood hazard from 2001 to 2009. Mitigation projects for river flooding involve acquisition or elevation of flood prone properties. Homes may be purchased and removed from a flood prone area and replaced with buffer areas such as walking trails installed along the rivers' edge. Properties may be elevated 2'-6' or more in order to raise the property above the base flood elevation. In this way the property will no longer be at risk for future flooding and this provides a losses avoided situation.

Mitigation efforts for a tornado event are more problematic as the costs to construct or retrofit a residence or commercial facility to withstand an EF5 tornado (200+ MPH winds) are cost prohibitive. Because of this, the construction of tornado safe rooms is where the majority of FEMA tornado hazard mitigation funding is spent.

Tornado Damaged Tushka School

The losses avoided by the construction of a safe room (mitigation project) are determined by comparing damage (in human injury or loss of life) that would likely have been caused by the same event without the project in place (Mitigation Project Absent [MP_A]) with damage that actually occurred with the project in place (Mitigation Project Complete [MPc]). For example:

MP_A= What type of injuries or loss of life would have occurred had the safe room not been present? A dollarized value is placed on this mitigation project absent (MP_A) scenario.

MP_C= What type of injuries or loss of life actually occurred during the tornado event? Was there damage to the safe room? What was the cost of the safe room? A dollarized value is then placed on this mitigation project complete (MP_C) scenario.

The difference between the two scenarios is calculated to determine losses avoided in dollars as shown in the following equation:

L (A)= $ [MPA] – $ [MPC] where L(A)= Losses Avoided in Dollars

In order to calculate losses that were avoided due to the completion of the Tushka Community Safe Room Project it was necessary to obtain the following data:

- Methodology
- Warning response time for the tornado event
- A radius in miles around the safe room to be used for analysis
- Determination of Tornado Event Data and Area of Analysis
- Damage Inventory of buildings and occupants in the area of analysis
- Determination of potential death and injuries had a safe room not been present
- Actual Injuries and Fatalities within the area of analysis
- Actual Cost of Community Safe Room and Operation
- Number of Safe Room Occupants and Safe Room Operation Plan
- Calculation of Losses Avoided and Losses Avoided Ratio
- Executive Summary

1.3 Warning Response Time for the Tornado Event

The National Weather Service (NWS) issued a tornado warning on April 24, 2011 for Atoka County at 1815 (6:15 PM) central standard time (CST). Additional warnings were provided to the Tushka community as the result of tornado spotters throughout the County. The exact time of various tornado siren activations from the Tushka Fire Department were not recorded, however, the NWS official time of the tornado event began at 1914 (7:14 PM) CST.

The Warning Response Time as determined by the NWS data is calculated at fifty nine minutes according to the following formula: (19 x 60 + 14)- (18 x 60 + 15) = **59 minutes.**

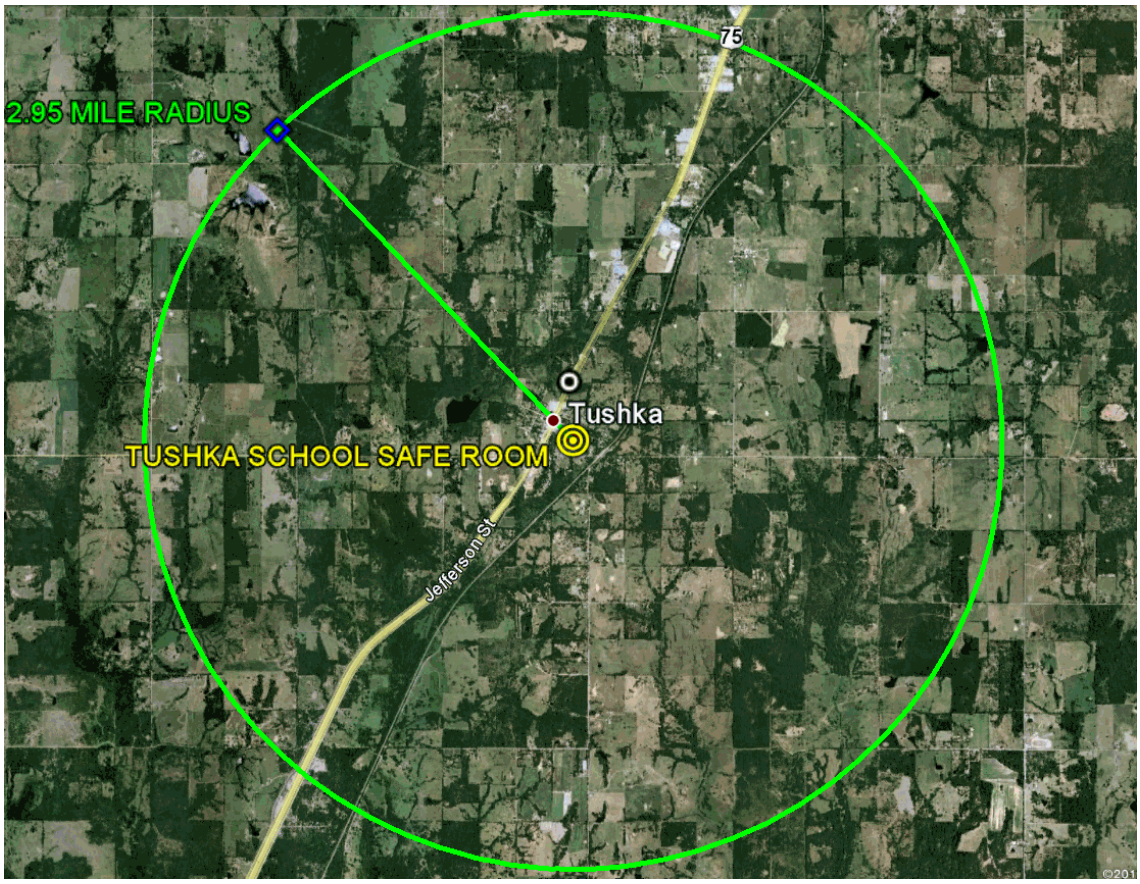
Inside of a FEMA Funded Safe Room in Newcastle, Oklahoma during the May 24th, 2011 Tornado Event

1.4 Radius in Miles around the Safe Room to be used for Analysis

The Losses Avoided Study (LAS) methodology requires that a *radius of analysis* be determined by the warning response time (59 minutes) multiplied by an average walking speed of 3 miles per hour. The radius of analysis was determined to be 2.95 miles using the following formula:

