2017

Resource Allocation Report

Tulsa Fire Department

CITY OF Tulsa
A New Kind of Energy

G.T. Bynum
OFFICE OF THE MAYOR

June 1, 2017

I am pleased to present the Tulsa Fire Department 2017 Resource Allocation Report. Substantial work and input from all areas of the Department resulted in a document that establishes a clear path forward for the Tulsa Fire Department.

At the City of Tulsa, we are shifting toward greater utilization of data, evidence, and evaluation in making decisions that impact the citizens we serve. In this report, the Tulsa Fire Department does an exceptional job of analyzing data to both fulfill its mission and maintain efficient operations. The Department rigorously assesses existing resources and new resources provided in the Vision Tulsa funding program to ensure fiscal responsibility and citizen protection.

As Mayor of the City of Tulsa, I appreciate the efforts of the Resource Allocation Committee to develop a framework for long-term planning within the Tulsa Fire Department.

Best Regards,

G.T. Bynum
Mayor
City of Tulsa

175 E. 2nd St. • Tulsa, OK 74103 • Office 918.596.7411 • Fax 918.596.9010
Email: Mayor@cityoftulsa.org
www.cityoftulsa.org

Fire Chief Ray Driskell
TULSA FIRE DEPARTMENT

May 18, 2017

Periodically, the Tulsa Fire Department reviews resource allocation data to ensure efficient and effective operational strategies to fulfill our mission statement. A Resource Allocation Committee is developed from a diverse pool of Tulsa Fire personnel who volunteer their time and knowledge. The Committee continues to meet regularly and update a dynamic response of fire and emergency medical service response in Tulsa, Oklahoma. The 2017 Resource Allocation Study is a living document which is meant as a guideline with opportunities for amendment based upon the needs of the citizens of Tulsa.

Within this document is the result of data from cumulative response and medical statistics. Factors considered in part were, fire station locations, apparatus placement and medical skill needed at individual fire station locations. Decisions were based upon NFPA 1710 recommendations, individual experience and data collected from outside sources (previous resource allocations, ICMA Study 2016 and incident response information). The Tulsa Fire Department will utilize the information within this document to establish a long term operational plan of which funding will be based upon.

I want to thank each of the individual members for their contribution and tireless efforts which resulted in the creating of this document. The Tulsa Fire Department recognizes that its members and their knowledge are critical components to ensure safety, efficient and effective success of a public organization.

Respectfully,

Ray Driskell

Ray Driskell
Fire Chief, Tulsa Fire Department

TULSA FIRE HEADQUARTERS OFFICE OF THE FIRE CHIEF
1760 Newblock Park Drive • Tulsa, OK 74127 • Office 918.596.9441 • Fax 918.596-1297
www.cityoftulsa.org

On the Cover – Tulsa Public Schools Art Contest

The cover art for the Tulsa Fire Department 2017 Resource Allocation Report was graciously provided by Mario Moreno, a second grade student at Tulsa Public Schools. Mario’s drawing was selected by the Deployment Committee.

Ms. Thomas, Mario’s teacher, provided these words from an interview with Mario:

Mario Moreno is a 7-year old student at Dual Language Academy in Tulsa Public Schools. He will be in the third grade next year. His favorite things to do at school are have fun in gym, go to the library, and make paper sculptures in art. He likes to pick up trash, make things look clean, and take care of his home. When he grows up, Mario wants to be a fire fighter!

Thank you Mario! We look forward to having you as a Tulsa Firefighter very soon!

Executive Summary

In July of 2015, Fire Chief Ray Driskell formed the Tulsa Fire Department Deployment Committee. The Deployment Committee was charged with producing realistic, data-based recommendations using reproducible methodologies to determine the optimal placement of the department's current and future resources based on life risk.

Following are the members of the Deployment Committee:

- Deputy Chief Andy Teeter
- Deputy Chief Scott Clark
- Chief of EMS Michael Baker
- Chief of Training Bryan Lloyd
- Administrative Chief Doug Carner
- Planning Officer Scott Nyman
- Assistant Chief Doug Woods
- District Chief Lee Horst
- District Chief Nate Morgans
- Captain Steve Shaw
- Fire Equipment Operator Tim Kuehnert
- Firefighter Bryan Bohbrink

The goals of this document were:

Goal 1: Fire Station Location: Use a realistic, reproducible, data-based methodology to determine the optimal placement of current and future stations based on identified life risk in the city.

Goal 2: Advanced Life Support Placement: Use a realistic, reproducible, data-based methodology to determine the most advantageous current stations for placement of ALS personnel.

Goal 3: Multiple Company Stations: Identify which current and future stations should house one staffed apparatus and which current and future stations should house two or more staffed apparatus based on the predominant risk and call demand.

Goal 4: Staffing: During the life of the study, the citizens of Tulsa approved a dedicated public safety funding package which provided for additional firefighters. Recommendations are included in this document for the most effective use of the personnel and equipment funded by this package.

Summary of Recommendations:

1. Station Moves/Additions

   The following table shows the final recommendations for fire station moves/additions based on the scenarios and data considered in Section 1 of this report.

Priority	Sequence/Funding	Station	Location	Staffing
High	1 Funded	33 New "East" Station	13500 E 41st St.	New staffing, Public Safety Funding
High	2 Unfunded	Move 27 (11707 E 31st St.)	10400 E. 31st St.	Move E27 and L27
High	2 Unfunded	New 34	10400 E. Admiral Pl.	Move one company from Station 31
High	2 Unfunded	Move 18 (4802 S. Peoria Ave.)	5600 S. Peoria	Move E18 and C643
Medium	3 Unfunded	Move 23 (4348 E. 51st St.)	5600-5900 S. Yale Ave.	Move SQ23 and L23
Medium	3 Unfunded	New 35	8400 S. Mingo	Move one company from Station 28 (funded by Public Safety Funding) (See Section 4 Recommendations)
Low	4 Unfunded Projected need (7-10 years) Economic Development Related Far East Tulsa	New 36	3300 S. 177th E. Ave.	New staffing Unfunded

2. Automatic Aid Agreement
   The City of Tulsa and the City of Broken Arrow should consider modifying the 2012 Mutual-Aid Agreement for Fire Protection and First Response to provide true automatic aid in far east Tulsa and ensure that the agreement is equitable and beneficial to both cities.

3. Mobile Water Supply Apparatus (Water Tenders).
   TFD should purchase and implement two mobile water supply apparatus.

4. Coordination with Neighboring Agencies
   As the City of Tulsa and other agencies make improvements to public safety infrastructure such as moving or adding fire stations or upgrading or replacing communications, agencies in the Tulsa Metro Area should work together to coordinate the provision of services to the citizens.

5. Advanced Life Support Fire Companies
   After consideration of data and subject matter expert review, no ALS moves are recommended for the calendar year 2017.

6. Annual Review of Advanced Life Support Companies
   The TFD EMS Branch should conduct an annual review of first hour quintet and transfer of care data each fall and consider any needed shifts in ALS capabilities for implementation the following calendar year.

7. Additional Advanced Life Support Capabilities
   The TFD EMS Branch should implement additional ALS capabilities on current apparatus to address geographically significant stations.

8. Effective Firefighting Force
   The Deployment Committee recommends implementing Scenario 6 (Section 3 of this report) which incorporates the following:

   - Move/construction of Fire Stations 33, 34, 27, and 18.
   - Addition of a new Fire Company at Station 28

9. TFD Aerial Apparatus
   Upon replacement of the following apparatus, the TFD Deployment Committee recommends the following apparatus for each of Tulsa's ladder companies:

Ladders 4, 29, 31	100'+ Heavy Duty Aerial Platform/Quint
Ladder 2	100'+ Heavy-Duty Aerial Ladder/Quint
Ladders 7, 20, 22, 23, 27, 32	100'+ Medium-Duty Aerial Ladder/Quint (preferably single rear axle)
Ladders 24, 26, and 30	60-65'Medium-Duty Aerial Ladder/Quint

10. Resilience and Redundancy
    Resilience and redundancy for the City of Tulsa should remain a consideration when making TFD deployment considerations.

11. Apparatus Staffing

    TFD should strive for four person staffing on all fire companies. Four person staffing should be prioritized as follows:
    a) Maintain four person staffing on each Ladder/Engine Company Tulsa's at five fire stations that house Squad Apparatus.
    b) Four person constant staffing of each single-company station on the perimeter of the City.
    c) Four person constant staffing of each single-company station.
    d) Four person constant staffing of all fire companies.

    When considered in conjunction with recommendations from previous sections of this report and the 2016 Public Safety funds, the Deployment Committee recommends the following:

Purpose	**Assignment**	**# Personnel**
Perimeter Fire Company Staffing	Perimeter/Large Coverage Area Fire Stations	33
New Fire Company	Fire Station 28	12
Fire Prevention Officers	Code Enforcement/Public Education	5
New Fire Company	Fire Station 33 (new east station)	15

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Glossary and Abbreviations

AED – Automated External Defibrillator

AHA – American Heart Association

ALARM ANSWERING TIME – The time interval that begins when the alarm is received at the fire communication center and ends when the alarm is acknowledged at the fire communication center.

ALARM HANDLING TIME - The time interval from when the alarm is acknowledged at the fire communication center to the beginning of transmittal of response information via voice or electronic means to emergency response facilities or the emergency response units in the field.

ALARM PROCESSING TIME – The time interval from when the alarm is acknowledged at the fire communication center until response information begins to be transmitted via voice or electronic means to emergency responder facilities or emergency response units.

ALARM TRANSFER TIME – The time interval from the receipt of an emergency alarm at the public service answering point until the alarm is first received at the fire department communication center.

ALS – Advanced Life Support. EMT-Paramedic level medical skills; i.e., licensed to perform invasive skills such as administering intravenous fluids/drugs, placing endotracheal airways, and reading/monitoring heart rhythms.

ARFF – Airport Rescue and Firefighting, a specialized category of firefighting that involves the response, hazard mitigation, evacuation and possible rescue of passengers and crew of an aircraft involved in (typically) an airport ground emergency.

ASSISTANT CHIEF – The department has three assistant chiefs, one for each shift. All are part of the Field Operations Section and command field personnel for the entire city.

AUTHORIZED STRENGTH – The total number firefighter payroll positions.

AUTOMATIC AID – Assistance dispatched automatically (without delay) via a contractual agreement between two communities or fire districts. This differs from mutual aid, in which agencies are dispatched upon specific request only.

BFA – A business fire alarm.

BLS – Basic Life Support. Emergency Medical Technician basic (EMT) **-** or Emergency Medical Responder (EMR) **-** level medical skills; i.e., licensed to perform only non-invasive skills such as CPR, defibrillation with an AED, administering oxygen, assisting breathing efforts, assessing vitals, stopping bleeding, bandaging, and splinting.

CAD(S) – Computer Aided Dispatch (System)

CAPTAIN – The person in charge of a fire crew during emergency responses and at the fire station. Answers to a district chief.

CFAI – Commission on Fire Accreditation International

COLD – A non-emergency response without the use of lights and sirens.

CONSENSUS STANDARD – A standard developed through the cooperation of all parties who have an interest in the development and use of the standard. During the development process all views and objections are considered and efforts made toward their resolution.

CPSE – Center for Public Safety Excellence

DEPUTY CHIEF – The department has three deputy chiefs who report directly to the fire chief. They administer the three sections of the fire department---Field Operations, Safety Services, and Support Services.

DISTRICT – For purposes of fire response, the city is divided into five districts. All responses in each district are administered by a district chief, who is part of the Field Operations Section, and who also oversees personnel and fire stations within the district boundaries.

DISTRICT CHIEF – The operational chief for one of the city's five fire response districts. Reports directly to the assistant chief.

EFFECTIVE FIREFIGHTING FORCE – The appropriate number of personnel and equipment with the appropriate capabilities on the scene of a fire incident in a predetermined time.

EMERGENCY CALL – A call requiring response using emergency lights and sirens. This type of call is used to compute the department's response time statistics. (See also HOT)

EMS – Emergency Medical Service

EMT – Emergency Medical Technician

EMT BASIC – An Emergency Medical Technician (EMT) licensed to perform only non-invasive lifesaving and first aid skills such as CPR, defibrillation with an AED, administering oxygen, assisting breathing efforts, assessing vitals, stopping bleeding, bandaging, and splinting.

EMSA -Emergency Medical Service Authority

ENGINE/PUMPER – A fire apparatus equipped with a water pump, 500-gallon water tank, fire hose, and ground ladders.

EXPOSURE – Property near a fire that may become involved in fire from transfer of heat or burning material. A good example would be a house next door to a house that is on fire.

EXTENSION – Fire extension. When fire grows and travels from one area to another. As in, "The fire has extended from the kitchen into the attic."

