HAZARD MITIGATION ACTION PLAN

GARLAND

For more information, visit our website at:

http://www.garlandtx.gov/gov/lq/safety/emergency/default.asp

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1. Introduction

Purpose

The City of Garland Hazard Mitigation Action Plan (HazMAP) is designed to meet the planning requirements set forth by the Texas Division of Emergency Management (TDEM), and the planning requirements set forth by the Federal Emergency Management Agency (FEMA). Local governments are required to develop a hazard mitigation plan as a condition for receiving certain types of non-emergency disaster assistance, including funding for mitigation projects. The Robert T. Stafford Disaster Relief and Emergency Assistance Act (Public Law 93-288), as amended by the Disaster Mitigation Act (DMA) of 2000, provides the legal basis for state, local, and tribal governments to undertake a risk-based approach to reduce risks from hazards through mitigation planning. The requirements and procedures for State, Tribal and Local Mitigation Plans are found in the Code of Federal Regulations (CFR) at Title 44, Chapter 1, Part 201 (44 CFR Part 201). Appendix A is reserved for the City Council Resolution, formally adopting the City of Garland Hazard Mitigation Action Plan.

Organization

The City of Garland Hazard Mitigation Action Plan is divided into nine sections. Each section is designed to address the planning requirements set forth by state and federal agencies tasked with oversight of DMA 2000. The City of Garland Hazard Mitigation Action Plan sections are identified below:

- Section One describes the purpose and authority of the Hazard Mitigation Action Plan and its organization.
- Section Two provides a description of the planning process the City of Garland followed to prepare the Hazard Mitigation Action Plan.
- Section Three describes the profile of the City of Garland and is a helpful tool in understanding how to best mitigate local hazards.
- Section Four provides detail on the hazard identification analysis and risk assessment, and shows how the Risk Summary (Table4.5) was developed and hazard ranking.
- Section Five contains the hazard profiles that pose the greatest risk to the City of Garland. Each hazard profile contains: the location, severity, previous occurrences, probability of future events, impacts and vulnerability of those hazards.
- Section Six outlines the City of Garland's mitigation strategy, goals and objectives, reports progress on previous mitigation actions and addresses prioritizing mitigation actions.
- Section Seven outlines mitigation actions for the identified hazards.
- Section Eight describes the plan maintenance process for how the plan will be monitored, evaluated, incorporated and updated.
- Section Nine is the Appendix which provides additional information referenced in the plan.

2. Planning Process

The City of Garland Hazard Mitigation Action Plan was developed in accordance with Federal Emergency Management Agency (FEMA) and Texas Division of Emergency Management (TDEM) standards and regulations. The mitigation planning process followed established guidelines published by the FEMA. The Planning Process was divided into four (4) phases as depicted in Figure 2-1, below.

At the onset of the planning process, numerous organizations and interested parties were invited to participate in the HazMAP efforts. These partners included local, regional and state agencies, private residents, and community based associations. Involving a variety of planning partners helped ensure a strong foundation for the Hazard Mitigation Action Plan.

Meetings were held with the Hazard Mitigation Planning Team, where risks were assessed and mitigation goals and actions created. Many local and regional contacts were also important in the planning process by providing information to the Planning Team. Some of these contacts include the Garland Geographic Information Systems, Garland Fleet Services, Texas Department of Emergency Management Recovery Division and other regional personnel.

Figure 2.1. Mitigation Planning Process

Source: Federal Emergency Management Agency

Planning Team

During the first phase the Planning Team members were identified based on their expertise and authority to implement the mitigation actions that would be developed. The following are the members of the Hazard Mitigation Action Planning Team:

- Garland Building Inspection, Building Official
- Garland Chamber of Commerce, Vice President
- Garland Emergency Management Coordinator
- Garland Emergency Management Specialist
- Garland Emergency Management Specialist
- Garland Engineering, Drainage and Development Engineer
- Garland Environmental Health Manager
- Garland Facilities, Director
- Garland Fire Department, Assistant Fire Chief
- Garland Neighborhood Vitality, Administrator
- Garland Parks and Recreation, Services Manager
- Garland Police Department, Captain
- Garland Power & Light, Chief Operation Officer
- Garland Public/Radio Amateur Civil Emergency Service (RACES)
- Garland Water Department, Utilities Director

Kickoff and Subsequent Meetings

The kickoff meeting was held at the City of Garland Emergency Operations Center on September 12, 2016. This initial meeting was an opportunity to inform key department heads and Planning Team members about how the planning process pertained to their distinct roles and responsibilities. Progress of past mitigation activities were discussed, and the new hazard identification process began.

The Planning Team participated in additional meetings and did work outside of the group. The Planning Team performed the following activities: identified hazards, conducted risk assessments, ranked hazards, developed a public outreach strategy, planned implementation of mitigation actions, assisted in research and gathering information to include in the plan and participated in the draft plan review. The Team will also monitor progress of the new mitigation actions and will update the plan as needed. A summary of planning meetings are described in Table 2.2. Documentation of meetings are found in Appendix B.

Table 2.2. Meeting Summaries

Date	Purpose
September 12, 2016	Kickoff meeting Discussion about the purpose of mitigation and planning process Reviewed Previous Mitigation Goal Progress and Implementation Hazard Mitigation Survey Explained
October 10, 2016	Hazard Mitigation Survey Results = Identified Hazards Community Risk Assessment Explained
November 9, 2016	Public Outreach Strategy and Survey Questions Discussed Discussed potential mitigation strategies and Capabilities Assessment
January 12, 2017	Finalized Mitigation strategies

Mitigation Review and Development

The Planning Team developed the 2017-2022 mitigation strategy. During the initial kickoff meeting, the Planning Team gave progress reports on all of the mitigation actions listed in the 2012 Plan. After initial reports were given the Planning Team completed department updates with additional details regarding 2012 mitigation actions and information. Planning Team members reported accomplishments, obstacles, delays, and revisions of the 2012 mitigation actions and updated information, images, data and statistics that related to each mitigation action and other details of the plan. An example of such updates are located in Appendix C. Development of the mitigation actions for the 2017 HazMAP was ongoing throughout the planning process. An educational component was conducted at the November 9th, 2016 meeting to ensure Planning Team members were actively considering all mitigation actions for HazMAP. FEMAs (2013), document titled, Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards was used to further examine mitigation actions that the City of Garland could utilize. The City's Capital Improvement Plan and department budgets were also inspected to determine possible mitigation actions. Planning Team members identified proposed actions, hazard(s) addressed, costs and benefits, the responsible department(s), effects on new and existing structures, implementation schedules, and potential funding sources. Mitigation actions identified during the process were made available to the Planning Team for review. In addition, the draft Plan was made available for public review and comment on the City of Garland's website and partner site EngageGarlandTx.

Review of Existing Plans, Plan Integration and Implementation

A variety of existing studies, plans, reports, and technical information were reviewed as part of the planning process. Sources of the information included FEMA, TDEM, Dallas County Plans, City of Dallas Plans, and City of Garland's 2012 Hazard Mitigation Action (HazMap) Plan.

Other documents, including those from the National Oceanic and Atmospheric Administration (NOAA) that includes the National Climatic Data Center (NCDC), provided previous hazard occurrence data and descriptions of events in the area. Materials from FEMA and TDEM were reviewed for guidance on plan development requirements and utilized in the development of the Plan at all stages. The State of Texas Mitigation Plan, Dallas County HazMAP and City of Dallas Local Mitigation Action Plan, were reviewed in order to develop the initial hazards to address in early planning phases. In addition, the HazMAP draft was sent to Dallas County, the City of Dallas, Mesquite, Richardson, and Plano neighboring communities to give them the opportunity to review and provide feedback regarding the Plan. The North Central Texas Council of Government also received the Plan for Regional input. Internally, the City of Garland's Capital Improvement Plan and Operating Budget were reviewed to identify what mitigating activities the City of Garland has currently budgeted to complete.

Planning team members will continuously implement HazMAP with other planning mechanisms within departments. The annual budget review is an important tool in controlling and executing mitigation goals and objectives. It is this phase where identified mitigation actions may be funded. Each action has been assigned to a specific department that is responsible for tracking and implementing the mitigation actions contained in Section Seven. A funding source as well as an implementation time period has also been listed and may be used when departments begin that phase. The timeline will partially be directed by the City's comprehensive planning process, Capital Improvement Plan, budgetary constraints, and community needs.

Capabilities Assessment

The Planning Team identified current capabilities for completing and implementing hazard mitigation actions. Members ensured all planning/regulatory, administrative/technical, financial and educational capabilities were included in the document for all City of Garland departments. The City of Garland organizational chart (Figure 2.3) presents departments who have roles in the hazard mitigation process. The capabilities assessment describes policies, programs, resources, codes and ordinances to accomplish hazard mitigation through the listed departments.

Figure 2.3. City of Garland Organization Chart

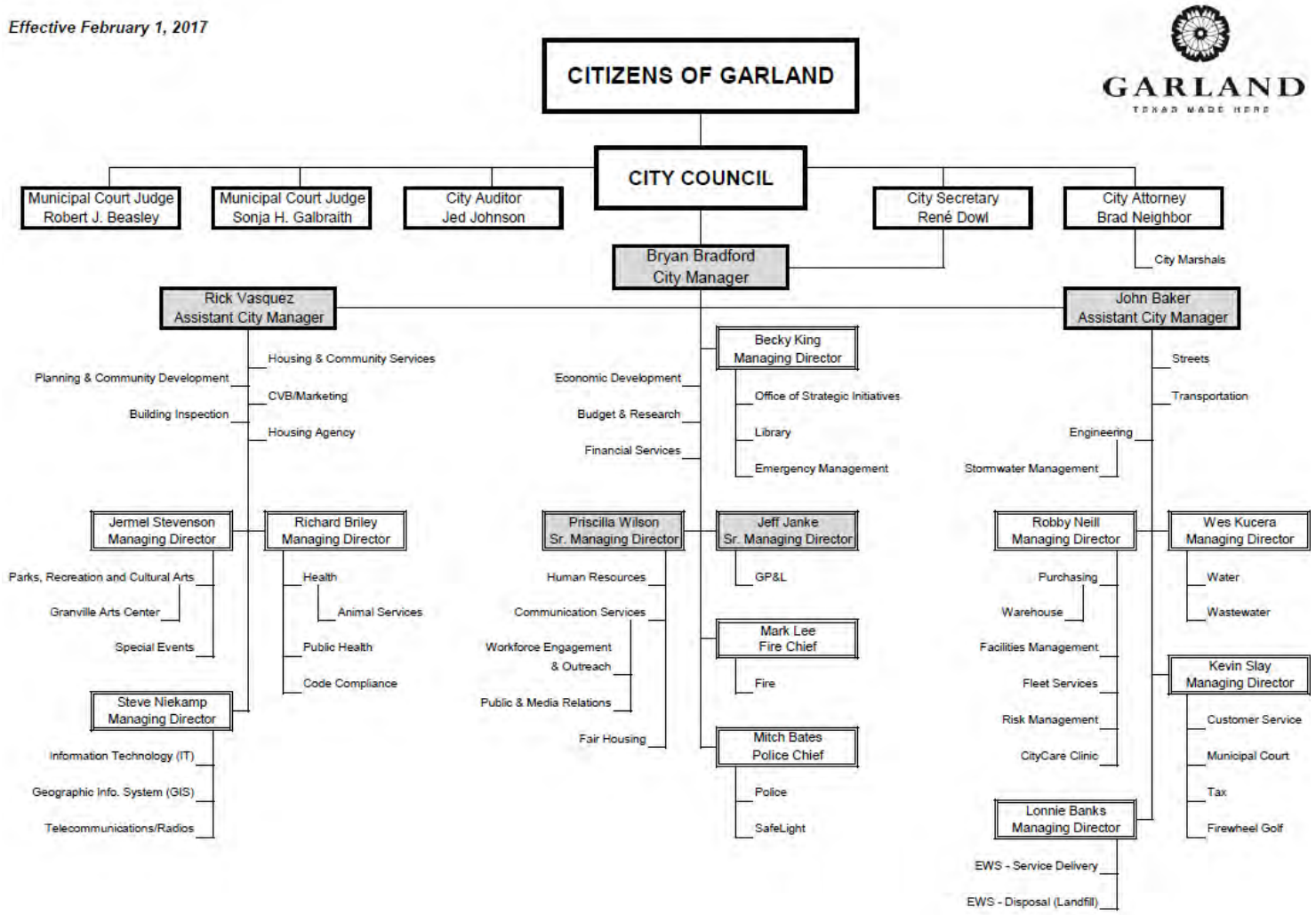


Table 2.4. Capabilities Assessment

Planning and regulatory capabilities are the plans, policies, codes and ordinances that prevent and reduce the impacts of hazards. The following table presents those capabilities that the City of Garland possesses.

Regulatory Tools (ordinances, codes, plans)	City of Garland	Additional Information
Comprehensive / Master Plan	X	2030 Envision Garland
Capital Improvements Plan	X	2016 CIP Plan Adopted
Economic Development Plans	X	Economic Development Department, 2030 Envision Garland, Garland Economic Development Partnership (GISD, City of Garland and Chamber of Commerce)
Local Emergency Operations Plans	X	Comprehensive Emergency Management Plan – advanced level
Continuity of Operations Plans	X	Citywide Comprehensive Continuity of Operations (COOP) Plan
Transportation Plan	X	Thoroughfare Plan, Comprehensive Corridor Plan SH-78, Strategic Transportation Enhancement Plan (STEP)
Building Code	X	Adopted 2015 International Building Code
Fire Department ISO Rating	X	ISO Rating 1 – highest rating
Site Plan Review Requirements	X	Approved by the City Engineering Department as part of the Site Permit.
Zoning Ordinance	X	Comprehensive Zoning List 4647. Includes the zoning districts, land use permissibility, definitions, parking requirements, and development standards.
Subdivision Ordinance	X	Garland Development Code
Flood Insurance Rate Maps	X	Engineering: Floodplain and Drainage - FEMA has published Flood Insurance Rate Maps (FIRMs) graphically showing the extents of approximately 2,400 acres in the 100-year floodplain in Garland. Passive recreational and park uses are encouraged while encroachments and obstructions are prohibited.
Growth management ordinances	X	Garland Development Code
Drought Management	X	Water Conservation Plan, Drought Contingency Response Plan

Administrative and Technical capabilities include staff, their skills and tools that can be used for mitigation planning and to implement mitigation actions.

Staff /Personnel Resources	City of Garland	Additional Information
Planning Commission	X	Composed of 9 members appointed by the City Council. One member is appointed to represent each of the 8 Council districts, and 1 member is appointed at-large.
Mitigation Planning Committee	X	Fourteen department representatives, Garland resident and volunteer as well as the local Chamber of Commerce serve on the Planning Committee.
Mutual aid agreements	X	Dallas County mutual aid agreement, Interlocal agreements with Rowlett and Sachse.
Maintenance programs to reduce risk (tree trimming, clearing drainage systems)	X	Code Compliance: Single Family Rental Program (requires properties to be permitted), Code Cares (tree trimming, fence maintenance, trash/debris removal) GP&L: Annual tree trimming/vegetation management program
Planner(s) / engineer(s) with knowledge of land management practices	X	Planning & Community Development, Engineering, Stormwater
Engineer(s) or professional(s) trained in construction practices related to buildings and/or infrastructure	X	Code Compliance, Building Inspection, Engineering, Streets, Stormwater, Wastewater Treatment
Planners or Engineer(s) with an understanding of natural hazards	X	Engineering, GP&L, Office of Emergency Management, Risk Management, Stormwater
NFIP Participation	X	Engineering: Floodplain and Drainage – 100 year floodplains are near Duck Creek, Rowlett Creek, Spring Creek, and their tributaries. All new development projects are reviewed for compliance with the flood prevention ordinance.
Chief Building Official	X	Full Time - Building Inspection – Jim Olk
Emergency Manager	X	Full Time – Office of Emergency Management – Kwa heri Harris, Director and Barbara Neville, Sr. Specialist
Floodplain Administrator	X	Full Time – Engineering – Michael Polocek
Community Planner	X	Full Time – Planning & Community Development – Will Guerin
Drainage and Development Engineer	X	Full Time – Lyle Jenkins
Surveyors	X	Engineering - land surveying, easements, platting and right-of-way
Staff with education and experience to assess the community's vulnerability to hazards	X	Hazard Mitigation Planning Team, Building Inspection, Engineering, Office of Emergency Management, Stormwater
Personnel skilled in GIS	X	Information Technology: Geographic Information Services (GIS)
Scientists familiar with hazards of the community	X	Full Time - Epidemiologist – Don Hart National Weather Service
Warning Systems/Services	X	CodeRED, Sixteen Outdoor Warning Sirens

Expanding and Improving

The City of Garland is progressive and forward thinking when it comes to expanding and improving existing policies and programs for the wellbeing of the community. For example, Garland recently adopted the 2015 International Building Code requiring storm shelters in critical emergency operations facilities where such facilities in geographical areas where tornadoes are highest. New Federal regulations and best practices are adopted through various ordinances to strengthen current policies.

Stakeholder and Public Involvement

Stakeholders provide an essential service in hazard mitigation planning; therefore, throughout the planning process, local government, members of community groups, and local businesses were invited to participate. The Chamber of Commerce business community, Garland Area Service Providers, a group of non-profits and aid organizations, the Community Leaders Group multicultural representatives, and the Multicultural Commission were all sent hazard mitigation information/surveys and encouraged to participate.

Input from individual residents and the community as a whole provided the Planning Team with a greater understanding of local concerns, and increases the likelihood of successfully implementing mitigation actions. The City of Garland incorporated several methods to actively engage the public throughout the planning process, prior to official Plan approval and adoption. These methods included two public surveys, posting information to the city's website, designated point of contact for HazMap questions and comments, the opportunity for public review and comment and inclusion of the general public on the Planning Team.

On January 16, 2017, the Office of Emergency Management placed a survey link on the City's website requesting public input. The survey was circulated to a wide audience through many channels that included:

- Distribution of the survey and mitigation information electronically via City of Garland Facebook, Twitter, COGNOTES employee news, and Garland's Nextdoor social network. Residents were also able to access the survey at all four public libraries computers and could request a paper copy of the survey from the HazMAP point of contact.
- Fliers were distributed and posted in six recreation centers, four public libraries, and at customer service sites within the City of Garland. Customer service site locations include: Building Inspection, Public Health, CityCare Clinic, Parkland Health Center, Police Department, Municipal Courts, Customer Service, Animal Shelter and the Pawsibilities pet adoption center.

The survey solicited public feedback on the hazards residents felt had the greatest impact on Garland. Residents were asked to review the list of hazards identified by the City's Planning Team and rank those hazards in order of importance and of greatest impact. The survey was a total of 7 questions and was available in English, Spanish and Vietnamese. A total of 269 surveys were completed, the survey and results are included in Appendix D.

The purpose of the survey was to solicit public input during the planning process, confirm the Planning Teams findings with the public, and determine any other areas of concern. The survey results were reviewed and incorporated into the Plan and are also summarized in Table 4.5, Risk Summary. Because 64% of residents report being only "somewhat prepared" for a disaster an 16% "not prepared" (80% combined) several public education and awareness mitigation actions or components were added to the Plan.

During hazard analysis it was determined that the Public ranked hazards based on their personal capabilities and experiences while the Planning Team ranked hazards according to the City of Garland capabilities to respond to each hazard.

After the initial public survey results were analyzed the Office of Emergency Management further surveyed and interviewed residents regarding hazard ranking and the rationale behind their ranking decisions. (Appendix D) These public conversations occurred at City of Garland Open Dialogue Forum held on March 3, 2017 and confirmed what the original survey had unveiled. The Public ranks hazards based on personal experiences not the community as a whole. Statements regarding ranking were made such as:

- "Some of these hazards have never impacted me."
- "I lived in California and am used to earthquakes but not tornadoes."
- "I worked in customer service so I know people are mad when they don't have power."
- "We are in severe weather season right now."

Closing this perception gap will require public education. Instructing individuals to see beyond themselves and understand the whole community concept of hazard mitigation will require much education.

Throughout the process of creating the Hazard Mitigation Action Plan updates were made to the City of Garland Office of Emergency Management website (www.garland-oem.com). The information posted on the website included:

- A definition of hazard mitigation
- Why Garland needs a plan
- Examples of mitigation actions
- An explanation of the planning process
- Hazards identified by the Planning Team
- Point of contact

The website also housed valuable information on the warning systems in the City of Garland to keep residents aware of hazards that may impact them.

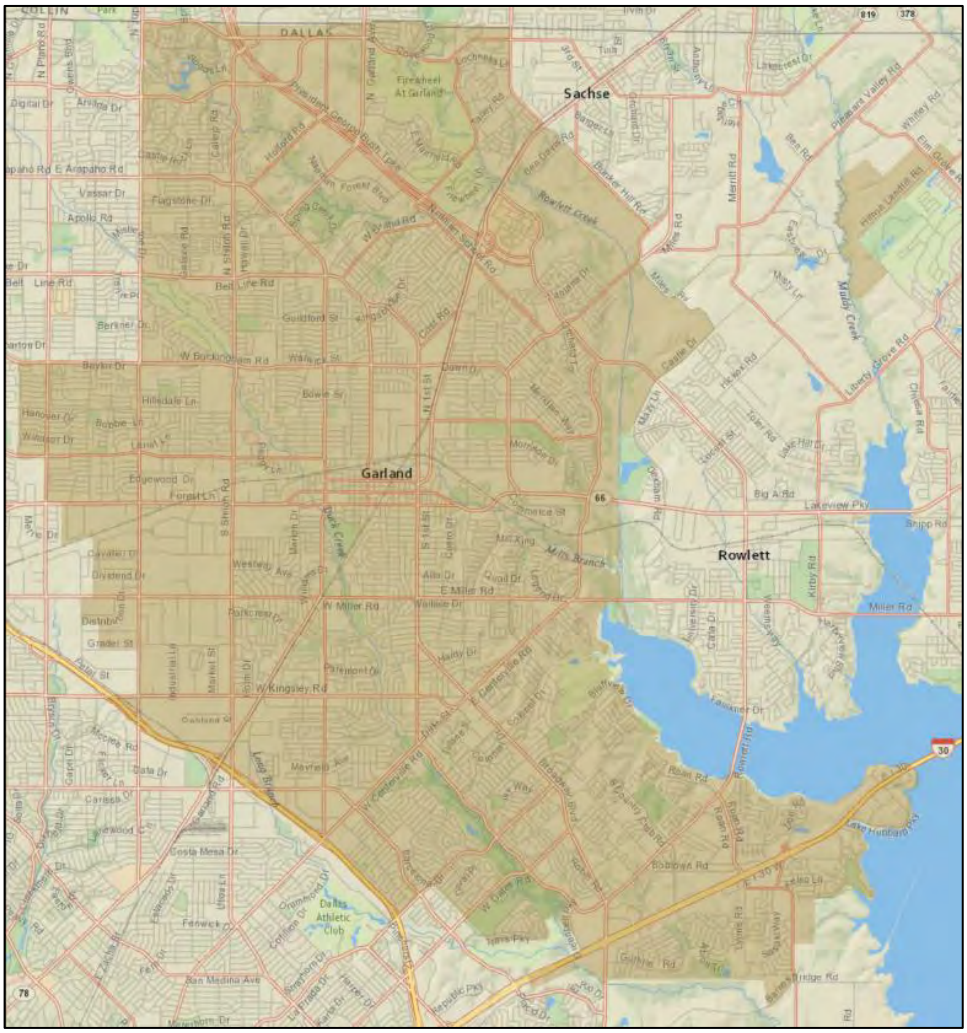
The Plan was placed on the Office of Emergency Management website, EngageGarlandTx website and placed at the public libraries for public comment and review prior to plan adoption, on insert date. A point of contact was also provided for residents to send additional comments privately or at length.

Documentation of public outreach methods are found in Appendix C.

Planning Area

The planning area for the Hazard Mitigation Action Plan includes the City of Garland incorporated areas. The planning area is indicated by the darker tan shading in Figure 3.1. The City of Garland is primarily located in northeast Dallas County, although a small portion of the city extends into Collin County which is the landfill. Garland shares common boundaries with the City of Dallas, Richardson, Mesquite, Rowlett, Sachse, and Sunnyvale. The City of Garland covers a land area of 57.1 square miles, six percent of the total area of Dallas County.

Figure 3.1. City of Garland Incorporated Area



Source: City of Garland GIS Department, 2016

Population

The City of Garland, like many other Dallas-Fort Worth communities, continues to grow significantly. Much of Garland's population growth occurred during the 1960s, 1970s, and 1980s. Growth now has slowed due to undeveloped land becoming scarcer as Garland approaches buildout. The City of Garland is the second largest city in Dallas County, and is home to an estimated 236,897 residents. Table 3.2 represents the City of Garland's population change from 1980-2015.

Table 3.2. Population Change

Year	1980	1990	2000	2009	2015
Population	138,857	180,650	215,768	228,858	236,897

Source: Garland Planning & Community Development, 2015 U.S. Census Data Garland Profile

Community Features and Special Considerations

Building Stock

The Dallas County Appraisal District Estimated Values Report for the City of Garland will be used in order to establish an accurate inventory of the types of buildings within the City of Garland. Table 3.3 shows the amount of parcels, estimated market value, and taxable value for commercial property, business personal property, residential property, and the combined totals for all three separate categories.

Table 3.3. Certified Estimated Values Report (EVR)
July 25, 2016 for tax year 2016

Type of Building	Parcels	Market Value	Taxable Value
Commercial	4,698	$ 4,549,594,430	$ 3,529,696,76
Business Personal Property	5,751	$ 2,062,673,650	$ 1,665,191,893
Residential	64,199	$ 8,807,329,810	$ 7,137,745,537
Grand Total	74,648	$ 15,419,597,890	$ 12,332,634,195

Source: Dallas Central Appraisal District (DCAD)

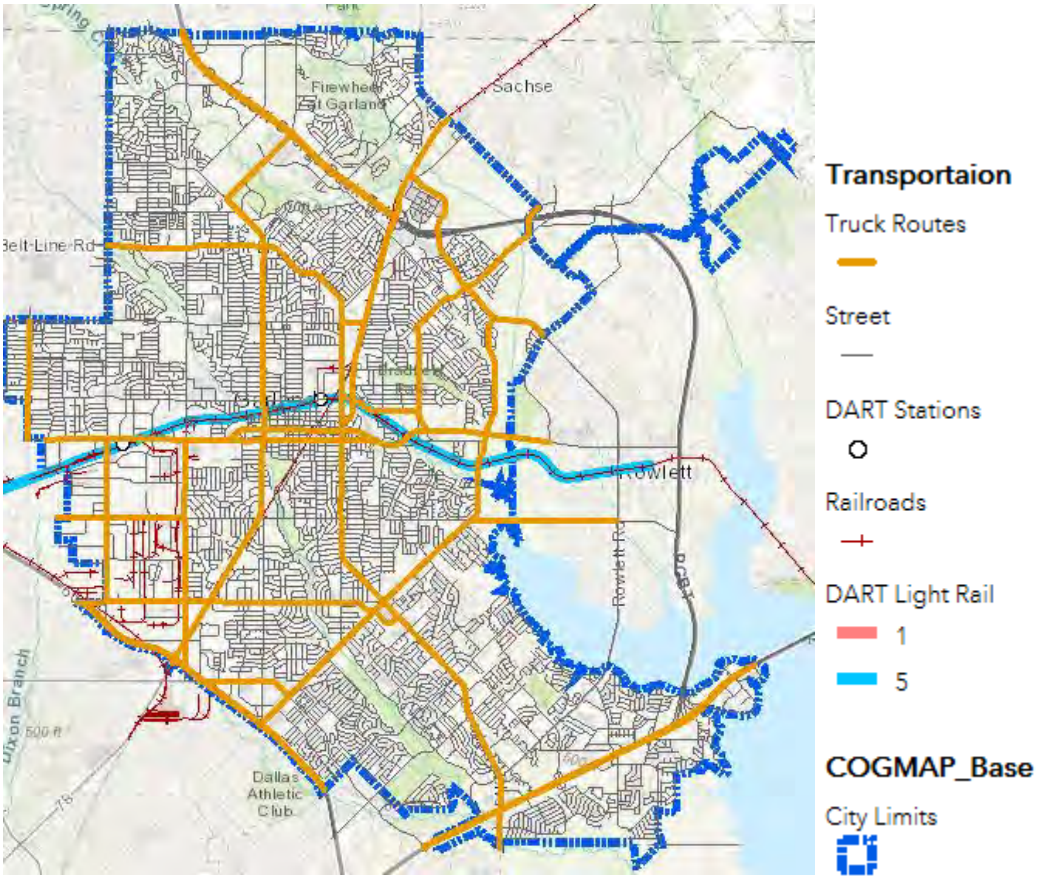
Transportation Systems

The City of Garland offers many transportation opportunities. Active transportation options include: the Dallas Area Rapid Transit (DART) light rail system, railroads, highways, and a heliport.

There are five highways and thoroughfares that serve the City of Garland: Lyndon Baines Johnson (LBJ) Freeway (IH-635), President George Bush Turnpike (SH 190), IH-30, State Highway 78 and State Highway 66. LBJ Freeway, IH-30, State Highway 66, and the President George Bush Turnpike run primarily east to west. State Highway 78 runs primarily north to south.

In addition to the highway routes that pass through the City, several major transportation arteries cross through the City. Figure 3.4 identifies the transportation routes and speed limits on those routes.

Figure 3.4. Transportation Routes

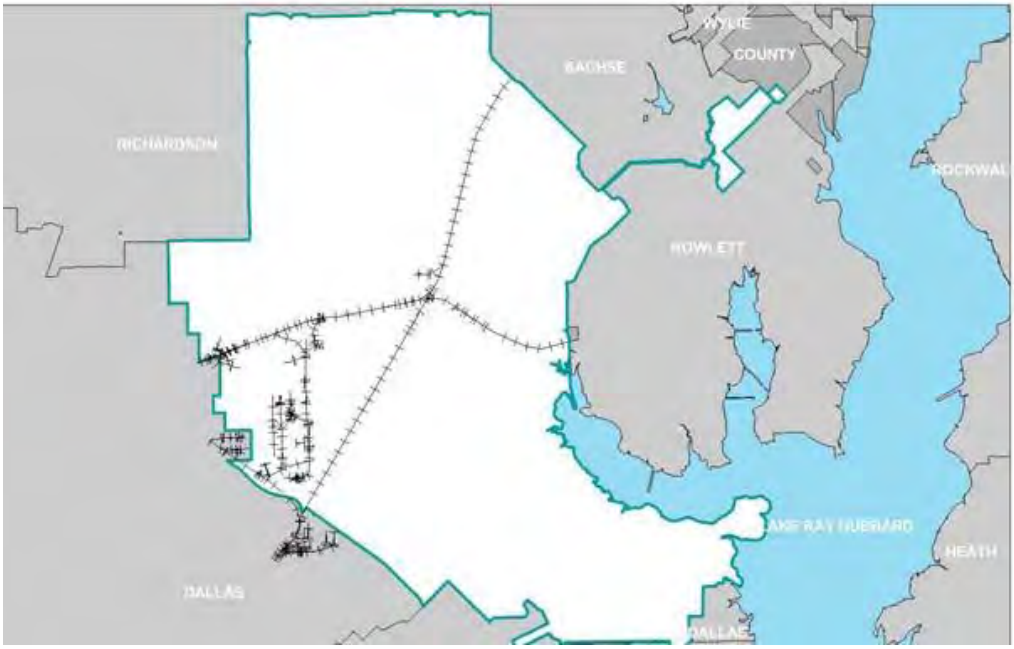


Source: Garland GIS

Two freight rail lines serve the City of Garland. Dallas Garland and Northeastern Railroad (DGNR) and Kansas City Southern Railroads pass through the city limits.
Figure 3.5 depicts the rail systems in Garland.

The freight rail lines intersect with the DART passenger light rail system in central Garland. The DART light rail system is a public transportation system that links downtown Garland to the rest of the Dallas-Fort Worth area and extends east into Rowlett.

Figure 3.5. Railroads



Garland GIS

The City of Garland is also home to a heliport. The Garland Heliport is a public heliport located within the city limits. The Garland Heliport opened in 1989 and is owned by the City of Garland, which, since 1993, has contracted with Sky Helicopters to manage the facility. The heliport operates as both a commercial entity and flight school.

Lifeline Utility Systems

The City of Garland owns and operates two state-of-the-art advanced biological wastewater treatment facilities. Wastewater is collected for each facility in two separate drainage basins, the Duck Creek Basin and the Rowlett Creek Basin. Wastewater is then received and treated at two separate facilities, the Rowlett Creek and Duck Creek Wastewater Treatment Centers. The Duck Creek Treatment Plant receives wastewater from the west side of Garland, and from portions of the cities of Dallas, Richardson and the City of Sunnyvale. The Rowlett Creek Treatment Plant serves the east side of Garland including the cities of Rowlett and Sachse.