(59÷60)= 0.9833 X 3= **2.95 miles.**

Radius of Analysis



3" X 3" Steel Post Impaled into an Oak Tree In the Radius of Analysis

1.5 Determination of Tornado Event Data and Area of Analysis

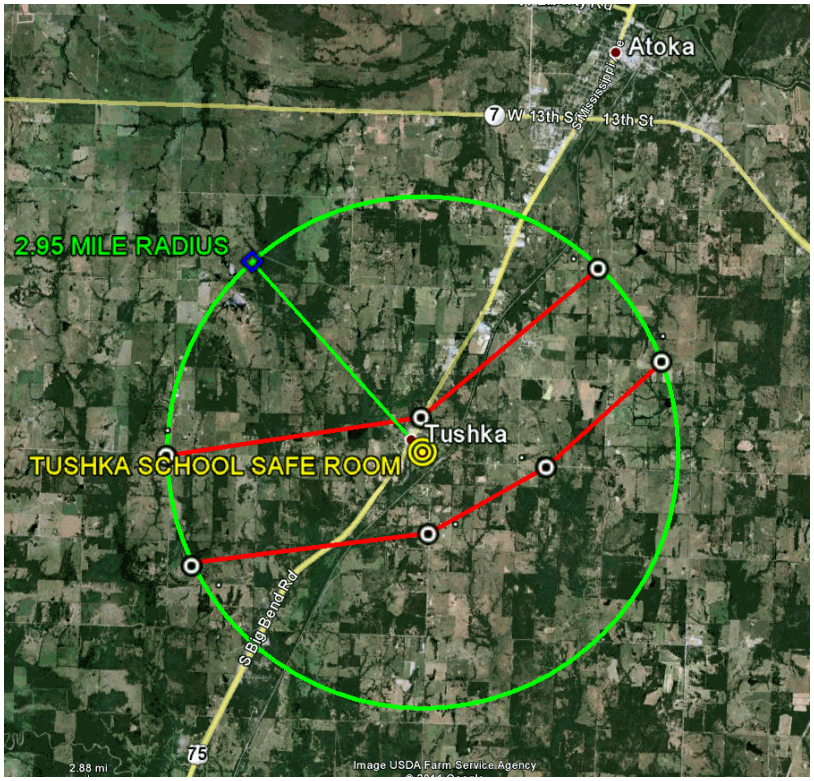
The LAS Methodology requires that we collect the following tornado event data as listed in the table below. We will then overlay the tornado track data as it passes through the radius of analysis and this area will become our ***area of analysis.*** The following data was obtained from the National Weather Service and field observations made by the OKCMAT.

TORNADO EVENT DATA

April 14, 2011 Atoka County, Tushka Tornado Event	
Category	***Data***
Event:	Tornado
Begin Date and Time:	4/14/2011 1914 Hours
Begin Location:	5 Miles WSW Tushka, OK
Begin LAT/LONG:	34.3115 W -96.24165 N
End Date and Time:	4/14/2011 1950 Hours
End Location:	3.5 Miles SE of Daisy, OK
End LAT/LONG:	34.48843 W -95.24165 N
Length	32 Miles Curving East to North East
Width:	1 Mile Average
Magnitude:	EF3
Fatalities:	2
Injuries:	59
Property Damage:	Not Determined
Crop Damage:	Not Determined

Table 1.1

Tornado Track through the Radius of Analysis



1.6 Actual Cost of Community Safe Room and Operation

The Tushka, Oklahoma Community Safe Room was completed in 2005 for a total cost of $ 287,218.00. The Federal share of this amount was $105,469.00 or approximately 37%. During the April 14th, 2011 EF3 tornado the shelter was packed shoulder to shoulder with men, women and children from both the Town of Tushka and from surrounding rural areas. The two bathrooms in the safe room were also packed with individuals seeking shelter from the storm. The Safe Room, built to FEMA 361 specifications, performed flawlessly with only superficial damage to the decorative metal siding. Additional safe room project data is listed in the follow table:

PROJECT DATA

Tushka Oklahoma Community Safe Room (TSS)	
Street Address:	101 SE 1st Street, Tushka, OK 74525
Latitude and Longitude:	N 34.32480 W-96.1687
Safe Room Size:	1075 SF
Date of Completion of Construction:	2005
Portion of Federal Costs of Construction:	$ 105,469.00
Portion of State/Community Costs:	$ 181,749.00
Costs of Maintenance/ Year Since Baseline:	$ 500/Yr x 5 Years = $2500.00
Total Cost of Safe Room:	287,218.00

Table 1.2

1.7 Tushka School 1947 Storm Bunker

In 1947 a storm bunker was completed next to the Tushka School. Like the Tushka Community Safe Room, this bunker was packed shoulder to shoulder and people were turned away as the shelter reached capacity and could not receive any more individuals. The Tushka Storm Bunker will reduce our Losses Avoided by the difference between the floor space of the two shelters. Additional Project data for the Tushka Storm Bunker is listed in the table below.

PROJECT DATA

Tushka School Storm Bunker (TSB)

Street Address:	204 S. Pecan St., Tushka, OK 74525
Latitude and Longitude:	N 34.3172 W-96.1657
Bunker Size:	552 SF
Date of Completion of Construction:	1947
Portion of Federal Costs of Construction:	None
Portion of State/Community Costs:	Unknown
Costs of Maintenance/ Year Since Baseline:	None
Total Cost of Safe Room:	Unknown

Table 1.3

1.8 Number of Safe Room and Storm Bunker Occupants

There was no formal accounting of the number of occupants that used the Safe Room or the Storm Bunker during the tornado event. Based upon the 1075 square feet of floor space for the safe room and a 3 square foot per person average we estimate that there were close to 350 people in the Community Safe Room and perhaps as many as 180 in the storm bunker for a total of 530 people in these two shelters. According to the U.S. Census Bureau there are 140 households in Tushka town proper with an average household size of 2.4 people for a total town population of approximately 336 people. It is assumed that a large portion of the Tushka population used the two shelters and that there were additionally a large number of people from the surrounding area of analysis. We determined during our interviews that at least 19 people were in the Tushka Safe Room whose homes were either severely damaged, totally collapsed or completely destroyed (see appendix A).

Our methodology to account for the additional storm bunker is to reduce our total losses avoided calculation by dividing the square footage of the storm bunker by the square footage of the Tushka Safe Room (552÷1075)= .51 or by 51%.

This .51 multiplier will be used in the calculation of losses avoided in the following section.

1.9 Damage Inventory of Buildings and Occupants

In order to determine the total cost of potential injuries and fatalities had the Safe Room not been present (MP_A) the Loss Avoidance Study (LAS) methodology requires that we collect a damage inventory of all properties within the area of analysis. The OKCMAT team made field observations of damaged properties and interviewed occupants of the properties using the following format:

(Sample) Inventory of Residential Homes in the Area of Analysis

SN	ST	DOD	NO	Lat/Long	SAD	IA	LDE
001	1,2 SF	Minor	2	005	Penn Carr Rd.	Y	PSS
002	MH	Moderate	1	006	Main St.	Y	TSB
003	1,2 FR	Minor	2.4	007	Boggy Depot Rd	N	AIR
004	1,2 SF	Severe PC	4	008	Boggy Depot Rd	Y	DA
005	1,2 SF	Total Collapse	3	009	Mockingbird Ln.	Y	SIR
006	MH	Minor	2.4	010	Penn Carr Rd.	N	AIR

Table 1.4

Appendix 1.1 has a listing of all structures that were inventoried in the area of analysis**.**

The codes used on our inventory as shown above are described as follows:

Structure Number (SN)
The Structure Number began with 001 and went forward with each successive property.