FIRE APPARATUS – A vehicle used for firefighting and/or medical response. In Tulsa, this could refer to an engine, ladder, squad, hazmat truck, heavy rescue truck, or grass rig.

FIRE COMPANY – A fire apparatus staffed with a fire officer and firefighters.

FIRE EQUIPMENT OPERATOR (FEO) – The person responsible for driving the fire apparatus. The FEO may also act as captain on the apparatus in the officer's absence. Reports directly to the captain.

FIRE FLOW – The amount of water, in gallons per minute, which must be available to be supplied to safely extinguish a fire of a given size. Varies according to what size and amount of material is burning.

FIRE STATION – A facility housing firefighters and apparatus, from which firefighters answer calls for assistance.

FIREFIGHTER – The person on the fire company responsible for basic firefighting and medical emergency duties. The firefighter may be certified to drive the apparatus in the absence of the FEO. Reports directly to the captain.

FIRST-IN AREA – The geographic area surrounding a fire station in which personnel from that station can respond to calls faster than any other station.

FLASHOVER – The sudden involvement of a room or area in flames from floor to ceiling. Caused when the thermal energy from a fire is reflected back from the walls, floor and contents of a room until the materials are superheated to a temperature where burning occurs.

GIS – Geographic Information System

HAZMAT – Hazardous materials.

HMRT – Hazardous Materials Response Team, the fire company responsible for responding to and mitigating hazardous materials emergencies. Currently housed at Station 6.

HAZMAT UNIT – A truck used to respond to a hazardous materials emergency. Staffed by the hazmat team.

HOT – An emergency response with the use of lights and sirens.

ICMA – International City/County Management Association

INITIATING ACTION/INTERVENTION TIME – The interval from when a unit arrives on scene to the initiation of emergency mitigation.

INTEROPERABILITY – The ability of a system to work with or use the parts and equipment of another system. Term most often used in reference to radio communications in large scale, multi-jurisdiction incidents or events.

ISO – Insurance Services Offices

JUVENILE FIRE SETTER PROGRAM – Offered by the fire department's Public Education Officers, this program targets children who have set fires (or tried to), or are determined to be at risk of doing so.

KPI- Key Performance Indicators

KPMG – A consulting firm hired by the city to study trends and offer advisory services for improving efficiency.

LADDER TRUCK – A fire apparatus equipped with an aerial ladder or elevating platform and a full complement of ground ladders.

MPDS – Medical Priority Dispatch System

MULTI-COMPANY STATION – A fire station housing more than one staffed apparatus.

MUTUAL AID – An agreement among emergency responders to lend assistance across jurisdictional boundaries on a case-by-case basis.

NAEMSP – National Association of EMS Physicians

NIMS – National Incident Management System

NFPA – National Fire Protection Association

NON-EMERGENCY CALL – A type of call not requiring a response using emergency lights and sirens. (See also COLD)

ODOT – Oklahoma Department of Transportation

OK-TF1 – Oklahoma Task Force 1

OMD – Office of the Medical Director

OPERABILITY –The ability to keep a system in a safe and reliable functioning condition according to pre-defined operational requirements. Operability normally refers to agencies from differing jurisdictions being able to operate together effectively on smaller, day-to-day incidents (i.e. radio communications).

PARTICIPATING AGENCY – Surrounding fire departments that have personnel that are members of the Oklahoma Task Force 1 Urban Search and Rescue Team.

PSAP – Public Safety Answering Point, the first point of contact for callers to the 911 Center.

PROTOCOL – For our purposes, a medical treatment protocol. This is a set of rules a medical provider must use to treat a specific medical condition or emergency.

RESPONSE MODE – Units respond to calls in one of two modes, emergency or non-emergency.

RFA - A residential fire alarm.

SPAN OF CONTROL – The number of subordinates that a fire officer/supervisor can directly control; this number varies with the type of work. The more hazardous the work, the narrower the span of control.

SPONSORING AGENCY – Tulsa Fire Department, as the agency responsible for management and personnel of the Oklahoma Task Force 1 Urban Search and Rescue team.

QUINT – A ladder truck with that has a pump and water tank. Traditionally ladder trucks did not have pumping capabilities. All but one Tulsa Fire Department ladder apparatus in front-line service are quints.

SINGLE COMPANY STATION – A fire station housing one staffed apparatus.

SQUAD – A smaller fire department response vehicle primarily for EMS response.

TANKER – See also Tender; a fire apparatus whose primary purpose is to deliver large quantities (usually 1,500+ gallons) of water to a fire scene when an adequate water supply is not available. Used frequently in areas underserved by a municipal water system or in rural areas for wildland fires.

TARGET HAZARD – Occupancies that pose specific risks to occupants and fire responders for a variety of reasons, such as occupancies with a high life or fire hazard, hazardous materials use/storage, etc.

TENDER – See also Tanker; a fire apparatus whose primary purpose is to deliver large quantities (usually 1,500+ gallons) of water to a fire scene when an adequate water supply is not available. Used frequently in areas underserved by a municipal water system or in rural areas for wildland fires.

TESCOT – The Executive Service Corp of Tulsa

TFD – Tulsa Fire Department

TOTAL RESPONSE TIME – The time interval between receipt of alarm at the primary PSAP to when the first emergency response unit is initiating action to control the incident.

TRANSFER OF CARE – The process by which an emergency medical responder treating a patient relinquishes responsibility for the patient to another provider of equal or greater certification level, and who agrees to accept responsibility for the patient.

TRAVEL TIME – The time interval that begins when a unit is enroute to the emergency incident and ends when the unit arrives at the scene.

TRIAGE – The assignment of degrees of urgency to emergency calls to decide the order of response.

TRT – Technical Rescue Team, the team of Tulsa firefighters deployed for specialized rescue situations such as confined-space, high-angle and water rescues, as well as complex vehicle extrications and building collapse. Team members are currently housed at Fire Stations 4 and 5.

TURNOUT TIME – The time interval that begins when the emergency response facilities' and emergency response units' notification process begins by either and audible alarm or visual annunciation or both, and ends at the beginning point of travel time.

UL – Underwriters' Laboratory

USAR – Urban Search and Rescue

"As an overarching desire, the Tulsa Fire Department intends to be the solution anytime a citizen needs a team of rapid deployment customer service and resilience experts to respond to their real or perceived emergency at any time and under any circumstance, so that our customers may begin to restore their quality of life and begin to put the pieces back together."

Introduction

In 1913, the Tulsa Fire Department became the first completely motorized department west of the Mississippi River. This is just one example of the progressive attitude and can-do spirit the Tulsa Fire Department has embodied throughout its history. Our organization is proud of its heritage and even more proud of the firefighters that serve the Tulsa community.

The Tulsa Fire Department, not unlike many other public entities, has been through some significant financial challenges due to downturns in the economy caused by sales tax funded budgets. In 2009 Tulsa firefighters were faced with the layoff of 147 personnel. Rather than allow that to happen, they chose instead to take a significant pay to cut to maintain the protection levels that the citizens of Tulsa expect and enjoy. At the same time, the department was reorganized by the former fire chief, resulting in the loss of six middle level managers and twenty-seven field personnel. It also saw five four-member engine companies replaced by five two-member squad units. Commitment to maintaining quality of service following the changes is just one example of the dedicated and progressive culture that exists within the department.

In 2005, the department embarked on an optimistic public/private partnership with Tulsa Community College to build a state of the art regional fire training center. There were many inherent challenges to overcome to reach this goal, but in July 2015 the dream was realized when the Tulsa Fire Safety Training Center officially opened. Now, world-class training is available to not only the Tulsa Fire Department, but to municipal, rural, and industrial fire and safety professionals from across the region. Partnerships with business and industry are being sought and solidified to broaden and enhance the training opportunities available.

The secondary goal of the Tulsa Fire Safety Training Center is to make firefighters safer. Knowledge is power. Firefighting is consistently rated as one of the most dangerous jobs in the world, and our public servants should expect to be as a safe as possible while working in a variety of high-hazard environments.

We are guided by the following statements of individual worth and accountability:

- Each individual is valuable to the department.
- Each individual must be treated ethically and provided training, proper equipment, support, safety, and the opportunity for professional growth and advancement.
- Each individual is accountable to others in the department, the city organization, and the public.
- When receiving a call for help or recognizing a situation where assistance is needed, firefighters will respond quickly, with compassion, and in a professional manner.
- The department will proactively utilize the collective intelligence of its members to evaluate and improve operational performance.

History

The story of the Tulsa Fire Department is the story of Tulsa. Appendix B contains links to several documents and sites describing the history of Tulsa. A history of the Tulsa Fire Department may be found at https://www.cityoftulsa.org/media/3311/tfdhistory2-2017.pdf. Over time, Tulsa has annexed new areas (Figure 1). One can look at the fire station numbers and see how Tulsa's growth over the years has spread southward and eastward (Figure 2).

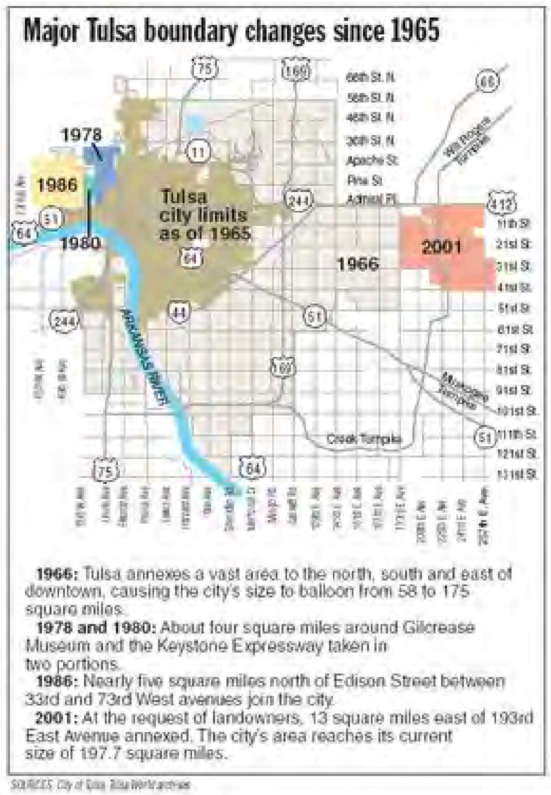


Figure 1: Major Tulsa Boundary Changes Since 1965 (Evatt, 2004)

The historical responses to this growth by the city and fire department have taken one of two forms. The first was to place one or more fire stations in a remote location serving a large area with little population and little demand. Often these stations were necessary to facilitate economic development and improve insurance ratings. Some of the stations needed to be moved later as urban sprawl defined the areas of population density and demand. Further, as the fire department's mission evolved from primarily fire response to all-hazards response, customer expectations, the insurance industry and evolving national standards demanded more consistent response times.

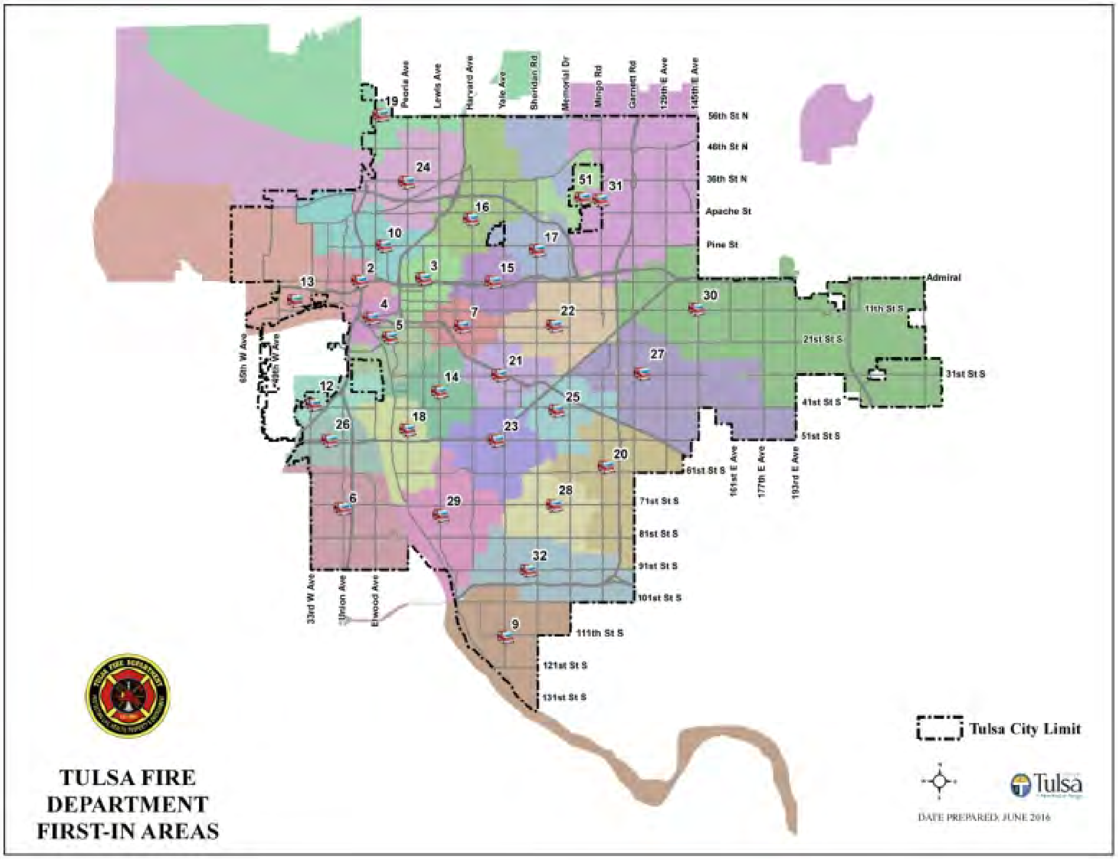


Figure 2: 2016 Tulsa Fire Stations

The second historical response to growth has been to move and redeploy stations from the downtown area. These lower-numbered stations were originally very closely spaced. As the effects of improvements in firefighting equipment and methods as well as building and fire codes began to be felt over time, Tulsa was able to space fire stations farther apart. The effort to address life safety through improvements in the building and fire codes is an ongoing progressive effort.