Since 1923, the City of Garland has been providing electric service to its residents through Garland Power & Light (GP&L), a locally owned and controlled not-for-profit municipal utility. With more than 69,000 customers, GP&L is the fourth largest municipal utility in Texas and the 42nd largest in the nation.

GP&L's diverse energy portfolio includes power from natural gas, coal, wind, solar and hydroelectric resources. The utility owns natural gas and hydroelectric generation facilities, and has power purchase contracts for coal, wind and solar energy.

GP&L's electric distribution system has 388 linear miles of overhead lines and 591 linear miles of underground lines. The transmission system consists of 28 substations and 200 linear miles of transmission lines. The utility's peak load for 2015 was 473 megawatts, with annual operating revenues of $339 million.

The other 15% of Garland residents are served by Oncor, a transmission and distribution provider that serves much of north Texas.

Economic Elements

The labor force within the City of Garland stands at 126,151 according to the Texas Workforce Commission (10/2016). The unemployment rate for the City as of October 2016 is 3.5%. The Garland Independent School District is the largest employer within the City, employing 7,300. The top ten major employers are listed in Table 3.6.

Table 3.6. Top Ten Major Employers

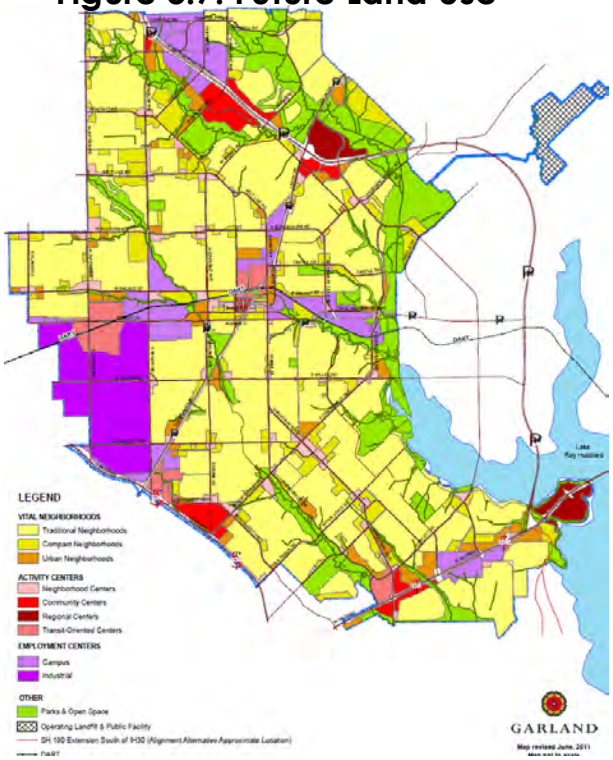
Garland Independent School District	7,300
City of Garland	2,000
Baylor Scott & White Medical Center - Garland	1,185
Kraft Foods	650
US Food Service	520
Hatco (Resistol)	401
L-3 Communications	400
Silver Line by Andersen	400
KARLEE	330
Atlas Copco	300

City of Garland Economic Development Partnership, Updated August 2016

Future Development Consideration

The City of Garland is legally required to have and maintain a comprehensive plan. Garland's first comprehensive plan was developed in the 1960s. A second plan was developed in the 1980s and was periodically updated. Envision Garland is the current comprehensive plan that addresses the community's future through 2030. This HazMAP has been extensively revised to reflect not only infrastructure and residence development which has been minimal but also reflects the changes in hazards that now greatly impact the City.

Figure 3.7. Future Land Use



Envision Garland, 2011

4. Risk Overview

Hazard Identification and Analysis

This section begins the risk assessment. The purpose of this section is to provide background information for the hazard identification and risk analysis process. Section five provides a hazard profile for each of the Planning Team's identified hazards for the City of Garland. Each hazard profile includes a description of the hazard, location, severity, previous occurrences, probability of those hazards occurring in the future, impacts and summary of vulnerability to each hazard.

The City of Garland Planning Team initially reviewed the full range of natural hazards suggested under FEMA planning guidance. The team also considered the State of Texas Hazard Mitigation Plan identified hazards, Dallas Counties Hazard Mitigation Action Plan identified hazards, City of Dallas Local Mitigation Action Plan identified hazards and other neighboring jurisdiction's hazards and risk assessments. Based on this analysis and historical occurrences that have impacted Garland, the Team identified a total of 31 natural and human-caused hazards that pose risk to Garland, Texas. Those hazards are listed below.

Active Shooter
Aircraft Incident
Biological Event
Bomb Threat
Civil Disturbance
Communications Failure
Dam Failure
Drought
Earthquake
Erosion
Expansive Soil
Extreme Cold
Extreme Heat
Flood
Fuel Shortage
Hail

Hazardous Materials (Fixed and Transport)
Information Systems Failure
Lightning
Plant Explosion
Power Outages
Railroad Incidents
Severe Winter Weather
Sewer Failure
Subsidence
Terrorism
Tornado
VIP Situation
Water Failure
Wildfire
Wind

Those 31 potential hazards were included in the hazard assessment (Appendix F). The hazard assessment identified high risk hazards, provided justification for resources spent and ensured risk and mitigation actions aligned. Because the City of Garland has limited funding, the Planning Team prioritized the hazards that have the greatest risk and impact to the City. As additional funding becomes available the Planning Team will reassess the list of hazards. The Hazard Assessment used a formula that accounted for: Geographic Area Affected, Probability of Future Events in the Next Year, Possibility of Death or Injury, Interruption of Business Services, Preparedness, Response Time, and Effectiveness and Resources Available. Each member of the Planning Team completed a Hazard Assessment and assigned a percentage to all 31 previously identified hazards for each parameter to collectively determine the risk for each hazard for Garland. The results of the hazard assessment determined Garlands top hazards that were then further evaluated in the Community Risk and Impact Assessment.

Hazard Ranking

Listed are the ten natural hazards and four technological hazards that were identified from the result of the hazard assessment. These are the hazards that will be addressed in the Hazard Mitigation Action Plan. FEMA "recognizes that a comprehensive strategy to mitigate the nation's hazards cannot address natural hazards alone" and "that natural events can trigger technological disasters."[1] Technological hazards are distinct from natural hazards primarily in that they originate from human activity.

Tornado
Severe Winter Weather
Flood
Drought
Biological Event
Terrorism/Cyber Attacks
Extreme Heat
Power Outages
Earthquake
Communications Failure/ Infrastructure Failure
Severe Thunderstorms/ Wind/Lightning
Hail
Erosion
Expansive Soil

Each member of the Planning Team completed a Community Risk and Impact Assessment located in Appendix G. This assessment estimated the potential impact each hazard would have on specific areas of the community. These areas include: Geographic Scope, Duration, Health Effects, Displacement, Economic Impact, Environmental Impact, Built Environment, Transportation, Critical Services, Confidence in Government, Frequency and Cascading Effects.

[1] Source: Technological Hazards, FEMA

Two scenarios were considered during the Community Risk and Impact Assessment, the most likely/typical scenario of a hazard occurring and the maximum impact/worst case scenario of a hazard occurring. Definitions of the parameters were provided for each impact type and level. These definitions are also located in Appendix G.

- **A collective risk score was calculated using the Community Risk and Impact Assessment for each hazard based on the given definitions.** The higher the score the higher the collective risk to the City of Garland.

- **The Community Risk and Impact Assessment also assessed the Severity of Impact** each hazard may have on the City of Garland and further prioritized the hazards to develop relevant mitigation actions.

- **The Public Ranking** represented in the Risk Summary table was **derived from the results** of the **public survey** (Figure 4.1).

- A statistical approach was also used to analyze the identified hazards. **Data from the National Climatic Data Center (NCDC) was used in determining Frequency.** Occurrences divided by the number of years of reliable data. That number was then compared to the frequency definitions in Table 4.2.

The combined analysis is shown in the Hazard Risk Summary in Table 4.5 (Frequency, Severity of Impact, Risk Score, Planning Team Risk Ranking and Public Ranking)

Figure 4.1 Public Survey Question

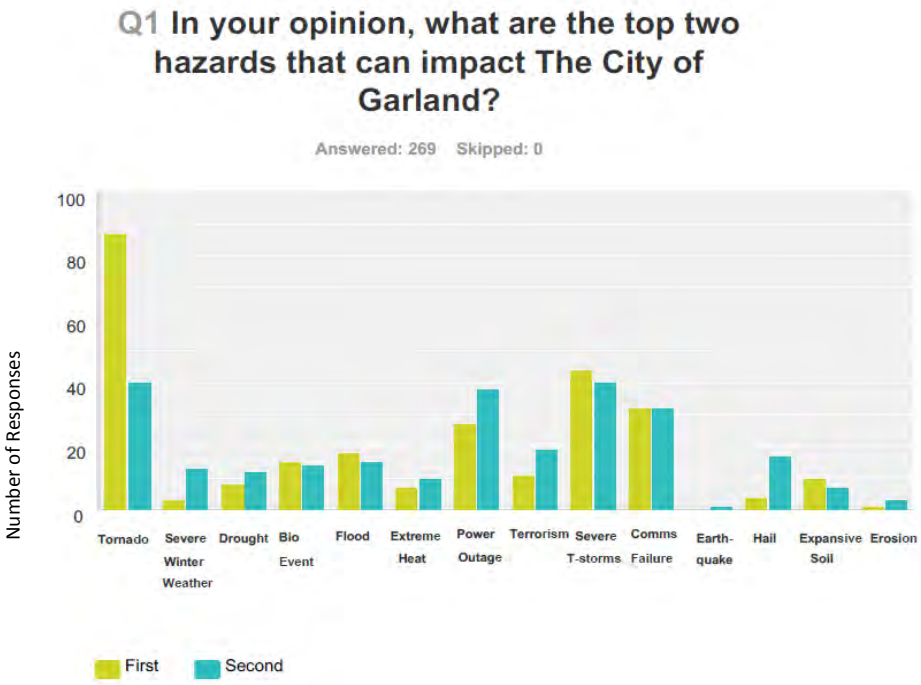


Table 4.2. Public Survey Hazard Ranking	Total
Tornado	127
Severe Thunderstorms (including wind and lightning)	84
Power Outage	65
Communications Failure (transmission lines, broadcast, satellites and/or utility capabilities)	64
Flood	33
Terrorism / Cyber Attacks	30
Biological Event (disease outbreak ex. H1N1, Smallpox)	29
Hail	21
Drought	20
Extreme Heat (Heat Index of 105 degrees or higher)	17
Expansive Soil (soils that expand when water is added, and shrink when they dry out)	17
Severe Winter Weather (snow, freezing rain, or sleet)	16
Erosion (gradual wearing away of land masses)	4
Earthquake	1

TABLE 4.3. Hazard Frequency Ranking

FREQUENCY	CALCULATION	PROBABILITY DEFINITION
Highly Likely	NCDC Data Calculations > .8 Or continuous hazards	Event is probable in the next year.
Likely	NCDC Data Calculations > .4	Event is probable in the next 3 years.
Occasional	Previous Occurrence	Event is probable in the next 6 years.
Unlikely	No unlikely hazards in HazMAP	Event is probable in the next 10 years.

	Table 4.4. SEVERITY of IMPACT
Substantial	Multiple deaths or Complete shutdown of critical facilities and services for 1 week or more or More than 50 percent of property or residents impacted
Major	Multiple Injuries and/or illnesses or Complete shutdown of critical facilities/services for at least 1or more days but < a week or More than 25 percent of property or residents impacted
Minor	Injuries and/or illnesses do not result in permanent disability or Critical facilities and services modified or More than 10 percent of property or residents impacted
Limited	Injuries and/or illnesses that are treatable with first aid or; Minor quality of life lost or No shutdown of critical facilities and services Less than 5 percent of property or residents impacted

Table 4.5. Hazard Risk Summary

HAZARD	FREQUENCY/ YEAR	SEVERITY of IMPACT	RISK SCORE	RISK RANKING	PUBLIC RANKING
Tornado	highly likely	substantial	34.071	high	high
Severe Winter Weather	highly likely	substantial	31.224	high	low
Terrorism/Cyber Attacks	occasionally	substantial	30.871	high	moderate
Biological Event	likely	major	29.661	moderate	moderate
Flood	highly likely	major	27.822	moderate	moderate
Earthquake	likely	major	26.696	moderate	low
Severe Thunderstorms/ Wind / Lightning	highly likely	minor	26.604	moderate	high
Communications Failure / Infrastructure Failure	occasionally	minor	25.898	moderate	high
Drought	likely	minor	25.827	moderate	moderate
Extreme Heat	highly likely	limited	24.676	low	low
Power Outages	highly likely	limited	24.022	low	high
Expansive Soil	highly likely	limited	21.918	low	low
Hail	highly likely	limited	21.765	low	moderate
Erosion	highly likely	limited	21.098	low	low

RISK SCORE (0-24.99) = LOW
PUBLIC RANKING (0-19) = LOW

RISK SCORE (25-29.99) = MODERATE
PUBLIC RANKING (20-60) = MODERATE

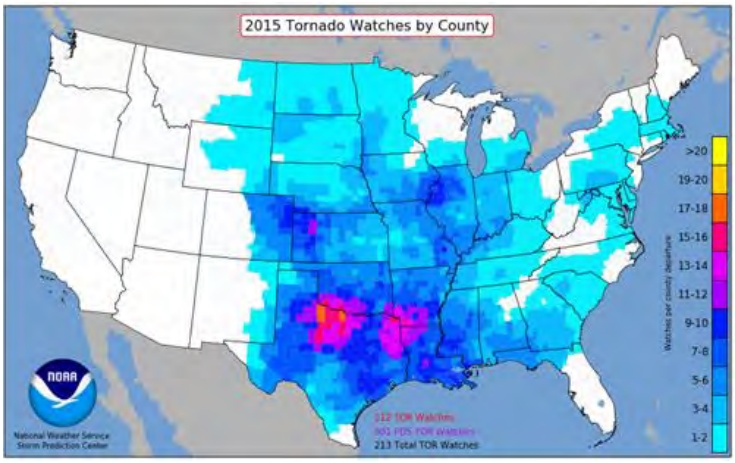
RISK SCORE (30-35) = HIGH
PUBLIC RANKING (61- 130) =HIGH

The following hazard profiles fall into two categories, natural and man-made/technological hazards. The hazards are addressed in order of ranking priority as shown above in Table 4.5 above.

Hazard Description

A tornado is defined as a rapidly rotating vortex or funnel of air extending ground ward from a cumulonimbus cloud. Most of the time, vortices remain suspended in the atmosphere. Spawned from powerful thunderstorms, tornadoes can cause fatalities and devastate neighborhoods in seconds. A tornado appears as a rotating, funnel-shaped cloud that extends from a thunderstorm to the ground with winds that can reach 300 miles per hour. According to the National Weather Service, the City of Garland is issued an average of 9-10 tornado watches per year as depicted in Figure 5.1.

Figure 5.1. NOAA's Storm Prediction Center



Location

Due to the unpredictable nature of tornadoes, it is impossible to determine the exact area of future tornado occurrences. The entire planning area, the City of Garland, is equally vulnerable to tornadoes.

Severity

The severity of a tornado can be determined by the Enhanced Fujita Scale. The Enhanced Fujita Scale rates tornadoes within the United States by estimating the amount of damage they cause. Table 5.2 provides a better understanding of the possible magnitude of tornado events. The table correlates the Enhanced Fujita Rating with the wind speed and severity of damage tornados may cause.

Figure 5.2. Enhanced Fujita Scale

EF Rating	Wind Speeds	Expected Damage		
EF-0	65-85 mph	'Minor' damage: shingles blown off or parts of a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.		
EF-1	86-110 mph	'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged.		
EF-2	111-135 mph	'Considerable' damage: roofs torn off well constructed homes, homes shifted off their foundation, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed.		
EF-3	136-165 mph	'Severe' damage: entire stories of well constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark.		
EF-4	166-200 mph	'Extreme' damage: Well constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse.		
EF-5	> 200 mph	'Massive/incredible' damage: Well constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped.		

Source: https://weather.com/storms/tornado/news/enhanced-fujita-scale-20130206

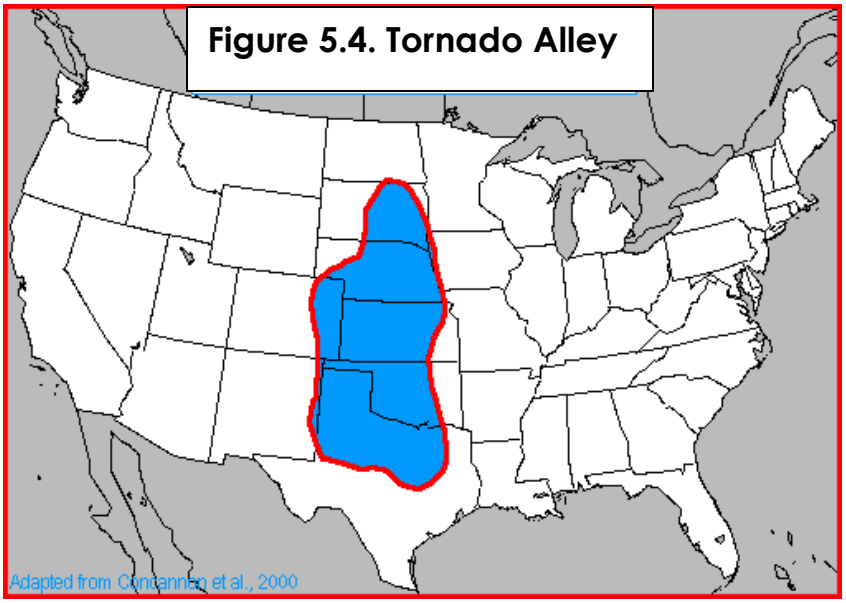
Previous Occurrences

On December 26, 2015 an EF 4 tornado with wind speeds of 180 mph impacted the City of Garland. The tornado left a 13 mile long and 550 yard wide path of destruction. The tornado caused nine fatalities on the George Bush Turnpike and caused damage to 440 single family homes, 753 apartment units, 17 commercial buildings and 2 churches. About 48,000 cubic yards of debris had to be removed from the impacted area and 26 animals rescued. This tornado cost the City of Garland roughly $1,703,320.00

Figure 5.3. Tornado Path

Probability of Future Events

The City of Garland sits in "Tornado Alley," and has a high vulnerability to tornados. Previous historical data in Table 5.5 shows a total of ninety seven tornados occurring within Dallas County since 1952. Data is not currently available specifically for the City of Garland. Calculations from this data suggests that a tornado will impact Dallas County 1.5 times a year. Therefore, according to Table 4.3 Hazard Frequency Ranking it is highly likely for a tornado to occur within Dallas County in the next year.



National Oceanic and Atmospheric Administration

Impact on Community

A future event is obviously capable of doing substantial damage to the community. The city is the second largest in Dallas County with an estimated 236,897 residents as of July 1, 2015. Infrastructure within the region is also for the most part built out. This makes warning time critical. A large population of residents would have little time to react to such an event. A tornado of medium severity (EF2-EF3) would be capable of doing great damage in such a heavily populated area.

Table 5.5 shows previous tornado occurrences from the National Climatic Data Center for all of Dallas County, Texas between 1/1/1952 and 12/31/2015. A total of 97 tornados have been reported in Dallas County. They have caused 23 deaths, 836 injuries, and an estimated $594,259,030 dollars in damage.

Summary of Vulnerability

The entire planning area is equally vulnerable to tornados. A large tornado event is capable of producing winds that can reach 300 miles per hour. Damage paths can be in excess of one mile wide and 50 miles long. The Hazard Mitigation Planning Team has determined that the City of Garland is at high risk of substantial impacts from tornados due to the number of previous occurrences combined with the impacts of those occurrences. All residential neighborhoods, businesses, critical facilities, infrastructure and populations can be impacted by tornadoes.

5.5. Tornado Historical Data

COUNTY	DATE	EVENT TYPE	EF SCALE	DEATHS	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
DALLAS CO.	3/2/1952	Tornado	F0	0	0	2,500	0
DALLAS CO.	4/2/1957	Tornado	F3	10	200	2,500,000	0
DALLAS CO.	4/3/1957	Tornado	F0	0	0	250	0
DALLAS CO.	4/20/1957	Tornado		0	0	30	0
DALLAS CO.	6/12/1957	Tornado	F3	0	0	2,500	0
DALLAS CO.	8/12/1958	Tornado	F2	0	0	2,500	0
DALLAS CO.	10/4/1959	Tornado	F3	0	0	250,000	0
DALLAS CO.	5/5/1960	Tornado	F0	0	0	0	0
DALLAS CO.	5/5/1960	Tornado	F0	0	0	2,500	0
DALLAS CO.	4/11/1961	Tornado	F2	0	3	25,000	0
DALLAS CO.	5/27/1963	Tornado	F0	0	0	0	0
DALLAS CO.	5/29/1963	Tornado	F0	0	0	0	0
DALLAS CO.	9/5/1963	Tornado		0	0	0	0
DALLAS CO.	5/23/1966	Tornado	F2	0	0	25,000	0
DALLAS CO.	3/26/1967	Tornado	F0	0	0	0	0
DALLAS CO.	5/13/1968	Tornado	F1	0	0	250	0
DALLAS CO.	5/25/1968	Tornado	F0	0	1	25,000	0
DALLAS CO.	5/8/1969	Tornado	F0	0	0	0	0
DALLAS CO.	10/12/1969	Tornado	F3	0	2	2,500	0
DALLAS CO.	4/25/1970	Tornado	F2	0	12	2,500,000	0
DALLAS CO.	2/18/1971	Tornado	F1	0	0	2500	0
DALLAS CO.	10/19/1971	Tornado	F1	0	2	250,000	0
DALLAS CO.	12/14/1971	Tornado	F1	0	1	2,500,000	0
DALLAS CO.	12/14/1971	Tornado	F1	0	1	25,000	0
DALLAS CO.	12/14/1971	Tornado	F1	0	0	250,000	0
DALLAS CO.	12/14/1971	Tornado	F2	0	4	2,500,000	0
DALLAS CO.	12/14/1971	Tornado	F1	0	4	2,500,000	0
DALLAS CO.	11/12/1972	Tornado	F1	0	0	25,000	0
DALLAS CO.	11/12/1972	Tornado	F1	0	0	250,000	0
DALLAS CO.	5/1/1973	Tornado	F1	0	0	25,000	0
DALLAS CO.	4/11/1974	Tornado	F2	0	0	250,000	0
DALLAS CO.	6/12/1974	Tornado		0	0	0	0
DALLAS CO.	6/8/1975	Tornado	F0	0	0	0	0
DALLAS CO.	7/25/1975	Tornado	F0	0	0	0	0
DALLAS CO.	3/26/1976	Tornado	F1	0	0	250	0
DALLAS CO.	5/26/1976	Tornado	F3	0	1	2,500,000	0
DALLAS CO.	7/4/1976	Tornado		0	0	2500	0
DALLAS CO.	4/20/1977	Tornado	F2	0	0	25,000	0
DALLAS CO.	5/3/1979	Tornado	F1	0	0	25,000	0
DALLAS CO.	5/3/1979	Tornado	F1	0	0	25,000	0
DALLAS CO.	5/3/1979	Tornado	F2	0	5	25,000,000	0
DALLAS CO.	5/3/1979	Tornado	F0	0	0	250	0
DALLAS CO.	5/8/1981	Tornado	F2	0	0	25,000	0
DALLAS CO.	10/13/1981	Tornado	F1	0	0	0	0
DALLAS CO.	3/14/1982	Tornado	F1	0	0	250,000	0
DALLAS CO.	4/16/1982	Tornado	F0	0	0	0	0
DALLAS CO.	5/11/1982	Tornado	F1	0	1	250,000	0
DALLAS CO.	3/23/1984	Tornado	F1	0	0	25,000	0

DALLAS CO.	12/13/1984	Tornado	F3	0	0	25,000,000	0
DALLAS CO.	12/13/1984	Tornado	F3	0	28	25,000,000	0
DALLAS CO.	5/13/1985	Tornado	F2	0	16	2,500,000	0
DALLAS CO.	3/16/1987	Tornado	F0	0	0	0	0
DALLAS CO.	1/19/1990	Tornado	F2	0	1	2,500,000	0
DALLAS CO.	10/7/1992	Tornado	F0	0	0	2,500	0
DALLAS CO.	5/9/1993	Tornado	F1	0	1	5,000,000	0
DALLAS CO.	4/25/1994	Tornado	F0	0	0	50,000	0
DALLAS CO.	4/25/1994	Tornado	F2	0	7	50,000,000	0
DALLAS CO.	4/25/1994	Tornado	F4	3	48	500,000	0
DALLAS CO.	4/29/1994	Tornado	F0	0	0	0	0
DALLAS CO.	10/21/1994	Tornado	F0	0	0	0	0
DALLAS CO.	10/21/1994	Tornado	F0	0	0	0	0
DALLAS CO.	10/21/1994	Tornado	F0	0	0	0	0
DALLAS CO.	10/21/1994	Tornado	F0	0	0	0	0
DALLAS CO.	3/25/1995	Tornado	F0	0	0	0	0
DALLAS CO.	4/19/1995	Tornado	F0	0	0	0	0
DALLAS CO.	4/19/1995	Tornado	F1	0	8	600,0000	0
DALLAS CO.	1/17/1996	Tornado	F1	0	1	750,000	0
DALLAS CO.	1/17/1996	Tornado	F2	0	0	750,000	0
DALLAS CO.	1/17/1996	Tornado	F1	0	0	0	0
DALLAS CO.	1/17/1996	Tornado	F1	0	0	0	0
DALLAS CO.	1/17/1996	Tornado	F0	0	0	0	0
DALLAS CO.	1/17/1996	Tornado	F0	0	0	0	0
DALLAS CO.	1/17/1996	Tornado	F1	0	0	0	0
DALLAS CO.	10/21/1996	Tornado	F1	0	7	3,000,000	0
DALLAS CO.	10/21/1996	Tornado	F0	0	1	120,000	0
DALLAS CO.	3/28/2000	Tornado	F2	0	0	0	0
DALLAS CO.	3/28/2000	Tornado	F0	0	0	0	0
DALLAS CO.	9/5/2001	Tornado	F1	0	0	125,000	0
DALLAS CO.	4/5/2003	Tornado	F0	0	0	1,000	0
DALLAS CO.	4/25/2005	Tornado	F0	0	0	0	0
DALLAS CO.	4/13/2007	Tornado	EF0	0	0	50,000	0
DALLAS CO.	6/26/2007	Tornado	EF0	0	0	60,000	0
DALLAS CO.	4/10/2008	Tornado	EF1	0	0	1,000,000	0
DALLAS CO.	9/8/2010	Tornado	EF1	0	0	200,000	0
DALLAS CO.	9/8/2010	Tornado	EF2	0	1	750,000	0
DALLAS CO.	5/24/2011	Tornado	EF1	0	0	150,000	0
DALLAS CO.	5/24/2011	Tornado	EF0	0	0	0	0
DALLAS CO.	4/3/2012	Tornado	EF2	0	10	400,000,000	3000
DALLAS CO.	4/3/2012	Tornado	EF0	0	0	4,000	0
DALLAS CO.	4/3/2012	Tornado	EF0	0	0	100,000	0
DALLAS CO.	4/3/2012	Tornado	EF0	0	0	150,000	0
DALLAS CO.	4/3/2012	Tornado	EF0	0	2	300,000	0
DALLAS CO.	5/8/2014	Tornado	EF0	0	0	80,000	0
DALLAS CO.	5/24/2015	Tornado	EF1	0	0	100,000	0
DALLAS CO.	5/24/2015	Tornado	EF1	0	0	600,000	0
DALLAS CO.	12/26/2015	Tornado	EF3	0	0	1,370,000	0
DALLAS CO.	12/26/2015	Tornado	EF4	10	468	26,000,000	0

National Climatic Data Center

Severe Winter Weather

Hazard Description

Severe winter weather can be a variety of precipitation that forms at low temperatures such as heavy snowfall, sleet or ice. Many winter depressions give rise to exceptionally heavy rain and widespread flooding. Conditions worsen if the precipitation is frozen.

Location

Due to the unpredictable nature of winter storms, it is impossible to determine the exact area of their future occurrences. The entire planning area, City of Garland, is equally subject to severe winter weather.

Severity

Table 5-10 shows the National Weather Service Wind Chill Temperature (WCT) index. It uses advances in science, technology, and computer modeling to provide an accurate, understandable, and useful formula for calculating the dangers from winter winds and freezing temperatures. The index:

- Calculates wind speed at an average height of five feet
- Incorporates heat transfer theory which is heat loss from the body to its surroundings during cold windy days
- Lowers the calm wind threshold to 3 mph
- Uses a consistent standard for skin tissue resistance
- Assumes no impact from the sun (i.e., clear night sky)

Table 5.10

NWS Windchill Chart

Wind (mph) \ Temperature (°F)	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
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

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

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

The National Weather Service

Table 5.11 is the Sperry–Piltz Ice Accumulation (SPIA) Index. This is a newly developed index that when combined with National Weather Service forecast data can help predict impacts from ice. It uses ice accumulation, wind speeds, and temperatures to predict the impact of winter storms on public utilities, particularly power lines. It is a tool used for risk management and winter weather preparedness.[2]

Table 5.11

The Sperry-Piltz Ice Accumulation Index, or "SPIA Index" – Copyright, February, 2009

ICE DAMAGE INDEX	* AVERAGE NWS ICE AMOUNT (in inches) *Revised-October, 2011	WIND (mph)	DAMAGE AND IMPACT DESCRIPTIONS
0	< 0.25	< 15	Minimal risk of damage to exposed utility systems; no alerts or advisories needed for crews, few outages.
1	0.10 – 0.25	15 - 25	Some isolated or localized utility interruptions are possible, typically lasting only a few hours. Roads and bridges may become slick and hazardous.
	0.25 – 0.50	> 15	
2	0.10 – 0.25	25 - 35	Scattered utility interruptions expected, typically lasting 12 to 24 hours. Roads and travel conditions may be extremely hazardous due to ice accumulation.
	0.25 – 0.50	15 - 25	
	0.50 – 0.75	< 15	
3	0.10 – 0.25	> = 35	Numerous utility interruptions with some damage to main feeder lines and equipment expected. Tree limb damage is excessive. Outages lasting 1 – 5 days.
	0.25 – 0.50	25 - 35	
	0.50 – 0.75	15 - 25	
	0.75 – 1.00	< 15	
4	0.25 – 0.50	> = 35	Prolonged & widespread utility interruptions with extensive damage to main distribution feeder lines & some high voltage transmission lines/structures. Outages lasting 5 – 10 days.
	0.50 – 0.75	25 - 35	
	0.75 – 1.00	15 - 25	
	1.00 – 1.50	< 15	
5	0.50 – 0.75	> = 35	Catastrophic damage to entire exposed utility systems, including both distribution and transmission networks. Outages could last several weeks in some areas. Shelters needed.
	0.75 – 1.00	> = 25	
	1.00 – 1.50	> = 15	
	> 1.50	Any	

(Categories of damage are based upon combinations of precipitation totals, temperatures and wind speeds/directions.)

Previous Occurrences

Several major severe winter weather events have impacted Garland over the past few years. An arctic front moved into the Dallas area during the early morning hours of January 31, 2011. The timing of the cold front interacted with the moist air from the Gulf and caused precipitation to fall as freezing rain at first, then sleet and finally snow. This caused a thick sheet of ice to form on all of the roadways causing extremely hazardous driving conditions. Temperatures continued to stay below freezing for the next few days which prevented the drying and clearing of roadways. School districts were closed for the duration of the event and most municipal courts and solid waste services had to be cancelled or postponed. On Friday, February 4th, the City of Garland chose to close most City facilities at noon after another storm system brought an additional 6 inches of snow. The ice storm nearly paralyzed the Metroplex for four days. As if that wasn't enough, a band of moderate sleet moved through Garland in the early morning hours of February 9, 2011, leaving roadways and sidewalks with about a ¼" of ice on them.

[2] SPIA Index: http://www.spia-index.com/

A few years later, Winter Storm Cleon delivered snow, sleet, and freezing rain to a large swath of the Dallas Country from December 1, 2013 through the morning of December 7, 2013. Garland had the following impacts from this winter weather event: approximately 200 reports of downed trees, 3,500 power outages, 7 house fires, City facility walkways iced over, one fire station could not take calls due to affected power lines, City services and staffing levels were modified, Garland Independent School District closed early, Dallas Area Rapid Transit (DART) light rails were not operational and major increases of vehicle accidents.