Structure Type (ST)
The structure type defined the Type of Building as:
1,2FR (1 and 2 Family Residence); MH (Mobile Home); MB (Metal Building System); SPB (Small Professional Building); SH (School); IB (Institutional Building)

Degree of Damage (DOD)
The Degree of Damage defined the damages in the following damage classes:
None; Minor; Moderate; Severe/Partial Collapse; Total Collapse; and Complete Destruction
These damage classes are described in the following chart:

Structure Damage Classes

Structure Damage Class	Description
No or Very Little Damage	-0-
Minor Damage	Includes broken windows and trees falling on structures
Moderate Damage	Portions of external walls beginning to fail, some internal damage
Severe Damage/Partial Collapse	Several Internal or external walls collapsed
Total Collapse	All internal and external walls collapsed
Complete Destruction	Slab blown clean

Table 1.5 Source: Wind Science and Engineering Center (2006)

Number of Occupants (NO)
The Number of Occupants was determined by a field interview with the occupant(s) or if no interview was possible we used current census data from the U.S. Census Bureau. The Data Set was 2005-2009 and we used the average household size for Tushka Town and Atoka County which was the same average of ***2.4 occupants per household.***

Latitude and Longitude (Lat/Lon)
The latitude and longitude measurements were made during our field observations and interviews. Each Lat/Long is associated with a Lat/Long number such as 024 or 125. The actual geographic coordinates are not included in this document but are available for research purposes from FEMA Region 6.

Street Address (SAD)
The street address will only list the street and not the physical address as many of these were had to find due to mail boxes and house numbers being damaged or lost during the tornado event.

Interview Available (IA)
We performed our field data collection several months after the tornado event and as a result many of the damaged structures were re-inhabited and we were able to conduct an interview. In the IA column of our data collection there will be either a "Y" for "*yes we conducted an interview*" or a "N" for "*we did not conduct an interview*.

Location of Occupants During the Event (LDE)
If we were able to conduct an interview with a property owner or neighbor we asked about the degree of damage and where they were during the event. We used to following codes to describe where the occupants were during the event:

DA= Drive Away from the Storm: The occupants got in their car and drove away from the storm
PSS= Personal Storm Shelter: Occupant had their own personal storm shelter
NSS= Neighbor's Storm Shelter: Evacuated to a Neighbor's Shelter
TSS= Tuska Storm Shelter: The subject of our Losses Avoided Study
SIR= Sheltered in their Residence: Usually the center hallway or a bathroom

TSB= Tuska Storm Bunker: Existing Storm Bunker built prior to the Tuska Storm Shelter
AIR= Assumed in Residence: If we were unable to interview the occupants.

If the occupants had driven away from the storm (DA), had a personal storm shelter (PSS) or evacuated to a neighbor's storm shelter (NSS) we did not include them in our losses avoided calculations. This methodology provides a more accurate LAS.

The inventory of structures and interviews with occupants resulted in the following data:

INVENTORY OF STRUCTURES

Description		***Total Number***	***Percentage of Total***
Total number of structures Inventoried		185	100%
Total Number of Interviews		94	50.8%
1,2 Single Family Homes (1,2 SF)		138	74.6%
Mobile or Modular Homes (MH)		39	21.1%
R/V Parks (RV)		2	1.1%
Metal Building Systems (MBS)		5	2.7%
Small Professional Buildings (SPB)		0	0%
Schools (K-12 SH)		1	.5%
Institutional Buildings (IB)		0	0%
Drive Away from the Storm (DA)	Number of Households	11	6.2%*
Personal Storm Shelter (PSS)	Number of Households	15	8.5%*
Neighbor's Storm Shelter (NSS)	Number of Households	9	5.1%*
Tushka Storm Shelter	Number of Households	20	11.3%*
Sheltered in Residence	Number of Households	40	22.6%*
Tushka Storm Bunker	Number of Households	4	2.3%*
Assumed in Residence	Number of Households	78	44%*
*Percentages from 177 households (commercial buildings not included)			

Table 1.6

The above ***Inventory of Structures*** (Table 1.4) shows that we were able to interview 50.8% of the individuals that occupied the structures we inventoried. The interview provides more specific and accurate data relating to the number of occupants in the structure as well as the location of the occupants during the tornado event.

It's significant that even with a 59 minute warning time over 66% of the occupants choose to shelter in their residence (44% AIR + 22.6% SIR). During the interviews it was mentioned that there had been a number of warnings earlier in the month and some residents were becoming complacent to the warnings.

Nearly 14% used storm shelters that were near their homes- either their own shelter or their neighbor's shelter. We found this to be especially true of those who lived in the surrounding rural areas.

13.6% of those interviewed used either the Tushka Safe Room or the old Storm Bunker.
The remaining occupants (6.2%) of those we interviewed choose to drive away (or out run) the storm.

1.10 Determination of Potential Injuries and Death

The LAS methodology determines the potential for injuries and death based upon the degree of damage of the structure and the number of occupants. We used the injury and casualty Table 1.7 for all of the homes that were in our area of analysis.

Injury and Casualty Table for Residential Homes

Structure Damage Class	Self Treat %	Treat & Release %	Hospitalized %	Fatal %
Minor	5	5	0	0
Moderate	10	10	5	0
Severe/Partial Collapse	15	10	5	2.5
Total Collapse	15	15	10	5
Complete Destruction	5	5	15	25
*Source: FEMA (2009b)**				

Table 1.7

**Oklahoma City JFO Mitigation Assessment Team reduced the percentages in the Tornado Wind Methodology Report by half based on field observations and interviews with occupants. This adjustment results in a more conservative estimate of losses avoided.*

The Federal Aviation Administration (FAA) has determined a Cost of Injury and Casualty Module that determines a dollar value for various injury severity levels and death. Our methodology will use this module as shown below:

Cost of Injury and Casualty Values Used in the BCA Tornado Module

Injury Severity Level	AIS Category	WTP Value
Self Treat	1	$ 12,000
Treat and Release	1,2	$ 90,000
Hospitalized	3,4,5	$ 1,088,000
Fatal	5,6	$ 5,800,000

Table 1.8

The FAA has designated Abbreviated Injury Severity (AIS) codes for six levels of injury. Our LAS methodology has abbreviated this further to only four Injury Severity Levels as listed above.

Each injury severity level has an associated dollar amount. This is the willingness to pay (WTP) value used to calculate losses from loss of life or injury. The WTP approach estimates the amounts that individuals are prepared to pay to reduce risks to their lives or alternatively- amounts accepted as compensation for bearing increased risks or for being injured in an accident (such as a plane crash).

In order to calculate our mitigation project absent values we used the percentages in table 1.7 and the dollar values in table 1.8. We will use the six sample properties below to demonstrate our methodology.

(Sample) Inventory of Residential Homes in the Area of Analysis

SN	ST	DOD	NO	Lat/Long	SAD	IA	LDE
001	1,2 SF	Minor	2	005	Penn Carr Rd.	Y	PSS
002	MH	Moderate	1	006	Main St.	Y	TSB
003	1,2 FR	Minor	2.4	007	Boggy Depot Rd	N	AIR
004	1,2 SF	Severe PC	4	008	Boggy Depot Rd	Y	DA
005	1,2 SF	Total Collapse	3	009	Mockingbird Ln.	Y	TSS
006	MH	Minor	2.4	010	Penn Carr Rd.	N	AIR

Structure number 001 had *minor* damage and the two occupants utilized their personal storm shelter. Since they would have used their personal shelter regardless of the mitigation project completed, we did not include them in our losses avoided calculation.