This document attempts to take advantage of data and a reproducible methodology to use taxpayer dollars in the most efficient manner, providing the greatest good to the greatest number of citizens as allowed by resources. One of the main purposes of this effort is to effectively place current and future stations in a manner that prevents the need for moving them in the future. Well placed and well built, a fire station should serve the citizens for 50-75 years, and hopefully more.

Tulsa Fire Department Deployment Committee

In July of 2015, Fire Chief Ray Driskell formed the Tulsa Fire Department Deployment Committee. The Deployment Committee is the sister committee to the Strategic Planning Committee, whose focus is internal processes and efficiencies. A key attribute of both committees is the inclusion of members from all ranks and areas of the department.

The Deployment Committee was charged with using reproducible methodologies to determine the optimal placement of the department's current and future resources based on life risk.

Following are the members of the Deployment Committee:

- Deputy Chief Andy Teeter
- Deputy Chief Scott Clark
- Chief of EMS Michael Baker
- Chief of Training Bryan Lloyd
- Administrative Chief Doug Carner
- Planning Officer Scott Nyman
- Assistant Chief Doug Woods
- District Chief Lee Horst
- District Chief Nate Morgans
- Captain Steve Shaw
- Fire Equipment Operator Tim Kuehnert
- Firefighter Bryan Bohbrink

Resource Allocation Report Goals

The committee worked to produce realistic, reproducible, data-based recommendations that considered the optimal placement of fire stations and resources using the existing number of full-time staffed fire apparatus, plus the proposed apparatus that would occupy (future) Fire Station 33. Station 33 was approved by the citizens in a 2005 general obligation bond vote after being recommended in a previous study conducted by TFD (Tulsa Fire Department, 2000). The recommendation for the new station was part of several from the 2000 report that realigned fire station locations and provided coverage to underserved areas of the city in a systematic way. The goals of this document are:

Goal 1: Fire Station Location: Use a realistic, reproducible, data-based methodology to determine the optimal placement of current and future stations based on identified life risk in the city. The committee was not bound by the current number of fire stations.

Goal 2: Advanced Life Support Placement: Use a realistic, reproducible, data-based methodology to determine the most advantageous current stations for placement of ALS personnel. Recommendations are based on the number of ALS apparatus and number of paramedic staff agreed to by the Office of the Medical Director (OMD). Any recommendations pertaining to this goal will be further reviewed by OMD.

Goal 3: Multiple Company Stations: Identify which current and future stations should house one staffed apparatus and which current and future stations should house two or more staffed apparatus based on the predominant risk and call demand.

Goal 4: Staffing: During the life of the study, the citizens of Tulsa approved a dedicated public safety funding package which provided for additional firefighters. Recommendations are included in this document for the most effective use of the personnel and equipment funded by this package.

TFD Vision, Mission, Values, and Strategies

The Strategic Planning Committee recently revised the department's vision, mission statement, values, and strategic statements to more accurately reflect the way the department operates.

Vision

Through selfless service to our customers, the Tulsa Fire Department will remain an organization that:

- Responds quickly and appropriately to all calls for service.
- Seeks continuous improvement (…of our services).
- Reflects good stewardship of the public's resources and trust.
- Maintains a versatile, proactive, and agile profile.
- Involves our community in our decisions.
- Immerses ourselves in our community.
- Maintains a vigilant watch over our first-in areas.
- Understands and works with the diversity of our community.
- Sends our members home safely.
- Continually evaluates and minimizes risks to our community.

Mission Statement

The Tulsa Fire Department delivers superior protection of life, health, property, and the environment.

Values

We are committed to providing the highest possible level of customer service to the community. Through education, we will strive for the level of professionalism our community deserves. Through training, we will acquire the skills and develop teamwork necessary to safely perform the tasks required of us. We will recognize the value of community involvement in providing diversity within our organization. Honesty and integrity will be the foundation of all interactions we have within and outside our organization.

Strategies

- TFD will prepare both human and physical resources for all-hazard response.
- TFD will work to prevent or reduce loss to the community and the department.
- TFD will respond quickly, with compassion, and in a professional manner.
- TFD will proactively utilize the collective intelligence of our members to evaluate and improve operational performance.

TFD Scope of Service

Since the early 1900's, the department has continued to provide its customers with high quality fire protection services. That protection has evolved over the years, moving from a primary focus on firefighting to one of all-hazard response. In more recent times, starting in the early 1990's, the department has taken on an increasing role in pre-hospital emergency care and response to natural and man-made disasters. The department has expanded its role in responding to all types of emergencies, such as hazardous materials incidents, technical rescue events, transportation accidents, utility-related incidents, and acts of terrorism. The public demands and expects a courteous and professional response to all types of emergencies and requests for service.

Fire Response – Structural and Nonstructural

The department responds to traditional residential structure fires, commercial fires, vehicle fires, wildland fires, and rescues related to these events.

Emergency Medical Services

The department began responding to EMS incidents in an official capacity in 1993 when it completed its certification as a first responder agency. Since then, the department has increased its level of medical training, added fire companies that respond with firefighter paramedics, and enhanced its overall EMS operations. According to the National Association of EMS Physicians (NAEMSP), first response by fire personnel equipped with an Automatic External Defibrillator (AED) is "the local government's best public service value".

In general, the department responds from 29 fire stations geographically located across the city to provide optimal coverage no matter the emergency. Since 1999, the department has expanded its level of EMS service to a total of 16 fire companies staffed with cross-trained/multiple-role fire personnel capable of delivering ALS medical care. Of those 16 fire companies, five are staffed with a smaller, EMS mission specific ALS response vehicle.

Tulsa firefighters respond to over 37,000 EMS incidents a year. In addition, the department's EMS Branch closely monitors the quality of the service delivered through an ongoing Clinical Quality Assurance and Improvement program. The department has also worked in cooperation with the OMD to ensure that the responses by fire personnel are on incidents that are at the highest risk and require the most rapid intervention. These efforts help to minimize the financial impact of delivering EMS by fire personnel, maintain a high level of readiness for both fire and EMS responses, and ensure that the right resource is deployed on medical incidents.

The department provides continuing education for over 100 Emergency Medical Technician (EMT) Paramedics and over 500 EMT Basic and Emergency Medical Responder (EMR) personnel. The department's paramedics work under the same medical protocol requirements as their EMSA counterparts, undergo the same level of initial clinical certification, and maintain an ongoing level of continuing medical and system-specific education.

Community Health Services

Over the past several years, the department has experienced an increase in requests for service outside of the traditional response to medical emergencies. These atypical responses range from lifting and moving invalids to assisting and feeding citizens with limited mobility and social support. The EMS Branch has also been tracking a dramatic increase in requests by fire company personnel on behalf of citizens for assistance from social service and other community service agencies. Two unique qualities of the fire service, 24/48 shift scheduling and neighborhood level station deployment, enable department personnel to develop and maintain close relationships with residents that call frequently for help. As a result, Tulsa firefighters are often the first to recognize negative changes in a person's health or living conditions. When these situations are identified, firefighters make every attempt to find the appropriate and often more specialized care required for their neighbors in need.

Although firefighters respond and deliver quality service any time they are requested, the increasing demands on fire department personnel have resulted in extended out-of-service times, response associated injuries, and the public's growing reliance upon public safety responders to provide low acuity healthcare services to vulnerable populations. By 2013, the department was clearly recognizing the impact of a changing community demographic, and understood the critical need to update the department's service model and explore available solutions to meet the demands of vulnerable residents.

The TFD Community Health Initiative was established as a pilot program to evaluate the department's response to those vulnerable individuals within the community that require the highest level of fire and EMS response. The result has been a new understanding of community needs and development of a firm foundation on which to create a specific program for the management of personnel safety and operations efficiency. The revelation is that the most simple of acts, communication, can be an effective tool in the management of those in need. Coupled with a strong support network, the department can be a great partner in the improvement of community health and resiliency.

Hazardous Materials Response

The City of Tulsa, as with most metropolitan cities, has a significant number of sensitive sites and target hazards that are both mobile and fixed. The department continues to expand the capabilities of the Hazardous Materials Response Team (HMRT) to meet the ever-increasing demand for response to chemical, biological, radiological, nuclear, and explosives events. Included in the HMRT's role are acts of terror, which have unfortunately become familiar events in our modern society. Issues arising from the recent rise in domestic and global terrorism necessitates that department personnel have the ability to respond to and mitigate all acts of terrorism, both domestic and international. The department has increased its readiness for these events through aggressive planning, training, and equipment acquisition.

Technical Rescue

The Technical Rescue Team (TRT) provides emergency response to incidents such as structural collapse, swift and rapid-rising water, trench rescue, confined space rescue, high-angle emergencies, and vehicle extrication. Members of the TRT are trained in the following rescue disciplines:

- Vehicle extrication
- High angle rescue
- Low angle rescue
- Trench rescue
- Confined space rescue
- Building/structural collapse
- Industrial rescue
- Water rescue
- Swift water rescue
- Ice rescue

Each member of the team trains each month to maintain their rescue skills and certifications.

Urban Search and Rescue - Oklahoma Task Force 1 (USAR-OK-TF1)

Oklahoma Task Force One (OK-TF1) Urban Search and Rescue (USAR) Task Force is an asset of the Tulsa Fire Department. Urban search and rescue is considered a "multi-hazard" discipline, capable of responding to a variety of emergencies or disasters, including earthquakes, hurricanes, tornadoes, floods, technological accidents, and terrorist attacks. Modeled after the Federal Emergency Management Agency's USAR program, OK-TF1 is one-half of a National Incident Management System (NIMS) Type I USAR Task Force, designed to be capable of 12 hour operations. OK-TF1 has a sister component in the Oklahoma City Fire Department. The two can merge and conduct 24 hour operations.

Components of a USAR Task Force are:

- Canine search
- Technical search
- Rescue
- Heavy equipment rigging
- Medical
- Hazardous Materials
- Logistics
- Planning
- Hazardous materials

The Tulsa Fire Department is the sponsoring agency for OK-TF1 and is responsible for management and personnel of the Tulsa half of OK-TF1. Surrounding fire departments, called participating agencies, have personnel that are also members of OK-TF1.

OK-TF1 Tulsa deployments to date:

- Coffeyville, KS Flood, July 2007
- Tulsa Ice Storm, December 2007
- Picher Tornado, May 2008
- Fort Gibson Missing Person Search, June 2010
- Sallisaw Missing Person Search, Feb 2011
- Joplin Tornado, June 2011
- Freedom Hills Wildland Fire, Aug 2012
- Moore Tornado, May 2013
- Sand Springs Tornado, March 2015

Transportation Incidents - Land, Air, Water, and Rail

The department responds to emergencies involving all modes of transportation. It maintains and provides the Airport and Fire Fighting (ARFF) capability for the Tulsa International Airport and also works closely with the Port of Catoosa to provide response to water related incidents. The department regularly works with the Oklahoma Department of Transportation (ODOT), the energy industry, and local, regional, and state law enforcement agencies to prepare and respond to transportation incidents.