Probability of Future Events

Severe winter weather within Dallas County occurs several times a year, although the severity of impact varies. Previous historical data in Table 5.12 shows a total of 58 severe winter weather events have occurred within Dallas County since 1996. Data is not currently available specifically for the City of Garland. Calculations from this data suggests that a severe winter weather event will impact Dallas County 2.9 times a year. Therefore, according to Table 4.3 Hazard Frequency Ranking it is highly likely for a severe winter weather event to occur within the next year.

Impact on Community

City of Garland residents are generally unfamiliar with snow, ice and freezing temperatures. When these conditions occur residents do not know how to prepare and respond. When temperatures fall below freezing this kills tender vegetation, such as flowering plants and citrus fruit crops. Wet snow and ice rapidly accumulates on trees with leaves, causing the branches to snap under the load. Motorists are unaccustomed to driving on slick roads and accidents increase exponentially. Some buildings are poorly insulated or lack heat altogether, forcing residents to live in freezing temperatures. While snowstorms are not frequent in Texas, ice storms create dangerous driving conditions causing an increase in accidents. Pipes freeze and leave residents without water and damage to their homes. Power lines and trees snap due to the weight of the ice on them leaving residents unable to run the heater in their homes. Because more than half of residents are impacted by large severe winter weather the Planning Team has determined that impacts are substantial.

The biggest concern with severe winter weather in the City of Garland is the previously stated nature of residents being unaccustomed to it. Although Dallas County is impacted by some form of severe winter weather several times a year large, incidents are not as frequent. This brings up safety concerns, as some are not educated on how to properly deal with large amounts of snow and ice. According to the National Climatic Data Center, 58 severe winter weather events have been reported in Dallas County, Texas between 1/1/1996 and 12/31/2016. They have caused 2 deaths, and caused an estimated $201,500,000 dollars in property damage.

Table 5.12 Severe Winter Weather Historical Data

COUNTY	DATE	EVENT TYPE	DEATHS	PROPERTY DAMAGE
DALLAS	2/1/1996	Heavy Snow	0	0
DALLAS	11/24/1996	Winter Storm	0	0
DALLAS	1/6/1997	Heavy Snow	0	0
DALLAS	1/12/1997	Winter Weather	0	0
DALLAS	1/14/1997	Winter Weather	0	0
DALLAS	12/22/1998	Ice Storm	0	0
DALLAS	1/25/2000	Winter Storm	1	0
DALLAS	12/12/2000	Winter Storm	0	0
DALLAS	12/25/2000	Winter Storm	0	0
DALLAS	12/31/2000	Winter Storm	0	0
DALLAS	1/1/2001	Heavy Snow	0	0
DALLAS	11/28/2001	Ice Storm	0	0
DALLAS	2/5/2002	Winter Storm	0	0
DALLAS	3/2/2002	Winter Storm	0	0
DALLAS	2/24/2003	Winter Storm	0	0
DALLAS	2/14/2004	Heavy Snow	0	0
DALLAS	12/22/2004	Winter Weather	0	0
DALLAS	12/7/2005	Winter Storm	0	0
DALLAS	2/18/2006	Winter Weather	0	0
DALLAS	11/30/2006	Winter Storm	0	20,000
DALLAS	1/13/2007	Ice Storm	0	50,000
DALLAS	1/17/2007	Winter Weather	0	20,000
DALLAS	2/1/2007	Winter Weather	0	0
DALLAS	12/15/2008	Winter Weather	0	0
DALLAS	12/23/2008	Winter Weather	0	0
DALLAS	1/5/2009	Winter Weather	0	35,000
DALLAS	1/27/2009	Ice Storm	1	300,000
DALLAS	12/24/2009	Winter Weather	0	250,000
DALLAS	1/7/2010	Winter Weather	0	700,000
DALLAS	2/11/2010	Heavy Snow	0	16,000
DALLAS	3/20/2010	Winter Weather	0	100,000
DALLAS	2/1/2011	Ice Storm	0	500,000
DALLAS	2/3/2011	Heavy Snow	0	150,000
DALLAS	12/5/2013	Winter Storm	0	2,000,000
DALLAS	2/10/2014	Winter Weather	0	0
DALLAS	2/22/2015	Winter Storm	0	25,000
DALLAS	3/4/2015	Heavy Snow	0	0
DALLAS	3/4/2015	Sleet	0	0
DALLAS	3/4/2015	Sleet	0	0
DALLAS	3/4/2015	Winter Weather	0	0
DALLAS	3/5/2015	Heavy Snow	0	0
DALLAS	3/5/2015	Heavy Snow	0	0

DALLAS	3/5/2015	Heavy Snow	0	0
DALLAS	3/5/2015	Heavy Snow	0	0
DALLAS	3/5/2015	Heavy Snow	0	0
DALLAS	3/5/2015	Heavy Snow	0	0
DALLAS	3/5/2015	Heavy Snow	0	0
DALLAS	3/5/2015	Heavy Snow	0	0
DALLAS	3/5/2015	Heavy Snow	0	0
DALLAS	3/5/2015	Heavy Snow	0	0
DALLAS	3/5/2015	Heavy Snow	0	0
DALLAS	3/5/2015	Heavy Snow	0	0
DALLAS	3/5/2015	Heavy Snow	0	0
DALLAS	3/5/2015	Heavy Snow	0	0
DALLAS	3/5/2015	Heavy Snow	0	0
DALLAS	3/5/2015	Sleet	0	0
DALLAS	3/5/2015	Winter Weather	0	0
DALLAS	3/5/2015	Winter Weather	0	0

National Climatic Data Center

Summary of Vulnerability

The entire planning area is equally vulnerable to severe winter weather. The Planning Team has determined that the City is at high risk of substantial impact from severe winter weather. The biggest concern to the planning area is maintaining power to structures, as winter weather may cause disruptions. The other concern is the citizen's inexperience in preparing for the highly likely severe winter weather events.

Terrorism

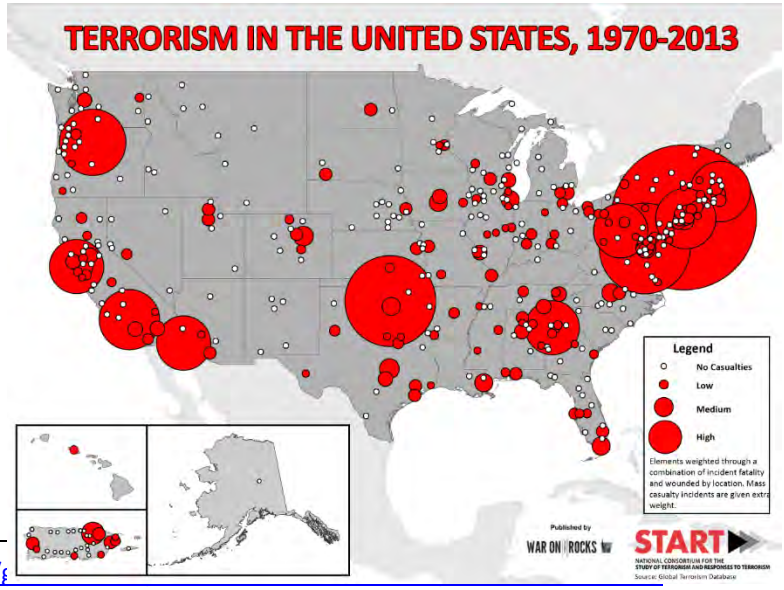
Hazard Description

According to the Homeland Security Act of 2002, terrorism is defined as activity that is dangerous to human life or potentially destructive of critical infrastructure or key resources. Terrorism can be a violation of the criminal laws of the United States or of any State or other subdivision. Terrorism can include intimidating or coercion of a civilian population to influence the policy or to affect the government by mass destruction, assassination, or kidnapping. There are different types of terrorism defined by the motivation behind attacks. There are also different methods and tactics that terrorists use in their attacks such as assassination, explosives, radiological threat, radicalization, chemical threats, biological threats, active shooters, infrastructure threats, arson, kidnapping and cyber threats.

Location

The entire planning area, the City of Garland, is subject to terrorism. It is thought that terrorism occurs most often where populations are high, at crowded events or symbolic venues that will generate the greatest media attention. Garland is a high population jurisdiction that is located near other areas that have had terrorism incidents occur. Figure 5.28 depicts all terrorist attacks over four decades. The size of the circle reflects the number of casualties from each attack. The data used was from the Global Terrorism Database. Terrorists often identify soft targets to attack. Soft targets are people or places that are relatively unprotected or vulnerable. Soft targets include public places like shopping malls, movie theaters, hotels, special events and community centers.[3] The City of Garland is not a stranger to terrorism. In May of 2015, a terrorist event occurred at the local Curtis Culwell Center.

Figure 5.28



[3] Global Risk Insights: http://

Michael Jetter, a professor at the School of Economics and Finance at Universidad EAFIT in Medellín, Colombia, and a research fellow at the Institute for the Study of Labour in Bonn, Germany, conducted a study on more than 60,000 terrorist attacks reported in the New York Times between 1970 and 2012. His research was able to link media coverage of acts of terrorism to an increase of attacks committed in the same area. If this research is accurate, because of the media coverage of the Garland terrorism incident the city is at a greater risk of another attack at that location. In addition to the Curtis Culwell Center, there are other vulnerable locations within the City such as, local special events.

Severity

In 2014, a total of 13,463 terrorist attacks occurred worldwide, resulting in more than 32,700 deaths and more than 34,700 injuries. In addition, more than 9,400 people were kidnapped or taken hostage.[4] Only a small percentage of these events occurred on American soil. However, with the ever changing political environment, it is not clear how much this percentage may shift over time.

Table 5.29. Terrorist attacks and casualties worldwide

	Total Attacks		Total Fatalities		Fatalities per Attack		Total Injuries		Injured per Attack		Hostages Taken	
Year	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**
Worldwide	13,463	9,964	32,727	18,066	2.57	1.86	34,791	32,880	2.86	3.45	9,428	3,137

Previous Occurrences

On May 3, 2015, a cartoon drawing contest, "Draw the Prophet", was held at Garland Independent School District (GISD), Curtis Culwell Center. As the event was coming to an end, two males drove up to the front of the building. Both males were armed and opened fire, striking a GISD security officer. Garland police shot and killed both gunmen. The security guard's injuries were not life threatening, and Garland police officers were able to minimize the threat quickly. Police believed the suspects' vehicle may have contained an incendiary device and the Garland Explosive Ordnance Disposal (EOD) Team cleared and secured the vehicle and surrounding area. The surrounding businesses and event participants were evacuated until the scene was cleared.

Probability of Future Events

Because there has been a related terrorism attack in the City of Garland the Planning Team determined that a terrorist attack will occasionally occur in the City of Garland. Occasionally is defined as within the next six years. The likelihood of another terrorism event has also increased due to the recent release of "Attack in Garland" on March 26, 2017, a 60 Minutes Anderson Cooper broadcast. According to Michael Jetter's research described above, terrorist thrive on media attention so this media coverage has potential to heighten the terrorism threat in Garland.

[4] U.S State Department: https://www.state.gov/j/ct/rls/crt/2014/239416.htm

Impact on Community
Terrorism is a rare occurrence in Garland, but because soft targets are the aim and because it's difficult to predict, the severity of impact would be substantial. The U.S Department of State reports that on average in 2014, there were 2.57 fatalities and 2.87 injuries per attack. The other risk of terrorism are regarding infrastructure and cyber-attacks that would impact government critical facilities and services.

Summary of Vulnerability
The entire planning area is equally vulnerable to terrorism. It is probable that there will be some type of terrorism in the City of Garland within the next six years. If a terrorist achieves their goal, the severity of impact would be substantial. Because of previous occurrences, the City of Garland Planning Team considers terrorism to be a high risk hazard.

Soft targets will remain a threat because they have operational characteristics that make them vulnerable and easy to exploit: open and spacious areas, multiple entrances and exits, parking in close proximity, lack of security, and individual screening. These characters give higher rates of success to terrorists and make the community more vulnerable.

Biological Event

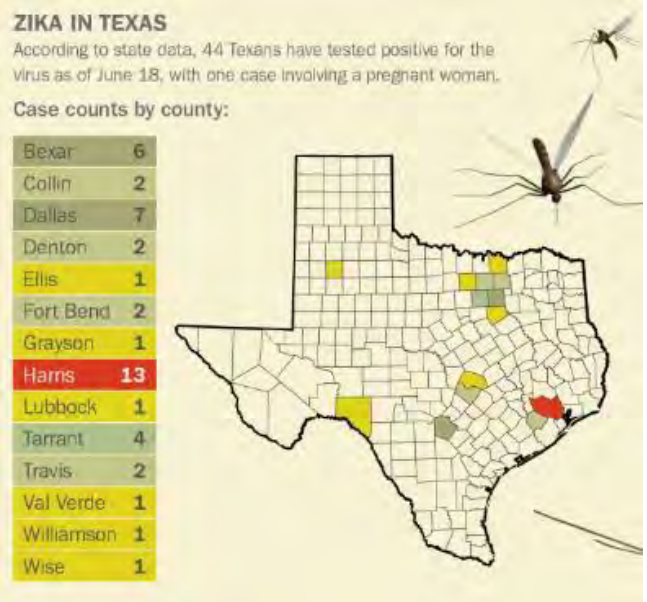
Hazard Description

In this section biological hazards refers to an accidental or naturally occurring disease outbreak of known or unknown origin that pose a threat to the health of living organisms, primarily that of humans. This definition also includes those biological agents found in the environment, or diagnosed in animals, that have the potential for transmission to humans. Intentional transmission of infectious agents is included in the terrorism profile. Examples of biological events include but are not limited to: Zika, H1N1, Ebola, and West Nile.

Location

Because of the mobile nature of populations, it is impossible to accurately map the location of biological events. The entire planning area, the City of Garland, is equally subject to biological events.

Figure 5.30

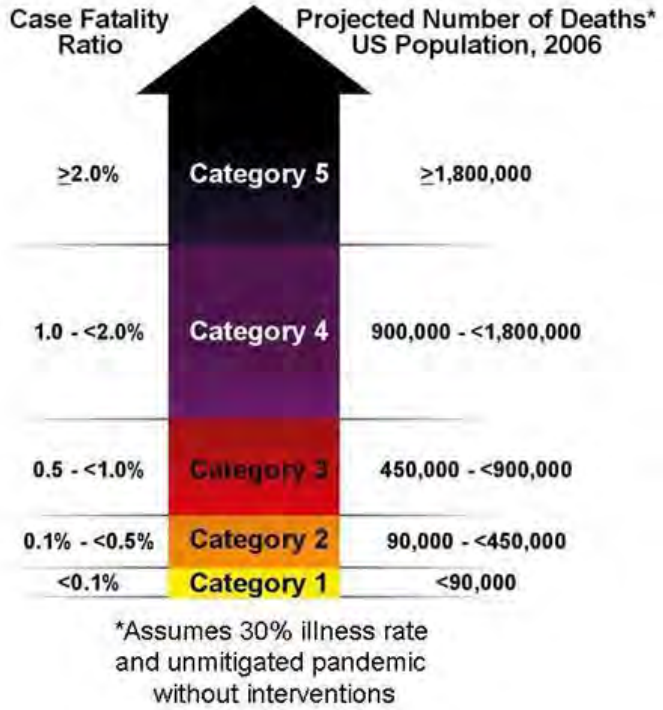


Severity

The Center for Disease Control and Prevention (CDC) determines the severity of pandemics and communicable disease outbreaks based on a measurement system known as the Pandemic Severity Index. The main criteria used to measure pandemic severity will be the case-fatality ratio (CFR), the percentage of deaths out of the total reported cases of the disease. Accompanying the Pandemic

Severity Index is the Interventions by setting table that can be used as a guide for mitigation actions during a biological event. In Table 5.31 below these tools are illustrated.

Table 5.31



	Pandemic Severity Index		
Interventions* by Setting	**1**	**2 and 3**	**4 and 5**
Home **Voluntary isolation** of ill at home (adults and children); combine with use of antiviral treatment as available and indicated	**Recommend†§**	**Recommend†§**	**Recommend†§**
Voluntary quarantine of household members in homes with ill persons¶ (adults and children); consider combining with antiviral prophylaxis if effective, feasible, and quantities sufficient	**Generally not recommended**	**Consider****	**Recommend****
School **Child social distancing**			
-dismissal of students from schools and school based activities, and closure of child care programs	**Generally not recommended**	**Consider: ≤4 weeks††**	**Recommend: ≤12 weeks§§**
-reduce out-of-school social contacts and community mixing	**Generally not recommended**	**Consider: ≤4 weeks††**	**Recommend: ≤12 weeks§§**
Workplace / Community **Adult social distancing**			
-decrease number of social contacts (e.g., encourage teleconferences, alternatives to face-to-face meetings)	**Generally not recommended**	**Consider**	**Recommend**
-increase distance between persons (e.g., reduce density in public transit, workplace)	**Generally not recommended**	**Consider**	**Recommend**
-modify postpone, or cancel selected public gatherings to promote social distance (e.g., postpone indoor stadium events, theatre performances)	**Generally not recommended**	**Consider**	**Recommend**
-modify work place schedules and practices (e.g., telework, staggered shifts)	**Generally not recommended**	**Consider**	**Recommend**

Source CDC - https://www.cdc.gov/media/pdf/MitigationSlides.pdf

Previous Occurrences

On October 17, 2014 the City of Garland Public Health Department reported that three cases of Ebola had been confirmed in Dallas County since September 28. At least five contacts in Garland were monitored by Dallas County Health and Human Services. These contacts were on an airplane with a nurse that tested positive for the virus. One of the contacts in Garland was asked by Dallas County Health to stay home for 21 days and was monitored twice a day by phone and was told not to travel. The four additional Garland contacts were considered extremely low risk. They self-monitored twice a day by phone. Approximately177 people in the Dallas area fell under some type of quarantine.[5]

On May 4, 2009, the Dallas County Department of Health and Human Services Department released a health alert which stated "the World Health Organization's pandemic alert level has been raised to 5, signifying human-to-human transmission and sustained community-wide outbreaks with the Novel Influenza A (H1N1) virus, and an imminent likelihood of a pandemic. Community transmission is currently occurring in Dallas County, with 58 probable and confirmed cases identified over the past 8 days."

Probability of Future Events

The occurrence of a biological event is largely impossible to predict, due to the mobile nature of humans and the speed at which a pathogen can spread and mutate. A total of 3 biological events have occurred within Dallas County, with a direct impact on the City of Garland, since 2009. Calculations from this data suggests that a biological event will occur in Dallas County and subsequently the City of Garland, 0.4 times a year. Therefore, according to Table 4.3 Hazard Frequency Ranking it is likely a biological event will occur in Garland within the next three years.

Impact on Community

The potential impact of loss of life and illness from a large biological event is major. Government service levels could potentially be modified to prevent the spread of illness.

Summary of Vulnerability

The entire planning area is equally vulnerable to biological events. The probability of a biological event occurring in Garland to some extent within the next three years is likely. This type of hazard has the potential to cause major impacts to the lives of Garland residents. These factors make a biological hazard a moderate risk for the City of Garland.

[5] Vanity Fair: http://www.vanityfair.com/news/2015/02/ebola-us-dallas-epidemic

Flood

Hazard Description

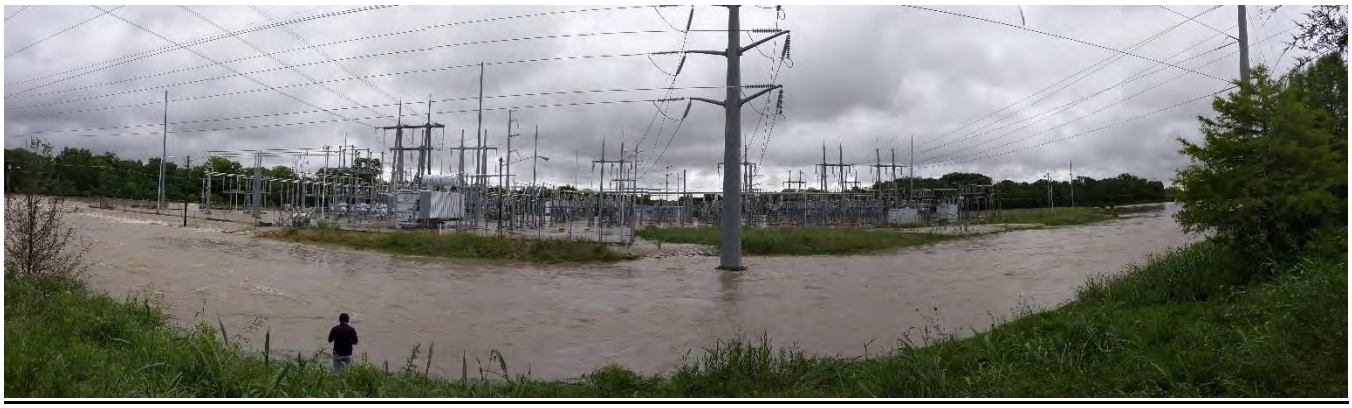
Floods are the most prevalent hazard in the United States. A flood is defined as two or more acres of dry land or two or more properties that are covered by water temporarily. There are three types of flooding that occur in Garland: river flood, inland flooding and flash floods. Two types of floods that does not impact Garland are coastal floods and storm surges.

A river flood occurs when water levels rise over the top of river banks due to excessive rain or persistent thunderstorms over the same area for extended periods of time.

Inland flooding occurs when moderate precipitation accumulates over several days where intense precipitation falls over a short period.

A flash flood is caused by heavy or excessive rainfall in a short period of time, generally less than six hours. Flash floods are usually characterized by raging torrents after heavy rains that rip through river beds and urban streets. They can occur within minutes or a few hours of excessive rainfall. They can also occur when no rain has fallen in the area or after a levee or dam has failed. Flash floods are particularly dangerous in urban areas and cause the greatest damage. As more farmlands and wooded areas are converted to urban and suburban areas, the amount of surface area available for water infiltration into the soils decrease. Home sites, parking lots, buildings, and roadways all decrease the surface area of soil on the Earth's surface.

According to the National Weather Service, about 10% of the land in the United States is paved. Water that would have been absorbed into the ground now is redirected into sewage and storm drain systems. In addition to the increase in urban structures, there is a resulting decrease in vegetation which causes additional flooding.



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Location

Figure 5.6 shows the City of Garland in relation to the 100 and 500 year floodplains. FEMA has published Flood Insurance Rate Maps (FIRMs) showing approximately 2,400 acres of the 100-year floodplain primarily along Duck Creek, Rowlett Creek, Spring Creek, Mills Branch and their tributaries.

Figure 5.6. FEMA 2014 100 and 500 Year Floodplain

City of Garland GIS. Note: FEMA-issued Flood Insurance Rate Maps should be used for detailed floodplain determinations.

Severity

Flood severities are determined by Federal Emergency Management Agency (FEMA) flood zone designations. Flood zones are geographic areas that FEMA has defined according to varying levels of flood risk. These zones are depicted on a community's Flood Insurance Rate Map (FIRM) or Flood Hazard Boundary Map. Each zone reflects the severity of impact or type of flooding in the area. Only a few small areas within the City of Garland are Zone A.

Table 5.7. FEMA Flood Zones

Moderate to Low Risk

Zone	Description
B and X (Shaded light blue in figure?)	Area of moderate flood hazard, usually the area between the limits of the 100-year and 500-year floods. B Zones are also used to designate base floodplains of lesser hazards, such as areas protected by levees from 100-year flood, or shallow flooding areas with average depths of less than one foot or drainage areas less than 1 sq. mi.
C and X (Shaded light blue in figure?)	Area of minimal flood hazard, usually depicted on FIRMs as above the 500-year flood level. Zone C may have ponding and local drainage problems that don't warrant a detailed study or designation as base floodplain. Zone X is the area determined to be outside the 500-year flood and protected by levee from 100-year flood.

High Risk Areas

Zone	Description
A	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas; no depths or base flood elevations are shown within these zones.
AE	The base floodplain where base flood elevations are provided. AE Zones are now used on new format FIRMs instead of A1-A30 Zones.
A1-30	These are known as numbered A Zones (e.g., A7 or A14). This is the base floodplain where the FIRM shows a BFE (old format).
AH	Areas with a 1% annual chance of shallow flooding, usually in the form of a pond, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
AO	River or stream flood hazard areas, and areas with a 1% or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Average flood depths are shown within these zones.
AR	Areas with a temporarily increased flood risk due to the building or restoration of a flood control system (such as a levee or a dam). Mandatory flood insurance purchase requirements will apply, but rates will not exceed the rates for unnumbered A zones if the structure is built or restored in compliance with Zone AR floodplain management regulations.
A99	Areas with a 1% annual chance of flooding that will be protected by a Federal flood control system where construction has reached specified legal requirements. No depths or base flood elevations are shown within these zones.

High Risk – Coastal Areas

Zone	Description
V	Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves. These areas have a 26% chance of flooding over the life of a 30-year mortgage. No base flood elevations are shown within these zones.
VE, V1-30	Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.

Undetermined Risk Areas

Zone	Description
D	Areas with possible but undetermined flood hazards. No flood hazard analysis has been conducted. Insurance rates are commensurate with the uncertainty of the risk.

FEMA Map Service Center
http://www.msc.fema.gov/webapp/wcs/stores/servlet/info?storeId=10001&catalogId=10001&langl d=-1&content=floodZones&title=FEMA%20Flood%20Zone%20Designations

Previous Occurrences

Damaging flood events occurred on Duck Creek in 1949, 1957, 1962, 1966, 1969, 1971, 1977, 1981, 1989, 1990, 1991 and 2015. These floods caused considerable damage. Following the flooding events of 1990 and 1991, the City of Garland partnered with the United States Army Corps of Engineers to complete a channel improvement project for Duck Creek. This project was complete in 1998. As a result, the base flood elevation was lowered to a level where 514 structures now have the ground floor situated above the base flood elevation. The Letter of Map Revision (LOMR) indicates this change and was finalized on February 5, 2003. Since this improvement to Duck Creek, flood events have lowered dramatically, until 2015 when two flood incidents took the life of one person attempting to cross a flooded road. This was a result of an estimated 100 year flood. However, damage would have been much greater had the Army Corps of Engineers channel improvement project not been completed. Since the 2015 incidents, locking flood gates have been installed across frequently flooded roadways to minimize future loss of life to residents and increase safety.

Probability of Future Events

The City of Garland is subject to flooding from Duck Creek, Rowlett Creek, Spring Creek, Mills Branch, and their tributaries. The planning area is subject to intense local thunderstorms of short duration and general storms extending over periods of several days. Flooding results primarily from stream overflow caused by rainfall runoff, ponding, and sheet flow. Most of the flooding events occur in the spring and summer months. However, severe flooding can be produced by rainfall at any time. Previous historical data in Table 5.8 shows 16 flood events have occurred within Garland since 1998. Calculations from this data suggests that a flood event will impact Garland 0.9 times a year. Therefore, according to Table 4.3 Hazard Frequency Ranking it is it is highly likely for a flood event to occur within the next year.

Impact on Community

A flood of the same magnitude as that of the 1991 Duck Creek flooding event would cause significantly less damage than it did before the channel widening project. Table 5.8 shows previous flood occurrence data from the NCDC. Sixteen flood events have been reported in Garland between 1/1/1998 and 12/31/2015. Those floods caused two deaths. The May 2015 flood caused an estimated $8 million dollars in property damage impacting over 100 homes and caused $884,506.19 of damage to City facilities and infrastructure. Another large flood event would undoubtedly cause major damage to the community.

Table 5.8. Flood Historical Data

COUNTY	TOWN	DATE	EVENT TYPE	DEATHS	PROPERTY DAMAGE	CROP DAMAGE
DALLAS CO.	GARLAND	9/16/1998	Flash Flood	0	0	0
DALLAS CO.	GARLAND	11/24/1996	Flash Flood	0	0	0
DALLAS CO.	GARLAND	9/16/1998	Flash Flood	0	0	0
DALLAS CO.	GARLAND	12/4/1998	Flash Flood	1	0	0
DALLAS CO.	GARLAND	12/4/1998	Flash Flood	0	0	0
DALLAS CO.	GARLAND	6/11/2000	Flash Flood	0	0	0
DALLAS CO.	GARLAND	4/7/2002	Flash Flood	0	0	0
DALLAS CO.	GARLAND	10/18/2002	Flash Flood	0	0	0
DALLAS CO.	GARLAND	1/3/2005	Flash Flood	0	0	0
DALLAS CO.	GARLAND	6/26/2007	Flash Flood	1	0	0
DALLAS CO.	GARLAND	6/27/2007	Flash Flood	0	0	0
DALLAS CO.	GARLAND	9/9/2007	Flash Flood	0	25,000	0
DALLAS CO.	GARLAND	3/18/2008	Flash Flood	0	15,000	0
DALLAS CO.	GARLAND	5/29/2015	Flash Flood	0	0	0
DALLAS CO.	GARLAND	5/29/2015	Flash Flood	0	8,884,506	0
DALLAS CO.	GARLAND	5/30/2015	Flash Flood	1	0	0

National Climatic Data Center

Summary of Vulnerability

The principal flood problem in the City of Garland is the low-lying area adjacent to Duck Creek. The Duck Creek watershed is approximately 96 percent developed with only a small portion of the watershed available for future development. The United States Army Corps of Engineers (USACE) considers existing and future urbanization conditions to remain the same for the Duck Creek basin. The mitigation enhancements to the City which also include 8 flood gates and an aggressive floodplain management program has lessened the impact of a flood event. The Hazard Mitigation Planning Team has determined that the City of Garland is at moderate risk of major impacts from floods due to the number of previous occurrences, combined with the impacts of those occurrences, severe thunderstorms the area sustains and heavy development surrounding Garland.

National Flood Insurance Program Overview

Summary

Nearly 20,000 communities across the United States and its territories participate in the NFIP by adopting and enforcing floodplain management ordinances. In exchange, the NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in these communities. Participation in the NFIP is voluntary.

Flood insurance is designed to provide an alternative to disaster assistance and reduce the costs of repairing damage to buildings and their contents caused by floods. Flood damage is reduced by nearly $1 billion a year through communities implementing sound floodplain management requirements and property owners purchasing flood insurance. Additionally, buildings constructed in compliance with NFIP building standards suffer approximately 80 percent less damage annually than those not built in compliance.

Local Participation in the NFIP

Based on TCEQ records, the City of Garland enrolled in the NFIP Emergency Program on August 8, 1970 and the Regular Program on April 16, 1971. As of September, 2015 the City of Garland had 450 active flood insurance policies within the community. Between January 1, 1978 and September 1, 2016 the City of Garland had 452 total flood losses, damage valued roughly at $10 million dollars. Table 5.8 shows all flood losses for the City of Garland.

Table 5.8

Federal Emergency Management Agency Loss Statistics from Jan 1, 1978 through 11/1/2016					
Community	Total	Closed	Open Losses	CWOP	**Total**
Garland	**462**	**376**	**0**	**86**	**$9,933,174.11**

Source: http://bsa.nfipstat.fema.gov/reports/1040.htm

Repetitive Loss Properties

- Two or more claims of more than $1,000 paid by the NFIP within any 10-year period since 1978.

To focus resources on those properties that represent the best opportunities for mitigation, Congress defined a subset called "Severe Repetitive Loss Properties" defined below

Severe Repetitive Loss Properties

- Four or more claims of more the $5,000; or
- Two to three claims that cumulatively exceed the building's value

Assessing Vulnerability: Addressing Repetitive Loss

The Federal Emergency Management Agency (FEMA) produces statistics on community flood losses. Losses are determined by claims made to the National Flood Insurance Program (NFIP). The following section is an assessment of claims to the NFIP, and properties within the City of Garland which are designated as repetitive loss structures.

Table 5.9 provides a summary of residential repetitive flood insurance claims for individual streets in Garland that include repetitive loss properties. Address data about individual sites has been omitted for confidentiality. The loss history includes all flood claims paid on an insured property, regardless of any change of ownership. The data begins at the building's construction or back to 1978 if the building was constructed prior to 1978. The history includes the number of repetitive loss properties on each street, average total amount paid to each structure, date of the last loss, and the average estimated structure value.