Structure number 002 had ***moderate*** damage and one occupant evacuated to the Tushka Storm Bunker (TSB). We included them in our calculations as we intend to reduce our (final) losses avoided number by the 51% difference in the size of the two shelters (see section 1.10). The formula is as follows:

1 (occupant) x 10% self treat (table 1.5) x $12,000 (Table 1.6) =	$ 1,200.00
1 (occupant) x 10% treat & release (table 1.5)x $ 90,000 (Table 1.6)=	$ 9,000.00
1 (occupant) x 5% hospitalized (table 1.5) x $1,088,000.00 (Table 1.6)=	$ 54,400.00
Total Losses for Structure Number 002:	***$ 64,600.00***

Structure Number 003 had ***minor*** damage and 2.4 occupants (Census Bureau data) and no interview was available. Our methodology is to assume they were in the residence at the time of the event (AIR).

2.4 (occupants) x 5% self treat (Table 1.5) x $12,000 (Table 1.6)=	$ 600.00
2.4 (occupants) x 5% treat and release (Table 1.5) x $90,000 (Table 1.6)=	$ 4,500.00
Total Losses for Structure Number 003=	***$ 5,100.00***

Structure Number 004 was a severe partial collapse but during our interview we were informed that the 4 occupants had gotten in their car and drove away from the storm. Since they drove away from the storm and did not go to the Tushka Safe Room we can assume the same behavior for the mitigation project absent and we do not include them in the LAS calculations.

Structure Number 005 was a Total Collapse with three occupants that went to the Tushka Storm Shelter (TSS). The LAS methodology requires that we still calculate these losses as we are trying to determine the Mitigation Project Absent scenario. This means that we assume they had to shelter in their home had the Tushka Storm Shelter not been in place.

The calculations for the three occupants are listed below.

3 (occupants) x 15% self treat (Table 1.5) x $12,000 (Table 1.6)=	$ 5,400.00
3 (occupants) x 15% treat & release(Table 1.5) x $90,000 (Table 1.6)=	$ 40,500.00
3 (occupants) x 10% hospitalized (Table 1.5) x $1,088,000 (Table 1.6)=	$ 326,400.00
3 (occupants) x 5% fatal(Table 1.5) x $ 5,800,000 (Table 1.6)=	$ 870,000.00
Total Losses for Structure Number 005=	***$ 1,242,300.00***

Structure Number 006 had minor damages with 2.4 occupants assumed in the residence (AIR).

2.4 (occupants) x 5% self treat (Table 1.5) x $12,000 (Table 1.6)=	$ 1,440.00
2.4 (occupants) x 5% treat and release (Table 1.5) x $90,000 (Table 1.6)=	$ 10,800.00
Total Losses for Structure Number 006=	***$ 12,240.00***

The final calculations for the (sample) mitigation project absent losses are as follows:

(Sample) Inventory of Residential Homes in the Area of Analysis

SN	ST	DOD	NO	LDE	DAMAGES
001	1,2 SF	Minor	2	PSS	-0-
002	MH	Moderate	1	TSB	$ 64,600
003	1,2 SF	Minor	2.4	AIR	$ 5,100
004	1,2 SF	Severe P/C	4	DA	-0-
005	1,2 SF	Total Collapse	3	SIR	$ 1,242,300
006	MH	Minor	2.4	AIR	$ 12,240
		Total:			***$ 1,321,240.00***

$ 1,321,240.00 X .51 (TSB Multiplier) provides the MP_A (sample) amount to: **$ 673,832.00**

The Total Residential Property Damage and Injury Costs are listed in Table 1.9 below. These totals are derived from the total residential properties (177) inventoried in Appendix A.

Total Residential Property Damage and Injury Costs:

Degree of Damage	Total Costs	Total Occupants
Total of Minor Damages	845,580.00	165.8
Total of Moderate Damages	3,669,280	56.8
Total of Severe/Partial Collapse:	20,095,120	95.6
Total of Total Collapse:	22,030,120	53.2
Total of Complete Destruction:	15,212,020	9.4
Total Cost of Injuries:	***61,852,120***	***Total Occupants: 380.8***

Table: 1-9

Total of Commercial Property Damage and Injury Costs:

Degree of Damage	Total Costs:	Total Occupants
RV Park Minor Damages	$ 10,200	2
RV Park Total Collapse	3,312,800	8
K-12 School Severe Damage	-0-	485*
MBS Severe Damage	-0-	65*
MBS Minor Damages	-0-	10*
Total Cost of Injuries:	***$ 3,323,000.00***	***10***

Table 1.10

***** Fortunately, the tornado event took place on a Sunday evening. As a result the school and commercial buildings were unoccupied at that time. The normal number of occupants during the work and school week are listed. The Metal Building System with 65 employees terminated their Sunday shift at 3:00 PM, only hours before the EF3 Tornado severely damaged the structure. ***The losses would have been much higher had this tornado hit during school and work hours.***

The final calculation for the Mitigation Project Absent (MP_A) is as follows:

Total Cost of Residential Injuries: $ 61,852,120.00
Total Cost of Commercial Injuries: $ 3,323,000.00 (Only from the RV Parks)
Total Cost of all Injuries: ***$ 65,175,120.00***
Storm Bunker Multiplier: ***$ 65,175,120.00 X .51 = $ 33,239,311.00***

Total Cost of Mitigation Project Absent (MP_A): ***$ 33,239,311.00***

1.11 Actual Injuries and Fatalities within the Area of Analysis

The OKCMAT team met with Paul Reano, Chief Executive Officer of the Atoka County Medical Center. All injuries resulting from the Sunday, April 14th 2011 tornado event were sent to the Atoka Medical Center which is 5 miles north of the Town of Tushka. Mr Reano offered to provide the data we needed as long as the names were kept confidential. No personally identifiable information was required for this study.

Injuries and Fatalities in the Area of Analysis

Type of Injuries	Number of Injuries	Cost of Injuries
Minor Injuries	54	648,000.00
Moderate Injuries	2	180,000.00
Serious Injuries	-0-	-0-
Severe Injuries	-0-	-0-
Critical Injuries	1	4,423,000.00
Fatal Injuries	2	11,600,000.00
Total Injuries and Fatalities	***Total Number: 59***	***Total Cost: $ 16,851,000.00***

Table 1.11

1.12 Calculation of Losses Avoided and Losses Avoided Ratio

Avoided casualties and injuries are the only losses avoided for a tornado safe room. The number of people who would have been injured or killed in the MPA scenario is determined. Then the actual number of people who were able to reach the safe room in the tornado event and the performance of the safe room in protecting those people are evaluated in the MPC scenario along with the costs associated with the safe room.

A. Total Cost of Mitigation Project Complete (MP_C) includes:

Total Cost of Tushka Community Safe Room:	$ 287,218.00
Total Cost of Repairs to Tushka Community Safe Room:	$ 4,500.00
Total Cost of Maintenance for Tushka Community Safe Room:	$ 2,500.00
Actual Cost of Injuries and Fatalities for Tornado Event:	$ 16,851,000
Total Cost of Mitigation Project Complete:	$ 16,336,218.00

B. Total Cost of Mitigation Project Absent (MP_A):

Calculations taken from Section 1.9	$ 33,239,311.00

C. Total Losses Avoided

The losses avoided calculation simply subtracts the MP_C amount from the MP_A amount as follows:

L_A (Losses Avoided) = MP_A- MP_C

L_A= ($ 33,239,311.00) – ($ 16,336,218.00)= $ 16,903,093.00

The losses avoided amount ($ 16,903,093.00) is the dollarized value of the injuries avoided and loss of life avoided by the presence of the completed Tushka Community Safe Room.