Incident Management Team (IMT)

The department plays a vital role in protecting life and property from the consequences of natural and man-made disasters. Similar to the functions of the USAR team, the department provides a management team to help the City of Tulsa and other surrounding communities with management of large scale disasters and special events. Special event planning includes activities such as the Great Raft Race, the Tulsa State Fair, logistics for visiting dignitaries, and other annual and one-time special events. With the added threat of terrorism, special event planning and response takes on a whole new dimension and is no longer routine.

Community Risk Reduction Programs

Fire prevention activities, such as inspection and enforcement, continue to play a prominent role in protecting the community from injury, loss of life, property loss, and environmental damage.

"Community Risk Reduction" represents a broad area which includes fire safety inspections, fire cause investigations, public relations, public education, injury prevention, and public information. These functions enable members of our department to connect with the community, institute programs based on hazards, discontinue programs that are not needed, and manage our progress while truly serving the public.

Fire and Life Safety Code Development and Enforcement

The department provides fire code enforcement for the City of Tulsa. Code enforcement personnel ensure that public and private buildings meet or exceed current nationally recognized and legal fire codes. The department works with the City of Tulsa and community business owners to ensure proper fire safety is provided throughout Tulsa.

The department's code enforcement efforts are a critical element in the success of fire prevention programs. Almost every aspect of a thorough fire prevention program is affected by code enforcement in some way. It plays a major role in fire and life safety inspections, plans review, hazardous materials, code adoption, environmental investigations, and the issuance of fire prevention code permits.

Public Education, Community Relations, and Public Information

The department's Community Relations Branch encompasses the functions of public education, community relations, and public information. This branch contains our Public Education Officers, the Public Information Officer, and the Recruiting Officer.

Our public education officers present educational programs to citizens across the community in schools, churches, day cares and other businesses about general safety and fire prevention. This service is a proactive program helping citizens of all ages learn how to keep themselves and their community safer. Our public education officers also plan and direct smoke detector installation events, the juvenile firesetter program, and all-hazard community risk reduction programs.

Fire Investigation, Origin and Cause Determination, Intelligence, and Prosecution.

The Fire Investigation Branch provides the community with advanced fire origin and cause determination. Investigators are highly trained and utilize the most current methodology to determine the origin and cause of all types of fires. Collectively, they operate as a major crime unit within the fire department. If a fire is suspected to be incendiary, investigators will process the scene, collect evidence, and submit written reports to the District Attorney. They provide expert testimony in both the state and federal courts during prosecution of suspected arsonists. In addition, our investigators work collaboratively with local, state, and federal law enforcement entities including the Bureau of Alcohol, Tobacco, Firearms, and Explosives to prevent and prosecute the crime of arson.

Investigators also document trends in accidental fires. Awareness of these trends allows the Public Information Officer and the Public Education Branch to focus education efforts in the community. As part of this effort, investigators and public education officers utilize the National Fire Academy Juvenile Fire Setter Program to document and educate at-risk youth and children who are involved in setting fires. Education equals prevention. The Investigations Branch not only prosecutes arson but plays an important role in fire prevention.

General Information about the Tulsa Fire Department

The City of Tulsa incorporated in 1898 with approximately 1,100 citizens. In 1901, the discovery of oil in Red Fork paved the way for Tulsa's growth. Like many cities, the downtown and initial areas of residential development surrounding the downtown area are densely populated with closely spaced legacy buildings. As urban sprawl progressed, residences became less densely spaced, often occupying larger lots with greater setbacks. Sprawl eventually led to subdivisions and other concepts of traditional urban planning.

Tulsa, unlike many newer and smaller cities surrounding it, has significant risk due to older buildings and densely concentrated businesses and residences that were built prior to modern life safety measures. Due to age and other factors, it's not safe to assume that every building in Tulsa meets modern fire codes and that every high-rise has automatic fire sprinklers. While fires nationwide have shown a downward trend since the urban renewal days (1960's through the early 1980's), the Tulsa Fire Department is still a very active structural firefighting department. Figure 3 shows the historic number of fires in Tulsa. If the days of urban renewal are excluded, fires in Tulsa are at the level they were in the 1960s and prior. In 2015, the department responded to 713 structure fires.

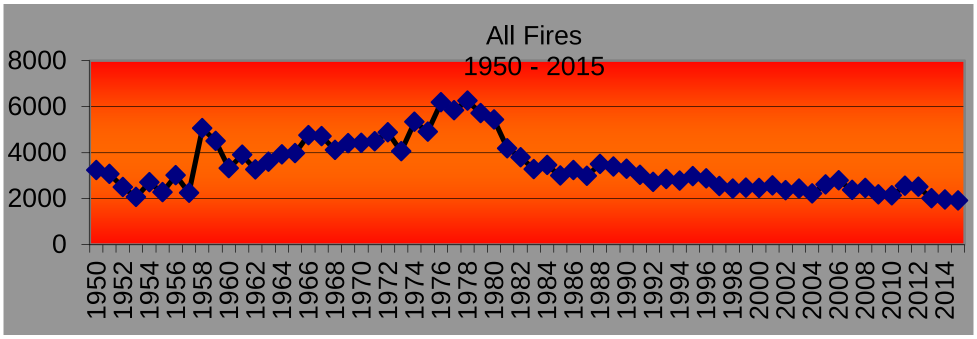


Figure 3: Historic Number of Fires in Tulsa

In just 26 years, the department has gone from approximately 10,000 incidents per year (1990) to nearly 60,000 incidents per year due to two trends (Figure 4). These trends are the use of firefighting resources for emergency medical first response and the transition to all-hazard response. Nationally, both trends began as early as the late 1970's; however, it was 1993 when the fire department was recognized as an EMS first response agency.

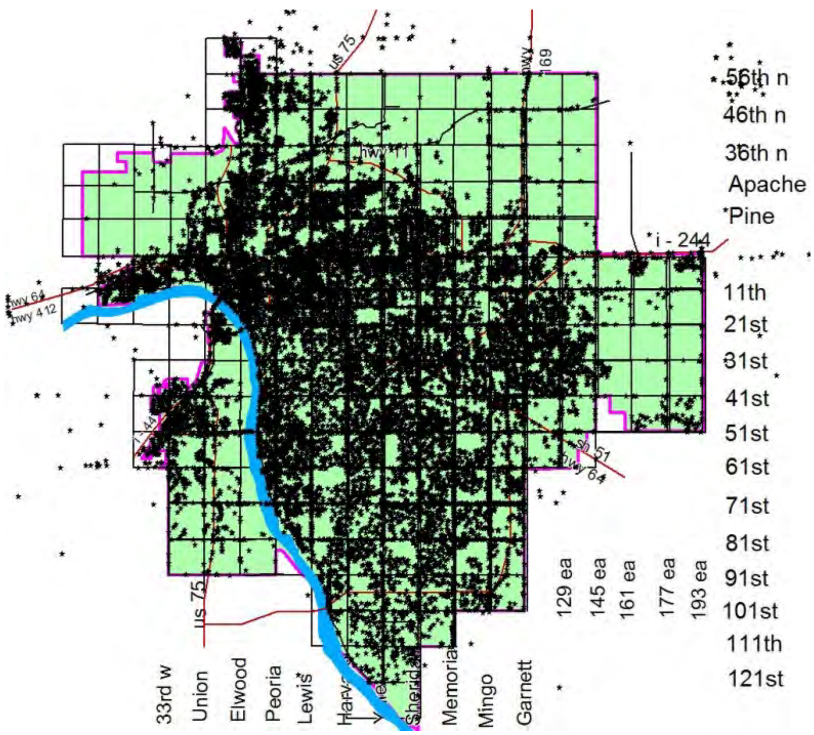


Figure 4: Annual Response Distribution in Tulsa (Each dot is an incident response from one or more units)

Today, Tulsa has a very typical dense and aged metropolitan downtown district with interspersed commercial/light industrial areas and older surrounding neighborhoods on all sides. Tulsa's downtown area experiences the highest density of incidents in the city (Figure 5). In general, the area of the city most in need of focus from an emergency medical and firefighting point of view is the east side followed by a strip along the south side along the area south of 61st St.

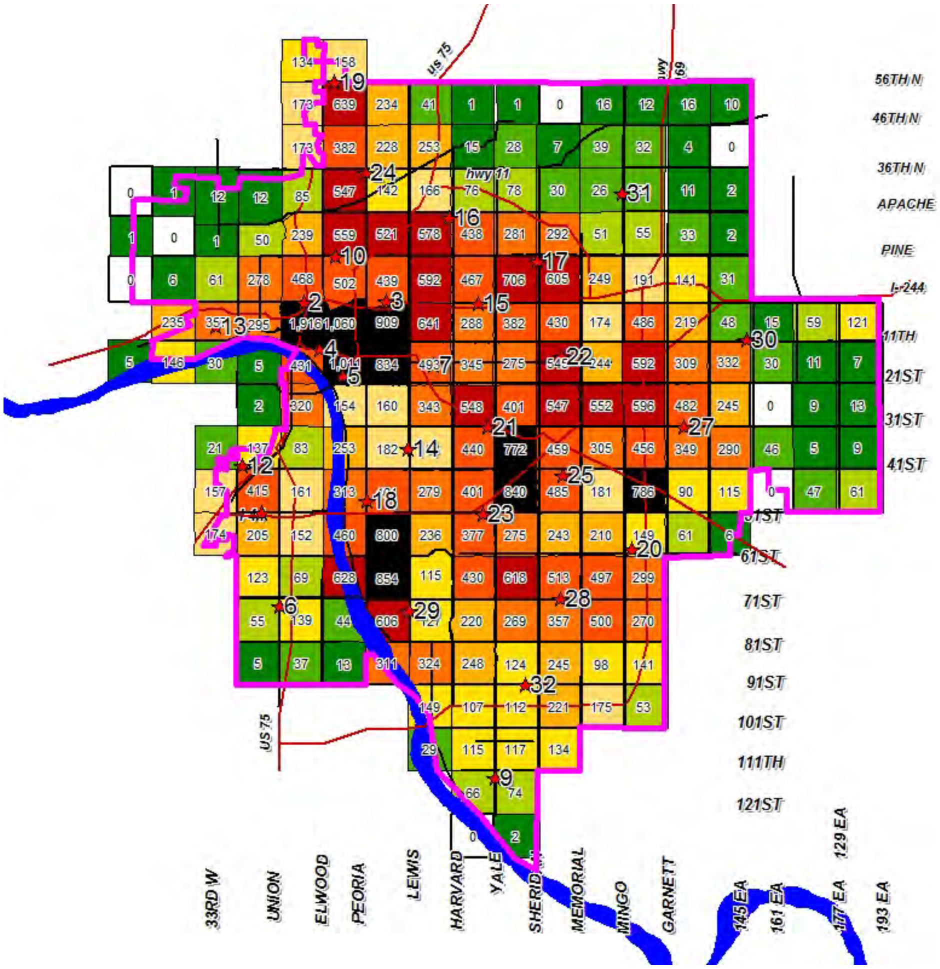


Figure 5: Tulsa Fire Department Incident Density by Square Mile

Tulsa's population has been nearing 400,000 residents since the early 1980's (360,000). As of July 2016, estimates indicate that Tulsa has reached 403,505 (Census.gov, 2016). Population density closely matches incident distribution (Figure 4, Figure 5, and Figure 6). As the city's population has shifted, annexation of land and socioeconomic conditions have influenced the location of incidents. The department has not been able to keep pace with these trends in the eastern and to some extent the southern part of the city. As a result, the department has seen increasing response times. This document serves to correct response time issues and lay a foundational methodology for studies at regular intervals to address future trends.