Table 5.9 City of Garland Repetitive Loss Properties

Street Name	Number of Properties with Losses	Total Number of Losses	Date of Last Loss	Average Amount Paid Per Structure	Average Structure Value
Glenbrook DR	24	78	9/10/2007	$105,223.88	$146,544.81
Ridgedale DR	13	32	3/19/2006	$81,330.96	$156,344.29
Forest LN	3	7	10/21/1994	$57,938.14	$269,333.33
Rock Creek	3	6	4/12/1991	$35,177.48	$138,866.67
Ranier Cir	3	6	4/11/1991	$34,047.75	$108,573.33
Pleasant Valley RD	2	16	3/18/2008	$218,739.30	$71,160.00
University DR	2	5	4/12/1991	$10,848.80	$145,610.00
Frances DR	1	2	4/11/1991	$25,616.67	$96,580.00
ST George	1	2	4/15/1990	$5,721.97	$98,730.00
W Centerville RD	1	4	6/11/2000	$30,761.74	$140,500.00
Iroquois	1	2	5/5/1995	$7,233.95	$119,590.00
Carroll DR	1	5	6/21/2000	$51,770.75	$234,170.00
Brookview	1	2	4/11/1991	$16,393.64	$67,000.00

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Earthquake

Hazard Description

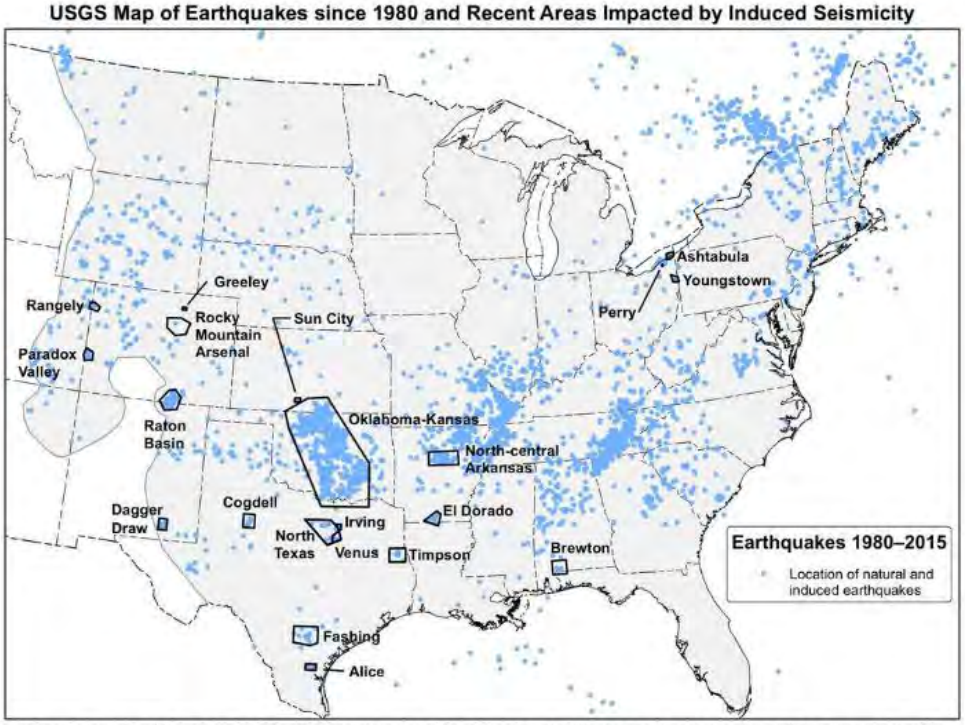
Earthquakes are sudden rolling or shaking events caused by movement under the earth's surface. Earthquakes happen along cracks in the earth's surface, called fault lines, and can be felt over large areas. They usually last less than one minute but can cause substantial damage to infrastructure in a short amount of time.

Location

All 50 states and 5 U.S. territories are at some risk for earthquakes and they can happen at any time of the year. The most significant hazards from induced seismicity are in six states, listed in order from highest to lowest potential hazard: Oklahoma, Kansas, Texas, Colorado, New Mexico and Arkansas. Oklahoma and Texas have the largest populations exposed to induced earthquakes.[6] The City of Garland, is equally subject to earthquakes.

Figure 5.23

USGS Map of Earthquakes since 1980 and Recent Areas Impacted by Induced Seismicity



USGS map displaying 21 areas where scientists have observed rapid changes in seismicity that have been associated with wastewater injection. The map also shows earthquakes—both natural and induced—recorded from 1980 to 2015 in the central and eastern U.S. with a magnitude greater than or equal to 2.5.

Severity

None of the Texas earthquakes have exceeded a magnitude of 6.0, and most have been fairly small and caused little to no damage. The largest one in Dallas County was a 3.6 on the Richter Scale. Table 5.24 below combines the Mercalli and Richter Scale which allows planners to assess the impact earthquakes have.

[6] U.S Geological Survey: https://www.usgs.gov/news/induced-earthquakes-raise-chances-damaging-shaking-2016

Table 5.24. Mercalli and Richter scale

Richter	Mercalli	Earthquake Effects
2	I	**Instrumental.** Not felt except by a very few under especially favourable conditions detected mostly by Seismography.
	II	**Feeble.** Felt only by a few persons at rest, especially on upper floors of buildings.
3	III	**Slight.** Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration similar to the passing of a truck.
	IV	**Moderate.** Felt indoors by many, outdoors by few during the day. At night, some awakening. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like a heavy truck striking building. Standing motor cars rock noticeably.
4	V	**Rather Strong.** Felt by nearly everyone; many awakened. Some dishes, windows broken. Un-stable objects overturned. Pendulum clocks may stop.
5	VI	**Strong.** Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
	VII	**Very Strong.** Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in ordinary structures; considerable damage in poorly built or badly designed structures.
6	VIII	**Destructive.** Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of factory stacks, columns, monuments, walls. Heavy furniture overturned.
7	IX	**Ruinous.** Damage considerable in specially designed structures; well designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
	X	**Disastrous.** Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bend greatly.
8	XI	**Very Disastrous.** Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bend greatly.
	XII	**Catastrophic.** Damage total. Lines of sight and level are distorted. Objects thrown into the air.

Pacific Northwest Seismic Network

Previous Occurrences

Earthquakes have only recently been recorded in the region. The strongest quake to rattle Dallas County occurred on January 6, 2015, and registered a magnitude of 3.6. To date there have been no injuries, fatalities or major damage recorded. The magnitudes experienced in Dallas County are considered minor and only felt by humans but have not caused damage. Currently, there is not a significant amount of data for earthquakes in Dallas County.

Probability of Future Events

According to the North Central Texas Council of Governments, 11earthquakes (within 3 days) have occurred in Dallas County since 2008 (Table 5.25). Data is not currently available specifically for the City of Garland. Calculations from this data suggests that a similar sized earthquake will occur 0.4 times a year. Therefore, according to Table 4.3 Hazard Frequency Ranking it is <u>likely</u> that an earthquake occur within the next 3 years.

Impact on Community

A 6.0 earthquake, the largest recorded in Texas, if in the City of Garland would have major impacts. Damage has occurred in at least twenty-five of the recorded earthquakes in Texas and one death has been attributed to a Texas quake.[7]

Because this hazard is new to the region, residents, businesses, built infrastructure and first responders have not been educated nor are they prepared for this type of event. The tremors could cause hairline cracks in underground pipes, gas lines and in walls of buildings. The majority of the damages to the community would be the result of property and infrastructure damages.

Table 5.25. Dallas County Earthquakes

County	Event Date	Latitude	Longitude	Depth	Magnitude
Dallas	1/6/2012	32.782	-96.685	5	2.1
Dallas	5/15/2009	32.79	-97.02	5	2.6
Dallas	11/1/2008	32.79	-97.02	8	3.3
Dallas	10/31/2008	32.87	-96.97	5	2.7
Dallas	10/31/2008	32.79	-97.03	5	2.9
Dallas	10/31/2008	32.83	-97.03	5	2.9
Dallas	10/31/2008	32.83	-97.01	5	2.9
Dallas	10/31/2008	32.76	-97.02	5	2.5
Dallas	10/31/2008	32.87	-96.97	5	2.6
Dallas	10/31/2008	32.84	-97.03	5	3
Dallas	10/31/2008	32.8	-97.02	5	2.6

Source: NCTCOG Regional Hazard Assessment Tool (RHAT)

Vulnerability

The entire planning area is equally vulnerable to earthquakes. The probability of a small earthquake occurring in Garland within the next 3 years is likely. Large scale earthquakes are considered to be an isolated event, however would cause major damage due to a low risk of high magnitude earthquakes in this area. The unpredictability and unschooled population regarding earthquakes is a concern. Because the region as a whole has not faced infrastructure complications regarding earthquakes the impacts of a large earthquake would be major. Therefore the risk of earthquakes to the City of Garland is moderate.

[7] University of Texas Arlington: https://www.uta.edu/ce/research/disaster/earthquake.php

Severe Thunderstorm and Lightning

Hazard Description

The National Weather Service defines a severe thunderstorm as a storm that has winds of at least 58 mph (50 knots), and/or hail at least 1" in diameter. Severe thunderstorms also can be capable of producing a tornado. Structural wind damage may imply the occurrence of a severe thunderstorm. Straight-line winds are often responsible for wind damage associated with a severe thunderstorm. These winds are often confused with tornadoes because of similar damage and wind speeds. Downbursts or micro bursts are examples of damaging straight-line winds. Wind speeds in some of the stronger downbursts can reach 100 to 150 miles per hour. In Garland's HazMAP, it was decided to include lightning as a component of severe thunderstorms. Lightning is a giant spark of electricity in the atmosphere between clouds, the air or the ground. Air acts as an insulator between the positive and negative charges in the cloud and between the cloud and the ground. When the opposite charges builds up, the insulating capacity of the air breaks down and there is a rapid discharge of electricity that we know as lightning.

Location

The greatest severe thunderstorm threat in the U.S. extends from Texas to southern Minnesota. But, no place in the United States is completely safe from the threat of severe thunderstorms.[8] Due to the unpredictable nature of severe thunderstorms and lightning, it is impossible to determine the exact area of their future occurrences. The entire planning area, the City of Garland, is equally subject to severe thunderstorms and lightning.

Severity

Table 5.19 shows the level of categorical risk of thunderstorms in Day 1-3 Convective Outlooks derived from probability forecasts of tornadoes, damaging winds and large hail.[9] Table 5.20 shows The Beaufort Wind Scale. The Beaufort Wind Scale is representative of the damage from high winds this community may sustain. The Beaufort Wind Scale allows planners in the community to assess historical data and mitigate for future events.

[8] The National Severe Storms Laboratory: http://www.nssl.noaa.gov/education/svrwx101/thunderstorms/

[9] Storm Prediction Center: http://www.spc.noaa.gov/misc/about.html

Table 5.20

Understanding Severe Thunderstorm Risk Categories

THUNDERSTORMS (no label)	1 - MARGINAL (MRGL)	2 - SLIGHT (SLGT)	3 - ENHANCED (ENH)	4 - MODERATE (MDT)	5 - HIGH (HIGH)
No severe* thunderstorms expected	**Isolated severe thunderstorms possible**	**Scattered severe storms possible**	**Numerous severe storms possible**	**Widespread severe storms likely**	**Widespread severe storms expected**
Lightning/flooding threats exist with all thunderstorms	Limited in duration and/or coverage and/or intensity	Short-lived and/or not widespread, isolated intense storms possible	More persistent and/or widespread, a few intense	Long-lived, widespread and intense	Long-lived, very widespread and particularly intense
• *Winds to 40 mph* • *Small hail*	• *Winds 40-60 mph* • *Hail up to 1"* • *Low tornado risk*	• *One or two tornadoes* • *Reports of strong winds/wind damage* • *Hail ~1", isolated 2"*	• *A few tornadoes* • *Several reports of wind damage* • *Damaging hail, 1 - 2"*	• *Strong tornadoes* • *Widespread wind damage* • *Destructive hail, 2" +*	• *Tornado outbreak* • *Derecho*

* NWS defines a severe thunderstorm as measured wind gusts to at least 58 mph, and/or hail to at least one inch in diameter, and/or a tornado. All thunderstorm categories imply lightning and the potential for flooding. Categories are also tied to the probability of a severe weather event within 25 miles of your location.

Table 5.19. Beaufort Wind Scale

Beaufort Wind Scale

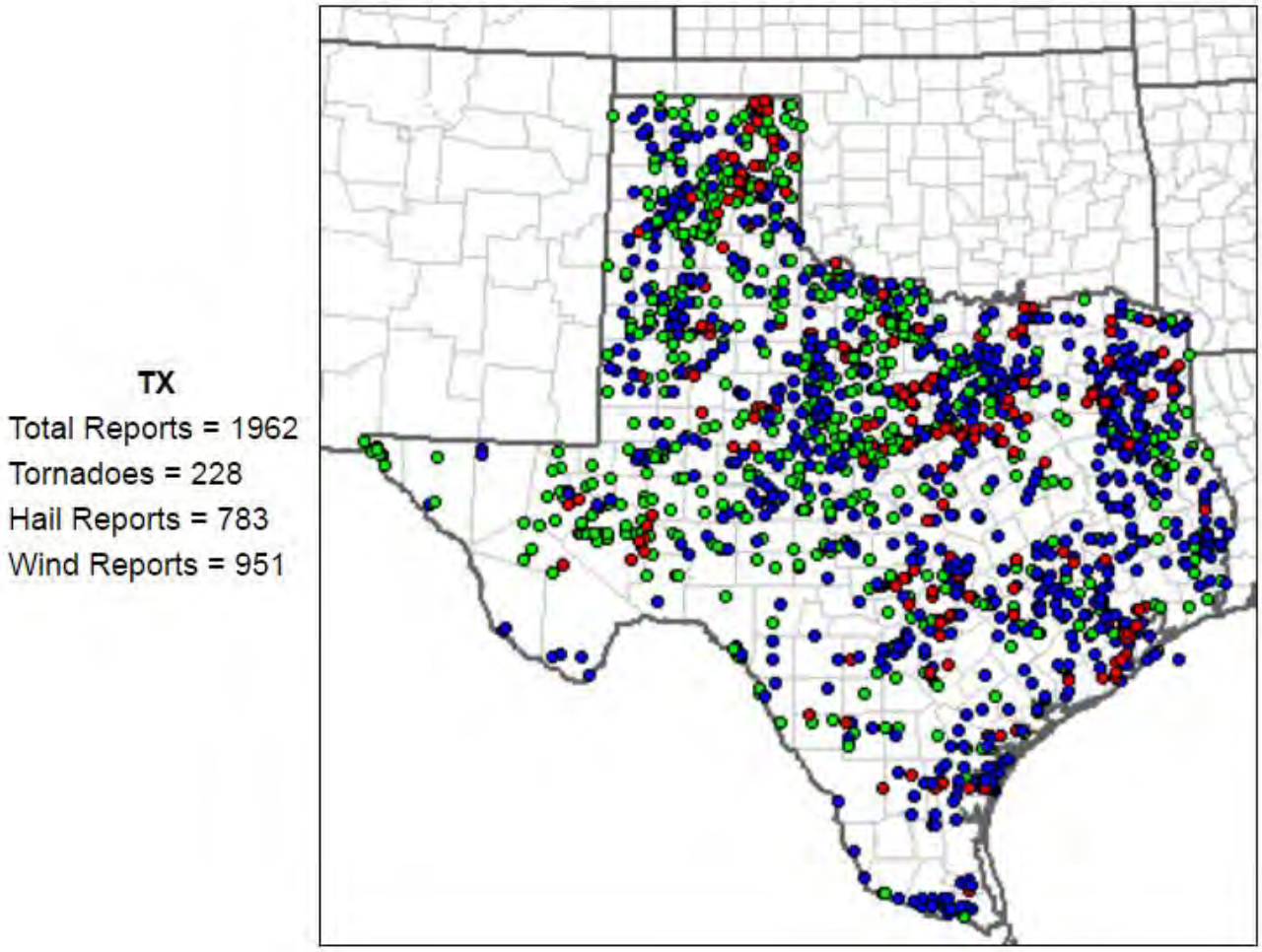
#	MPH	Knots	Description	Specifications
0	< 1	< 1	Calm	Smoke rises vertically.
1	1-3	1-3	Light Air	Direction of wind shown by smoke drift but not by wind vanes.
2	4-7	4-6	Light Breeze	Wind felt on face; Leaves rustle; Wind vanes moved by wind
3	8-12	7-10	Gentle Breeze	Leaves and small twigs in constant motion; Wind extends light flag.
4	13-18	11-16	Moderate	Raises dust, loose paper; Small branches moved.
5	19-24	17-21	Fresh	Small trees begin to sway; Crested wavelets form on inland waters.
6	25-31	22-27	Strong	Large branches in motion; Whistling heard in telephone wires; Umbrellas used with difficulty.
7	32-38	28-33	Near Gale	Whole trees in motion; Inconvenience felt walking against the wind.
8	39-46	34-40	Gale	Twigs break off trees; Wind generally impedes progress; Mobile homes may shake.
9	47-54	41-47	Strong Gale	Slight structural damage occurs; Mobile homes, sheds, roofs, lanais, and RV's suffer minor damage.
10	55-63	48-55	Storm	Small trees uprooted; Moderate damage occurs to mobile homes and RV's; Brick and wood frame houses receive minor structural and roof damage; Some signs blown down.
11	64-73	56-63	Violent Storm	Moderate sized trees uprooted; Large branches snapped off trees; Chimneys and road signs toppled; Significant mobile home damage; Power lines downed.
12	74-95	64-83	Hurricane Category 1	Mobile homes overturned; Large trees and branches downed; Moderate roof damage to wood and brick homes; Minor pier damage.

Source:https://www.weather.gov/tbw/beaufort

Previous Occurrences

The National Weather Service's Storm Prediction Center reported 1,734 severe thunderstorm events in Texas during 2015. This excludes tornadoes as Garland's HazMAP classifies tornadoes as a separate hazard. Narrowing occurrences to the defined planning area of Garland, the National Climatic Data Center reported 22 thunderstorms have been reported between 2/29/1994 and 12/31/2016.

Figure 5.21. Annual Severe Thunderstorm Report Summary - 2015



Probability of Future Events

Calculations from historical data suggests that a severe thunderstorm will impact Garland at least 1 time a year. Therefore, according to Table 4.3 Hazard Frequency Ranking it is highly likely that severe thunderstorms and lightning occur in the next year.

Impact on Community

According to the National Climatic Data Center, 22 severe thunderstorms/thunderstorms with significant wind have caused an estimated $200,000 in property damage. The most common impacts of severe thunderstorms are power outages and private property damage consisting of roof and vehicle damage from wind and hail.

Because severe thunderstorms and lightning are such a common occurrence, residents are prepared and practiced in mitigating damage. Public education is also a focus through many different channels: the National Weather Service, media outlets and several City departments push severe thunderstorm messaging year round. The City of Garland and Garland Power & Light both have tree trimming programs to help mitigate effects of severe thunderstorms. GP&L trims trees and other vegetation away from power lines to provide safe and reliable electric service. Because of this proactive vegetation management program, GP&L customers experience fewer outages than average as reported by the American Public Power Association (APPA). For these reasons it has been determined that severe thunderstorms impacts that do occur are minor.

Table 5.22. Severe Thunderstorm Historical Data

COUNTY	DATE	EVENT TYPE	WIND SPEED	PROPERTY DAMAGE
GARLAND	5/29/1994	Thunderstorm Wind	52 kts.	0
GARLAND	11/3/1994	Thunderstorm Wind	56 kts.	0
GARLAND	6/15/1996	Thunderstorm Wind	61 kts.	2,000
GARLAND	6/16/1997	Thunderstorm Wind	52 kts.	0
GARLAND	10/2/1998	Thunderstorm Wind	55 kts.	0
GARLAND	11/9/1998	Thunderstorm Wind	52 kts.	0
GARLAND	2/9/2001	Thunderstorm Wind	52 kts.	0
GARLAND	6/14/2001	Thunderstorm Wind	52 kts.	0
GARLAND	6/14/2001	Thunderstorm Wind	52 kts.	0
GARLAND	4/7/2002	Thunderstorm Wind	52 kts.	0
GARLAND	8/8/2005	Thunderstorm Wind	50 kts.	20,000
GARLAND	5/2/2007	Thunderstorm Wind	50 kts.	0
GARLAND	2/10/2009	Thunderstorm Wind	70 kts.	0
GARLAND	4/14/2011	Thunderstorm Wind	70 kts.	50,000
GARLAND	4/14/2011	Thunderstorm Wind	64 kts.	50,000
GARLAND	10/23/2011	Thunderstorm Wind	61 kts.	10,000
GARLAND	10/23/2011	Thunderstorm Wind	61 kts.	10,000
GARLAND	5/21/2013	Thunderstorm Wind	50 kts.	10,000
GARLAND	5/21/2013	Thunderstorm Wind	60 kts.	30,000
GARLAND	8/13/2013	Thunderstorm Wind	43 kts.	3,000
GARLAND	10/2/2014	Thunderstorm Wind	60 kts.	5,000
GARLAND	3/8/2016	Thunderstorm Wind	51 kts.	10,000

National Climatic Data Center

Summary of Vulnerability

The entire planning area is equally vulnerable to severe thunderstorms and lightning. The highly likelihood of severe thunderstorm is a concern but because the City of Garland is so accustomed to severe thunderstorms and have current mitigation programs the impacts are minor, therefore the risk of severe thunderstorms are moderate.

Infrastructure and Communications Failure

Hazard Description

Infrastructure is the basic facilities and services needed for a community. The City of Garland infrastructure includes roads, wastewater treatment plants, water and wastewater pipes, power plants, electrical lines, bridges, an airport, railroads, and schools. Infrastructure also includes telecommunications equipment, which if impacted may cause a communications failure. A communications failure is the interruption or loss of communications systems including transmission lines, communications satellites, and associated hardware and software necessary for the communications system to function. It can include telecommunications, radio and information technology failures. A communications failure may be the result of an equipment failure, human act (deliberate or accidental) or the result of another hazard event.

Location

Because of the large array of possible infrastructure and communications failures it is impossible to map the location they would occur. The entire planning area, the City of Garland, is equally subject to infrastructure and communications failures.

Severity

When an infrastructure/communications failure occurs, it can have a wide range of effects on a community. Deteriorating infrastructure is a problem all of America is facing. Every four years, the American Society of Civil Engineers Committee on America's Infrastructure provides a comprehensive assessment of the nation's 16 major infrastructure categories grading A to F. The components that are considered when grading include: capacity, condition, funding, future need, operation and maintenance, public safety and resilience. The 2012 Report Card for Texas' Infrastructure was an overall grade of "C".[10]

Previous Occurrences

Most past occurrences have been small incidents that were quickly addressed and to date there has not been a significant infrastructure failure within the City of Garland. There was however a communications failure. On March 8, 2017, there was a nationwide issue. AT&T cell phone were unable to call 911 for several hours.

Probability of Future Events

The occurrence of an infrastructure/communications failure is largely impossible to predict. The likelihood of a large-scale extended communications failure is low. However, small scale failures with a short duration is not abnormal. Therefore, according to Table 4.3 Hazard Frequency Ranking the Planning Team has concluded that an infrastructure/communications failure may occasionally occur in the City of Garland in the next six years.

[10] 2012 Report Card for Texas' Infrastructure: https://www.infrastructurereportcard.org/wp-content/uploads/2013/02/2012-Texas-Report-Card-FINAL.pdf

Impact on Community

Nearly every aspect of modern life is dependent on digital infrastructure. Critical infrastructure services, such as emergency services, utility services, water services and telecommunications can be impacted by a communications or infrastructure failure. Failures can result in a 911 or emergency warning system failure, a delay of response times by emergency service providers, and has the potential to impact the entire community.

Flooding typically damages the infrastructure of a community, including roads, bridges, power lines and plants. It can take a significant amount of time to fully repair these facilities and infrastructure, depending on the nature of the damage and the resources available that can be dedicated.

A 2016 report estimates that continued underinvestment in infrastructure will cost each U.S. family $3,400 a year over the next decade. "Poor infrastructure means more congestion on our roadways, broken water lines, power outages and an inability to get our goods to market," said Greg DiLoreto, chair of ASCE's Committee for America's Infrastructure. "From lost time, to inconvenience, to spending money to fix our cars or a flooded basement, it's a very real cost that we're paying."[11] The potential impacts can be great. However, because historical occurrences of infrastructure/communications failure have been small incidents the planning team determined the potential impact from this type of incident would be minor.

Summary of Vulnerability

The entire planning area is equally vulnerable to infrastructure and communications failures. This type of failure will occasionally occur to some extent within the next six years. This type of hazard has historically caused minor impacts to the City of Garland. These factors make infrastructure/communications failure a moderate risk for the City of Garland.

[11] American Society of Civil Engineers: http://www.infrastructurereportcard.org/wp-content/uploads/2016/05/2016-FTA-Report-Close-the-Gap.pdf

Drought

Hazard Description

Drought is a period of time without substantial rainfall that persists from one year to the next. Drought is a normal part of virtually all climatic regions, including areas with high and low average rainfall. Drought is the consequence of anticipated natural precipitation reduction over an extended period of time, usually a season or more in length. Droughts can be classified as meteorological, hydrologic, agricultural and socioeconomic.

- Meteorological drought is an interval of time, generally on the order of months or years, during which the actual moisture supply at a given place consistently falls below the climatically appropriate moisture supply.
- Agricultural drought occurs when there is inadequate soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought usually occurs after or during meteorological drought, but before hydrological drought and can affect livestock and other dry land agricultural operations.
- Hydrological drought refers to the deficiencies in surface and subsurface water supplies. It is measured as stream flow, snow pack, and as lake, reservoir and groundwater levels. There is usually a delay between lack of rain or snow and less measurable water in streams, lakes, and reservoirs. Therefore, hydrological measurement tends to lag behind other drought indicators.
- Socio-economic drought occurs when physical water shortages start to affect the health, well-being and quality of life of people, or when the drought starts to affect the supply and demand of an economic product.

Droughts are one of the most complex natural hazards as it is difficult to determine their precise beginning or end. In addition, droughts can lead to other hazards such as extreme heat and wildfires. Their impact on wildlife and environment is enormous, often killing crops, grazing land, edible plants and trees.

Location

Due to the unpredictable nature of a drought, it is impossible to determine the exact area of their future occurrences. The entire planning area, the City of Garland, is equally subject to drought.

Severity

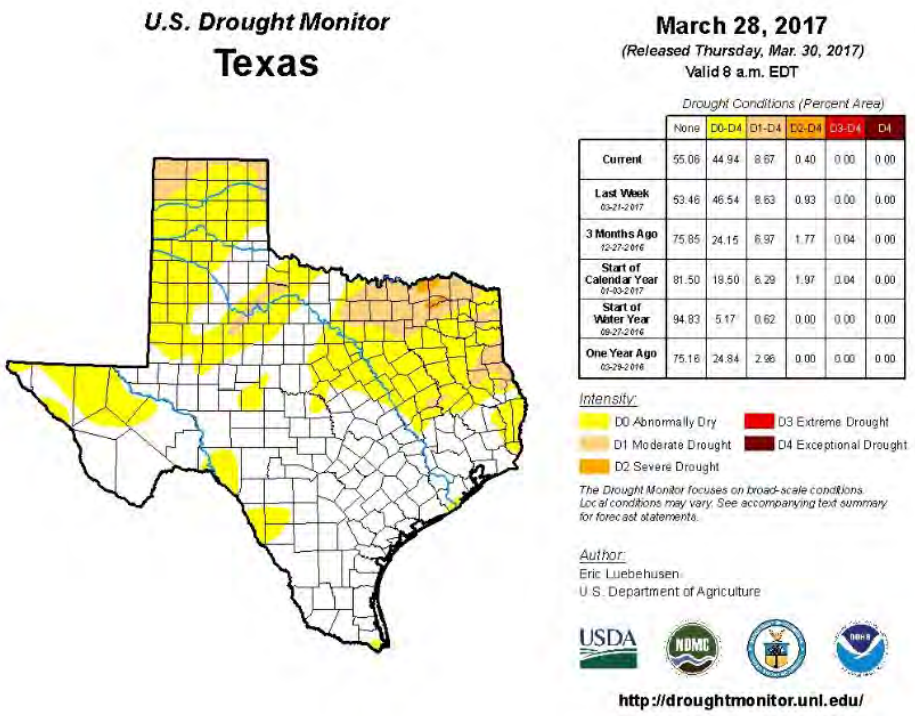
The Severity of drought periods is measured using the U.S. Drought Monitor (USDM) (Table 5.17). The USDM was developed by Mark Svoboda in 1999 and is produced through a partnership between the National Drought Mitigation Center at the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. The USDM uses a process that synthesizes multiple indices, outlooks and local impacts, into an assessment that best represents current drought conditions and reflects observed precipitation. The final outcome of each Drought Monitor map is a consensus of federal, state and academic scientists. The maps, which are based on analysis of the data, are released each Thursday at 8:30 a.m. Eastern Time.[12]

Table 5.17. Drought Severity Classification and Map

Drought Severity	Return Period (years)	Description of Possible Impacts	Drought Monitoring Indices		
			Standardized Precipitation Index (SPI)	NDMC* Drought Category	Palmer Drought Index
Minor Drought	3 to 4	Going into drought; short-term dryness slowing growth of crops or pastures; fire risk above average. Coming out of drought; some lingering water deficits; pastures or crops not fully recovered.	-0.5 to -0.7	D0	-1.0 to -1.9
Moderate Drought	5 to 9	Some damage to crops or pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested.	-0.8 to -1.2	D1	-2.0 to -2.9
Severe Drought	10 to 17	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed.	-1.3 to -1.5	D2	-3.0 to -3.9
Extreme Drought	18 to 43	Major crop and pasture losses; extreme fire danger; widespread water shortages or restrictions.	-1.6 to -1.9	D3	-4.0 to -4.9
Exceptional Drought	44+	Exceptional and widespread crop and pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells creating water emergencies.	less than -2	D4	-5.0 or less

*NDMC - National Drought Mitigation Center

[12] National Centers for environmental Information: https://www.ncdc.noaa.gov/temp-and-precip/drought/nadm/overview



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	55.06	44.94	8.67	0.40	0.00	0.00
Last Week 03-21-2017	53.46	46.54	8.63	0.93	0.00	0.00
3 Months Ago 12-27-2016	75.85	24.15	6.97	1.77	0.04	0.00
Start of Calendar Year 01-03-2017	81.50	18.50	6.29	1.97	0.04	0.00
Start of Water Year 09-27-2016	94.83	5.17	0.62	0.00	0.00	0.00
One Year Ago 03-29-2016	75.16	24.84	2.96	0.00	0.00	0.00

Previous Occurrences

According to the National Climatic Data Center, Dallas County, Texas was in a drought for 28 months during the last 20 years. This consisted of seven separate droughts that continued for multiple months. The longest of which was almost a full year and began in January 2006 through November 2006. Data is not currently available specifically for the City of Garland.

Probability of Future Events

Drought events are not expected to occur every year, but are prevalent enough to be a concern. Previous historical data in Table 5.18 shows that seven drought events (28 months) have occurred within Garland since 1996. Calculations from this data suggests that a drought event will impact Garland 0.4 times a year. Therefore, according to Table 4.3 Hazard Frequency Ranking it is <u>likely</u> a drought will occur in the next three years.

Impact on Community

The impact of a drought within the City of Garland is expected to be <u>minor</u>. This considers the large water supply available to the community. The major damages associated with droughts are typically on crops and livestock. However, Garland is a more urbanized area and contains very little agricultural land or livestock to cause major financial disruptions. For Garland, the financial burden of droughts is on structures. The primary causes of structural damage associated with drought are foundation issues. This is caused by expansive soil, resulting in structural repairs. Since 1996 droughts have caused $500,000 dollars in structural damage and $1,345,000 in crop damage within Dallas County.

The Water Conservation Plan and Drought Contingency Response Plan have been put into place in the City of Garland to negate the effects of drought. These consist of a strict seasonal water use schedule that goes into effect within the City between April and October. Details of this plan include: customers may water twice-per-week using an in-ground sprinkler system. November through March watering with sprinkler systems are limited to one day a week. Sprinkler system use is not allowed between 10 a.m. and 6 p.m. to prevent excessive evaporation. Newly planted landscape and/or sod requiring water more than 1 time a week, must request a variance. In stage 3 of a drought, no lawn watering at any time is allowed within the City. These actions make the community more resilient during drought events.