D. The Losses Avoided Ratio

The losses avoided ratio (L_R) is calculated by comparing the Losses Avoided (L_A) to the net present value of the cost of the project to date. An L_R of greater than one indicates that project benefits have exceeded project costs and the mitigation activity is determined to be cost effective and performing successfully. A losses avoided ratio of 2 would indicate a 100% mitigation project return on investment.

The Losses Avoided Ratio (L_R) is calculated as follows: $L_R = L_A \div P_C$ Where: P_C = Project Costs

16,903,093.00 ÷ 294,218.00 = 57 (losses avoided ratio)

This roughly translates into the statement that for every dollar spent on a safe room mitigation project you avoid 57 dollars in losses (of life and injuries).

In summary, this Losses Avoid Study demonstrates that Federal, State and local funds used to construct Community Safe Rooms provides a cost effective long term mitigation measure that helps reduce injuries and loss of life during a severe tornado event.

Appendix A

Inventory of Properties in Area of Analysis

Inventory of Properties in Area of Analysis

The Oklahoma City Hazard Mitigation Assessment Team (OKCMAT) collected the following data in the field using GPS equipment, personal interviews and site visits. Interviews were conducted with the Tushka Chief of Police, the Tushka City Manager, the Tushka School Superintendent, the Atoka County Commissioner and the Chief Executive Officer of Atoka County Medical Center.

Commercial damage was limited to a number of Recreational Vehicles (RV) located in Commercial RV Parks and much of the data concerning the RV damage was obtained by the Park Managers.

The other structures on the following *Commercial Property Damage Chart* were commercial businesses or a school, and fortunately, both that were closed on Sunday, the day of the tornado event.

In the last column we have a yellow color block to indicate that the occupants listed on this line had used the Tushka Community Safe Room (TSS). The purple block indicates that the occupants were in a personal storm shelter (PSS); a neighbor's storm shelter (NSS) or drove away from the storm (DA). In this case we deducted these occupants from the total number of occupants to provide for a more accurate Losses Avoided Study (LAS).

Commercial Property Damage and Injury Costs

SN	ST	DOD	NO	Lat/Long	SAD	IA	LDE
201	RV	TC	1	56	Boggy Depot Rd.	Y	TSS
202	RV	TC	2	56	Boggy Depot Rd.	Y	TSB
203	RV	TC	1	56	Boggy Depot Rd.	Y	TSS
204	RV	TC	2	56	Boggy Depot Rd.	Y	TSB
205	RV	TC	2	56	Boggy Depot Rd.	Y	TSS
206	K-12 SH	Severe	485	153	Pecan St.	Y	DA
207	MBS	Severe	65	200	Main Highway	Y	DA
208	MBS	Minor	8	200	Main Highway	N	DA
209	MBS	Minor	2	141	Main Highway	Y	DA
210	RV	Minor	2	140	Main Highway	Y	TSS
		Total NO:	570				***Total Deduct:*** 560
	Total Occupancy:		10		***Total Injury Costs:***		$3,317,900

Residential Property with Minor Damages

SN	ST	DOD	NO	Lat/Lon	SAD	IA	LDE
3	1,2 SF	Minor	1	13	Carr Penn Rd	Y	PSS
12	1,2 SF	Minor	1	19	Carr Penn Rd	Y	PSS
14	1,2 SF	Minor	6	21	Carr Penn Rd	Y	NSS
15	1,2 SF	Minor	3	22		Y	SIR
20	1,2 SF	Minor	4	26		Y	SIR
22	1,2 SF	Minor	2.4	28		N	AIR
25	1,2 SF	Minor	1	32	Boggy Depot	Y	PSS
26	1,2 SF	Minor	2.4	33	Boggy Depot	N	AIR
27	1,2 SF	Minor	2.4	34	Boggy Depot	N	AIR
39	1,2 SF	Minor	2.4	47	Hummingbird Rd.	N	AIR
40	1,2 SF	Minor	2.4	48	Hummingbird Rd.	N	AIR
42	1,2 SF	Minor	2.4	50		N	AIR
43	1,2 SF	Minor	2.4	51		N	AIR
45	1,2 SF	Minor	4	53	Boggy Depot	Y	SIR
46	1,2 SF	Minor	4	54		Y	TSS
48	1,2 SF	Minor	2	58		Y	DA
49	1,2 SF	Minor	2	59		Y	DA
53	1,2 SF	Minor	2	65	Meadow Rd.	Y	SIR
54	MH	Minor	3	66	S. Gin Rd	Y	SIR
55	1,2 SF	Minor	1	67		Y	DA
63	1,2 SF	Minor	2.4	76		N	AIR
64	1,2 SF	Minor	1	77		Y	SIR
67	1,2 SF	Minor	2.4	80		N	AIR
76	1,2 SF	Minor	2.4	89		N	AIR
87	1,2 SF	Minor	2	100	Oklahoma St.	Y	SIR
88	1,2 SF	Minor	4	101	Oklahoma St.	Y	SIR
89	1,2 SF	Minor	4	102	Oklahoma St.	Y	SIR
90	MH	Minor	2.4	103		N	PSS
93	MH	Minor	2.4	106	1st Street	N	AIR
94	MH	Minor	2.4	107	1st Street	N	AIR
96	1,2 SF	Minor	3	109	N. Hickory St.	Y	SIR
98	MH	Minor	2.4	111	N. Hickory St.	N	AIR
99	1,2 SF	Minor	6	112	N. Hickory St.	Y	SIR
100	1,2 SF	Minor	3	113	Main St.	Y	TSS

101	1,2 SF	Minor	3	114	Main St.	Y	TSS
103	1,2 SF	Minor	2.4	116	Pecan St.	N	AIR
104	1,2 SF	Minor	2.4	117	Pecan St.	N	AIR
105	1,2 SF	Minor	2.4	118	Pecan St.	N	AIR
106	1,2 SF	Minor	1	119	Main St.	Y	TSS
107	1,2 SF	Minor	2.4	120	Pecan St.	N	AIR
108	1,2 SF	Minor	2.4	121	Pecan St.	N	AIR
109	MH	Minor	2.4	122	Pecan St.	N	AIR
110	1,2 SF	Minor	2.4	123	Pecan St.	N	AIR
111	1,2 SF	Minor	2.4	125	Pecan St.	N	AIR
112	1,2 SF	Minor	2.4	126	N. Second St.	N	AIR
113	MH	Minor	2.4	127	N. Second St.	N	AIR
114	1,2 SF	Minor	2.4	128	N. Second St.	N	AIR
115	1,2 SF	Minor	2.4	129	N. Second St.	N	AIR
117	1,2 SF	Minor	2.4	132	1st Street	N	AIR
118	1,2 SF	Minor	2.4	133	1st Street	N	AIR
119	1,2 SF	Minor	3	134	1st Street	Y	SIR
120	1,2 SF	Minor	2	135	1st Street	Y	TSS
121	1,2 SF	Minor	2.4	136	1st Street	N	AIR
122	1,2 SF	Minor	2.4	137	1st Street	N	AIR
123	1,2 SF	Minor	2.4	138	1st Street	N	AIR
124	1,2 SF	Minor	2.4	139	1st Street	N	AIR
127	1,2 SF	Minor	3	144	Pool Rd.	Y	TSB
128	1,2 SF	Minor	4	145	Pool Rd.	Y	SIR
129	1,2 SF	Minor	4	146	Pool Rd.	Y	TSS
131	MH	Minor	2.4	148	Pool Rd.	N	AIR
140	1,2 SF	Minor	1	158	Katy Rd.	Y	SIR
143	1,2 SF	Minor	2	161	Katy Rd.	Y	SIR
144	1,2 SF	Minor	3	162	Katy Rd.	Y	SIR
145	1,2 SF	Minor	2.4	163	Katy Rd.	N	AIR
146	1,2 SF	Minor	2.4	164	Katy Rd.	N	AIR
147	1,2 SF	Minor	2.4	165	Katy Rd.	N	AIR
162	1,2 SF	Minor	5	181	Robin Rd.	Y	SIR
164	1,2 SF	Minor	3	183	Boggy Depot	Y	TSS
169	1,2 SF	Minor	2.4	188	Boggy Depot	N	AIR
173	1,2 SF	Minor	2.4	192	Mungle Rd.	N	AIR
177	MH	Minor	2.4	196	Mungle Rd.	N	PSS
							Deduct: 18.8
	Total Occupants:		165.8		***Total Injury Costs:***		$ 845,580