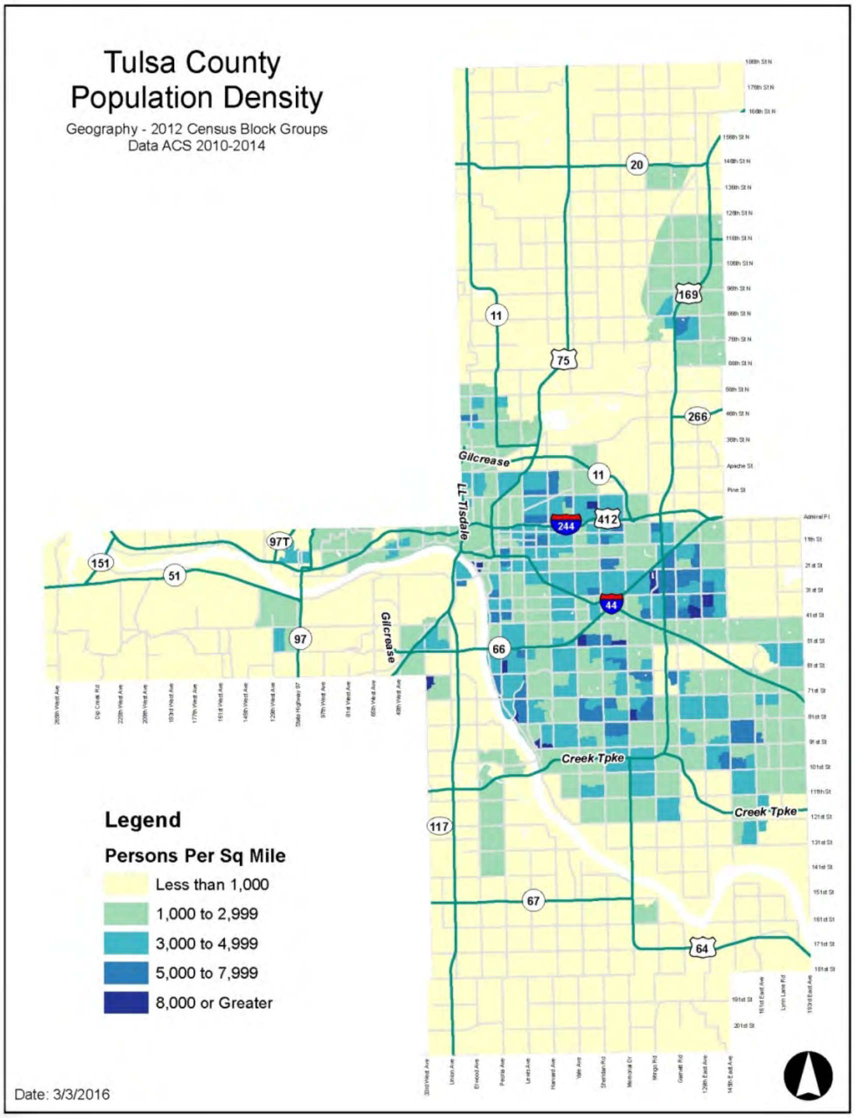


Figure 6: Tulsa Area Population Density, 2014

Past Studies

Several studies and assessments which either focused on or included the Tulsa Fire Department have occurred in recent history.

2000 Resource Allocation Report/1997 Station Location Report

The 1997 Station Location Report recommended closing one fire station and establishing three new stations that were to be staffed through redistribution of current resources. Additionally, this report recommended construction of four new fire stations.

On December 15, 2000, the department published its Resource Allocation Report. The purpose of the report was to examine and determine effective allocation of department resources. This report included an examination of station locations, apparatus placement, and fire company staffing levels. The methodologies used critical criteria to allow duplication and confirmation of results. The report recommended reallocating current resources and expanding with new resources.

The 2000 Resource Allocation Study also recommended increasing staffing at six fire companies from four to five personnel to reduce major fire suppression deficiencies. The methodology was based on information from the National Fire Protection Agency and the American Heart Association that included fire and EMS response scenarios.

Strategic Blueprint

The Strategic Blueprint is a document cooperatively prepared by the Office of the Medical Director, EMSA, and Tulsa Fire Department. The document is intended to examine necessary evidence-based data to establish the components of Tulsa's EMS system. One of the key components of the blueprint is the effort to create a living document that will stand the test of time. This can only be accomplished through continuous joint strategic planning.

The Blueprint establishes some guiding principles, core issues, and operational steps for implementation of the EMS system. One example of improving efficiency in the report is to have all providers using the same protocols. This puts all responders on the same page when treating every patient. EMS system design and response time standards are also laid out in the document along with combined training. The Blueprint also takes a close look at dispatch and the role this function plays in patient outcomes. The report emphasizes that the correct resource, at the right time, in the correct response mode (emergency or non-emergency) is critical to the positive patient outcome.

As a result of the Blueprint, the authority and expertise of system responders began to change. Prior to this report, EMSA system medics were tasked with being the primary provider for all patients. Simply put, once an EMSA paramedic arrived they were making all of the decisions regarding patient care. The Blueprint identified and recognized the experience level of fire department paramedics and delegated more patient care responsibility to them. This was an important dimension of the Strategic Blueprint.

University of Oklahoma Department of Emergency Medicine (OUDEM) – Emergency Medical Services Evidence Based System Design White Paper for EMSA

In July of 2011, a group of physicians were selected to complete a system design document for EMSA. The intent of this study was to examine response times as they relate to performance and reliability as well as the methods used to measure these times. Additionally, the study was to analyze the integration of first responders, management of the communication system, data reporting requirements, and the number of personnel and associated work schedule in the system. This report examined the dispatch codes determining how responders were to respond (emergency or nonemergency).

The study also examined response times. The emphasis here was to let medical outcomes tell the story as they relate to an acceptable response time and system makeup. The white paper emphasizes that more is not better. More personnel, more equipment, and more medications do not necessarily mean a patient receives better or more effective care. A carefully constructed system that includes interventions by first responders and transport to the hospital is the most effective for patients.

As this paper was reviewed and the recommended changes implemented, there was a visible change in the consideration and utilization of fire department paramedics. As mentioned before, previously all patient care responsibility was relegated to EMSA medics; however, this report recognized the talent and experience of fire department providers. The outcomes and performance of the EMS system in its current state are primarily based on the interventions provided by fire department first responders. It was possible for EMSA to increase Priority 1 and Priority 2 response time requirements because TFD first responders were recognized as an integral part of the EMS system.

City of Tulsa Auditor – Resource Utilization Analysis

This analysis was conducted in 2015 by the City Auditor. The intent of this analysis was to conduct a survey across city employees requesting information regarding overtime use, span of control for supervisors, and benchmarking employee staffing. About half of city employees responded to the survey. Overall employees indicated that 86% liked their jobs with 63% indicating their co-workers' morale was low. Overtime was another dimension of the survey. It identified that 74% of city employees were paid overtime in 2014. Finally, the survey looked at span of control data within the city identifying that were we comparatively staffed with other similar cities.

City of Tulsa Customer Polls

In 2010/2011 a citizen survey was done. The purpose of this survey was to measure the residents' opinion and attitude as it relates to quality of life. The poll defined quality of life as personal satisfaction or dissatisfaction with the cultural or intellectual conditions under which a person lives, which is distinct from material comfort. The methodology used in this poll was the implementation of a simple random selection technique of addresses within the city. Fire department results from within the poll showed that 81% of respondents who had an opinion were satisfied with the timeliness of fire response, and 88% of respondents were satisfied overall with the fire department.

In April of 2016, the City of Tulsa solicited another citizen satisfaction study. Citizens were asked some 109 questions with topics ranging from quality of life issues to public safety. When asked about the fire department and the quality of fire services, 79% indicated satisfaction. In fact, 46% of these citizens were very satisfied. The very satisfied percentage was up almost 10% from the previous survey. Also, 77% of the respondents were satisfied with how quickly the fire department responds. When it came to the location of fire stations, 83% of the citizens surveyed were satisfied. Residents were also asked their opinion of fire safety education programs, and 52% said they were satisfied. However, an additional 41% were neutral or did not know about the programs. This in and of itself identifies a need to better market and explain our fire safety education programs.

Insurance Services Office (ISO), 2012 Public Protection Classification Report (PPC)

In February 2012, the Insurance Services Office (ISO) issued a Public Protection Classification Summary Report based on an evaluation of the Tulsa Fire Department. ISO scores departments based on four areas:

- Needed Fire Flows- theoretical fire flow for representative building location within protected area
- Receiving and Handling Fire Alarms- alarm office, radio system, staffing, phone system and telephone lines
- Fire Department- apparatus number/type, staffing, experience, training, and geographic distribution
- Water Supply- water system, hydrants, distance between sources, alternative water sources

ISO rates the fire protection in a city on a scale of one to 10, with one being the best. Tulsa was rated as an ISO Class 3/9. Most of the City of Tulsa has an ISO rating of 3. Areas that are more than five miles from a fire station or 1000 feet from a fire hydrant have an ISO rating of 9.

Insurance companies use the ISO system to determine property insurance rates. For residential homeowner's insurance, the greatest savings occurs when a fire department receives an ISO Class 5 rating. This is due to the low potential loss from residential fires. ISO ratings such as Class 1, 2, and 3 pertain more to commercial, industrial, and other structures. A city's ISO rating is an important index of how effectively a city is providing fire protection services as compared with other cities in the area. ISO ratings can be a very important economic development tool. When determining a location, a city's ISO rating in comparison with other cities is looked to as a consideration for businesses.

Tulsa scored 77.34 points out of a possible 100 points in 2012. A score of 80 is required to achieve an ISO Class 2 rating. Tulsa's water supply and alarm handling scores were near perfect; however, the fire department score was 35 points out of 50. The combination of the low fire protection score and the disparity between the fire protection score and the other scores kept Tulsa from an ISO Class 2 rating. ISO refers to disparity between scores as divergence, and cities are penalized for divergence.

Center for Public Safety Excellence (CPSE), Commission Fire Accreditation International (CFAI): Standard of Coverage

In April of 2001 the fire department embarked on a successful effort to meet the Commission on Fire Accreditation International's requirements. The review included nine categories:

1. Governance and administration
2. Assessment and planning
3. Goals and objectives
4. Financial resources
5. Fire suppression
6. Physical resources
7. Human resources
8. Training and competency
9. Water supply and communications
10. External systems relations

The department renewed CPSE accreditation in 2006 and had prepared the documentation package to renew in 2011; however, the funding to continue accreditation was withdrawn in 2010 due to the city's financial shortfalls. A 2016 ICMA report recommended that the fire department should again seek CPSE accreditation.

Mayor Bartlett's Public Safety Task Force

In May of 2012 Mayor Bartlett commissioned several citizens and public safety employees to examine police, fire, and 911. The group was directed to evaluate personnel needs, departmental needs, and obtain feedback and buy-in from the citizens involved. The citizens selected were influential and well established in the community. The group met for approximately six months gathering data and determined staffing and associated needs for the involved departments. The fire department examined staffing models, resource distribution maps, and fire fatality statistics as part of the study. Other data examined included arson fires, structure fires, and EMS responses. Overtime and the associated personnel numbers were studied in an attempt to correlate staffing shortages with overtime costs. The study determined that the fire department should be kept within 20 personnel of fully staffed (authorized strength) to avoid overtime costs. Additionally, the committee recommended adding 148 additional firefighters.

KPMG

On July 10, 2010 KPMG was tasked with a strategic review of programs and services provided by the City of Tulsa across 20 departments. The review consisted of five phases, including:

- Project planning and mobilization
- Service inventory, budget allocation, and cost allocation
- Survey and scorecard process
- Opportunity generation
- Finalize and present project deliverables

KPMG recognized the importance of public/private partnerships and praised the City of Tulsa for its efforts in this area. KPMG also encouraged city officials to pursue additional partnerships.

The strategic review gave all 20 departments a scorecard on their efforts and areas for improvement. The considerations offered by KPMG supported the 2009 fire department reorganization. They concluded that the organization of the department was in support of the Mayor's public safety strategic objective. Future considerations included sharing services, maintaining internal and external balance, and generating revenue. Efforts and improvements have been made in all three areas. One area of evaluation was to identify mandated processes, duplicated processes, the associated structure and overall performance.

University Science Center

On March 2, 1993 a Comprehensive Resource Utilization study of the Tulsa Fire Department was conducted by the University Science Center. The study was done by a team of fire and emergency medical experts and intended to examine fire prevention, suppression operations, and support services. A five year service trends analysis was conducted along with a more detailed analysis of 1991.

The overall assessment indicated that TFD provided good basic fire services and that it had the capacity to increase both the range and quantity of provided to the public. The study found that the overall management structure in place was sound. It did recommend a decentralizing program and delegating operational responsibilities to line officers. They suggested a two year plan to adjust department policies and institute a Total Quality Management initiative. The study recommended that over a two year period the department increase first response involvement, implement additional training programs, and increase company level inspections. When examining safety services, the study identified a need for additional inspectors as only the larger and potentially more hazardous occupancies in the city were being periodically inspected. Regarding the support services section, the study recommended sharing information and responsibility for training department personnel.

This study also recommended closing three closely-spaced downtown fire companies: Engine 8, Engine 9, and Ladder 1. All three were subsequently closed. However, this study fell short of addressing other fire company spacing issues throughout the city. Many of these issues would later be resolved by a series of fire station spacing initiatives by the department in the late 1990's and 2000's.