Table 5.18. Drought Historical Data

COUNTY	DATE	EVENT TYPE	PROPERTY DAMAGE	CROP DAMAGE
DALLAS	5/1/1996	Drought	0	0
DALLAS	8/1/1996	Drought	0	0
DALLAS	7/1/1998	Drought	0	0
DALLAS	8/1/2000	Drought	0	0
DALLAS	9/1/2000	Drought	0	0
DALLAS	6/1/2005	Drought	0	0
DALLAS	7/1/2005	Drought	0	0
DALLAS	8/1/2005	Drought	0	0
DALLAS	9/1/2005	Drought	0	0
DALLAS	10/1/2005	Drought	0	0
DALLAS	11/1/2005	Drought	0	0
DALLAS	12/1/2005	Drought	0	0
DALLAS	1/1/2006	Drought	0	0
DALLAS	2/1/2006	Drought	0	0
DALLAS	3/1/2006	Drought	0	0
DALLAS	4/1/2006	Drought	0	0
DALLAS	5/1/2006	Drought	0	0
DALLAS	6/6/2006	Drought	0	0
DALLAS	7/1/2006	Drought	0	0
DALLAS	8/1/2006	Drought	0	0
DALLAS	9/1/2006	Drought	0	0
DALLAS	10/1/2006	Drought	500,000	500,000
DALLAS	11/1/2006	Drought	0	800,000
DALLAS	4/1/2011	Drought	0	5,000
DALLAS	8/1/2011	Drought	0	10,000
DALLAS	9/1/2011	Drought	0	25,000
DALLAS	10/1/2011	Drought	0	5,000
DALLAS	8/7/2012	Drought	0	0

Extreme Heat

Hazard Description

Extreme heat is characterized by a combination of exceptionally high temperatures and humidity. When these conditions persist over a period of time, it is called a heat wave. Although heat can damage buildings and facilities, it presents a more significant threat to the safety and welfare of residents.

Location

Due to the unpredictable nature of extreme heat, it is impossible to determine the exact area of their future occurrences. The entire planning area, the City of Garland, is equally subject to extreme heat.

Severity

The danger of extreme heat is gauged by using the Extreme Heat Index (Figure 5.15). The Heat Index, as seen below, displays the relative danger in regards to Air Temperature and Relative Humidity.

Figure 5-15. Extreme Heat Index

Temperature (F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	113	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	117	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Caution | Extreme Caution | Danger | Extreme Danger

Source: http://www.nc-climate.ncsu.edu/images/climate/heat_index.jpg

Previous Occurrences

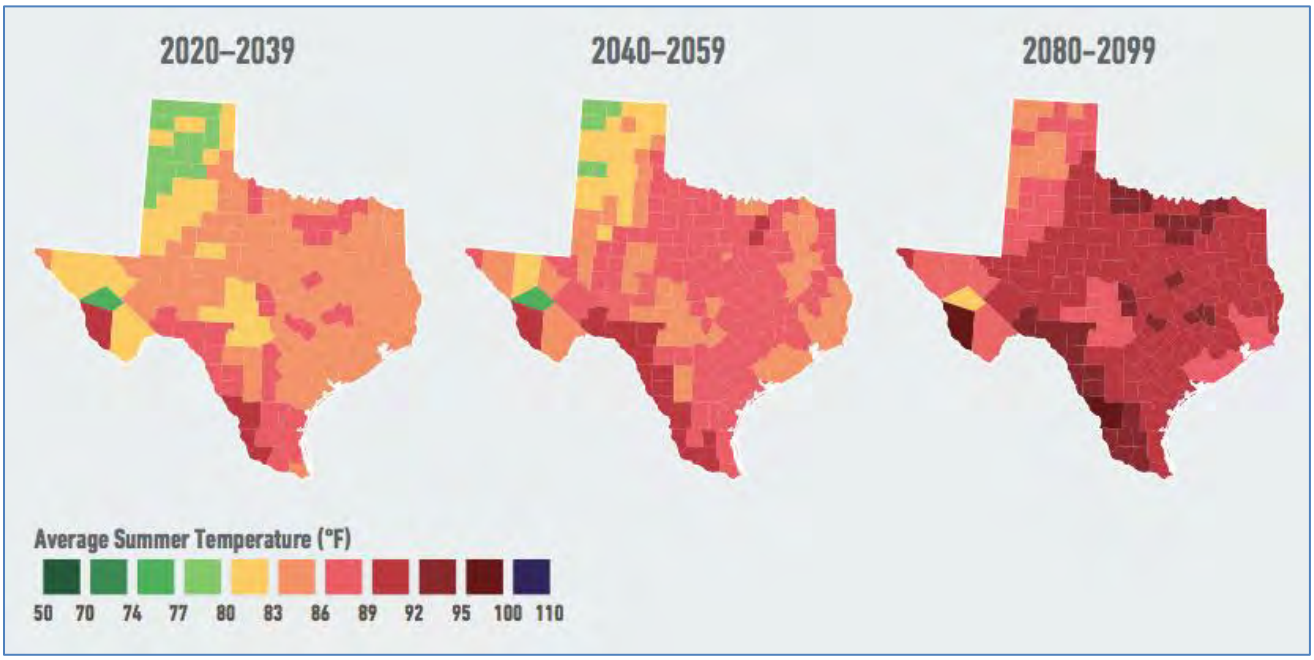
According to the National Climatic Data Center, 27 extreme heat events have been reported in Dallas County, Texas between 7/1/1996 and 12/31/2016.

Probability of Future Events

Temperatures remain warm throughout the summer months and are relatively warmer throughout the year than other areas of the country. The occurrence of extreme heat events is likely within the area given the humidity levels and high summer temperatures. Previous historical data in Table 5.16 shows 27 extreme heat events have occurred in Dallas County since 1996. Data is not currently available specifically for the City of Garland. Calculations from this data suggest that an extreme heat event will impact Dallas County 1.4 times a year. Therefore, according to Table 4.3 Hazard Frequency Ranking it is highly likely for an extreme heat event to occur within the next year.

According to the Southeast Report released by the Risky Business Project, average temperatures are likely to increase across Texas due to climate change. The prospectus states dangerous levels of extreme heat are projected to threaten lives, dramatically reduce labor productivity and increase energy demand and cost. The study predicts over the next 5 to 25 years extreme heat will likely cause as many as 2,570 additional deaths per year. By the end of this century, the average number of days where temperatures are above 95° will likely increase by as much as 14 times.[13]

Figure 5.16. Future Average Summer Temperatures in Texas



Source: American Climate Prospectus

[13] Risky Business: https://riskybusiness.org/report/come-heat-and-high-water-climate-risk-in-the-southeastern-u-s-and-texas/

Impact on Community

The major human risks associated with extreme heat include: sunburn, dehydration, heatstroke, heat exhaustion, heat syncope, heat cramps and in severe cases death. The most at risk populations are outdoor laborers, the elderly, children, and the disabled who frequently live on low or fixed incomes and do not run air conditioning on a regular basis. These populations are sometimes isolated, with no immediate family or friends to look out for their well-being. The effects of extreme heat are always more pronounced in urbanized areas than in rural areas. According to the Journal of Applied Meteorology and Climatology, the problem is exacerbated in Garland by what is known as the heat island effect. The concrete and metal infrastructure absorbs radiant heat energy from the sun during the day and radiates that heat energy during the night. This cyclical process essentially "traps" the heat in the urbanized area and makes it as much as 5.4°C warmer. [14] Since 1996 there have been 85 fatalities and 704 injuries caused by extreme heat in Dallas County. The Planning Team has determined that because of available cooling centers and programs in place to mitigate extreme heat the impacts of this hazard are limited.

5.16 Extreme Heat Historical Data

COUNTY	DATE	EVENT TYPE	DEATHS	INJURIES
DALLAS	8/13/2007	Excessive Heat	1	0
DALLAS	7/23/2008	Excessive Heat	1	0
DALLAS	7/28/2008	Excessive Heat	2	0
DALLAS	8/1/2008	Excessive Heat	4	0
DALLAS	8/1/2011	Excessive Heat	4	130
DALLAS	7/20/2012	Excessive Heat	1	0
DALLAS	5/17/2013	Excessive Heat	1	0
DALLAS	7/18/2015	Excessive Heat	1	0
DALLAS	7/1/1996	Heat	2	0
DALLAS	7/19/1997	Heat	2	0
DALLAS	6/1/1998	Heat	1	0
DALLAS	7/1/1998	Heat	23	0
DALLAS	8/3/1998	Heat	5	0
DALLAS	8/1/1999	Heat	3	0
DALLAS	7/1/2000	Heat	8	0
DALLAS	8/1/2000	Heat	3	0
DALLAS	9/1/2000	Heat	4	0
DALLAS	7/14/2006	Heat	1	0
DALLAS	7/27/2006	Heat	1	0
DALLAS	8/10/2006	Heat	0	0
DALLAS	6/23/2009	Heat	1	0
DALLAS	4/29/2010	Heat	0	0
DALLAS	6/20/2010	Heat	1	0
DALLAS	6/13/2011	Heat	3	140
DALLAS	7/1/2011	Heat	9	223
DALLAS	8/6/2011	Heat	3	210
DALLAS	6/15/2016	Heat	0	1

National Climatic Data Center

[14] http://www.uta.edu/faculty/awinguth/Publications/publications/2013/JAMC-D-12-0195.pdf

Summary of Vulnerability

The entire planning area is equally vulnerable to extreme heat events. For now, extreme heat is considered a low risk to the City of Garland. Because extreme heat is a common occurrence, residents are prepared and practiced in mitigating damage. The City of Garland also has many faith based communities that offer cooling centers during these times of extreme heat. Although heat events are very common to the area, they cause little damage to structures. The main concern with an extreme heat event is that it leads to other hazards, such as drought and dust storms. The City of Garland is accustomed to long periods of hot weather, as local summer temperatures often reach one hundred degrees or more. Structure damage from extreme heat is not likely. The most vulnerable structures to extreme heat are underground water pipes,

Power Outage

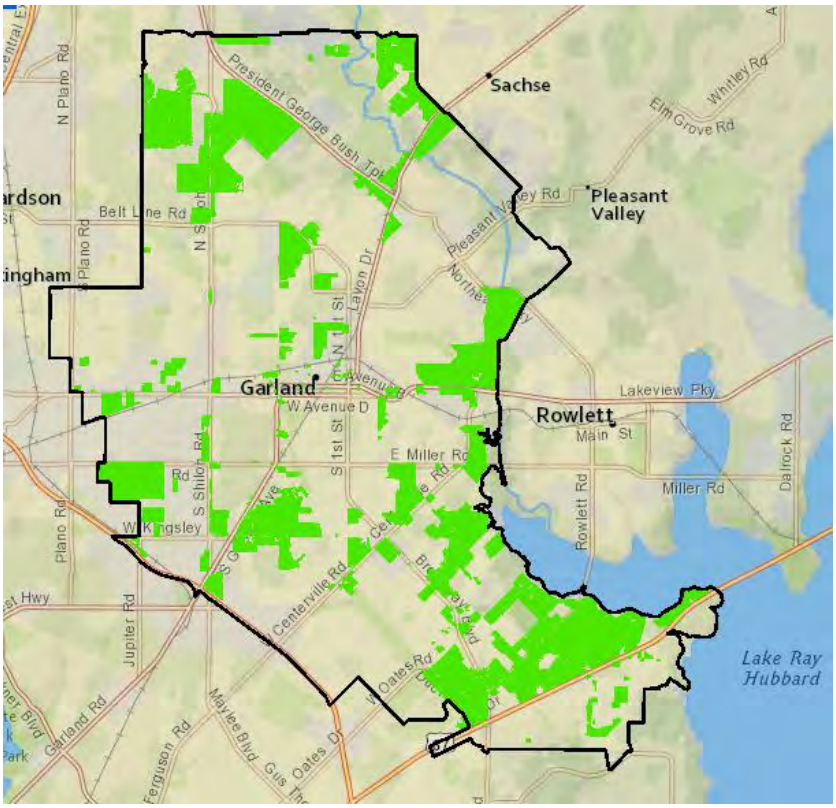
Hazard Description

Power outage is defined as any interruption or loss of electrical service caused by disruption of power transmission which may be the result of an accident, sabotage, natural hazards or equipment failure. A significant power failure is defined as any incident of a long duration, which would require the City of Garland to provide food, water, heating, cooling and/or shelter.

Location

Power outages in the City of Garand are usually localized and are normally the result of a natural hazard involving high winds. The entire planning area, the City of Garland, is equally subject to power outages. However, the City of Garland has their own power provider, Garland Power & Light (GP&L), which serves approximately 85% of Garland. The other 15% of residents are served by Oncor. Figure 5.26 below shows the areas in Garland that are not in the GP&L service area. When outages do occur, areas that are GP&L customers typically have power restored faster than those with other providers. Table 5.27 illustrates the American Public Power Association average interruption duration as 62.53 minutes compared to the GP&L average interruption of 15.1 minutes during 2016.

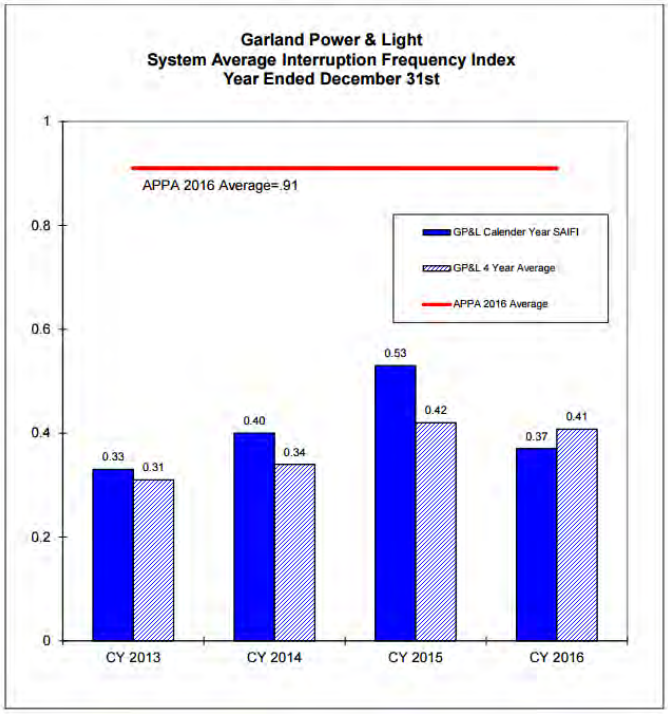
Figure 5.26. Garland Power & Light Service Area

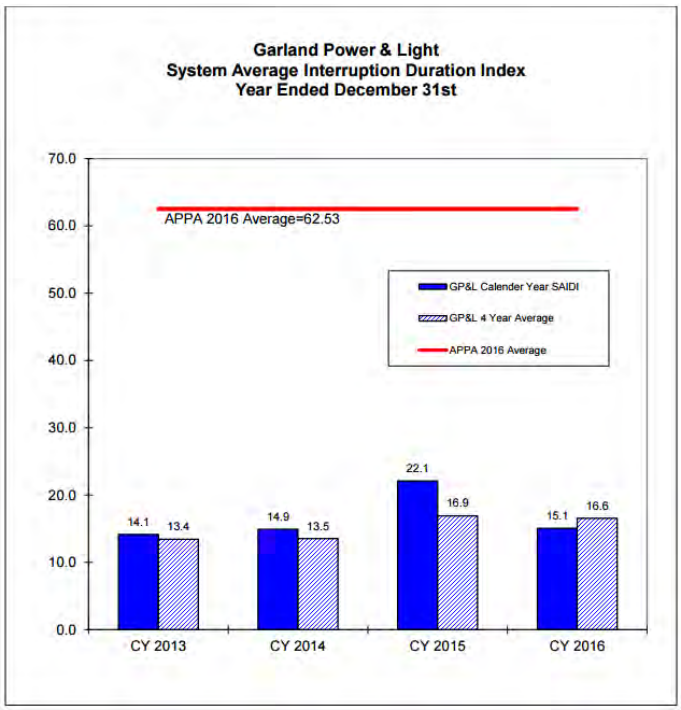


Severity

Power outages can range in duration and also in the severity of impacts, from minor loss of communication systems at a facility, to loss of water and electricity. Power outages and interruptions usually occur because of severe thunderstorms, high winds, tornado, ice accumulation on lines, flooding or heavy demand on the electrical grid. Outages can also be caused by faulty equipment, human error and animals. Individuals who rely on power for health and/or life safety, such as those on life support systems, could be placed in jeopardy in the event of a power outage.

Figure 5.27





Previous Occurrences

On December 26, 2016, an EF 4 tornado impacted the City of Garland. This tornado destroyed families, homes, vehicles and left about 3,000 residents without power. The tornado knocked down an estimated 40 power poles along the I-30 service road. In October 2014 severe storms left thousands without power causing several school districts to cancel classes. Oncor reported more than 113,000 North Texas electricity customers without service. 65,977 residents were impacted in Dallas County.[15]

Probability of Future Events

According to Garland Power & Light, an average of 0.37 interruptions occur annually per customer for a duration of 15 minutes.[16] There are number of hazards that occur often in Garland that result in power outages. Therefore, according to Table 4.3 Hazard Frequency Ranking it is highly likely for a power outage occur within the next year.

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[15] NBCDFW - http://www.nbcdfw.com/weather/stories/Severe-Storms-Cause-Power-Outages-Thursday-277944491.html

[16] GP&L Website http://www.gpltexas.org/outage-center/service-reliability
http://www.gpltexas.org/home/showdocument?id=90

Impact on Community

The United States Annual Blackout Tracker Report of 2014 ranked Texas as having the third most outages in the U.S. Between 2008 and 2014, 335 outages occurred that affected 818,506 people. Because power outages average a short duration and Garland has its own power provider, the overall impact to the community is limited. The greatest impact to the City of Garland occurs during summer outages when residents are unable to use air conditioning. This cascading event may then cause impacts from extreme heat as previously described

Summary of Vulnerability

The entire planning area is equally vulnerable to power outages. The probability of a power outage less than half an hour occurring in Garland within the next year is highly likely and would cause limited impacts to the community. This high frequency low impact hazard is a low risk for the City of Garland. As the days get warmer, temperatures rise as discussed in the extreme heat section. Demand for energy on the grid will increase, therefore increasing the vulnerability of the power providers in Garland.

Expansive Soils

Hazard Description

Expansive soils contain minerals such as smectite clays that are capable of absorbing water. When they absorb water, they increase in volume. The more water they absorb, the more their volume increases. Expansions of ten percent or more are not uncommon. This change in volume can exert enough force on a building or other structure to cause damage. Expansive soils will also shrink when they dry out. This shrinkage can remove support from buildings or other structures, and result in damaging subsidence. Fissures in the soil can also develop. These fissures can facilitate the deep penetration of water when moist conditions or runoff occurs. This produces a cycle of shrinkage and swelling that places repetitive stress on structures.[17] Soils with this shrink-swell capacity fall under the soil order of Vertisols which is how this hazard is referred to by the United States Department of Agriculture.

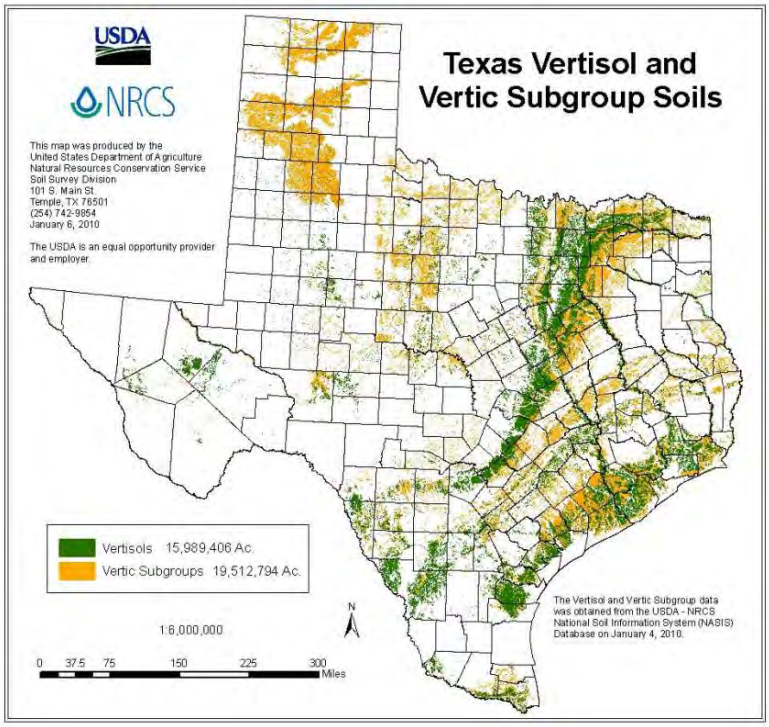
Location

The entire planning area, the City of Garland, is subject to expansive soils.

Severity

Utility poles and roadways are often the victims of expansive soils, which causes over 2.3 billion dollars in damage each year nationwide. Figure 5.32, below depicts the areas where expansive soil is prevalent.

Figure 5.32



USDA 2010

[17] Geology.com: http://geology.com/articles/expansive-soil.shtml

Previous Occurrences

The City of Garland Streets department is currently undertaking seven street rehab and reconstruction projects. Street maintenance and repairs are a constant problem that is compounded by the large amount of expansive soil in the area.

Garland Streets Department Projects

Broadway Blvd. - Street Rehabilitation
Commonwealth Dr. - Street Reconstruction
Firewheel Pkwy. - Street Rehabilitation
Nash St. - Street Reconstruction
Sunnybrook Ln. - Street Reconstruction
Vera Cruz Dr. - Asphalt Rehab/Overlay
E. Vista Dr. - Street Reconstruction

Probability of Future Events

Expansive soils are a continuous hazard for the city. Therefore, according to Table 4.3 Hazard Frequency Ranking it is highly likely that expansive soils will occur in the next year. Predictions are not reliable because the location and time when water is available to the soil cannot be easily foreseen. Most associated structural distress can occur a few years after construction, but the effects may also not be observed for many years until some change occurs in the foundation conditions.

Impact on Community

As development and city build-out occurs, the unforeseen consequences of dense construction activities on shrinking and swelling soil are constantly occurring.
Soil expansion poses risks for existing and future infrastructure and homes. Transportation, utility public works, including electrical, communications and water infrastructure are all impacted, as well as residential housing. Many structural foundations are susceptible to damage by slow, continuous soil movements. This greatly impacts residents. Poor foundations lessen a family's greatest asset and can become a financial burden. Poor structural integrity of a home also poses a life threatening risk, especially when combined with other hazards like tornadoes, floods and earthquakes. The City of Garland and its residents have endured expansive soils for quite some time. Residents, however can take mitigating actions by simply watering the foundation of their homes during droughts. The severity of impact to the community from expansive soil is limited.

Summary of Vulnerability

The entire planning area is equally vulnerable to expansive soils. Although the hazard is constantly occurring, the impact is limited therefore the planning team considers expansive soil to be a low risk hazard.

Hail

Hazard Description
Severe thunderstorms produce precipitation in the form of irregular pellets or balls of ice more than 5 mm in diameter, falling from a cumulonimbus cloud. These balls of irregularly shaped ice fall with rain. Early in the developmental stages of a hailstorm, ice crystals form within a low-pressure front due to warm air rising rapidly into the upper atmosphere and the subsequent cooling of the air mass. Frozen droplets gradually accumulate on the ice crystals until they have developed sufficient weight and fall as precipitation.

The size of hailstones is a direct correlation of the severity of impact and size of the storm. For example, penny size hail may cause damage to crops and vegetation. Ping pong ball size hail will cause damage to windows in homes and vehicles. High velocity updraft winds are required to keep hail in suspension in thunderclouds. The strength of the updraft is a function of the intensity of heating at the Earth's surface. Higher temperature gradients relative to elevations above the surface result in increased suspension time and hailstone size.

Location
Due to the unpredictable nature of hailstorms, it is impossible to determine the exact area of their future occurrences. The City of Garland, is equally subject to hailstorms.

Severity
Table 5.13 shows the Combined National Ocean and Atmospheric Administration's and the Tornado and Storm Research Organization's Hailstorm Intensity Scales. The Hailstorm Intensity Scale is representative of the damage from hail storms this community has experienced in the past. The Hailstorm Intensity Scale allows planners to gauge past damage and mitigate for future expected damage.

Table 5.13
Combined NOAA/TORRO Hailstorm Intensity Scales

Size Code	Intensity Category	Hail Diameter (inches)	Approximate Size	Typical Damage Impacts
H0	Hard Hail	.25	Pea	No damage
H1	Potentially Damaging	.50	Moth-ball	Slight damage to plants, crops
H2	Potentially Damaging	.75	Penny	Significant damage to fruit, crops, vegetation
H3	Severe	1.00	Quarter	Severe damage to fruit and crops, damage to glass and plastic structures, paint and
H4	Severe	1.5	Ping Pong Ball	Widespread glass damage, vehicle bodywork damage
H5	Destructive	2.0	Golf Ball	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	2.25	Lime	Aircraft bodywork dented, brick walls pitted
H7	Very destructive	2.5	Tennis ball	Severe roof damage, risk of serious injuries
H8	Very destructive	2.75	Baseball	Severe damage to aircraft bodywork
H9	Super Hailstorms	3.8	Softball	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
H10	Super Hailstorms	4.5	Grapefruit	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the

North Central Texas Council of Governments (modified)

Previous Occurrences

On April 11, 2015 quarter-sized to softball-sized hail was reported in Collin and Rockwall counties. Wylie was among the hardest-hit areas with reports of softball sized hail (4.25-inch), reported by the National Weather Service. Classes were canceled for all Wylie ISD schools. The number of storm damage calls to Wylie 911 overwhelmed the system, tennis ball-sized hail flew through windows and the area had wind gusts up to 60 mph.

This major event is significant to the City of Garland as the impacted area is only a few miles away from Garland. This hail event alone caused $300 million dollars in property damage. According to the Insurance Council of Texas, insured losses from Texas hail claims for 2016 are about $4 billion dollars.[18] Garland has recorded 20 hail events since 1994 and reported 3.75 inch hail on February 25, 2000.

[18] Star-Telegram: http://www.star-telegram.com/news/local/community/fort-worth/article138903113.html
Dallas News: http://www.dallasnews.com/news/news/2016/04/11/baseball-size-hail-expected-as-severe-thunderstorm-moves-through-collin-denton-counties

Probability of Future Events

The possibility of a hail occurrence is highly likely to happen every year based on historical data, although the severity of impacts will vary. Hail events are common in Garland, as the North Central Texas region is frequented by severe thunderstorms in the spring through summer months. Previous historical data Table 5.14 shows 20 hail events have occurred within Garland since 1994. Calculations from this data suggests that a hail event will impact Garland 0.9 times a year. Therefore, according to Table 4.3 Hazard Frequency Ranking it is highly likely for a hail event to occur within the next year.

Impact on Community

The severity of impact from hail in the City of Garland would be limited relative to their frequent occurrence. Property damage would be the biggest impact to the community. Broken windows, damaged vehicles, and roofing are all subject to damage from a severe hailstorm. According to the National Climatic Data Center, 20 hail events have been reported in Garland, Texas between 1/1/1994 and 12/31/2015. Hail has caused an estimated $10,005,000 dollars in property damage. The City is located in a very urbanized region making the loss of crops a minimal concern.

Table 5.14. Hail Historical Data

TOWN	DATE	EVENT TYPE	SIZE	DEATHS	PROPERTY DAMAGE
GARLAND	5/2/1994	Hail	0.75 IN.	0	0
GARLAND	8/7/1994	Hail	0.75 in.	0	0
GARLAND	10/21/1994	Hail	2.00 in.	0	0
GARLAND	11/3/1994	Hail	0.75 in.	0	0
GARLAND	3/25/1995	Hail	1.75 in.	0	10,000,000
GARLAND	4/12/1996	Hail	1.00 in.	0	0
GARLAND	5/28/1996	Hail	1.50 in.	0	0
GARLAND	6/15/1996	Hail	0.75 in.	0	0
GARLAND	1/21/1998	Hail	1.00 in.	0	0
GARLAND	4/8/1998	Hail	0.75 in.	0	0
GARLAND	5/2/1998	Hail	2.00 in.	0	0
GARLAND	2/25/2000	Hail	3.75 in.	0	0
GARLAND	6/29/2001	Hail	2.00 in.	0	0
GARLAND	7/12/2002	Hail	0.75 in.	0	0
GARLAND	5/24/2003	Hail	0.75 in.	0	0
GARLAND	6/5/2004	Hail	1.00 in.	0	0
GARLAND	4/5/2005	Hail	1.50 in.	0	0
GARLAND	2/5/2008	Hail	1.00 in.	0	0
GARLAND	7/19/2009	Hail	1.75 in.	0	5,000
GARLAND	7/19/2009	Hail	1.00 in.	0	0

National Climatic Data Center

Summary of Vulnerability

The entire planning area is equally vulnerable to hail events. If tennis ball size hail (2.5 inches) were to occur it would cause major impacts to the community, causing severe roof damage and serious risk of injuries. However, that type of impact is rare compared to how often hail occurs in the area. The Planning Team has determined that a hail incident for the City of Garland is low risk and has a limited impact due to the small hail size that usually occurs in Garland. Large hail that caused major damage has only occurred once since 1991.

Erosion

Hazard Description

Erosion involves the wearing away of rock and soil found along the river bed and banks. Erosion also involves the breaking down of the rock particles being carried downstream by the river. Vertical erosion is the downward erosion which deepens the channel, and lateral erosion is sideward erosion which widens the channel.

There are four ways a river can erode a bed and bank:

- Hydraulic action – the force of water flow that breaks rock and drags it away from the bed and the banks of the river.
- Corrosion/abrasion – the grinding of the rock fragments carried by the river against the banks and bed of the channel. This grinding action widens and deepens the channel.
- Attrition – the knocking of rock fragments in the water against each other. The fragments are broken into smaller, smoother pebbles.
- Solution/corrosion – the process of the water reacts chemically with soluble minerals in the rocks and dissolve them.

Water erosion is not the only type of erosion impacting soil in the area; wind erosion will also be considered in this section.

Location

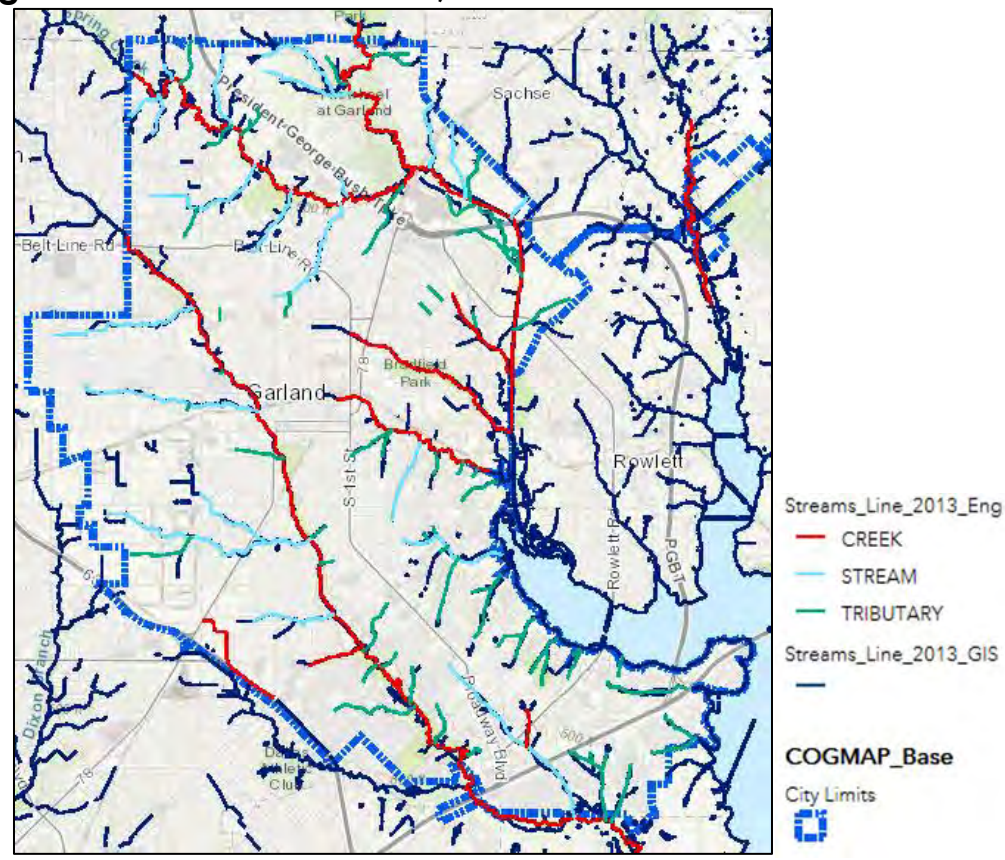
All of the creeks, streams and tributaries in the City of Garland are equally subject to erosion. The planning area also includes about eight miles of lakeshore that is subject to erosion. Duck Creek has had the greatest water erosion problems in the City of Garland. Figure 5.33 shows the location of the areas that may experience erosion. The droughts in Garland increase the effects of wind erosion on the entire planning area as well. When droughts occur there is less vegetation to hold land in place.

Severity

Of the 32 million acres of cropland in Texas, more than 12.8 million acres or 40 percent are classified as highly erodible. According to the Texas Environmental Almanac, Texas soil erosion rates is one of the eight highest in the country.[19] Garland floods have scoured the silt banks near the concrete pedestrian and bike path at Duck Creek Greenbelt Park. The bank eroded to a point where an 8-ft wide concrete trail must be relocated. Creek bank erosion, creates a loss of park land and facilities leading to loss of park infrastructure.