Residential Property with Moderate Damages

SN	ST	DOD	NO	Lat/Lon	SAD	IA	LDE
2	1,2 SF	Moderate	2	12	Carr Penn Rd.	Y	SIR
11	1,2 SF	Moderate	4	18	Carr Penn Rd.	Y	TSS
31	1,2 SF	Moderate	8	38	Mockingbird Rd.	Y	DA
32	1,2 SF	Moderate	2	39	Mockingbird Rd.	Y	PSS
33	1,2 SF	Moderate	2	40	Mockingbird Rd.	Y	PSS
36	1,2 SF	Moderate	3	43	Mockingbird Rd.	Y	SIR
41	MH	Moderate	2.4	49		N	AIR
47	1,2 SF	Moderate	2	57		Y	PSS
56	1,2 SF	Moderate	2.4	68		N	AIR
70	1,2 SF	Moderate	1	83	Pool Dr.	Y	DA
71	1,2 SF	Moderate	3	84	Pool Dr.	Y	TSS
72	1,2 SF	Moderate	3	85	Pool Dr.	Y	TSS
74	1,2 SF	Moderate	2.4	87	Katy Rd.	N	AIR
80	1,2 SF	Moderate	2.4	93	Oklahoma Rd.	N	AIR
84	MH	Moderate	2.4	97	Oklahoma Rd.	N	AIR
92	1,2 SF	Moderate	2.4	105	1st Street	N	AIR
95	1,2 SF	Moderate	2.4	108	1st Street	N	AIR
125	1,2 SF	Moderate	1	142	1st Street	Y	TSS
126	1,2 SF	Moderate	2	143	1st Street	Y	TSS
136	1,2 SF	Moderate	2	154	Katy Rd.	Y	SIR
141	1,2 SF	Moderate	2.4	159	Katy Rd.	N	AIR
142	1,2 SF	Moderate	2.4	160	Katy Rd.	N	AIR
148	1,2 SF	Moderate	2.4	166	Katy Rd.	N	AIR
149	1,2 SF	Moderate	1	167	Katy Rd.	Y	SIR
150	1,2 SF	Moderate	3	168	Katy Rd.	Y	SIR
159	1,2 SF	Moderate	2	178	Boggy Depot Rd.	Y	SIR
166	1,2 SF	Moderate	2.4	185	Boggy Depot Rd.	N	AIR
170	MH	Moderate	2.4	189	Boggy Depot Rd.	N	AIR
174	1,2 SF	Moderate	1	193	Mungle Rd.	Y	PSS
176	1,2 SF	Moderate	2	195	Mungle Rd.	Y	TSS
							Deduct: 16
	Total Occupants:		56.8		***Total Injury Costs:***		$ 3,669,280

Residential Property with Severe/Partial Collapse Damage

SN	ST	DOD	NO	Lat/Lon	SAD	IA	LDE
28	1,2 SF	Severe	2	35	Boggy Depot Rd.	Y	SIR
29	1,2 SF	Severe	2.4	36	Boggy Depot Rd.	N	AIR
37	1,2 SF	Severe	2	45	Mockingbird Rd.	Y	SIR
38	1,2 SF	Severe	2	46	Mockingbird Rd.	Y	DA
51	1,2 SF	Severe	4	61		Y	SIR
52	1,2 SF	Severe	8	64	Meadow Rd.	Y	SIR
58	1,2 SF	Severe	1	70		Y	SIR
59	1,2 SF	Severe	5	71		Y	PSS
60	1,2 SF	Severe	2	72		Y	PSS
62	1,2 SF	Severe	4	74		Y	PSS
65	MH	Severe	2.4	78		N	AIR
75	1,2 SF	Severe	2.4	88	Katy Rd.	N	AIR
77	MH	Severe	2.4	90	Main St.	N	AIR
78	MH	Severe	2.4	91	Main St.	N	AIR
79	MH	Severe	2.4	92	Main St.	N	AIR
81	1,2 SF	Severe	2.4	94	Oklahoma Rd.	N	AIR
82	1,2 SF	Severe	3	95	1st Street	Y	TSS
85	MH	Severe	2.4	98	Oklahoma Rd.	N	AIR
86	MH	Severe	1	99	1st Street	Y	TSS
91	1,2 SF	Severe	1	104	1st Street	Y	SIR
97	1,2 SF	Severe	2.4	110	N. Hickory	N	AIR
102	1,2 SF	Severe	1	115	Main St.	Y	SIR
116	1,2 SF	Severe	2.4	131	N. Jefferson	N	AIR
132	MH	Severe	2.4	149	Pool Rd.	N	AIR
134	1,2 SF	Severe	2.4	151	Pool Rd.	N	AIR
152	MH	Severe	2.4	170	Katy Rd.	N	AIR
154	MH	Severe	2.4	173	Boggy Depot Rd.	N	AIR
155	MH	Severe	2.4	174	Boggy Depot Rd.	N	AIR
157	MH	Severe	2.4	176	Boggy Depot Rd.	N	AIR
160	1,2 SF	Severe	3	179	Robin Rd.	Y	SIR
161	MH	Severe	3	180	Robin Rd.	Y	TSB
163	1,2 SF	Severe	3	182	Robin Rd.	Y	SIR

167	1,2 SF	Severe	7	186	Boggy Depot Rd.	Y	SIR
171	1,2 SF	Severe	7	190	Boggy Depot Rd.	Y	TSB
178	MH	Severe	2.4	197	Milk Lane	N	AIR
179	1,2 SF	Severe	2.4	198	Boggy Depot Rd.	N	AIR
180	MH	Severe	2.4	199	Boggy Depot Rd.	N	AIR
							Deduct: 9
	Total Occupancy:		95.6		***Total Injury Costs:***		$ 20,095,120