The Executive Service Corp of Tulsa (TESCOT) Study

In 1991, The Executive Service Corp of Tulsa (TESCOT) engaged a study to review and analyze the organization structure of the fire department for effectiveness and efficiency, and make recommendations for changes and improvements as appropriate. The makeup of the data the study group considered included one-hour interviews with 18 sworn members. The study identified three areas where consideration should be given:

- Whether the department should respond to medical emergencies
- The extent to which the department should be involved in developing data on hazardous materials and the response to a hazmat incident
- The scope of public safety education, code development and enforcement, fire investigation, risk analysis, disaster planning, and mutual assistance programs with surrounding communities

The general conclusion drawn by the study was that the organization of the fire department was workable. They did recommend some changes to enhance efficiency and effectiveness. Additionally the group identified that personnel assigned to staff positions were selected without a competitive exam process. The group recommended that the selection process include a competitive evaluation. They also recommended that some positions be filled by civilians rather than sworn firefighters. These positions were in large part contained within the Safety Service Section (fire prevention).

The TESCOT study is one of the oldest studies evaluated. Today the fire department is a premiere first response agency that has a dedicated Hazmat Team and has premier disaster planning and mutual assistance programs with surrounding communities.

Section 1: Fire Station Location (First-In Response)

Life safety is the primary consideration when placing fire stations. Firefighting efforts and EMS first response weigh equally. Optimal fire station location is achieved by placing fire stations at fixed locations to provide the consistent ability to deploy an appropriately staffed and equipped apparatus to 90% of all emergency calls for service within a six minute response time (four minute drive time). An appropriately staffed and equipped apparatus has the following minimum capabilities:

- BLS
- AED
- Class A pumping capabilities[1]
- Basic firefighting equipment and tools

Fire station placement creates theoretical geographical areas for each fire station called "first-in" areas. First-in areas are the locations that a station can respond to more quickly than any other station. To an all-hazard response department such as Tulsa's, the first-in response area footprint is critical. It defines the department's ability to rapidly get an appropriate apparatus on scene, assess the situation, and begin intervention until more resources can arrive if needed. The placement of fire stations is a critical component in Tulsa's tiered[2] EMS system. The consistency of the department's deployment pattern supports and allows the dynamic modeling used by EMSA while also addressing firefighting and all-hazard response needs.

The fire department operates 29 fire stations and provides the staffing for a thirtieth station located on the Tulsa International Airport. Figure 7 shows the current facilities and their first-in areas. Sixteen of Tulsa's 29 stations house a single apparatus. Thirteen stations house a second apparatus, for a total of 42 citywide.

Stations that house one apparatus are referred to as "single company" stations. Each single company station houses an engine company staffed with three personnel. Stations that house two apparatus are referred to as "multi-company" stations. Multi-company stations have one of the following configurations:

- Engine company and ladder company (Stations 4, 7, 20, 24, 27, 29, 30, and 31)
- Ladder company and EMS Squad company (Stations 22, 23, 26, and 32)
- Engine company and EMS Squad company with cross-staffed ladder apparatus (Station 2)

Appendix A contains detailed information about each fire station.

[1] "Class A" pumping capabilities – the ability to pump a minimum of 1000 gallons per minute and carry a minimum of 500 gallons of water.
[2] Tiered EMS system in Tulsa: fire department first response followed by ambulance transport.

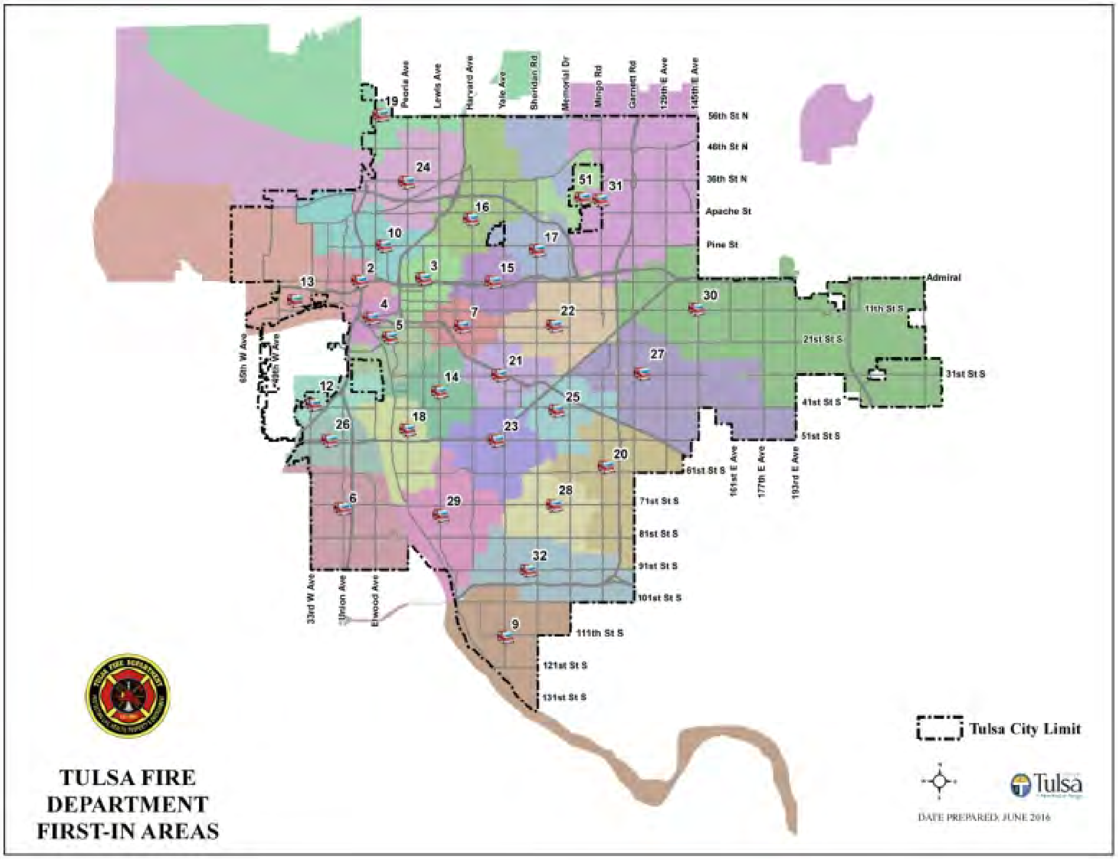


Figure 7: 2016 Tulsa Fire Stations

When a call for help comes in, the 911 Center dispatches the closest apparatus with the capability to address the need. If the call requires more than one apparatus, the 911 Center dispatches the appropriate number and type of apparatus from the closest locations using predetermined response algorithms.

In general, the 42 apparatus a have a home station in which they are housed unless the crew is at an incident or conducting other duties. Apparatus are generally expected to stay in their first-in areas. However, the department does dynamically move apparatus from station to station based on events in the city such as large incidents or training. For instance, most fire department training occurs during normal on-duty time[3]. Each weekday, the training schedule necessitates several apparatus going to the Tulsa Fire Safety Training Center. While apparatus are in training, the Assistant Chief moves other apparatus to make sure that as many stations as possible have at least one apparatus available in the station. A similar situation occurs when one or more large incidents are underway. In these instances, the assistant chief will consider the area of the city that has vacant fire stations and move apparatus from other parts of the city to provide coverage in as many stations as possible until the indent(s) are over. The coverage across the city will be decreased during these times; however, moving apparatus attempts to ensure that no call experiences an inordinately long response time during this period.

[3] Many industries and organizations do training outside of normal working hours using overtime.

First-In Response Time

The City of Tulsa uses a commonly accepted response time criteria: arrive on scene within six minutes 90% of the time (from receipt of the 911 call). The department's response time goal is grounded in numerous sources, and the goals are also established considering the department's role as an integral part of the Tulsa's EMS system.

The department responds to emergency (using warning lights and sirens) and non-emergency (without the use of warning lights and sirens) calls. Non-emergency calls are not included when computing compliance with response time standards. The term "response time," or more accurately "total response time," consists of several components which are discussed herein.

Response Time Standards

Response time standards are derived from several sources, including:

- National consensus standards
- Insurance Services Office
- Office of the Medical Director
- Medical literature
- Laboratory testing
- National trends
- Local customer expectations

National Consensus Standards

National consensus standards, like those developed by the National Fire Protection Association (NFPA), contain specific performance-based measurements, or benchmarks, which are used and accepted across many organizations. According to NFPA:

> The NFPA standards development process encourages public participation in the development of its standards. All NFPA standards are revised and updated every three to five years, in revision cycles that begin twice each year. Normally a standard's cycle takes approximately two years to complete. Each revision cycle proceeds according to a published schedule which includes final dates for each stage in the standards development process. The four fundamental steps in the NFPA standards development process are:
>
> 1. Public Input
> 2. Public Comment
> 3. NFPA Technical Meeting (Tech Session)
> 4. Standards Council Action (Appeals and Issuance of Standard)
>
> NFPA Technical Committees and Panels serve as the principal consensus bodies responsible for developing and updating all NFPA codes and standards. Committees and Panels are appointed by the Standards Council and typically consist of no more than 30 voting members representing a balance of interests. NFPA membership is not required in order to participate on an NFPA Technical Committee. Appointment to a Technical Committee is based on such factors as technical expertise, professional standing, commitment to public safety, and the ability to bring to the table the point of view of a category of interested people or groups. Each Technical Committee is constituted so as to contain a balance of affected interests, with no more than one-third of the Committee from the same interest category. The Committee must reach a consensus in order to take action on an item.
>
> Standards developed by NFPA and similar standards development organizations (SDOs) are "voluntary consensus standards," created through procedures accredited for their consensus decision-making, openness, balance of interests represented, and fairness by the American National Standards Institute (ANSI). Because of their credibility and reach, independent SDOs are able to attract thousands of volunteer experts to serve on their standards drafting committees.

SDOs are standards development organizations which work to formulate health and safety standards. The term "standard' includes a wide variety of technical works that prescribe rules, guidelines, best practices, specifications, test methods, design or installation procedures and the like. The size, scope and subject matter of standards varies widely, ranging from lengthy model building or electrical codes to narrowly scoped test methods or product specifications.

NFPA is by no means the only independent, public service organization that develops health and safety standards used by government. Many not-for-profit professional societies, testing organizations and other 501(c)(3) organizations also develop consensus-based health and safety standards for private and government use. NFPA is part of a small but significant group which serves the public through the creation of standards that promote reliability, interoperability and quality thus bringing economic and other societal benefits to the country. (NFPA, 2016)

Accrediting Agencies – CPSE/CFAI

The Tulsa Fire Department was accredited through the Center for Public Safety Excellence (CPSE) – Commission on Fire Accreditation International (CFAI) from 2001 until 2011 when financial restrictions in 2010 prevented continuation of accreditation. The department continues to use the tenets of CSPE/CFAI as benchmarks for service delivery and aims to reapply for CFAI accreditation when funding becomes available. According to CSPE:

> The Center for Public Safety Excellence (CPSE) is a not-for-profit 501(c)(3) corporation and is a primary resource for the fire and emergency profession to continuously improve services, resulting in a higher quality of life for communities.
>
> CPSE has successfully helped public safety agencies around the world streamline and improve the services they provide their communities through its numerous programs and services.
>
> CPSE provides the only accreditation program for fire service organizations in the world, and offers nationally for fire and emergency services officers. CPSE has over 200 accredited agencies and over 1700 designated officers throughout the world.
>
> Accreditation is a comprehensive self-assessment and evaluation model that enables organizations to examine past, current, and future service levels and internal performance and compare them to industry best practices. This process leads to improved service delivery.
>
> CPSE's Accreditation Program, administered by the Commission on Fire Accreditation International (CFAI) allows fire and emergency service agencies to compare their performance to industry best practices in order to:
>
> - Determine community risk and safety needs and develop community-specific Standards of Cover.
> - Evaluate the performance of the department.
> - Establish a method for achieving continuous organizational improvement.
>
> Local government executives face increasing pressure to "do more with less" and justify their expenditures by demonstrating a direct link to improved or expanded services. Particularly for emergency services, local officials need criteria to assess professional performance and efficiency. The CFAI accreditation process provides a well-defined, internationally-recognized benchmark system to measure the quality of fire and emergency services. (CPSE, 2016)

Insurance Services Office - ISO

Insurance companies use the Insurance Services Office (ISO) classification system to determine property insurance rates. ISO rates the fire protection in a city on a scale of one to 10 with one being the best. TFD was rated as an ISO Class 3/9. ISO scores departments based on four areas:

- Needed Fire Flows- theoretical fire flow for representative building location within protected area
- Receiving and Handling Fire Alarms- alarm office, radio system, staffing, phone system and telephone lines
- Fire Department- apparatus number/ type, staffing, experience, training, and geographic distribution
- Water Supply- water system, hydrants, distance between sources, alternative water sources

According to ISO:

> Through the Public Protection Classification (PPC™) program, ISO evaluates municipal fire-protection efforts in communities throughout the United States. A community's investment in fire mitigation is a proven and reliable predictor of future fire losses. So insurance companies use PPC information to help establish fair premiums for fire insurance - generally offering lower premiums in communities with better protection. Many communities use the PPC as a benchmark for measuring the effectiveness of their fire-protection services. The PPC program is also a tool that helps communities plan for, budget, and justify improvements. (ISO, 2016)

ISO contributes to the determination of response times in one of two ways, with grading criteria based on one of the following (at the choice of the fire department):

1. Fire station and engine companies spacing at three mile diamond intervals and ladder company spacing at five mile diamond intervals.
2. Computer Aided Dispatch (CAD) analysis to determine compliance with NFPA 1710 response time benchmarks. By using this criteria, departments can avoid placing unnecessary fire stations in unpopulated areas (in Tulsa's case, this saves the placement of 10 or more fire stations).