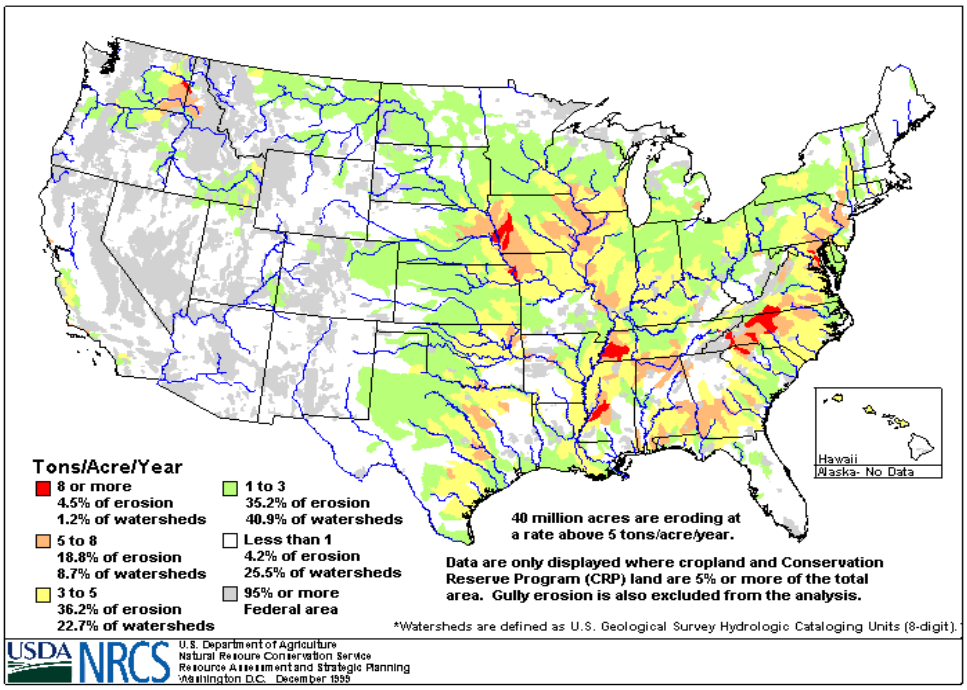
[19] Texas Environmental Almanac: http://www.texascenter.org/almanac/Land/SOILCH5P1.HTML

Figure 5.33. Garland Creeks, Streams and Tributaries



Garland GIS

Figure 5.34. Average Annual Soil Erosion by Wind and Water



Natural Resources Conservation Service

Previous Occurrences

The City of Garland Parks and Recreation Department has identified some problem erosion areas that include:

- Windsurf Bay Park
- Duck Creek
- Meadowcreek Branch Greenbelt

Probability of Future Events

Erosion is a continuous hazard for the city. Therefore, according to Table 4.3 Hazard Frequency Ranking it is highly likely that erosion will occur in the next year. Predictions are not reliable because the different variables that exacerbate erosion cannot be easily foreseen.

Impact on Community

Erosion can impact many different areas of a community. Erosion can cause city parks, residents and business to lose property, and even structures. Another problem that can arise from erosion is sedimentation. The Texas Environmental Almanac states sedimentation is usually the end result of the erosion process. When a soil particle is detached and transported by water to a new site of deposit, it is referred to as sediment. The soil particle might be temporarily deposited several times before it reaches its end destination. Sediment can fill reservoirs, clog waterways, reduce recreational use of waters, and increase operating costs of water-treatment facilities. Erosion also loosens soils and forms dust, leading to allergies, crop loss, desertification, and the spread of noxious weeds. There are a wide range of impacts that erosion may have, however the severity of impact to the community is limited.

Summary of Vulnerability

All of the creeks, streams and tributaries in the City of Garland are equally subject to erosion. Although the hazard is constantly occurring, the impact is limited therefore the planning team considers erosion to be a low risk hazard.

Local Hazard Mitigation Goals and Objectives

The City of Garland has identified mitigation goals to help direct mitigation planning efforts within the community. These mitigation goals have changed based on the updated Hazard Assessment, Community Impact and Risk Assessment and Capabilities Assessment. The Hazard Mitigation Action Plan now includes additional hazards than the previously FEMA approved plan contained. These goals identify areas to which specific mitigation actions should be directed. They were developed to reduce or avoid vulnerabilities to identified hazards. Implementation of the following goals and objectives will help the community to reduce or eliminate the loss of life and property from the identified hazards.

Goal 1: ***Protect residents from the impacts of natural, technological and man-made disasters.***

Objective 1.1 - Reduce or eliminate hazards that may cause injuries, loss of life or severe risk.

Goal 2: ***Protect property, new and existing structures, from the impacts of natural, technological, and man-made disasters.***

Objective 2.1 - Reduce or eliminate hazards that cause property damage/repetitive loss.
Objective 2.2 - Ensure compliance with the National Flood Insurance Program.
Objective 2.3 - Implement training activities and regulations that provide the community with a more hazard resistant infrastructure.

Goal 3: ***Enhance public education, awareness and support for hazard mitigation.***

Objective 3.1 – Provide guidance to local businesses to lessen the economic impact when hazards occur.
Objective 3.2 - Provide strategies for the public to apply mitigation within their own household.
Objective 3.3 - Encourage public involvement in the emergency management process.
Objective 3.4 - Identify agencies, personnel and resources available or needed to implement pre-disaster mitigation activities and initiatives.
Objective 3.5 - Continue to assess and understand hazards to the community.

Mitigation Action Report

Table 6.1 is a summary of project progress for hazard mitigation actions discussed in Garland's previous FEMA approved HazMAP plan.

Table 6.1. Mitigation Action Report

Mitigation Action	Description	Status
Building Code Monitoring and Assessment	Mitigate wind related hazards by adopting and implementing new building codes to enhance tornado and wind resistance of structures within the community	**Complete** - The 2015 series of the International Codes was adopted. This code increased the design wind speed from 90 to 115 mph for structures. This design change will produce more resilient buildings.
Increased Flood Hazard Warning Capabilities	• Installation of approximately eight flood sirens and sensors at strategic locations along Duck Creek. • Use of Volunteers emergency response teams.	**Canceled** – In lieu of this mitigation action the City installed 8 flood gates in the flood prone area. The Streets Department, Fire Department and Police Department can close these gates. Map in Appendix G. • The City of Garland also purchased an emergency notification system, CodeRed, which is utilized for public warning.
Stream 2C3 and 2C4 Channel Improvements	Improvements/widening of the channels of streams 2C3 and 2C4 in Garland to reduce flooding risks to residents and businesses along said streams.	**Project Delayed** – Funding and property acquisition obstacles. This project also has a BC ratio <1.
Country Club Estates Storm Sewer Improvements	Storm sewer and channel improvements to increase their drainage capacity	**Project Delayed –** Funding obstacles. Possible future Capital Improvement Program project. This project also has a BC ratio <1.
Keen Branch Channel Improvements	Channelization improvements to Keen Branch	**Project Delayed** - This project also has a BC ratio <1.
Fleet Services Continuity of Operations	•Acquisition of generators at the two main City of Garland fuel sources, 2343 Forest Lane and Gasoline Alley, and a new mobile fuel truck for emergency operations •Generators and a new fuel truck would ensure continuity of operations in a winter storm event as fuel would remain available to City vehicles	**Project Progress -** Two surplus generators have been earmarked for reinstallation at the two major (City) fuel sites. **Project Delayed –** Funding obstacles
Recreation Center Generators	•Attainment of generators at all City recreation centers in order to provide more resilient warming centers in winter weather conditions •Power loss is often one of the results of winter storms; generators would maintain energy for these facilities, which the City uses as local warming centers and community shelters	**Project Delayed –** Funding obstacles and communication between departments.

Misting Stations at Local Recreation Centers	Purchase and installation of six outdoor misting stations, one for each community recreation center.	**Project Canceled –** Cooling stations predominately opened through non-profit organizations.
Rapid First Response Communications	Outsource mission-critical paging to a company that utilizes more advanced technology that focuses on rapid and accurate delivery of text messages during emergency operations	**Project Canceled** - Due to the ease of switching page messages to personnel cell phones.
West Pressure Plane Improvements	• A phased approach to add additional capacity to the West Pressure Plane of the water distribution system. • Phase one - the expansion and rehabilitation of Wallace Pump Station and construction of a new 24-inch transmission line. •Phase two – construction of a 2.5-million-gallon elevated storage in the southwest portion of Garland.	**Project on Schedule** - The 3.5 MG ground storage tank has been removed from this project.
East Zone Water Tower	Design and construction of a new elevated water storage tank and associated piping in the East Pressure Plane. This will provide peak-hour pressures to the southern portion of Garland and enhance off-peak service and fire protection.	**Project Delayed -** A new water distribution system study is being conducted to determine size, location and phasing with additional projects.
"Texas Individual Saferoom Rebate Program"	The "Texas Individual Saferoom Rebate Program" will reimburse a homeowner or developer for ½ of the cost to install an individual saferoom in an existing or planned home, up to a cap of $3,000. Individuals may not apply directly to the State; their city or county must apply for funds on their behalf.	**Project Delayed –** Grant funding and staffing have delayed this project. This program is also offered through the North Central Texas Council of Governments.
All Hazards National Weather Radio	Distribute All Hazards Nation Weather Service Radios to all city facilities	**Project Complete –** All City facilities including recreation centers and libraries were given a weather radio. This was also part of the National Weather Service "Storm Ready" certification.
Storm Spotter Training	Increase the number of storm spotters in the community and the training they receive by hosting an annual SKYWARN Spotter Training Conference.	**Project Complete and Ongoing –** SKYWARN has been held annually and will continue. Over 300 participants each year are trained by the National Weather Service to be storm spotters.
Extreme Heat Preparedness Campaign	Implement an aggressive public awareness campaign concerning extreme heat and how to mitigate heat within the household.	**Project Canceled –** All hazards preparedness campaigns are preferred. When staffing becomes available, specific preparedness campaigns will be examined again.
Advanced Hazardous Materials Training	Emergency Management staff attend training through the Pipeline Safety Office of Training and Qualifications, in order to develop more thorough plans for hazardous materials	**Project Complete**
Hazardous Materials Flood Protection	Identify hazardous materials facilities that exist in the floodplain and encourage mitigation/protection measures Help facilities to prepare plans for flood events	**Project Complete**

7. Hazard Mitigation Actions

The City of Garland Hazard Mitigation Planning Team identified the following mitigation actions in order to reduce the impact of local hazards. Each mitigation action was developed in conjunction with local mitigation goals and objectives. The mitigation actions identified below are organized by hazard. The actions are described along with the benefits of each action, the estimated cost, the organization responsible for completing the action, the effect on new and existing structures, timeline, and the potential funding sources.

Tornado, Severe Winter Weather, Severe Thunderstorm and Hail Combined Mitigation Actions

#1
Title: Implementation of the "Texas Individual Saferoom Rebate Program" **Description**: The "Texas Individual Saferoom Rebate Program" will reimburse a homeowner or developer for ½ of the cost to install an individual saferoom in an existing or planned home, up to a cap of $3,000. Individuals may not apply directly to the State; their city or county must apply for funds on their behalf. **Hazard(s) Addressed**: Tornado and Severe Thunderstorms **Goals and objectives addressed**: 1.1, 3.2 **Lead Office**: Emergency Management **Funding Source(s):** Hazard Mitigation Grant Program or Pre-Disaster Mitigation **Effect on New Structures**: Improved safety for new structures participating in the program **Effect on Existing Structures**: Improved safety for existing structures **Timeline for Completion**: To be determined upon receipt of funding **Costs (Estimated)**: ½ of the cost to install an individual saferoom in an existing or planned home, up to a cap of $3,000
Cost Effectiveness and Risk Reduction: Implementation of this program would save lives in the event of a tornado. The amount of lives saved would increase with the amount of participating residents

#2

Title: Building Code enforcement and maintenance.
Description: Mitigate wind related hazards by adopting and implementing new building codes in order to enhance tornado and wind resistance of structures.
Hazard(s) Addressed: Severe Thunderstorms, Tornado and Flood
Goals and objectives addressed: 1.1, 2.1
Lead Office: Building Inspection
Funding Source(s): General Fund
Effect on New Structures: New structures will be more resilient to high wind and flood.
Effect on Existing Structures: Existing structures may be more resilient if remodeled.
Timeline for Completion: Ongoing
Costs (Estimated): Staff time

Cost Effectiveness and Risk Reduction: More resilient buildings withstand higher wind speeds, reducing loss during high wind events and saving on reconstruction costs along with more durable finishes, which should last longer.

#3

Title: Overhead Line Maintenance Program
Description: Ongoing program to upgrade GP&L's overhead electrical equipment
Hazard(s) Addressed: Tornado, Severe Winter Weather and Severe Thunderstorms
Goals and objectives addressed: 1.1, 2.1, 3.4
Lead Office: Garland Power & Light
Funding Source(s): GP&L O&M Budget
Effect on New Structures: Reduce the potential for weather hazards to interrupt electric service by keeping the equipment in good working order.
Effect on Existing Structures: Reduce the potential for weather hazards to interrupt electric service by keeping the equipment in good working order.
Timeline for Completion: Ongoing
Costs (Estimated): $312,500 annually

Cost Effectiveness and Risk Reduction: GP&L's excellent service reliability scores, which beat national averages, show that this program works and mitigates power outages and loss.

#4

Title: 24/7 Standby Electric Crews
Description: Garland Power & Light has dedicated troubleshooter and standby crews available to respond to power outages and emergencies. Additional crews are activated when inclement weather is imminent.
Hazard(s) Addressed: Tornado, Severe Winter Weather, Hail and Severe Thunderstorms
Goals and objectives addressed: 1.1, 3.4
Lead Office: Garland Power & Light
Funding Source(s): GP&L O&M Budget
Effect on New Structures: Reduce the power outage duration times
Effect on Existing Structures: Reduce the power outage duration times
Timeline for Completion: Ongoing
Costs (Estimated): $300,000 annually

Cost Effectiveness and Risk Reduction: GP&L's excellent service reliability scores, show that this program works and can get the City operating again after hazards reducing loss.

#5
Title: Mutual Aid Agreements **Description:** Maintain agreements with local utilities to provide power restoration assistance **Hazard(s) Addressed:** Tornado, Severe Winter Weather, Hail and Severe Thunderstorms **Goals and objectives addressed**: 3.4 **Lead Office:** Garland Power & Light **Funding Source(s):** GP&L O&M Budget **Effect on New Structures:** Reduce the power outage duration times **Effect on Existing Structures:** Reduce the power outage duration times **Timeline for Completion:** Ongoing **Costs (Estimated):** $200,000 annually
Cost Effectiveness and Risk Reduction: When an all hands on deck emergency occurs and the City is down, GP&L relies on mutual aid to help prevent further loss. Ongoing power outages paralyze a community, businesses and City services.

#6
Title: Tree Trimming Program **Description:** Ongoing program to trim trees and remove vegetation to prevent encroachment into the clearance space of GP&L's transmission and distribution power lines **Hazard(s) Addressed**: Tornado, Severe Winter Storm, Hail and Severe Thunderstorms **Goals and objectives addressed**: 1.1, 2.1, 2.3, 3.1, 3.4 **Lead Office:** Garland Power & Light **Funding Source(s):** GP&L O&M Budget **Effect on New Structures:** Reduce the potential for trees and/or branches to damage power lines and interrupt electric service **Effect on Existing Structures:** Reduce the potential for trees and/or branches to damage power lines and interrupt electric service **Timeline for Completion**: Ongoing **Costs (Estimated):** Annually: Distribution lines - $725,000; Transmission lines - $136,104; TMPA lines - $120,000
Cost Effectiveness and Risk Reduction: This program reduces the hazard of power outage. This is a proactive program, which reduces the risk to the grid when hazards occur through proactive programs.

#7
Title: Fleet Services Continuity of Operations **Description:** Acquisition of generators at the two main City of Garland fuel sources, 2343 Forest Lane and Gasoline Alley, and a new mobile fuel truck for emergency operations would ensure continuity of operations in a winter storm event as fuel would remain available to city vehicles **Hazard(s) Addressed**: Winter Storm **Goals and objectives addressed**: 1.1, 2.3, 3.4 **Lead Office:** Fleet Services **Funding Source(s):** Mitigation grant funding **Effect on New Structures:** New structures would have improved capabilities and continuity of operations due to fuel accessibility **Effect on Existing Structures:** Existing structures would have improved capabilities and continuity of operations due to fuel accessibility **Timeline for Completion:** To be determined upon receipt of funding **Costs (Estimated):** $300,000
Cost Effectiveness and Risk Reduction: The City of Garland would be able to continue services as Fleet would be able to maintain operations throughout all City departments. First responders would more effectively respond to the hazard, which would also minimize loss of life.

#8
Title: Increase Storm Spotter Training **Description:** Increase the number of storm spotters in the community and the training they receive by hosting an annual SKYWARN Spotter Training Conference. **Hazard(s) Addressed:** Tornado, Hail and Severe Thunderstorms **Goals and objectives addressed:** 1.1, 2.1, 3.2, 3.3 **Lead Office:** Emergency Management **Funding Source(s):** General fund **Effect on New Structures:** None **Effect on Existing Structures:** None **Timeline for Completion:** Annually **Costs (Estimated):** $2,500
Cost Effectiveness and Risk Reduction: This conference is very cost effective as hundreds of storm spotters can be trained annually at a relatively low price. The training received by local storm spotters will result in advanced warning times and help to save lives.

#9
Title: Onspot Automatic Tire chains **Description:** On icy and slippery roads, the automatic tire chains are activated by the driver from a dashboard switch. These tire chains should be installed on vehicles identified as critical during times of severe winter weather response, such as EMS, Fire and GP&L. **Hazard(s) Addressed:** Severe Winter Weather **Goals and objectives addressed:** 1.1 **Lead Office:** Fire Department **Funding Source(s):** General fund **Effect on New Structures:** None **Effect on Existing Structures:** None **Timeline for Completion:** 2021 **Costs (Estimated):** Critical vehicles must be identified.
Cost Effectiveness and Risk Reduction: These chains shorten response times during emergencies, therefore reducing loss of life.

Terrorism and Cyber Attack Mitigation Actions

#10

Title: Desktop Security Training

Description: Conduct Wombat Training to City employees on safe web browsing, mobile device security, identifying phishing and smishing attacks, password security, and safe URLs. Phishing emails are sent to employees to test response.

Hazard(s) Addressed: Cyber Attacks

Goals and objectives addressed: 1.1, 2.3, 3.4, 3.5

Lead Office: Information Technology

Funding Source(s): General Fund

Effect on New Structures: N/A

Effect on Existing Structures: N/A

Timeline for Completion: Ongoing

Costs (Estimated): $50,000

Cost Effectiveness and Risk Reduction: All City departments depend on IT systems to make informed, critical decisions and successfully carry out their missions. Those IT systems and information resources are subject to almost constant threats that can have significant and wide-ranging impacts on operations, compromising the confidentiality, integrity or availability of information for an agency. Educating employees, who are the weak point in the system, will mitigate the loss that can be occurred during and attack.

#11

Title: SWAT and EOD Team Equipment Enhancement

Description: Enhancing the SWAT and EOD team response capabilities through the procurement of equipment needed to sustain NIMS Type 1 status.

Hazard(s) Addressed: Terrorism

Goals and objectives addressed: 1.1

Lead Office: Police Department

Funding Source(s): Grant and general funding

Effect on New Structures: N/A

Effect on Existing Structures: N/A

Timeline for Completion: 2020

Costs (Estimated): $100,000

Cost Effectiveness and Risk Reduction: Maintaining Type 1 status is a crucial part of this in house regional asset. Not maintaining these capabilities would not only have major impacts to the City of Garland, but the entire region. This team saves lives and protects infrastructure.

Biological Event Mitigation Actions

#12
Title: Mosquito Trucks **Description:** This plan will help to minimize breeding sources in the City by the use of truck-mounted larviciding equipment and liquid larvicide. The one-time purchase of equipment plus the ongoing purchase of liquid biological larvicide is an alternative to using chemical adulticide, which can kill other beneficial insects. **Hazard(s) Addressed**: Biological Event **Goals and objectives addressed:** Minimize mosquito breeding sources **Lead Office:** Health Department **Funding Source(s)**: Unfunded budget supplement **Effect on New Structures:** N/A **Effect on Existing Structures**: N/A **Timeline for Completion:** 1 year **Costs (Estimated):** $50,000
Cost Effectiveness and Risk Reduction: The use of a truck mounted larviciding disperser will reach more areas that are not accessible by humans. The dispersing of the larvicide using a buffalo turbine and liquid larvicide is a substantially cheaper alternative to using aerial applications of larvicide. One night of aerial larvicide application is approximately $45.00/acre. The City of Garland is approximately 36,500 acres. This process will protect the population from mosquito transmitted disease.

Flood Mitigation Actions

#13

Title: Ben Davis Substation Flood Study and Equipment Upgrade
Description: Flood Study and new control house
Hazard(s) Addressed: Flood
Goals and objectives addressed: 1.1, 2.1, 3.1, 3.4, 3.5
Lead Office: Garland Power & Light
Funding Source(s): GP&L CIP Budget
Effect on New Structures: Continued electric service in the event of a flood at the Ben Davis Substation
Effect on Existing Structures: Continued electric service in the event of a flood at the Ben Davis Substation
Timeline for Completion: FY 2017 for Flood Study; FY 2018 for control house
Costs (Estimated): $72,000 for Flood Study; $5 million for new control house

Cost Effectiveness and Risk Reduction: Operations at the Ben Davis Substation will be better protected from a flood event, therefore keeping the community with power.

#14

Title: Stream 2C3 and 2C4 Channel Improvements
Description: Improvements/widening of the channels of streams 2C3 and 2C4 in Garland to reduce flooding risks to residents and businesses along said streams.
Hazard(s) Addressed: Flooding
Goals and objectives addressed: 2.1, 3.1, 3.4
Lead Office: Engineering
Funding Source(s): To be proposed in a future budget; Mitigation grant funding
New Structures: Flood losses would be reduced in any new structures along the stream.
Effect on Existing Structures: Flood losses would be reduced in any existing structures along the stream.
Timeline for Completion: To be determined upon receipt of funding.
Costs (Estimated): $9,207,500

Cost Effectiveness and Risk Reduction: Homeowners along affected stream would save money on flood insurance premiums and possibly see an improvement in property values. Fewer insurance payments would be required under NFIP, and loss of life and property would be reduced.

#15
Title: Country Club Estates Storm Sewer Improvements **Description:** Storm sewer and channel improvements to increase their drainage capacity **Hazard(s) Addressed:** Flooding, Erosion **Goals and objectives addressed:** 1.1, 2.1, 2.2, 3.1,3.4 **Lead Office:** Engineering **Funding Source(s):** To be proposed in a future budget; Mitigation grant funding **New Structures:** Elimination of some known cases of homes that are subject to Code "A" internal flooding; also, reduction of Code "C" bank erosion in new structures built in the Country Club Estates neighborhood. **Effect on Existing Structures:** Elimination of some known cases of homes that are subject to Code "A" internal flooding; also, reduction of Code "C" bank erosion in existing structures in the Country Club Estates neighborhood. **Timeline for Completion:** To be determined upon receipt of funding. **Costs (Estimated):** $1,122,500
Cost Effectiveness and Risk Reduction: Homeowners in the Country Club Estates neighborhood would see a reduction or elimination of flood loss. Garland would reduce money spent on bank erosion repairs.

#16
Title: Keen Branch Channel Improvements **Description**: Channelization improvements to Keen Branch **Hazard(s) Addressed:** Flooding **Goals and objectives addressed:** 1.1, 2.1, 2.2, 3.1, 3.4 **Lead Office:** Engineering **Funding Source(s):** To be proposed in a future budget; Mitigation grant funding Effect on **New Structures:** New structures built along Keen Branch would be less vulnerable to flood hazards **Effect on Existing Structures:** Existing structures along Keen Branch would be less vulnerable to flood hazards **Timeline for Completion:** To be determined upon receipt of funding **Costs (Estimated):** $7,073,750
Cost Effectiveness and Risk Reduction: Project would reduce flood claims for residential flood losses in structures along Keen Branch.

Communications Failure Mitigation Actions

#17
Title: Backup Police and Fire Communications Center / Dispatch **Description**: The radio network will be connected with microwave and fiber. All 8 work stations and equipment in the 911 center will be on UPS and generator backup power. **Hazard(s) Addressed:** Communications Failure **Goals and objectives addressed:** 1.1, 2.3, 3.4 **Lead Office:** IT **Funding Source(s):** General **New Structures:** A new structure will be equipped to manage Police and Fire Dispatch for the City of Garland. **Effect on Existing Structures:** N/A **Timeline for Completion:** September 2017 **Costs (Estimated):** $230,000
Cost Effectiveness and Risk Reduction: The impact to the community would be detrimental in the event of dispatch communications failure. This backup facility provides redundancy and will be a part of the Police Department's continuity of operations.

Drought Mitigation Actions

#18

Title: West Pressure Plane Improvements

Description:

- This project incorporates a phased approach to add additional capacity to the West Pressure Plane of the water distribution system. Phase one includes the expansion and rehabilitation of Wallace Pump Station and the construction of a new 24-inch transmission line
- In Phase two, a 2.5-million-gallon elevated storage tank will be constructed in the southwest portion of Garland

Hazard(s) Addressed: Drought

Goals and objectives addressed: 1.1, 2.3, 3.4

Lead Office: Water

Funding Source(s): Capital Improvement Plan - $4,050,000; Potential mitigation grant funding - $17,574,000

Effect on New Structures: New structures would have more access to water in a drought event

Effect on Existing Structures: Existing structures would have more access to water in a drought event

Timeline for Completion: July 2017

Costs (Estimated): $21,624,000

Cost Effectiveness and Risk Reduction: Minimal impact due to offsetting pumping costs by reducing pumping from Apallo and Northside Pump Stations. Residents of the southern portion of Garland will be less vulnerable to water shortages in a drought.

#19

Title: East Zone Water Tower

Description: Design and construction of a new elevated water storage tank and associated piping in the East Pressure Plane in order to provide peak-hour pressures to the southern portion of Garland and enhance off-peak service and fire protection

Hazard(s) Addressed: Drought

Goals and objectives addressed: 1.1, 2.3, 3.4, 3.5

Lead Office: Water

Funding Source(s): To be proposed in a future budget; Mitigation grant funding

Effect on New Structures: New structures would have more access to water in a drought event

Effect on Existing Structures: Existing structures would have more access to water in a drought event

Timeline for Completion: 2020

Costs (Estimated): $7,000,000

Cost Effectiveness and Risk Reduction: Minor impact on the City's operating budget due to additional facility maintenance costs. Residents of the southern portion of Garland will be less vulnerable to water shortages in a drought.

Erosion Hazard Mitigation Actions

#20

Title: Bank Stabilization - Duck Creek Greenbelt Park

Description: Installation of bank stabilization along sections of Duck Creek Greenbelt where flood events have scoured the silt banks near the concrete pedestrian and bike path. The bank has failed, sluffing-off to a point where this 8-ft wide concrete trail will need to be relocated because it is now too close to the edge of the bank. Project design will need to include topographic survey, hydraulic study of that segment, and an analysis of possible materials and methods for the most appropriate stabilization.

Hazard(s) Addressed: Erosion and Flooding

Goals and objectives addressed: 2.1, 2.3, 3.4

Lead Office: Parks and Recreation and Engineering

Funding Source(s): Grant

Effect on New Structures: N/A

Effect on Existing Structures: Will protect creek bank and adjacent park pedestrian and bike facilities from further damage.

Timeline for Completion: 2018 – 2020

Costs (Estimated): $3.5 Million

Cost Effectiveness and Risk Reduction: This section of Duck Creek Greenbelt Park is part of a multimodal pedestrian and bike system which connects with transit facilities and provides off-street connection between Centerville Road and the City of Mesquite's bike/ pedestrian trail, south of IH-30. Current funding will be extending the concrete trail from IH-30 into Mesquite, and extending the off-street bike path from its current north terminus, into Lon Wynne Park and will cross Duck Creek via a pedestrian–bike bridge, and connect to on-street bike facilities.

All Hazards Mitigation Actions

#21
Title: Economic Resistance and Recovery Education **Description**: Provide economic resistance and recovery education to local businesses to improve their ability to quickly recover from disasters. **Hazard(s) Addressed:** All **Goals and objectives addressed:** 2.1, 2.3, 3.1, 3.2, 3.3, 3.4, 3.5 **Lead Office:** Chamber of Commerce **Funding Source(s):** General **Effect on New Structures:** Development of business continuity plan. **Effect on Existing Structures:** Development of business continuity plan. **Timeline for Completion:** 2020 **Costs (Estimated):** $5,000
Cost Effectiveness and Risk Reduction: Business losses translate into the loss of resources for local residents as they try to recover, and the loss of taxes and services to local governments as they try to manage the recovery.

#22
Title: Recreation Center Generators **Description:** Power loss is often one of the results of many hazards; generators would maintain energy for these facilities, which the City uses as community shelters. **Hazard(s) Addressed:** All hazards **Goals and objectives addressed:** 1.1, 3.1, 3.4 **Lead Office:** Parks and Recreation **Funding Source(s):** Mitigation grant funding **Effect on New Structures:** None **Effect on Existing Structures:** Existing recreation centers will have power backup to serve as more sustainable warming centers and shelters to local residents **Timeline for Completion:** To be determined upon receipt of funding **Costs (Estimated):** $10,000
Cost Effectiveness and Risk Reduction: Generators at the community recreation centers would provide more sustainable warming centers and shelters for residents as people will have a safe place to stay during hazard events. The City will save money by sending fewer first responders on calls related to hazards.

#23
Title: Mitigation and Preparedness Coordinator **Description:** This new position within the Office of Emergency Management will focus on implementing City mitigation actions, educate the public on what they can do to mitigate hazards in their homes and how prepare for emergencies. **Hazard(s) Addressed:** All hazards **Goals and objectives addressed:** 1.1, 2.1, 2.3, 3.1, 3.2, 3.3, 3.4, 3.5 **Lead Office:** Office of Emergency Management **Funding Source(s):** Grant funding or General fund **Effect on New Structures:** This position would focus on educating the public on protecting their homes. **Effect on Existing Structures:** This position could focus on attaining grant funding and educate the public on protecting their homes. **Timeline for Completion:** To be determined upon receipt of funding **Costs (Estimated):** $60,000 a year
Cost Effectiveness and Risk Reduction: Educating residents and businesses to prepare for disasters, mitigate hazards and build emergency plans will put less of a strain on local government resources.

Benefit-Cost Review and Prioritizing Mitigation Actions

The City of Garland Planning Team prioritized mitigation activities using the Social, Technical, Administrative, Political, Legal, Economic, and Environmental (STAPLEE) Method, per Federal Emergency Management Agency (FEMA) recommendations. STAPLEE is a benefit-cost review tool and includes considerations for Social, Technical, Administrative, Political, Legal, Environmental and Economic issues. Each of these items is assigned a positive or negative value. Projects that score the highest are considered to be the most effective, and their funding most justified. A lower score indicates that several obstacles exist that would prevent the proposed project from being completed. Most mitigation strategies have at least one obstacle and, very frequently, this obstacle is economic. Part of putting the mitigation strategies in a prioritized list is being able to justify the need for a project should funding become available.