Residential Property with Total Collapse

SN	ST	DOD	NO	Lat/Lon	SAD	IA	LDE
1	MH	T. Collapse	2.4	11	Carr Penn Rd.	N	AIR
4	1,2 SF	T. Collapse	4	14	Carr Penn Rd.	Y	PSS
5	1,2 SF	T. Collapse	3	15	Carr Penn Rd.	Y	DA
6	MH	T. Collapse	5	16	Carr Penn Rd.	Y	PSS
7	1,2 SF	T. Collapse	4	(same Lot) 17	Carr Penn Rd.	Y	SIR
8	1,2 SF	T. Collapse	3	(same Lot) 17	Carr Penn Rd.	Y	SIR
9	MH	T. Collapse	3	(same Lot) 17	Carr Penn Rd.	Y	SIR
10	1,2 SF	T. Collapse	2	(same Lot) 17	Carr Penn Rd.	Y	NSS
16	MH	T. Collapse	4	23	N3830 Road	Y	NSS
17	1,2 SF	T. Collapse	2	(Same Lot) 23	N3830 Road	Y	NSS
18	1,2 SF	T. Collapse	4	24	N3830 Road	Y	NSS
19	1,2 SF	T. Collapse	6	25		Y	SIR
30	1,2 SF	T. Collapse	2.4	37	Boggy Depot Rd.	N	AIR
34	1,2 SF	T. Collapse	2	41	Mockingbird Rd.	Y	TSS
44	1,2 SF	T. Collapse	2.4	52	Boggy Depot Rd.	N	AIR
50	1,2 SF	T. Collapse	2	60		Y	DA
57	1,2 SF	T. Collapse	2.4	69		N	AIR
68	MH	T. Collapse	2	81	Pool Rd.	Y	TSS
69	MH	T. Collapse	2	82	Pool Rd.	Y	TSS
73	1,2 SF	T. Collapse	2.4	86		N	AIR
130	MH	T. Collapse	1	147	Pool Rd.	Y	SIR
133	MH	T. Collapse	2.4	150	Pool Rd.	N	AIR
135	1,2 SF	T. Collapse	5	152	Pool Rd.	Y	TSB
137	1,2 SF	T. Collapse	2	155	Boggy Depot Rd.	Y	PSS
138	1,2 SF	T. Collapse	4	156	Boggy Depot Rd.	Y	NSS
139	1,2 SF	T. Collapse	1	157	Boggy Depot Rd.	Y	NSS
151	1,2 SF	T. Collapse	2.4	169	Katy Rd.	N	AIR
153	1,2 SF	T. Collapse	2.4	172	Boggy Depot Rd.	N	AIR
156	MH	T. Collapse	6	175	Boggy Depot Rd.	Y	TSS
158	MH	T. Collapse	5	177	Boggy Depot Rd.	Y	NSS
							Deduct: 38
	Total Occupancy		53.2		***Total Injury Costs:***		$ 22,030,120

Residential Property with Complete Destruction

SN	ST	DOD	NO	Lat/Long	SAD	IA	LDE
21	MH	C.D.	3	27	Boggy Depot Rd.	Y	SIR
23	1,2 SF	C.D.	1	30	Boggy Depot Rd.	Y	SIR
35	MH	C.D.	2.4	42	Mockingbird Ln.	N	AIR
66	1,2 SF	C.D.	4	79	Milk Lane	Y	DA
83	MH	C.D.	3	96	Oklahoma Ave	Y	TSS
165	1,2 SF	C.D.	4	184	Boggy Depot Rd.	Y	NSS
168	1,2 SF	C.D.	3	187	Boggy Depot Rd.	Y	DA
175	MH	C.D.	1	194	Mungle Rd.	Y	DA
							Deduct: 12
	Total Occupancy:		9.4		***Total Injury Costs:***		$ 15,212,020

The following table is a summary of the Residential Properties Inventoried above.

Total Residential Property Damage and Injury Costs:

Degree of Damage	Total Costs	Total Occupants
Total of Minor Damages	845,580.00	165.8
Total of Moderate Damages	3,669,280.00	56.8
Total of Severe/Partial Collapse:	20,095,120	95.6
Total of Total Collapse:	22,030,,120	53.2
Total of Complete Destruction:	15,212,020	9.4
Total Cost of Injuries:	***61,852,120.00***	***Total Occupants: 380.8***

Table: 1-9

Appendix B

References and Resources

Atoka County, Oklahoma Tornadoes (1875-2010)

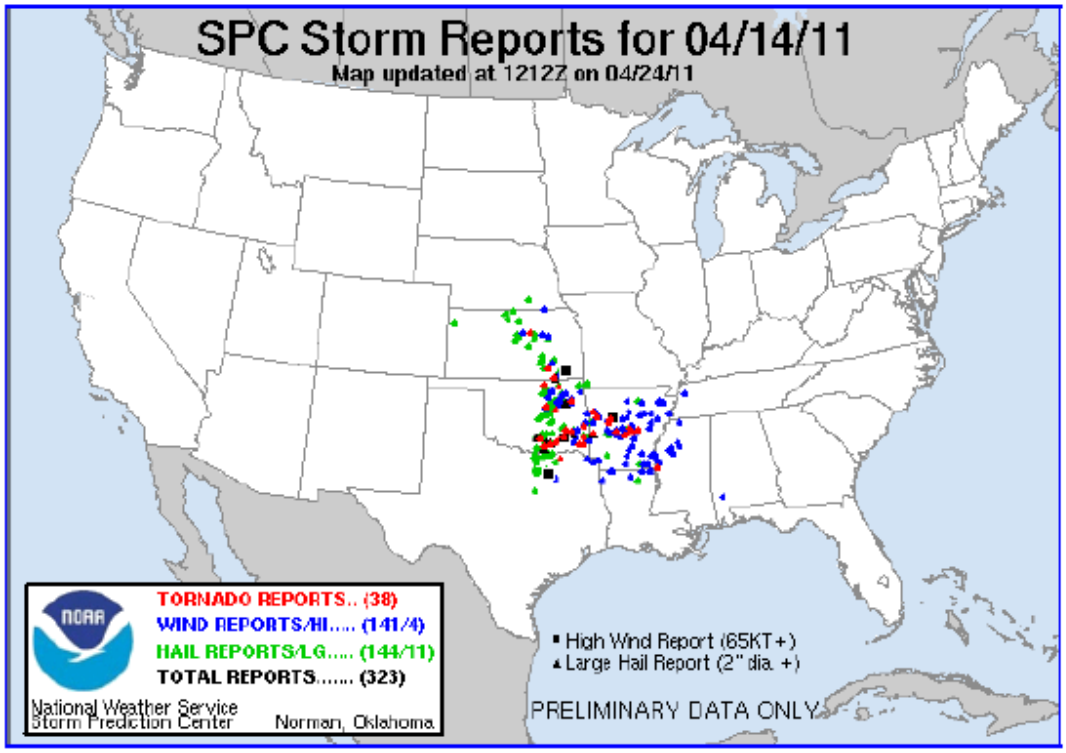
SPC ID #	Date	Time (CST)	Path Length (miles)	Path Width (yards)	F-Scale	Killed	Injured	County	Path
26-1/2	04/23/1926	1627		300		4	9	Johnston/ Atoka	2 NW Fillmore - E of Coleman
	04/13/1945	2130	3	440		0	10	Atoka	1 W Farris
	05/03/1948	1230	55	750		0	3	Murray/ Johnston/ Atoka	4 S Sulphur - 3 SW Mill Creek - near Caney
53-14	04/14/1953	2300	0.3	25	F2	0	0	Atoka	Near Tushka
56-23	04/28/1956	2200	28	300	F2	0	0	Bryan/ Atoka/ Pushmataha	Near Matoy - Antlers
66-8	04/27/1966	1900	10	300	F4	0	2	Johnston/ Atoka	4 NW Fillmore- 3 E Coleman
68-6	04/19/1968	1215	5	150	F1	0	3	Atoka	N of Farris - ~4 SE Farris
71-4	03/12/1971	1910	n/a	n/a	F1	0	0	Atoka	3 E Atoka
72-8	04/20/1972	2010	0.1	10	F1	0	0	Atoka	Stringtown
74-17	06/06/1974	2130	4	100	F2	0	0	Atoka	8 SE- 8 ESE Atoka
81-15	05/13/1981	1635	2	50	F1	0	0	Atoka	4 NE Atoka
82-62	05/26/1982	1600	0.5	50	F1	0	0	Atoka	4 ESE Atoka
82-82	06/03/1982	1848	0.1	5	F0	0	0	Atoka	4 N Atoka
82-83	06/03/1982	1937	3	50	F1	0	0	Atoka/ Pushmataha	3 E Farris - near Darwin
82-87	06/11/1982	1500	20	50	F1	0	0	Atoka/ Pushmataha	E of Atoka - near Moyers (* not continuous)
82-97	11/22/1982	1610	5	150	F2	0	0	Atoka	Near Tushka - E of Atoka
84-12	04/20/1984	1850	0.1	n/a	F0	0	0	Atoka	Near Atoka
85-2	02/23/1985	0100	10	500	F2	0	3	Atoka	Bentley- Harmony
85-36	11/30/1985	1930	4	300	F2	0	0	Atoka	W part of Bentley- 4 NE Bentley
87-22	11/15/1987	1130	1.0	40	F1	0	0	Atoka	2 E Stringtown
91-4	03/21/1991	1710	19	400	F2	0	6	Atoka	5 W Caney- near Lane
91-9	03/21/1991	1855	0.5	50	F0	0	0	Atoka	Near Bentley
91-12	03/21/1991	2006	0.3	50	F0	0	0	Atoka	4 SE Atoka
91-62	06/05/1991	1207	0.2	50	F0	0	0	Atoka	2 SE Stringtown
91-63	06/05/1991	1207	0.3	50	F0	0	0	Atoka	11 SE Lane
91-64	06/05/1991	1232	4	100	F0	0	0	Atoka/ Choctaw	11 SE Lane- 7 NNE Boswell
92-27	05/11/1992	1515	4	75	F0	0	0	Coal/ Atoka	2 N Cairo- 5 W Chockie
92-33	05/11/1992	1615	16	100	F2	0	0	Atoka/	Daisy- 8 NW Dunbar