As discussed previously, a city's ISO rating is an economic development tool and improving it is one of the best ways a fire department can contribute a city's economic development efforts.

Office of the Medical Director

In July of 2001, the Department of Emergency Medicine at The University of Oklahoma School of Community Medicine under the leadership of Dr. Jeffrey M. Goodloe published a white paper on the EMS system design in the EMSA System (Tulsa and Oklahoma City metro areas).

When taken in its entirety, over the multiple documents and authors, the Tulsa system is a tiered system supporting a five minute threshold (one minute turnout time and four minute travel time) for first response in 90% of the cases for which first response is dispatched (life threatening or high priority calls).

One of the aspects of this document was the use of the Medical Priority Dispatching System (MPDS). The MPDS is used to categorize EMS calls from Omega to Echo (Figure 8). Calls are then assigned a code that corresponds to a priority (MPDS Code). Patients with time-critical symptoms, as determined by EMS dispatchers using standard questions/algorithms, are given highest priority and resources and response modes are allocated to match the problem.

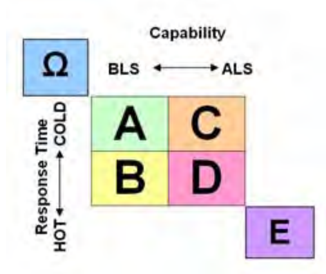


Figure 8: Medical Priority Dispatch System (MPDS)

This system of medical dispatching was developed by Dr. Jeff J. Clawson. Clawson was a contributor to the OUDEM white paper. The key aspects of this research are the basis for the determining which calls the fire department responds to and at what priority. Most low priority/non-life threatening calls never get assigned to the fire department. The OMD has determined the following priorities and response modes for assignment to TFD (Table 1). It is the policy of fire department to only respond using emergency mode (warning lights and sirens or "hot") when truly needed and when warranted by the criteria.

MPDS PRIORITY LEVEL	RESPONSE UNITS	MODE
ECHO	AMBULANCE FIRE DEPARTMENT	HOT HOT
DELTA	AMBULANCE FIRE DEPARTMENT	HOT HOT
CHARLIE	AMBULANCE	COLD
BRAVO	FIRE DEPARTMENT AMBULANCE	HOT or COLD COLD
ALPHA	AMBULANCE	COLD
OMEGA	AMBULANCE or REFERRAL TO ALTERNATE CARE	COLD

Table 1: TFD and EMSA Response Modes to Medical Calls per OMD

American Heart Association

The ability to resuscitate an individual from cardiac arrest has been one of the key underpinnings of EMS. The American Heart Association (AHA) has been on the forefront in the effort to improve cardiac arrest survival rates nationwide. According to AHA:

> The American Heart Association's Emergency Cardiovascular Care (ECC) Programs deliver a dynamic message of hope — the hope of saving lives. New treatments have improved the possibility of survival from cardiovascular emergencies, cardiac arrest, and stroke. These new treatments offer the hope of improved quality of life for people who suffer these events.
>
> Increasing public awareness of the importance of early intervention and ensuring greater public access to defibrillation will save many lives. ECC programs train more than 18 million people every year by educating healthcare providers, caregivers, and the general public on how to respond to these emergencies.
>
> About 88 % of people who experience out-of-hospital cardiac arrest do not survive to hospital discharge. Immediate CPR can double, or even triple, a victim's chance of survival.
>
> ECC Mission
>
> The ECC Programs Department is responsible for implementing program initiatives, and providing guidance and support to the ECC Training Network. The ECC Mission supports this responsibility.

The Mission of the American Heart Association's ECC Program is to reduce disability and death from acute circulatory and respiratory emergencies, including stroke, by improving the chain of survival in every community and in every health care system.

ECC Guiding Philosophy

- Improve the Chain of Survival in Every Community
- Increase Quality, Timeliness of Materials
- Identify, Expand Training
- Document Effectiveness
- Improve Efficiency (AHA, 2016)

For years, many EMS systems were based on statistics provided by AHA indicating that irreversible brain damage occurred after four to six minutes of a sudden cardiac arrest. AHA no longer publishes such a definite number. Instead, AHA literature now states “death occurs within minutes” of a sudden cardiac arrest and “the longer the person goes without treatment, the greater the damage,” in the case of a heart attack. The fire department is a critical part of “The Chain of Survival,” a commonly accepted AHA continuum that illustrates the recommended steps for the best possible chances for survival and recovery from a cardiac arrest (Figure 9).

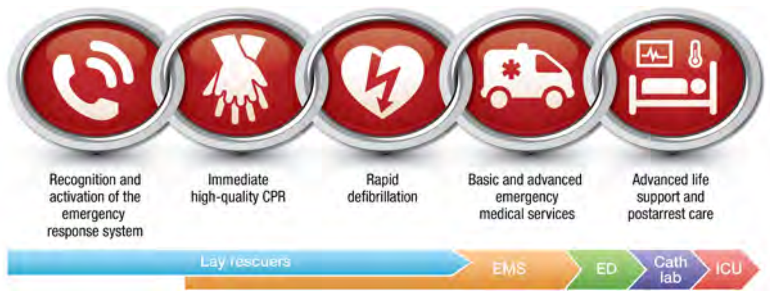


Figure 9: AHA Out of Hospital Cardiac Arrest Chain of Survival (AHA:2, 2016)

According the AHA:

The term *Chain of Survival* provides a useful metaphor for the elements of the ECC systems concept.

The 5 links in the adult out-of-hospital Chain of Survival are

- Recognition of cardiac arrest and activation of the emergency response system
- Early cardiopulmonary resuscitation (CPR) with an emphasis on chest compressions
- Rapid defibrillation
- Basic and advanced emergency medical services
- Advanced life support and post-cardiac arrest care (AHA:, 2016)

Laboratory Testing

The NFPA Fire Propagation Curve

The NFPA Fire Propagation Curve is a fire model developed through laboratory testing by Underwriter’s Laboratories (UL). Through repeated empirical testing, this model reinforces the response time benchmarks established in NFPA 1710.

Excerpt from NFPA 1710 Appendix A:

A.5.2.2.2.1 An early, aggressive, and offensive primary interior attack on a working fire, where feasible, is usually the most effective strategy to reduce loss of lives and property damage. In Figure A.5.2.2.2.1, the line, which combines temperature rise and time, represents a rate of fire propagation in an unsprinklered room and roughly corresponds to the percentage of property destruction. At approximately 10 minutes into the fire sequence, the hypothetical room of origin flashes over. Extension outside the room begins at that point.

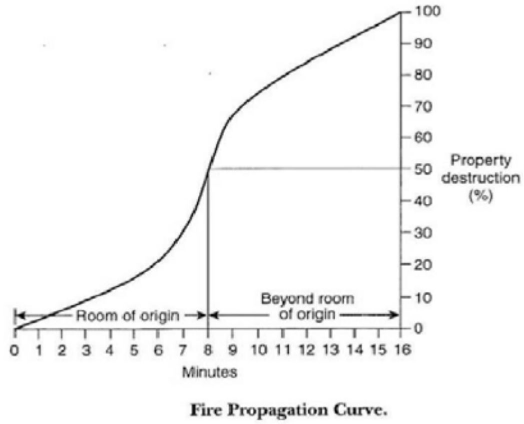


FIGURE A.5.2.2.2.1 Fire Propagation Curve.

> Consequently, given that the progression of a structure fire to the point of flashover (i.e., the very rapid spreading of the fire due to superheating of room contents and other combustibles) generally occurs in less than 10 minutes, two of the most important elements in limiting fire spread are the quick arrival of sufficient personnel and equipment to attack and extinguish the fire as close to the point of its origin as possible.
>
> The ability of adequate fire suppression forces to significantly influence the outcome of a structure fire is undeniable and predictable. Data generated by NFPA and used by the committee in developing this standard provide empirical data that rapid and aggressive interior attack can substantially reduce the human and property losses associated with structure fires (See Table A.5.2.2.2.1(b) as an update of Table 5.2.2.2.1(a)). (NFPA1710, 2016)

A few areas of note regarding the fire propagation curve are that first, built-in fire suppression systems (automatic sprinkler systems or kitchen hood systems) along with fire resistant construction can flatten the curve. Second, the fire propagation curve does not fully account for the time it takes for a fire to be discovered and reported to the fire department via 911 or other means. Third, the curve has steepened remarkably in recent years as construction and furnishings in buildings and homes has shifted with the use of synthetic materials and the lightweight construction.

"Analysis of Changing Residential Fire Dynamics and Its Implications on Firefighter Operational Timeframes"

The Underwriter's Laboratories' report, *Analysis of Changing Residential Fire Dynamics and Its Implications on Firefighter Operational Timeframes* (October 2012), provides empirical data that substantiates response times based on the NFPA 1710 benchmarks. According to UL:

> There has been a steady change in the residential fire environment over the past several decades. These changes include larger homes, more open floor plans and volumes, increased synthetic fuel loads and new construction materials. The larger the home is the more air available to sustain and grow a fire in that home. Additionally, the larger the home, the greater the potential to have a larger fire, and the greater the potential hazard to the responding fire service resources.
>
> Combining of rooms and taller ceiling heights creates large volume spaces which when involved in a fire require more water and resources to extinguish. These fires are more difficult to contain. This also means shorter escape times for occupants as the egress routes may be compromised earlier due to lack of compartmentation.

Four examples of new construction materials were examined; wall linings, structural components, windows and interior doors. The change in wall linings now allows for more content fires to become structure fires by penetrating the wall lining and involving the void spaces. This change allows for faster fire propagation and shorter times to collapse. The changes in structural components have removed the mass of the components, which allows them to collapse significantly earlier. In these experiments an engineered "I joist" floor system collapsed in less than one-third the time that the dimensional lumber floor system collapsed. Modern windows and interior doors fail faster than their legacy counterparts. The windows failed in half the time and the doors failed in approximately five minutes. If a fire in a closed room is able to get air to burn from a failed window, then it can burn through a door and extend to the rest of the house. This can lead to faster fire propagation, rapid changes in fire dynamics and shorter escape times for occupants as well as firefighters.

Using the conservative value of 10 minutes as the start of the operational timeframe and comparing it to the modern and legacy fire timelines shows the hazard that the modern fire environment poses to firefighters. It also highlights that the operational timeframe begins after potential flashover. In many cases this means that if sufficient ventilation is available the fire will spread significantly prior to fire service arrival. If sufficient ventilation is not available the fire will become ventilation limited and be very sensitive to initial fire service operations. The potential for fast fire propagation and rapidly changing fire conditions should be expected in the modern fire environment; but when arriving after eight minutes at a legacy fire, it would still be in the growth stage and less volatile.

Looking beyond fire development and to collapse, further hazards are highlighted. In the modern fire environment, after arriving at eight minutes, collapse is possible as soon as 90 seconds later. Firefighters may not be in the house yet or may be just entering to search for occupants. The legacy fire collapse hazard begins 40 minutes after arrival of firefighters. This allows for a significant amount of fire operations to take place while simultaneously monitoring the safety of the structure. Figure 27 shows the standard response times for different types of fire departments and the location on the fire development timeline at which they arrive in both the modern and legacy fires. (Kerber 2012, p. 16-17)

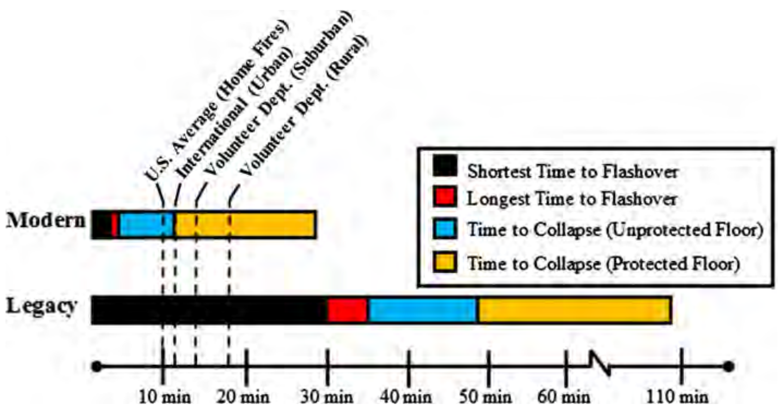


Figure 27 [SIC]: Fire service arrival times versus fire development (Kerber 2012, p. 17)

Local Customer Expectations

Public expectations are a critical consideration in providing any kind of government or public service. Governmental entities are established with checks and balances to ensure public expectations are met. Expectations on specific topics, such as response time, are perhaps the most difficult factor to establish when compared to the other sources for response time. There is much discussion in medical literature surrounding response times and to the effect (or not) of response times on mortality. What the medical literature often fails to consider when establishing conclusions based on mortality is quality of life. For instance, humans can sustain horrific injuries and survive for hours or even days without care. However, where does the element of pain and suffering and the mental aspect of receiving help enter into the response time equation? That is the dimension established by local customers, often referred to by the term "acceptable risk".