City of Garland STAPLEE Action Evaluation and Prioritization Table

Mitigation Actions	Community Acceptance	Effect on Segment of	Technically Feasible	Long-Term Solution	Secondary Impacts	Staffing	Funding Allocation	Maintenance/Operations	Political Support	Local Champion	Public Support	State Authority	Existing Local Authority	Potential Legal Challenges	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land/Water	Consistent with Federal Laws	Effect on HAZMAT Waste Sites	Matches Environmental Goals	**Total Prioritization Score**
#1 Saferooms	+	+	+	+	+	N	-	N	+	N	+	N	+	+	+	N	N	-	N	+	N	N	9
#2 Code	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	-	+	N	N	+	N	N	14
#3 Line Pgm	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	+	N	N	19
#4 Crew	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	+	N	+	N	N	18
#5 Mutual Aid	+	+	+	+	+	N	N	+	+	+	+	+	+	+	+	+	N	+	N	+	N	N	16
#6 Trimming	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	N	+	N	+	N	N	16
#7 Fuel Truck	+	+	+	+	+	+	-	+	+	N	+	+	+	+	+	N	N	-	N	+	N	N	12
#8 Skywarn	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	+	N	+	N	N	18
#9 Tire Chains	+	+	+	+	+	+	+	+	+	N	+	+	+	+	+	+	N	-	N	+	N	N	18
#10 IT Training	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	+	N	+	N	N	18
#11 SWAT Eqpt	+	+	+	+	-	+	+	+	+	+	-	+	+	+	+	+	N	-	N	-	N	N	14
#12 Mosq Truck	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	+	N	+	N	+	19
#13 Ben Davis	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	+	N	+	20
#14 Channel	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	N	-	+	+	N	+	16
#15 Sewer	+	+	+	+	+	+	-	+	+	+	+	+	+	+	-	-	N	-	+	+	N	+	13
#16 Keen Br	+	+	+	+	+	+	-	+	+	+	+	+	+	+	-	-	N	-	+	+	N	+	12
#17 Dispatch	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	+	N	+	N	+	19
#18 West Pressure	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	+	21
#19 East Tower	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	-	+	+	N	+	17
#20 Duck Creek	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	+	21
#21 Eco Edu	+	+	+	+	+	+	+	N	+	+	+	+	+	+	+	+	+	+	N	+	N	N	18
#22 Generators	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	N	-	N	+	N	N	14
#23 Position	+	+	+	+	+	N	+	+	+	+	+	+	+	+	+	+	+	+	+	+	N	N	19

8. Plan Maintenance

Planning Team members will be responsible for coordinating a periodic review of the Plan to ensure integration of hazard mitigation strategies

Monitoring, Evaluating and Updating the Plan

The City of Garland Hazard Mitigation Action Plan will be reviewed annually within its five year life cycle by the Planning Team in order to determine whether or not any changes need to be made. Updates may be the result of the City of Garland Budget Review, Capital Improvement Plan or major disaster within the community. The Planning team will evaluate, maintain and revise the Hazard Identification, and Community Risk and Impact Assessment beginning each January. The Advisory Committee will then be responsible for assessing progress in mitigation techniques that were implemented by the plan and decide how improvements could be made to the overall mitigation strategy.

Following each update to the Hazard Mitigation Action Plan, the City of Garland Office of Emergency Management will document the update in the record of changes table in the Plan. This table will track any meetings, activities, completed initiatives, resulting risk reduction, limitations or processes used for the purpose of the plan update.

Incorporation into Existing Planning Mechanisms

Integration of the Hazard Mitigation Action Plan into other existing planning mechanisms will take place through coordinating the plan with Annex P: Hazard Mitigation of the local Basic Emergency Management Plan, by working with City departments to coordinate Capital Improvement planning and mitigation goals.

Continued Public Involvement

In order to maintain public involvement The City of Garland Planning Team will continue to seek the input of the community stakeholders. A copy of the Local Hazard Mitigation Action Plan will be available through the Office of Emergency Management for review and comment. The public will also be continuously engaged through a number of various tasks completed by the City of Garland Office of Emergency Management and other City Departments. Methods may include but are not limited to: adding an Economic Resistance and Recovery Education Coordinator, Economic Resistance and Recovery Education at the Chamber of Commerce, presentations, community preparedness campaigns, and seasonal preparedness updates on the departmental website.

A. City Council Resolution

B. Documentation of Planning Meetings

HazMAP Kickoff

Goals and Objectives

- Organize Resources and Convene Planning Team
- Review Previous Mitigation Goal Progress and Implementation
  - Other activities current/or completed not in the plan
- Set 2nd Planning Team Meeting – Monday October 10th at 10am?
  - Update Community Capabilities and Risk Assessment
- Set Individual Meetings with each Planning Team Member
  - In depth mitigation goal progress, documentation, etc.
  - Update statistics, data and figures
    - Send document with information that needs an update.
- Create Outreach Strategy
- Previous Strategy
  - Stakeholders, Public and Officials
  - Materials on website (tornado safety, HazMAP info, extreme heat safety)
  - Plan placed at library for public review and comments.
- Identify Mitigation Goals and Actions
  - Add manmade hazards to plan (terrorism)
  - Add aircraft incident, biological event, expansive soil, dam and levee failure, earthquake, lightening, wildfire
- Develop Action Plan for Implementation
- Set annual meeting to coincide with FEMAS grant cycle
- Identify Plan Maintenance Procedures
- Review Final Draft
- Submit Plan to State and FEMA
- Adopt Plan

Planning Team

Building Inspection
Chamber of Commerce
Emergency Management
Engineering
Facilities
Fire Department
GIS
Garland Power & Light
Health
Parks and Recreation
Planning/Neighborhood Vitality
Police
Water

Summary of Past Mitigation Goals

Y ***The "Texas Individual Saferoom Rebate Program" will reimburse a homeowner or developer for ½ of the cost to install an individual saferoom in an existing or planned home, up to a cap of $3,000.**
Y **Adopting and implementing new building codes which in order to enhance tornado and wind resistance of structures within the community.**
***Installation of approximately eight flood sirens and sensors at strategic locations along Duck Creek to warn citizens in the event of a serious flood incident, allowing evacuation from homes and businesses. Volunteer emergency response teams would be able to block roads that are flooded; preventing citizens from driving through hazardous areas.** Outdoor warning sirens/CodeRed/flood gate locations
Improvements/widening of the channels of streams 2C3 and 2C4 in Garland to reduce flooding risks to residents and businesses along said streams.
***Country Club Estates Storm Sewer Improvements. Storm sewer and channel improvements to increase their drainage capacity.**
Channelization improvements to Keen Branch.
***Recreation Center Generators**
Acquisition of generators at the two main City of Garland fuel sources, 2343 Forest LN and Gasoline Alley, and a new mobile fuel truck for emergency operations
Y ***Distribute All Hazards Nation Weather Service Radios to all city facilities.**
Y **Increase the number of storm spotters in the community and the training they receive by hosting an annual SKYWARN Spotter Training Conference.**
***Purchase and installation of six outdoor misting stations, one for each community recreation center.**
Implement an aggressive public awareness campaign concerning extreme heat and how to mitigate heat within the household
***West Pressure Plane improvements of the water distribution system. Phase one includes the expansion and rehabilitation of Wallace Pump Station and the construction of a new 24-inch transmission line. In Phase two, a 2.5-million-gallon elevated storage tank will be constructed in the southwest portion of Garland. The final phase will provide an additional 3.5 million gallons of ground storage.**

New East Zone Water Tower and associated piping in the East Pressure Plane in order to provide peak-hour pressures to the southern portion of Garland and enhance off-peak service and fire protection.
***Advanced Hazardous Materials Training for Emergency Management staff through the Pipeline Safety Office of Training and Qualifications, in order to develop more thorough plans for hazardous materials** Training
N **Identify hazardous materials facilities that exist in the floodplain. Help facilities to prepare plans for flood events.**
Rapid First Response Communications. Outsource mission-critical paging to a company that utilizes more advanced technology that focuses on rapid and accurate delivery of text messages during emergency operations

*Identifies the highest level of prioritization using the STAPLEE evaluation

Questions

- Is growth and development an issue?

HazMAP Planning Meeting 2

10/10/2016

Survey Results

- Handout
- Are these correct?
- Priority?
- Do changes need to be made?
- Hazard Survey Results – Just Feelings, Resources Spent, and Grant Funding –Alignment of Risk and Mitigation Efforts

Community Impact / Risk

Factors to Consider:

Prioritization

- Geographic Scope
- Duration
- Health Effects
- Displacement
- Economy
- Environment
- Built Environment
- Transportation
- Critical Services
- Confidence in Gov't
- Frequency (F)
- Cascading Effects (CE)
- Future Emphasis

Agenda

- Today
  - Hazard Survey Results
  - Top 10 Hazards in Garland
  - Calculate Community Impact and Risk of Hazards
  - Determine Public Outreach Approach

What is the best way to get Public Input?

Grants need Public Approval

Top ID Hazards = Top Risk

What are the top 5 hazards in Garland ?

Cyber Disaster	Hail
Aircraft Incident	Hazardous Materials (Fixed and Transport)
Biological Event	Infrastructure Failure/Failure
Bomb Threat	Lightning
Civil Disturbance	Plant Epidemic
Communications Failure	Power Outage
Dam Failure	Railroad Incidents
Drought	Severe Winter Weather
Earthquake	Sewer Failure
Erosion	Subsidence
Expansive Soil	Terrorism
Extreme Cold	Tornado
Extreme Heat	Urban Situation
Fires	Water Failure
Fuel Shortage	Wildfire
	Wind

Public Outreach

- Take decisions to Public in survey form
- Materials on website – all dept. sites
- City Press
- Library
- Chamber of Commerce

Geographic Scope

Dimension	Definition	One (1)	Two (2)	Three (3)	Four (4)	Five (5)
Geographic Scope	How large is the affected area (includes area of damage, but not only) affected by the incidents. For example, areas based on type of emergency or incidents.	Single site. Does not cross barriers	Single site, multiple blocks	Community specific (by Department)	City-wide	Regional

Duration

Dimension	Definition	One (1)	Two (2)	Three (3)	Four (4)	Five (5)
Duration	How long does the hazard affect the city or have lasting impacts?	Less than 1 hours	1-2 days	2-7 days	7-30 days	30+ days

Economy

Dimension	Definition	One (1)	Two (2)	Three (3)	Four (4)	Five (5)
Economic Impact	How does the hazard affect the local economy?	No measurable impact	Negligible impact on overall economy, but isolated businesses experience hardship	Some owners experience effects & unable to generate revenue or expand	Owners of economic enterprises affected & unable to generate revenue over extended period	Significant loss of GDP, or economic value, loss of ability to generate revenue

Transportation

Dimension	Definition	One (1)	Two (2)	Three (3)	Four (4)	Five (5)
Transportation	How does the hazard affect the ability of residents and visitors to consistently consume day-to-day?	No effect on mobility	Some residents and visitors experience difficulties, but always reasoning and alternate essential services	Some residents and visitors experience difficulties, but without alternate essential services	Many Critical Services inaccessible. Some major arteries inaccessible. Some residents and visitors impacted	Most critical services inaccessible. Most major arteries inaccessible. Most residents and visitors impacted

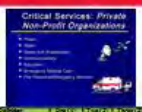
Health Effects

Dimension	Definition	One (1)	Two (2)	Three (3)	Four (4)	Five (5)
Health Effects	How dangerous is the hazard to the human health and safety?	No deaths or injuries	1-2 deaths and/or 1-50 injuries	3-10 deaths and/or 50-100 injuries	11-50 deaths and/or 100-500 injuries	over 50 deaths and/or 500+ injuries

Environment

Dimension	Definition	One (1)	Two (2)	Three (3)	Four (4)	Five (5)
Environment	How damaging is the disaster to the natural environment	No damage, temporary, minor damage	Negligible loss of the environment, easily recovered	Negligible loss of environment, requires intervention	Significant loss of environment, but recoverable over time	Significant loss of environment

Critical Services



Dimension	Definition	One (1)	Two (2)	Three (3)	Four (4)	Five (5)
Critical Services (Includes GDCC and Emergency)	How likely is the hazard to reduce the ability of government to provide critical services?	Less than 1 hour of critical services	Temporary interruption of critical services	Temporary interruption of critical services, but long-term impacts	Temporary interruption of critical services, long-term impacts, and interruption of multiple services	Critical or delivery of critical services

Displacement

Dimension	Definition	One (1)	Two (2)	Three (3)	Four (4)	Five (5)
Displacement	How likely is the hazard to negatively impact the region's population in terms of displacement and permanent property loss	No displacement, minor inconvenience	Displaced people, temporarily displaced	Displaced people, temporarily displaced and unable to work or produce income	250+/1000 people displaced, 50% of population displaced, long-term or permanent	1000+ displaced people, more than 50% of population displaced, long-term or permanent displacement, whole neighborhoods or cities displaced

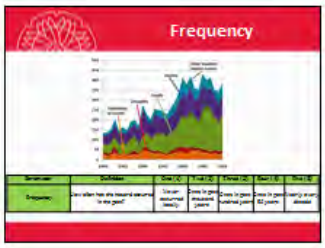
Built Environment

Dimension	Definition	One (1)	Two (2)	Three (3)	Four (4)	Five (5)
Built Environment (Property, Facilities, and Infrastructure)	How does the hazard affect buildings and physical infrastructure (roads, utilities, etc.)	No effects	1-10 structures damaged, 0-10% loss of area value	11-500 structures damaged, buildings will be affected up to 50% loss of area value	More than 500 structures damaged, 50% loss of area value	1000+ structures damaged, 50% loss of area value, utilities impacted for 500+ users

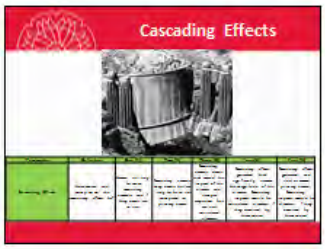
Confidence in Government

Dimension	Definition	One (1)	Two (2)	Three (3)	Four (4)	Five (5)
Confidence in Government	"Would public's confidence in the government be shaken?"	No		Somewhat		Yes

Appendix


Frequency

Next
• Community Impact Completed?
• Next Meeting – November 14th 10am
• Mitigation Actions


Cascading Effects

Future Emphasis
EDUCATION
FUTURE

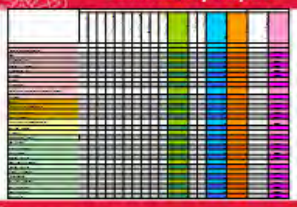
HazMAP Planning Meeting 3

11/9/2016

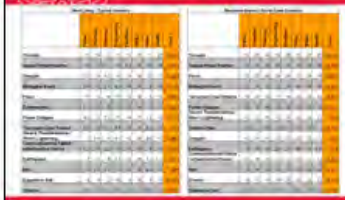
Agenda

- Today
  - Top 10 Hazards in Garland
    - Community Impact Results
  - Capabilities Assessment
  - Public Outreach Update

Community Impact



Community Impact Results



Community Impact Results = Priority

Public Outreach Update

- Memo to Council
- A web page will be designed to improve public awareness on hazard mitigation and all hazards that impact Garland.
- The web page will have a survey link to solicit input on identified hazards from the public.
- The information and survey link will be posted at customer service sites and hard copies can be requested from the Office of Emergency management.

Capabilities Assessment

- Additional Information?
- How can these capabilities be expanded and improved to reduce risk?

Hazard Mitigation Activities

Handouts – What activities are we already doing?
What activities may be a good ideas or you never heard of?

Wind - Adopt and Enforce Building Codes
- Requiring tie-downs with anchors and ground anchors appropriate for the soil type for manufactured homes.

Drought - Retrofit Water Supply Systems
- Designing water delivery systems to accommodate drought events.
- Developing new or upgrading existing water delivery systems to eliminate breaks and leaks.

Extreme Heat - Require max temperatures in housing/landlord codes.

Flood – Install flood sensor at Duck Creek
Participate in Community Rating System (CRS)

Next

- Do you need to add mitigation actions from the Capital Improvement Plan or Budget?
- Next Meeting
  Thursday, December 8thth 10am
- Public Outreach Survey Rollout
- Plan Information Implementation

Appendix

HazMAP Planning Meeting 4

1/12/2017

Agenda

- Public Outreach
- Mitigation Actions

Public Outreach

- FEMA Requirement – Public Participation
- Web Page
  - Survey links in Vietnamese and Spanish
  - Definition
  - Purpose
  - Process
  - Identified Hazards
  - Role of Public Involvement
  - POC
- Post Flyer at Customer Service Sites
  - All Libraries (4)
  - Permit Office - 800 Main Street?
  - Customer Service – 217 N. 5th Street
  - Recreation Centers
  - Health Department
  - City Care Clinic
  - Pet Adoption Center

Public Outreach Cont.

- Survey link pushed through:
  - Nextdoor, COG Twitter, COG Facebook
  - Chamber of Commerce Business Group
  - Community Leaders Group
  - Citizens Fire and Police Academy
  - GASP
- Residents can use libraries computers
- Hard copies Requested through OEM
- Memo Sent to Council
- Live January 16th – February 20th
- Results included in HazMAP

Mitigation Actions

- Building Inspection
  - Ordinance No. 6850 adopted the 2015 International Building Code (IBC) Section 423 of the IBC requires that a Storm Shelter capable of withstanding 250 MPH winds be constructed with new police, fire and ambulance facilities as well as with public schools
  - Building Code enforcement and maintenance - adopting and implementing new building codes which in order to enhance tornado and wind resistance of structures within the community
  - Update Construction Codes - Review the 2018 series of the International Codes for possible adoption by the City Council
  - Incentive for new homes?

Mitigation Actions

- Chamber of Commerce
  - Economic Recovery?
- Emergency Management
  - Work with NWS flood sensor at Duck Creek?
  - Strategic Plan
  - EMAP Accreditation
  - Texas Individual Saferoom Rebate Program
  - Skywarn Training

Mitigation Actions

- Engineering
  - Flood Gate Map
  - Improvements/widening of the channels of streams 2C3 and 2C4 in Garland to reduce flooding risks
  - Country Club Estates Storm Sewer Improvements
  - Keen Branch Channel Improvements
  - Community Rating System (CRS) ?
  - Any from CIP and Budget?
- Health
  - Biological Event Mitigation?
  - Accreditation?
- Facilities
  - Security Cameras – Terrorism? Is this complete?
  - Window film on 2nd floor 911 communication center?

Mitigation Actions

- Fire Department
  - New fire station
  - Pre fire planning program for target hazard locations?
- Fleet
  - Fleet Services Continuity of Operations
  - Emergency Management Capabilities Assessment?
- Neighborhood Vitality
- Parks and Recreation
  - Duck Creek Greenbelt Drainage
  - Recreation Center Generators? Delayed is correct?
- Police Department
  - Terrorism/Cyber Attacks? New equipment?
  - Communications Failure? New radio system?

Mitigation Actions

- GP&L
  - Tree Trimming Program
  - Overhead Line Maintenance Program
  - Ben Davis Substation Flood Study and Equipment Upgrade
  - Mutual Aid Agreements to provide power restoration assistance
  - 24/7 Standby Electric Crews
  - Fans & window units?
- Water
  - West Pressure Plan Improvements - more access to water in a drought
  - East Zone Water Tower
  - Water Resource Plan / Conservation Ordinance? Capabilities?
  - Increased backflow inspections?
  - Cross connection control?
  - Any from CIP and Budget?

Mitigation Actions

- Risk Management
  - Updating facility evacuation and sheltering plans?
  - RMIS Safety Training?
  - Property reevaluation for property insurances purposes
- Others Mentioned
  - Housing – Income based repairs? Emergency a/c?
  - Automatic Chains for FD/EMS/Streets?
  - Lightening – doing warning signs?

Next

- Confirm mitigation actions with all departments
- Survey available through February 20th
- Implement survey results and mitigation actions into plan
- Put draft HazMAP on City website for comment – 2 weeks
- Next meeting

Appendix

C. Department Updates

Parks and Rec HazMAP Updates

The hazard mitigation action(s) below have been extracted from the 2011 HazMAP plan. The 5 year HazMap update requires a progress report for each mitigation action to include the following information:

Project status:
- ☐ Project Completed
- ☐ Project Canceled
- ☐ Project on Schedule
  Anticipated completion date: _____
- ☐ Project delayed
  Explain _____

What was accomplished for this project?

_____

_____

What obstacles, problems or delays did the project encounter?

_____

_____

If uncompleted, is the project still relevant? Should the project be changed or revised?

_____

_____

Other comments or areas of concern needing mitigation action?

_____

Winter Storm Action #1
Title: **Recreation Center Generators** Description: • **Attainment of generators at all city recreation centers in order to provide more resilient warming centers in winter weather conditions** • **Power loss is often one of the results of winter storms; generators would maintain energy for these facilities, which these city uses as local warming centers and community shelters** Hazard(s) Addressed: **Winter Storms** Goals and objectives addressed: **5.1.1 and 5.1.2** Lead Office: **Parks and Recreation** Funding Source(s): **Mitigation grant funding** Effect on New Structures: **None** Effect on Existing Structures: **Existing recreation centers will have power backup to serve as more sustainable warming centers and shelters to local citizens** Timeline for Completion: **To be determined upon receipt of funding** Costs (Estimated): **$10,000.00**
Cost Effectiveness: **Generators at the community recreation centers would provide more sustainable warming centers and shelters for citizens and result in lives saved, as people will have a safe place to stay out of the freezing weather. The city will save money by sending less first responders on calls related to winter storms**

C. Public Outreach Methods

City of Garland Website information

GARLAND
EMERGENCY MANAGEMENT

Hazard Mitigation Action Plan

What Is Hazard Mitigation?

Hazard Mitigation is the effort to reduce loss of life and property by lessening the impact of disasters.

Why Do We Need A Hazard Mitigation Plan?

Through projects, programs, and policies the City of Garland is constantly creating ways to protect the City from hazards and recover from disasters quickly. The Hazard Mitigation Action Plan (HazMAP) creates safer communities by reducing loss of life and property damage. When the HazMAP is complete, it will include a list of specific actions and goals for city departments within the next five years. These actions will lessen the impact of hazards on individuals and our community. HazMAP also includes information that the public can use to prepare themselves for hazards. Readiness is a partnership, and you play an important role in making sure hazards don't become disasters. Another partner is the Federal Emergency Management Agency (FEMA), who requires local jurisdictions to revise their HazMAP and obtain federal approval every five years in order to remain eligible for mitigation grant funding. Garland's plan is up for renewal in 2017. FEMA also requires the public to participate in the planning process.

Examples of Mitigation Actions

- Prohibiting development in high-hazard areas
- Educating citizens regarding the dangers of extreme heat and cold
- Elevation of structures in flood prone areas
- Safe rooms
- Erosion and drainage control to reduce flooding
- Mutual aid agreements to reduce response and recovery times
- Update construction codes for improved structural stability
- Trimming Program to reduce potential for trees and branches to damage power lines
- Line Maintenance Program to reduce electric service interruptions
- Water distribution system improvements to access more water in a drought

The Planning Process

Local hazard mitigation planning forms the foundation for a community's long-term strategy to reduce disaster losses and break the cycle of disaster damage, reconstruction, and repeated damage in the next disaster. The planning process consists of:

1. **Organizing Resources** –This includes identifying and organizing Planning Team Members and Stakeholders, as well as securing needed technical expertise and authority to implement mitigation goals. Review of existing plans for inclusion and necessary updates were also accomplished during this step.

2. **Assessing Risks** – The Planning Team identified hazards that effect Garland and potential risks they pose through Hazard and Public Surveys as well as Community Impact and Capabilities Assessments.

3. **Developing a Mitigation Plan** – Based on an understanding of risk and impact, the Planning Team set priorities and developed mitigation actions and strategies for avoiding or minimizing the effects of disasters in Garland.

4. **Implementing Plan and Monitor Progress** – Garland can bring the mitigation plan to life in a variety of ways, from implementing specific mitigation projects to changing aspects of day-to-day organizational operations.

Hazards Identified by the City's Hazard Mitigation Action Planning Team:

Tornado
Severe Winter Weather
Flood
Drought
Biological Event
Terrorism/Cyber Attacks
Extreme Heat
Power Outages
Earthquake
Communications Failure/Infrastructure
Failure
Severe Thunderstorms/Wind/Lightning
Hail
Erosion
Expansive Soil

Point of Contact:
Office of Emergency Management
972-781-7272 | OEM@GarlandTx.gov

Flier Distributed

Help keep Garland *safe*.

The Office of Emergency Management is updating the City's Hazard Mitigation Action Plan and needs your help. A short survey can be found at Garland-OEM.com under Hazard Mitigation. Your opinion will help make a better plan to keep Garland safe.

Hazard Mitigation Survey
https://www.surveymonkey.com/r/7GPTYT7

Encuesta sobre la Mitigación de Peligros
https://es.surveymonkey.com/r/73YCT65

Tham Vấn cho việc Giảm Thiểu Nguy Hiểm
https://www.surveymonkey.com/r/7GXHQZN

All Garland library locations will allow residents to complete the survey on library computers. Call 972-205-2500 for locations and hours.

Paper copies can be requested by contacting Barbara Neville at 972-781-7273 or BNeville@GarlandTX.gov.

Hazard mitigation *is the effort to reduce loss of life and property by lessening the impact of disasters.*

D. Neighboring Communities, Local and Regional Agency Participation

All,

The City of Garland Planning Team has been working on the Hazard Mitigation Action Plan (HazMAP) update. While making revisions the Team considered the Dallas County and the City of Dallas identified hazards. At this time we would like to provide you the opportunity to review the City of Garland's HazMAP and provide feedback to enhance the Plan. We appreciate your time and ask that all feedback be provided by May 31st. Thank you in advance and please let me know if you have any questions.

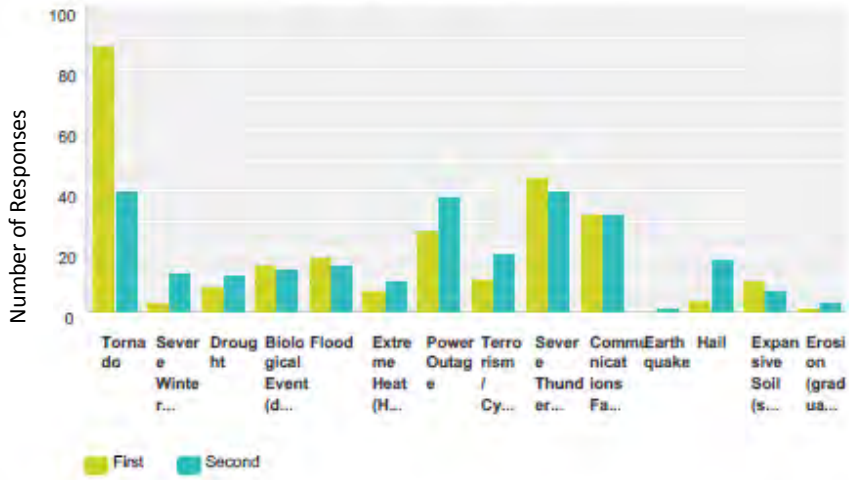
Respectfully,

Barbara B. Neville
Senior Emergency Management Specialist
Garland Office of Emergency Management

E. Public Survey and Results

Q1 In your opinion, what are the top two hazards that can impact The City of Garland?

Answered: 269 Skipped: 0

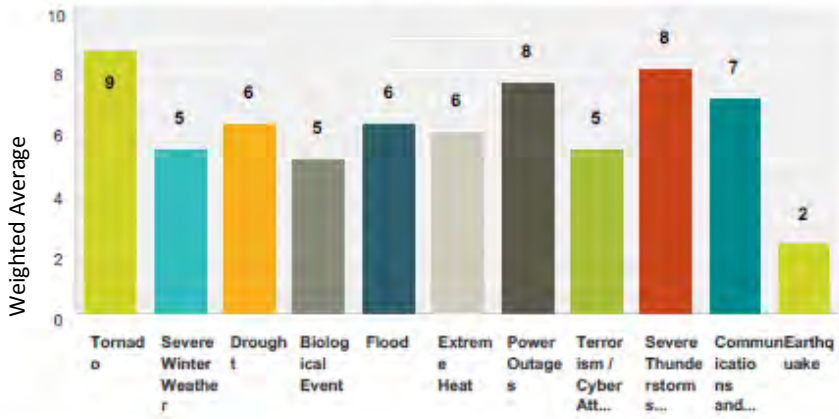


	First	Second	Total
Tornado	68.50% 87	31.50% 40	127
Severe Winter Weather (snow, freezing rain, or sleet)	18.75% 3	81.25% 13	16
Drought	40.00% 8	60.00% 12	20
Biological Event (disease outbreak ex. H1N1, Smallpox)	51.72% 15	48.28% 14	29
Flood	54.55% 18	45.45% 15	33
Extreme Heat (Heat Index of 105 degrees or higher)	41.18% 7	58.82% 10	17
Power Outage	41.54% 27	58.46% 38	65
Terrorism / Cyber Attacks	36.67% 11	63.33% 19	30
Severe Thunderstorms (including wind and lightening)	52.38% 44	47.62% 40	84
Communications Failure (transmission lines, broadcast, satellites and/or utility capabilities)	50.00% 32	50.00% 32	64
Earthquake	0.00% 0	100.00% 1	1
Hail	19.05% 4	80.95% 17	21
Expansive Soil (soils that expand when water is added, and shrink when they dry out)	58.82% 10	41.18% 7	17
Erosion (gradual wearing away of land masses)	25.00% 1	75.00% 3	4

#	Other (please specify)	Date
1	Crime and homelessness	2/3/2017 11:29 PM
2	Not being prepared for natural disasters	2/2/2017 10:41 PM
3	I took you "top two" to be the ones which will create the most devistation	2/2/2017 6:43 PM
4	Immigration (loss of poulation)	1/31/2017 12:01 PM
5	housing the homeless in winter weather	1/29/2017 6:20 PM
6	loss of computer cable	1/23/2017 9:24 AM
7	Sight restricted by bushes and trees at many intesections	1/22/2017 6:30 PM
8	Fracking...hopefully this in not happening.	1/20/2017 2:42 PM

Q2 The City of Garland's Hazard Mitigation Planning Team has identified the following hazards as having the largest impact on Garland. Please rank each hazard in order of importance. (1 being the most important)

Answered: 268 Skipped: 1

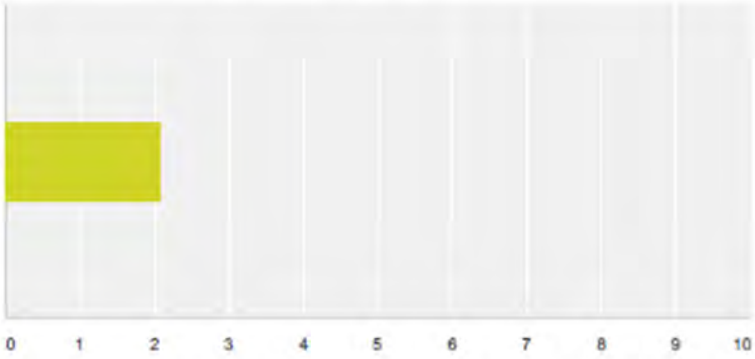


	1	2	3	4	5	6	7	8	9	10	11	Total	Weighted Average
Tornado	31.50% 80	17.72% 45	11.42% 29	12.60% 32	6.30% 16	6.30% 16	5.51% 14	2.76% 7	3.15% 8	1.97% 5	0.79% 2	254	8.62
Severe Winter Weather	1.24% 3	5.37% 13	11.16% 27	7.85% 19	13.22% 32	7.44% 18	11.16% 27	11.16% 27	9.50% 23	15.29% 37	6.61% 16	242	5.34
Drought	6.53% 16	5.31% 13	8.16% 20	12.24% 30	10.61% 26	16.73% 41	10.61% 26	14.29% 35	8.98% 22	4.90% 12	1.63% 4	245	6.20
Biological Event	9.88% 24	5.76% 14	6.58% 16	6.17% 15	5.76% 14	4.53% 11	6.17% 15	8.23% 20	15.64% 38	20.58% 50	10.70% 26	243	5.05
Flood	6.33% 15	6.33% 15	8.44% 20	12.66% 30	13.50% 32	13.92% 33	10.55% 25	9.28% 22	9.70% 23	5.91% 14	3.38% 8	237	6.22
Extreme Heat	2.10% 5	6.30% 15	7.98% 19	10.92% 26	16.39% 39	14.71% 35	10.92% 26	11.34% 27	10.92% 26	6.30% 15	2.10% 5	238	5.96
Power Outages	10.55% 27	15.63% 40	13.28% 34	14.84% 38	12.89% 33	10.55% 27	10.55% 27	5.86% 15	3.13% 8	1.95% 5	0.78% 2	256	7.54
Terrorism / Cyber Attacks	7.76% 19	6.53% 16	7.35% 18	5.71% 14	6.53% 16	7.35% 18	11.43% 28	12.65% 31	13.88% 34	13.47% 33	7.35% 18	245	5.36
Severe Thunderstorms (including wind and lightening)	17.13% 43	18.73% 47	18.73% 47	9.16% 23	10.76% 27	7.57% 19	5.98% 15	3.98% 10	3.19% 8	2.79% 7	1.99% 5	251	8.01
Communications and/or Infrastructure Failure	12.40% 31	15.60% 39	11.20% 28	9.60% 24	8.00% 20	9.60% 24	10.40% 26	8.80% 22	8.00% 20	5.60% 14	0.80% 2	250	7.07
Earthquake	1.24% 3	0.83% 2	0.00% 0	2.48% 6	0.83% 2	3.72% 9	3.31% 8	7.02% 17	8.26% 20	15.29% 37	57.02% 138	242	2.27

Q3 Please rank how prepared you and your household are for a disaster or hazard listed above.