								Pushmataha	
94-12/13	04/26/1994	1425	12	80	F1	0	0	Atoka/ Pushmataha/ Pittsburg	Daisy- 9 NE Daisy - 12 ENE Daisy
	03/26/2000	1855	0.5	250	F1	0	0	Atoka	2.5 E Daisy
	04/11/2001	0345	19	500	F2	0	4	Johnston/ Atoka	6 SE Tishomingo - 7 NNW Boggy Depot
	04/11/2001	0425	13	200	F2	1	1	Coal/ Atoka	3 SE Coalgate - 1 NW Wardville
	09/08/2001	1433	0.3	25	F0	0	0	Atoka	Near Chockie
	04/16/2002	1918	3	100	F1	0	0	Atoka	2 W - 1 N Atoka
	05/09/2006	1901	0.6	30	F0	0	0	Atoka	2 ESE Stringtown
	05/09/2006	1904	0.2	20	F0	0	0	Atoka	2 SE Stringtown
	09/21/2006	1910	11	100	F1	0	0	Atoka	4 SSW Lane - 4 E Farris
	05/10/2008	1705	4	100	EF2	0	0	Atoka/ Pushmataha	3 NE Daisy - 4 WSW Adel
	05/10/2010	1942	1.9	400	EF2	0	0	Johnston/ Atoka	1.5 SSW - 2 SSE Coleman

Records taken from the Storm Prediction Center archive data, "Storm Data", and data from the National Weather Service office in Norman. Data modified as described in NOAA Tech Memo NWS SR-209 (Speheger, D., 2001: "Corrections to the Historic Tornado Database").

Historic data, especially before 1950, are likely incomplete.

Preliminary Storm Reports Associated with the April 14, 2011 Severe Weather Event in Oklahoma



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___ NWS Maps and Graphics Associated with the April 14, 2011 *Severe Weather Event in Oklahoma*

___ NWS Damage Photos Associated with the April 14, 2011 *Severe Weather Event in Oklahoma*

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___ Tushka town, Oklahoma; 2005-2009 American Community Survey

___ Atoka County, Oklahoma; Household Population and Household Type by Tenure 2010

National Emergency Management Information System (NEMIS)
Hazard Mitigation Grant Program Data for Tushka School Safe Roomq

Appendix C

Forms Used for Field Data Collection

Building Inventory of Damage and Occupancy: Inventory of Open Spaces

SN	ST	DOD	NO	Lat/Long	SAD	IA	LDE

Type of Building= 1,2FR (1 and 2 Family Residence); MH (Mobile Home); MB (Metal Building System); SPB (Small Professional Building); SH (School); IB (Institutional Building)

Degree of Damage: None; Minor; Moderate; Severe/Partial Collapse; Total Collapse; Complete Destruction

Building Occupancy: Was Building Occupied during Tornado Event (Y)yes or (N)no- and include Estimated Number of Occupants

SN= Structure Number; ST= Structure Type; DOD= Degree of Damage; NO= Number of Occupants

Lat/Lon = Latitude and Longitude of Structure; SAD= Street Address; IA= Interview Available

LDE= Location of Occupants During the Event will be:

- **DA= Drive Away from the Storm**
- **PSS= Personal Storm Shelter**
- **NSS= Neighbor's Storm Shelter**
- **TSS= Tuska Storm Shelter (This is the subject of our Losses Avoided Study)**
- **SIR= Sheltered in their Residence (hallway or bathroom)**
- **TSB= Tuska Storm Bunker (Existing Storm Bunker built prior to the Tuska Storm Shelter)**
- **AIR= Assumed in Residence: If we were unable to interview the occupants**

Safe Room Occupants

#	Name	Address	Phone	Home Damaged

Injuries and Fatalities in Area of Analysis

#	Name (optional)	Address	Severity Level	

FAA Injury Level Categories

AIS Code	Injury Severity Level	Selected Injuries
1	Minor	Superficial abrasion or laceration of skin; first degree burn, sprain
2	Moderate	Major abrasion or laceration; cerebral concussion; finger or tow crush or amputation; closed pelvic fracture with or without dislocation
3	Serious	Major nerve laceration; multiple rib fracture; abdominal organ contusion; hand, foot or arm crush/ amputation
4	Severe	Spleen rupture; leg crush; chest wall perforation; cerebral concussion with other neurological signs (unconscious for less than 24 hours)
5	Critical	Spinal cord injury (with cord transaction) extensive second or third degree burns; cerebral concussion with severe neurological signs
6	Fatal	Injuries that that result in a fatality even if they survive the first 30 days