Answered: 269 Skipped: 0

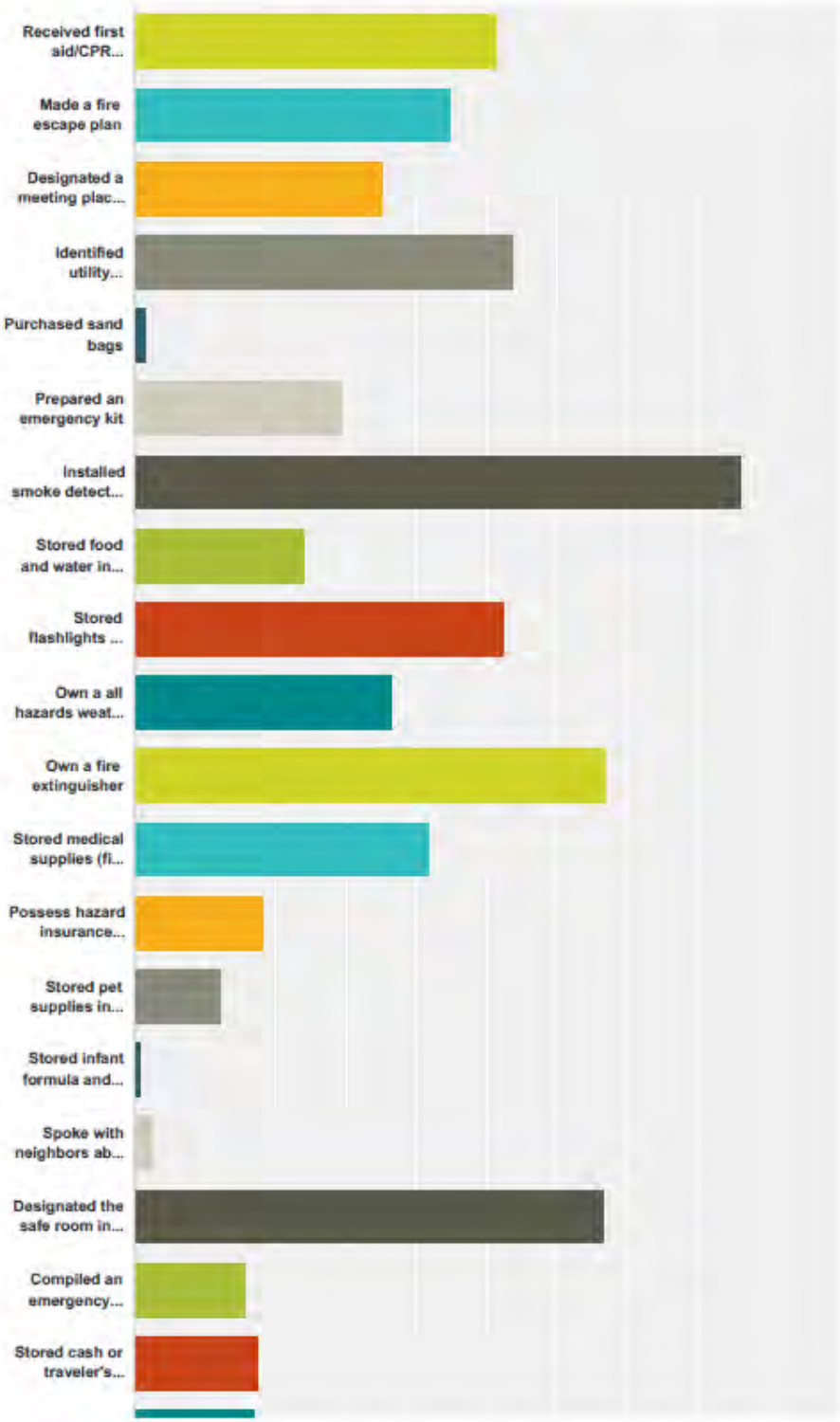
5 Extremely Prepared
4 Very Prepared
3 Prepared
2 Somewhat Prepared
1 Not Prepared

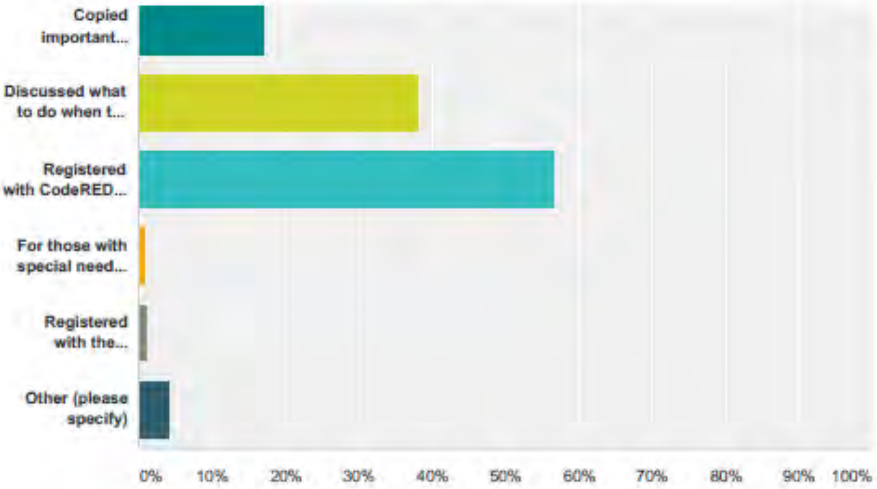


	Not Prepared	Somewhat Prepared	Prepared	Very Prepared	Extremely Prepared	Total	Weighted Average
(no label)	15.99% 43	63.94% 172	16.73% 45	2.97% 8	0.37% 1	269	2.08

Q4 Which of the following steps has your household taken to prepare for a disaster/hazard? (Check all that apply)

Answered: 269 Skipped: 0





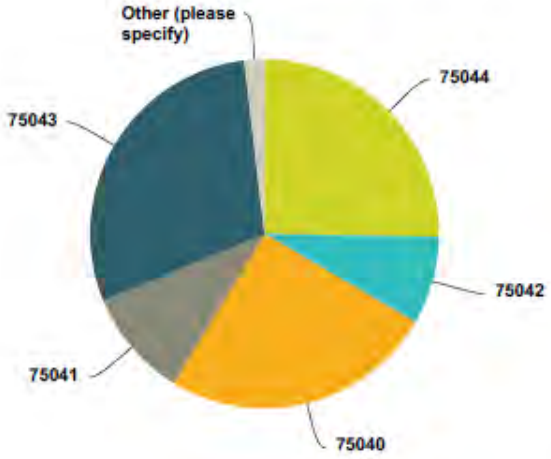
Answer Choices	Responses	
Received first aid/CPR training	51.30%	138
Made a fire escape plan	44.98%	121
Designated a meeting place outside the home	35.32%	95
Identified utility shutoffs	53.90%	145
Purchased sand bags	1.49%	4
Prepared an emergency kit	29.37%	79
Installed smoke detectors on each level of the house	86.25%	232
Stored food and water in emergency kit (for 72 hours)	24.16%	65
Stored flashlights and batteries in emergency kit	52.42%	141
Own a all hazards weather radio	36.43%	98
Own a fire extinguisher	66.91%	180
Stored medical supplies (first aid kit, medications, eyeglasses)	42.01%	113
Possess hazard insurance (Flood, Earthquake, Wildfire)	18.22%	49
Stored pet supplies in emergency kit	12.27%	33
Stored infant formula and diapers in emergency kit	0.74%	2
Spoke with neighbors about disaster plans	2.60%	7
Designated the safe room in home	66.54%	179
Compiled an emergency contact list (not on a digital device)	15.61%	42
Stored cash or traveler's checks in emergency kit	17.47%	47
Copied important documents (insurance policies, identification and bank account records in a waterproof, portable container)	17.10%	46
Discussed what to do when the outdoor warning system is activated	37.92%	102
Registered with CodeRED (the local emergency notification system)	56.51%	152
For those with special needs during evacuation, registered with 211 if assistance is needed	0.74%	2
Registered with the electric company if there are electric life dependent medical equipment in home	1.12%	3

Other (please specify)	4.09%	11
Total Respondents: 269		

#	Other (please specify)	Date
1	Ammunition stockpile	2/3/2017 11:53 AM
2	Can we get more info.	2/3/2017 10:59 AM
3	none	2/3/2017 9:11 AM
4	Professionally trained and skilled at hazard abatement	2/2/2017 10:41 PM
5	Skywarn training, portable water purifier	2/2/2017 4:57 PM
6	N	1/29/2017 8:31 PM
7	Portable electric generator	1/29/2017 6:13 PM
8	None	1/26/2017 9:59 PM
9	gas powered generator	1/26/2017 9:40 AM
10	Enrolled in USAA's Wildfire Response Program	1/23/2017 12:56 PM
11	maintain documtation both electroic, and on paper and distributed to others medical history with medines, emergency contact for family and neighbors, funeral plans	1/20/2017 2:04 PM

Q5 What is your zip code?

Answered: 269 Skipped: 0

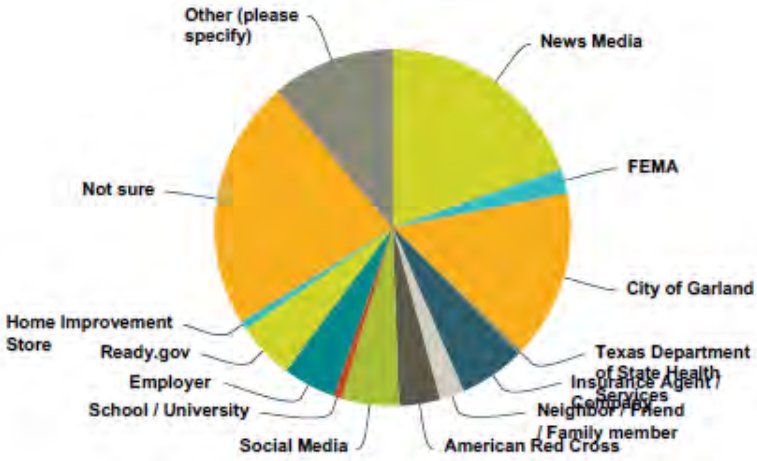


Answer Choices	Responses	
75044	25.28%	68
75042	8.18%	22
75040	25.28%	68
75041	10.04%	27
75043	29.37%	79
Other (please specify)	1.86%	5
Total		**269**

#	Other (please specify)	Date
1	75115	1/30/2017 8:52 AM
2	No	1/29/2017 8:31 PM
3	75089	1/26/2017 1:34 PM
4	75013	1/26/2017 9:42 AM
5	75082	1/25/2017 3:39 PM

Q6 Where did you last receive information on how to protect your household during a disaster/hazard?

Answered: 269 Skipped: 0



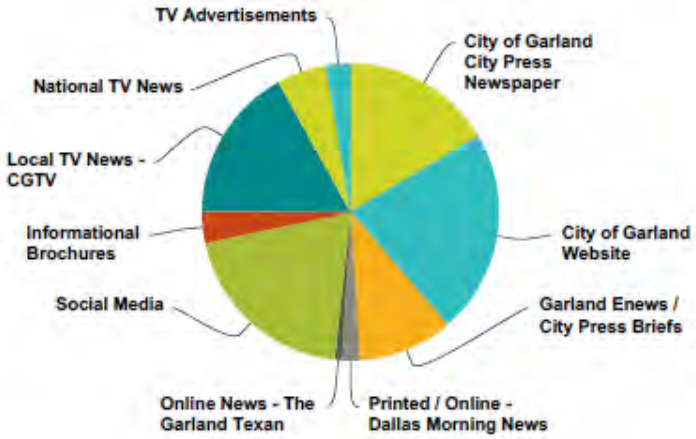
Answer Choices	Responses	
News Media	19.70%	53
FEMA	2.23%	6
City of Garland	15.24%	41
Texas Department of State Health Services	0.37%	1
Insurance Agent / Company	5.95%	16
Neighbor / Friend / Family member	2.23%	6
American Red Cross	3.72%	10
Social Media	5.20%	14
School / University	0.74%	2
Employer	4.83%	13
Ready.gov	5.20%	14
Home Improvement Store	0.74%	2
Not sure	22.68%	61
Other (please specify)	11.15%	30
Total		269

#	Other (please specify)	Date
1	Various internet blogs	2/19/2017 9:48 PM
2	CERT	2/19/2017 8:40 PM
3	Haven't received any information	2/17/2017 1:37 AM
4	Garland Fire Club	2/15/2017 8:27 PM

5	Church	2/14/2017 2:50 PM
6	Haven't received any	2/13/2017 9:05 AM
7	Internet searches	2/13/2017 5:46 AM
8	internet	2/12/2017 8:03 PM
9	Books	2/11/2017 11:04 PM
10	My own reading	2/7/2017 4:27 PM
11	My research	2/6/2017 5:17 PM
12	Past experience of living in earthquake zone in California. Preparedness exercises at work.	2/3/2017 2:42 PM
13	Retired 9-1-1/Communications Manager	2/3/2017 2:33 PM
14	Dallas CERT	2/3/2017 2:05 PM
15	Did I?	2/3/2017 8:30 AM
16	No one, I just did some on my own.	2/2/2017 7:41 PM
17	Weather radio	2/2/2017 7:04 PM
18	Garland Amateur Radio Club	2/2/2017 6:16 PM
19	Air Force	2/2/2017 5:04 PM
20	OJT	2/2/2017 4:57 PM
21	Texas Baptist Men Disaster Relief	2/2/2017 4:35 PM
22	Question #7 needs a place for additional comments - If no power electronic resources are useless	1/31/2017 2:13 PM
23	internet research	1/30/2017 3:27 PM
24	Boy Scouts	1/29/2017 6:44 PM
25	City of Dallas	1/29/2017 6:16 PM
26	Common Sence	1/26/2017 11:00 AM
27	SELF- Family First/ Safety discussions at home	1/26/2017 10:48 AM
28	Preparedness Website	1/26/2017 10:35 AM
29	Garland Police Fire Cert trained	1/23/2017 9:56 AM
30	Tv show	1/23/2017 8:10 AM

Q7 What is the most effective way to receive additional information regarding hazard mitigation, emergency plans or information after disasters?

Answered: 261 Skipped: 8



Answer Choices	Responses	
City of Garland City Press Newspaper	16.48%	43
City of Garland Website	22.22%	58
Garland Enews / City Press Briefs	10.34%	27
Printed / Online - Dallas Morning News	1.92%	5
Printed / Online - The Dallas Examiner	0.00%	0
Printed / Online News - A Chau Thoi Bao	0.00%	0
Online News - The Garland Texan	0.77%	2
Social Media	19.92%	52
Informational Brochures	3.45%	9
Local TV News - CGTV	16.86%	44
National TV News	5.36%	14
TV Advertisements	2.68%	7
Total		**261**

F. Hazard Assessment

HAZARD AND VULNERABILITY ASSESSMENT TOOL

EVENT	LOCATION	PROBABILITY	SEVERITY = (MAGNITUDE - MITIGATION)					RISK
			HUMAN IMPACT	BUSINESS IMPACT	PREPAREDNESS	INTERNAL RESPONSE (The City of Garland)	EXTERNAL RESPONSE (Community Partners, Mutual Aid Staff/Supplies)	
	Geographic Area Affected	Probability of Future Events in the next year	Possibility of death or injury	Interruption of services	Preplanning for event	Response time, effectiveness, resources available	Response time, effectiveness, resources available	Relative threat*
SCORE	0 = Negligible: Less than 10% 1 = Limited: 10 to 25% 2 = Significant: 25 to 75% 3 = Extensive 75 to 100% * 10% of Garland = 5.71 sq mi	0 = Unlikely: Less than 1% 1 = Occasional: 1-10% 2 = Likely 10-90% 3 = Highly Likely 90	0 = Unlikely: Less than 1% 1 = Occasional: 1-10% 2 = Likely 10-90% 3 = Highly Likely 90% * 1% of Garlands population = 2355 * 1% of businesses in Garland = 118		0 = N/A 1 = High 2 = Moderate 3 = Low or none			0 - 100%
Active Shooter								0%
Aircraft Incident								0%
Biological Event								0%
Bomb Threat								0%
Civil Disturbance								0%
Communications Failure								0%
Dam Failure								0%
Drought								0%
Earthquake								0%
Erosion								0%
Expansive Soil								0%
Extreme Cold								0%
Extreme Heat								0%
Flood								0%
Fuel Shortage								0%
	Geographic Area Affected	Probability of Future Events in the next year	Possibility of death or injury	Interruption of services	Preplanning for event	Response time, effectiveness, resources available	Response time, effectiveness, resources available	
	0 = Negligible: Less than 10% 1 = Limited: 10 to 25% 2 = Significant: 25 to 75% 3 = Extensive 75 to 100% * 10% of Garland = 5.71 sq mi	0 = Unlikely: Less than 1% 1 = Occasional: 1-10% 2 = Likely 10-90% 3 = Highly Likely 90	0 = Unlikely: Less than 1% 1 = Occasional: 1-10% 2 = Likely 10-90% 3 = Highly Likely 90% * 1% of Garlands population = 2355 * 1% of businesses in Garland = 118		0 = N/A 1 = High 2 = Moderate 3 = Low or none			
Hail								0%
Hazardous Materials (Fixed and Transport)								0%
Information Systems Failure								0%
Lightning								0%
Plant Explosion								0%
Power Outages								0%
Railroad Incidents								0%
Severe Winter Weather								0%
Sewer Failure								0%
Subsidence								0%
Terrorism								0%
Tornado								0%
VIP Situation								0%
Water Failure								0%
Wildfire								0%
Wind								0%
AVERAGE SCORE	0	0.00	0.00	0.00	0.00	0.00	0.00	

	Planning Team Hazard Assessment Results													
Hazard	**OEM Results**	**OEM Results**	**BI Results**	**GIS Results**	**Fleet Results**	**Eng Results**	**CC Results**	**Health Results**	**Plan Results**	**Water Results**	**Fire Results**	**PD Results**	**Fac Results**	**Risk**
Extreme Heat	16.63%	22.58%	3.23%	29.035	5.38%	19.35%	25.81%	23.66%	0%	22.58%	11.835	0	32.26%	17.655
Severe Winter Weather	22.58%	17.20%	12.90%	25.81%	7.53%	11.83%	19.35%	27.96%	5.38%	17.20%	11.83%	10.00%	21.51%	16.24%
Hail	19.35%	19.35%	15.05%	32.26%	15.05%	19.35%	4.30%	12.90%	8.60%	7.53%	23.66%	8.00%	21.51%	15.92%
Extreme Cold	16.13%	22.58%	0.00%	25.81%	7.53%	19.35%	15.05%	25.81%	0.00%	17.20%	11.83%	5.00%	23.66%	14.61%
Power Outages	12.90%	29.03%	12.90%	25.81%	8.60%	7.53%	23.66%	10.75%	0.00%	0.00%	32.26%	8.00%	19.35%	14.68%
Expansive Soil	15.05%	29.03%	6.45%	9.68%	0.00%	9.68%	2.15%	19.35%	5.38%	25.81%	0.00%	0.00%	25.81%	11.41%
Drought	6.45%	22.58%	0.00%	9.68%	8.60%	19.35%	17.20%	9.68%	5.38%	19.35%	0.00%	0.00%	25.81%	11.08%
Flood	16.13%	12.90%	6.45%	22.58%	4.30%	7.53%	15.05%	15.05%	5.38%	6.45%	7.53%	6.00%	15.05%	10.80%
Lightning	3.23%	22.58%	16.13%	35.48%	3.23%	6.45%	2.15%	12.90%	0.00%	0.00%	22.58%	0.00%	6.45%	10.09%
Hazardous Materials (Fixed and Transport)	12.90%	7.53%	4.30%	17.20%	19.35%	5.38%	17.20%	15.05%	0.00%	6.45%	7.53%	0.00%	15.05%	9.84%
Tornado	6.45%	9.68%	4.30%	32.26%	7.53%	7.53%	7.53%	9.68%	4.30%	7.53%	21.51%	8.00%	4.30%	10.04%
Wind	8.60%	15.05%	8.60%	21.51%	0.00%	4.30%	6.45%	8.60%	3.23%	3.23%	25.81%	0.00%	12.90%	9.10%
Communications Failure	0.00%	8.60%	NA	12.90%	0.00%	7.53%	9.68%	23.66%	0.00%	0.00%	11.83%	0.00%	23.66%	8.15%
Civil Disturbance	6.45%	10.75%	3.23%	11.83%	21.51%	0.00%	12.90%	23.66%	3.23%	0.00%	0.00%	0.00%	7.53%	7.78%
Bomb Threat	6.45%	17.20%	NA	25.81%	0.00%	0.00%	6.45%	21.51%	3.23%	0.00%	3.23%	9.00%	6.45%	8.28%
Information Systems Failure	0.00%	0.00%	NA	6.45%	18.28%	0.00%	9.68%	23.66%	0.00%	0.00%	12.90%	8.00%	11.83%	7.57%
Active Shooter	3.23%	12.90%	NA	23.66%	8.60%	0.00%	5.38%	0.00%	4.30%	9.68%	0.00%	9.00%	6.45%	6.93%
Erosion	0.00%	0.00%	0.00%	25.81%	0.00%	22.58%	2.15%	19.35%	0.00%	0.00%	0.00%	0.00%	7.53%	5.96%
Biological Event	7.53%	11.83%	0.00%	13.98%	11.83%	0.00%	10.75%	11.83%	0.00%	0.00%	0.00%	0.00%	0.00%	5.21%
Terrorism	5.38%	6.45%	5.38%	9.68%	17.20%	0.00%	0.00%	10.75%	0.00%	6.45%	0.00%	0.00%	0.00%	4.71%
Fuel Shortage	0.00%	0.00%	NA	0.00%	27.96%	0.00%	3.23%	9.68%	0.00%	0.00%	0.00%	0.00%	13.98%	4.57%
Earthquake	7.53%	6.45%	0.00%	9.68%	12.90%	0.00%	10.75%	0.00%	0.00%	0.00%	0.00%	0.00%	10.75%	4.47%
Water Failure	0.00%	0.00%	0.00%	27.96%	0.00%	5.38%	0.00%	7.53%	0.00%	3.23%	0.00%	0.00%	6.45%	3.89%
Railroad Incidents	4.30%	7.53%	5.38%	10.75%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	9.68%	0.00%	12.90%	3.89%
Sewer Failure	0.00%	0.00%	0.00%	21.51%	0.00%	5.38%	0.00%	10.75%	0.00%	3.23%	0.00%	0.00%	6.45%	3.64%
Plant Explosion	5.38%	7.53%	7.53%	0.00%	0.00%	0.00%	0.00%	8.60%	0.00%	0.00%	10.75%	0.00%	5.38%	3.47%
Subsidence	0.00%	0.00%	0.00%	17.20%	0.00%	9.68%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	6.45%	2.56%
Aircraft Incident	5.38%	0.00%	0.00%	13.98%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.49%
VIP Situation	0.00%	0.00%	NA	8.60%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	11.00%	6.45%	2.17%
Dam Failure	0.00%	0.00%	0.00%	10.75%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.83%
Wildfire	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	8.60%	0.00%	0.00%	0.00%	0.00%	0.00%	0.66%

G. Community Risk and Impact Assessment

	Most Likely / Typical Scenario															Maximum Impact / Worst Case Scenario																
	Geographic Scope	Duration	Health Effects	Displacement	Economic Impact	Environmental Impact	Built Environment	Transportation	Critical Services	Confidence in Gov't	Base Score	Frequency (F)	Cascading Effects (CE)	Multiplier (F + CE)	Subtotal	Geographic Scope	Duration	Health Effects	Displacement	Economic Impact	Environmental Impact	Built Environment	Transportation	Critical Services	Confidence in Gov't	Base Score	Frequency (F)	Cascading Effects (CE)	Multiplier (F + CE)	Subtotal	Future Emphasis	Combined Ranking
Drought											0			0	0											0			0	0		0
Earthquake											0			0	0											0			0	0		0
Erosion											0			0	0											0			0	0		0
Expansive Soil											0			0	0											0			0	0		0
Extreme Heat											0			0	0											0			0	0		0
Flood											0			0	0											0			0	0		0
Hail											0			0	0											0			0	0		0
Severe Thunderstorms / Wind / Lightening											0			0	0											0			0	0		0
Severe Winter Weather											0			0	0											0			0	0		0
Tornado											0			0	0											0			0	0		0
Biological Event											0			0	0											0			0	0		0
Communications Failure / Infrastructure Failure											0			0	0											0			0	0		0
Power Outages											0			0	0											0			0	0		0
Terrorism/Cyber Attacks											0			0	0											0			0	0		0

Community Impact Results

Most Likely / Typical Scenario

	Parks	Chamber	Planning	Engineering	Facilities	GP&L	Water	Health	Total
Tornado	12	14	12	13	13	25	11	27	18.057
Severe Winter Weather	10	15	11	16	9.2	26	11	24	17.543
Drought	9.5	19	9.5	18	14	14	12	11	15.229
Biological Event	5.6	17	5.4	6.9	18	24	9	19	15.129
Flood	11	15	14	11	13	18	9	14	15.086
Extreme Heat	8.5	15	9	15	18	14	9	11	14.229
Power Outages	6.5	13	7.5	11	19	17	7.2	15	13.714
Terrorism/Cyber Attacks	6.5	13	3.2	8.4	13	18	8.5	22	13.2
Severe Thunderstorms / Wind / Lightening	7	8.4	9	8.4	13	20	9.6	15	12.957
Communications Failure / Infrastructure Failure	7.2	13	3.2	11	17	17	8	13	12.586
Earthquake	7	11	8	8.4	12	25	4.2	6.6	11.571
Hail	6	8.4	7.8	7.8	16	10	8.4	14	11.286
Expansive Soil	8	9	3	10	8	14	9	11	10.343
Erosion	8.5	11	3.3	11	11	8	6.6	11	10.029

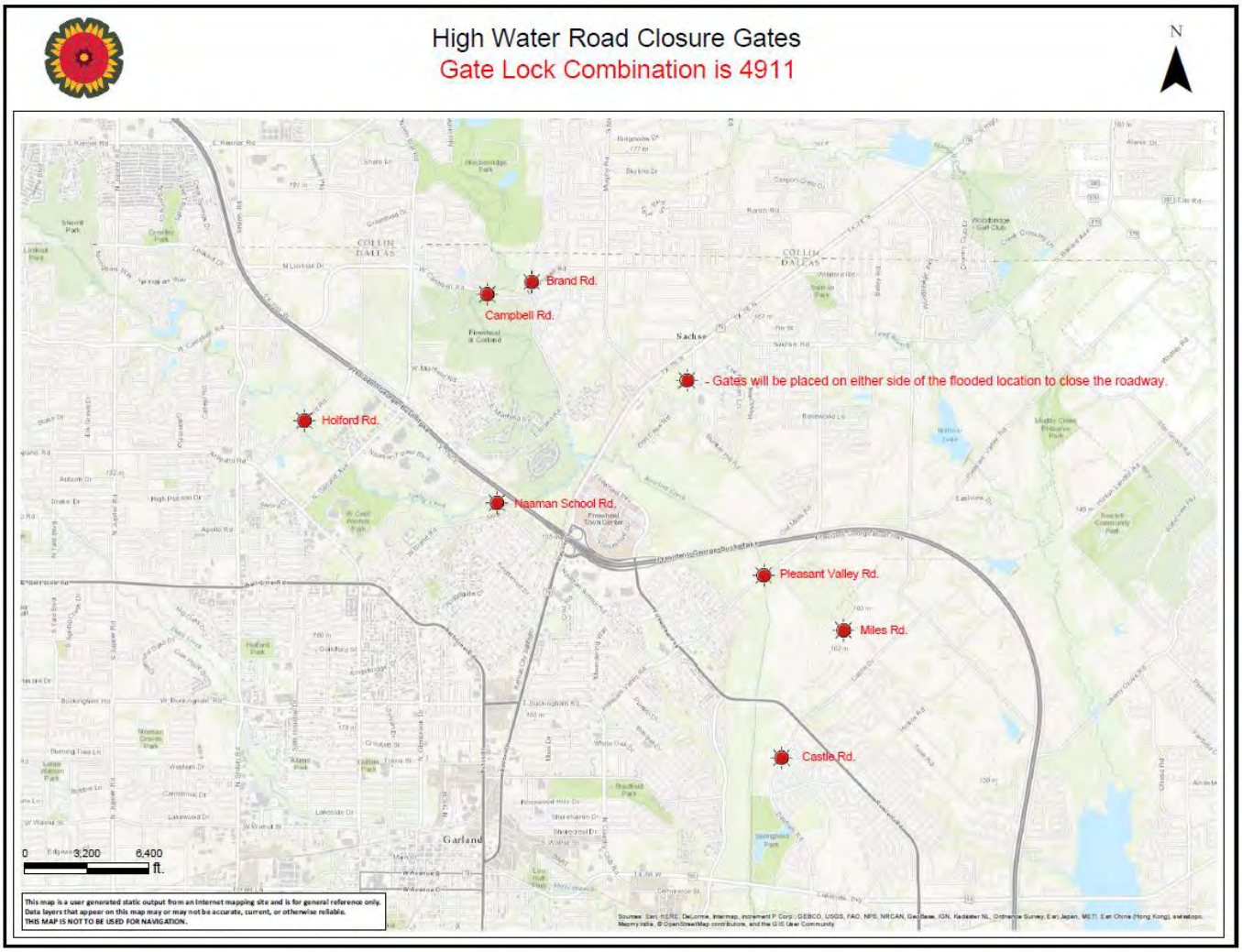
Maximum Impact / Worst Case Scenario

	Parks	Chamber	Planning	Engineering	Facilities	GP&L	Water	Health	Total
Tornado	16	22	34	18	29	37	22	27	29.243
Severe Winter Weather	15	20	23	26	25	35	19	24	26.729
Flood	15	25	28	20	26	31	28	14	26.671
Biological Event	12	24	25	12	24	45	14	19	24.929
Terrorism/Cyber Attacks	14	23	14	11	34	32	22	22	24.571
Power Outages	10	19	36	14	32	29	15	15	24.414
Severe Thunderstorms / Wind / Lightening	11	13	19	15	35	33	18	15	22.9
Extreme Heat	11	21	18	20	41	22	15	11	22.729
Drought	12	31	21	22	22	22	19	11	22.7
Earthquake	9	16	18	20	27	46	14	6.6	22.4
Communications Failure / Infrastructure Failure	13	18	18	15	32	32	11	13	21.729
Hail	9	14	13	14	32	19	18	14	18.914
Erosion	9	17	13	10	34	18	13	11	18.114
Expansive Soil	11	13	9	6.6	35	20	14	11	17.186

Combined Ranking

Planning Team	Parks	Chamber	Planning	Engineering	Facilities	GP&L	Water	Health	Total
Tornado	28	35	46	31	41	62	34	54	47.3
Severe Winter Weather	25	35	34	42	34	61	30	49	44.271
Flood	26	40	42	32	39	49	37	28	41.757
Drought	21	50	30	39	51	36	31	23	40.086
Biological Event	17	41	30	19	38	69	23	38	39.429
Terrorism/Cyber Attacks	20	36	17	20	53	50	30	45	38.6
Extreme Heat	19	36	27	34	54	36	24	22	36.229
Power Outages	17	32	44	25	34	46	23	30	35.657
Earthquake	16	27	26	28	49	71	18	13	35.471
Communications Failure / Infrastructure Failure	20	31	21	26	53	49	19	26	34.786
Severe Thunderstorms / Wind / Lightening	18	22	28	24	41	53	28	30	34.729
Hail	15	22	21	22	40	29	26	29	29.057
Erosion	18	28	17	21	50	26	20	23	28.886
Expansive Soil	19	22	12	17	46	33	23	23	27.929

Future Emphasis

	Parks	Chamber	Planning	Engineering	Facilities	GP&L	Water	Health	Total
Biological Event	3	5	5	3	5	5	5	5	5.1429
Tornado	5	5	5	4	3	5	3	5	5
Earthquake	3	5	5	3	3	5	3	5	4.5714
Communications Failure / Infrastructure Failure	3	3	5	5	3	5	3	5	4.5714
Flood	5	5	5	4	3	3	3	3	4.4286
Power Outages	1	3	5	5	3	5	3	5	4.2857
Terrorism/Cyber Attacks	1	5	5		3	5	5	5	4.1429
Severe Winter Weather	3	5	3	3	5	3	3	3	4
Drought	3	5	3	5	3	3	3	1	3.7143
Extreme Heat	5	5	3	3	3	3	3	1	3.7143
Severe Thunderstorms / V	3	3	3	3	3	5	3	3	3.7143
Erosion	3	5	3	3	5	3	3	1	3.7143
Hail	3	3	3	3	5	3	3	3	3.7143
Expansive Soil	3	5	3	3	3	3	3	1	3.4286

H. Flood Gates