Explanation of Response Time Components

Cascade of Events

Figure 10 shows the sequence of an emergency. Certain intervals described, such as turnout time (the time it takes firefighters to get out of the station) and travel time, can be directly influenced by the department via station location and design, as well as response procedures (Figure 11). Other factors such as the alarm interval (call to 911) can be influenced through public education. The 911 center can influence the call processing time and transfer time (call triage and dispatch).

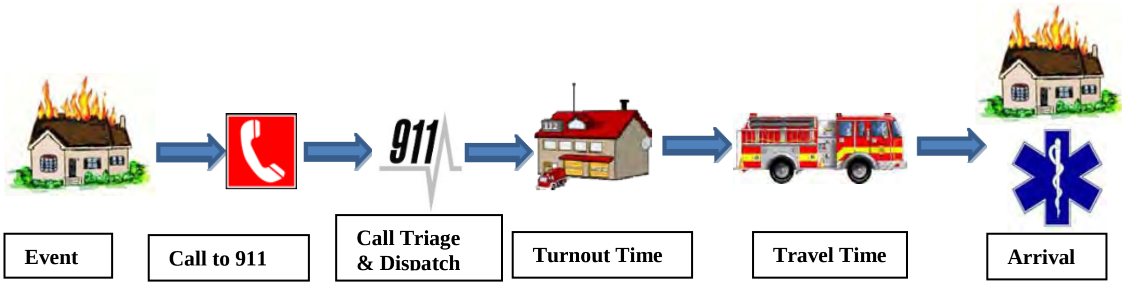


Figure 10: Sequence of an Emergency

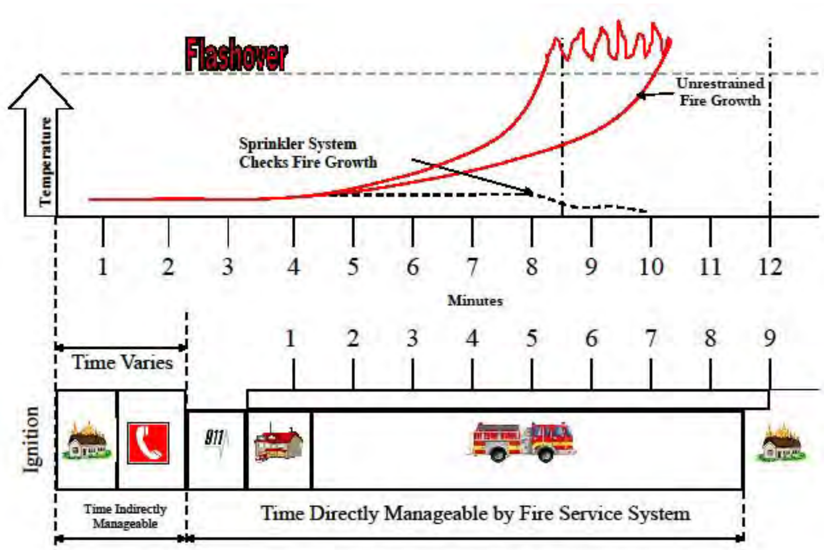


Figure 11: Fire Propagation Curve combined with the Sequence of an Emergency

The CFAI has defined response time elements as a cascade of events. NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments* and NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems* define the elements of the Cascade of Events (Figure 12).

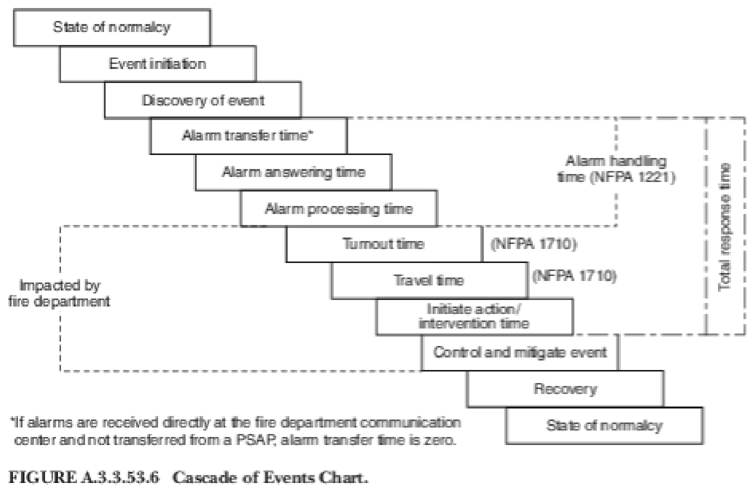


Figure 12: Cascade of Events (NFPA 1710, p. 18/A.3.3.53.6, 2016)

Total Response Time

The total response time is "the time interval from the receipt of alarm at the primary PSAP to when the first emergency response unit is initiating action to control the incident." The total response time consists of several components (Figure 12):

- Alarm transfer time
- Alarm answering time
- Alarm processing time
- Turnout time
- Travel time
- Initiating action/intervention time (NFPA 1710, p.8/3.3.53.6, 2016)

Alarm Transfer Time

The alarm transfer time is "the time interval from the receipt of an emergency alarm at the public service answering point (PSAP) until the alarm is first received at the fire department communication center." Alarm transfer time is generally under the control of the PSAP/911 communications center. (NFPA 1710, p.8/3.3.53.4, 2016)

Alarm Answering Time

The alarm answering time is "the time interval that begins when the alarm is received at the fire communication center and ends when the alarm is acknowledged at the fire communication center." Alarm answering time is generally under the control of the communications center that supports the fire/EMS department. (NFPA 1710, p.8/3.3.53.1, 2016)

Alarm Processing Time

The alarm processing time is "the time interval from when the alarm is acknowledged at the fire communication center until response information begins to be transmitted via voice or electronic means to emergency-response facilities (ERFs or fire stations) and emergency-response units (ERUs or fire apparatus). Alarm answering time is generally under the control of the communications center that supports the fire/ems department. (NFPA 1710, p.8/3.3.53.3, 2016)

Alarm Handling Time

The alarm handling time is the "time interval from the receipt of the alarm at the primary PSAP until the beginning of the transmittal of response information via voice or electronic means to emergency response facilities or the emergency response units in the field." (NFPA 1710, p.8/3.3.53.2, 2016)

Turnout Time

Turnout time is "the time interval that begins when the emergency response facilities and emergency response units notification process begins by either an audible alarm or visual annunciation or both and ends at the beginning point of travel time. Turnout time is under the control of the fire/EMS department. (NFPA 1710, p.8/3.3.53.8, 2016)

Travel Time

Travel time is "the time interval that begins when a unit is enroute to the emergency incident and ends when the unit arrives at the scene." Travel time is the responsibility of the fire/EMS department, but often dependent on factors not in their control, like distance to the scene. (NFPA 1710, p.8/3.3.53.7, 2016)

Initiating Action/Intervention Time

The initiating action/intervention time is "the interval from when a unit arrives on the scene to the initiation of emergency mitigation." Initiating action/intervention time is under the control of the fire/EMS department. (NFPA 1710, p.8/3.3.53.5, 2016)

Response Time Guidelines

NFPA 1710, ISO, and CAFI (CSPE) use the same response time goals. The following are excerpts from NFPA 1710, 2016 ed.:

Service Delivery Objectives:

4.1.2.1 The fire department shall establish the following objectives:

(1) Alarm handling time to be completed in accordance with 4.1.2.3. (See below)

(2) 80 Seconds turnout time for fire and special operations response and 60 seconds turnout time for EMS response

(3) 240 seconds or less travel time for the arrival of the first arriving engine company at a fire suppression incident

(4) For other than high-rise, 480 seconds or less travel time for the deployment of an initial full alarm assignment at a fire suppression incident

(5) For high-rise, 610 seconds or less travel time for the deployment of an initial full alarm assignment at a fire suppression incident

(6) 240 seconds or less travel time for the arrival of a unit with first responder with automatic external defibrillator (AED) or higher level capability at an emergency medical incident

(7) 480 seconds or less travel time for the arrival of an advanced life support (ALS) unit at an emergency medical incident, where service is provided by the fire department provided a first responder with AED or basic life support (BLS) unit arrived in 240 seconds or less travel time.

4.1.2.3 Alarm Handling:

4.1.2.3.1 The fire department shall established a performance objective of having an alarm answering time of not more than 15 seconds for at least 95 percent of the alarms received and not more than 40 seconds for at least 99 percent of the alarms received by NFPA 1221.

4.1.2.3.1.1 Any call not answered within 20 seconds shall be routed to a secondary answering (alternate) center if the primary center is full. Alarm should sound if a call is not answered (not processed, just answered) within 60 seconds.

4.1.2.3.2 When the alarm is received at a public safety answering point (PSAP) and transferred to a secondary answering point or communication center, the agency responsible for the PSAP shall establish a performance objective of having an alarm transfer time of not more than 30 seconds for at least 95 percent of all alarms processed, as specified by NFPA 1221.

4.1.2.3.3 The fire department shall establish a performance objective of having an alarm processing time of not more than 64 seconds for at least 90 percent of the alarms and not more than 106 seconds for at least 95 percent of the alarms, as specified by NFPA 1221.

4.1.2.4 The fire department shall establish a performance objective of not less than 90 percent for the achievement of each turnout time and travel time objective specified in 4.1.2.1.

Fractile Measurement

TFD uses fractile response time measurement to measure performance benchmarks. The department's benchmarks mirror those found in NFPA 1710, ISO, and CFAI (CSPE). Fractile response time measurement shows the percentage of responses to which the fire department arrives within a certain amount of time.

In the past, TFD and many other fire and EMS organizations have used average response times. The issue with average response times is that an agency can show an average response time, but the process of averaging can hide what is really happening. For example, if the department had an average response time of six minutes, it is mathematically possible that half of the responses would take less than six minutes and half more than six minutes, which would be poor performance. Figure 13 shows the 2015 average response times for each fire station. Each station has an average response time of less than six minutes. However, when one looks at the fractile measure of performance, TFD is not meeting its performance goals (Figure 14).

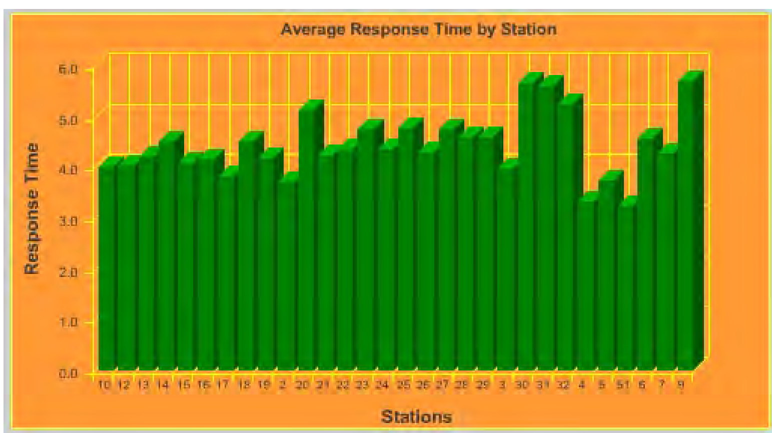


Figure 13: 2015 Average Response Times by Tulsa Fire Stations

Time Range	# of Incidents	% of Incidents	Percentile
0.0 - 0.9	1265	2.7%	2.7%
1.0 - 1.9	1676	3.5%	6.2%
2.0 - 2.9	6435	13.5%	19.7%
3.0 - 3.9	11961	25.1%	[illegible]
4.0 - 4.9	11726	[illegible]	[illegible]
5.0 - 5.9	7253	15.2%	84.7%
6.0 - 6.9	[illegible]	7.4%	92.1%
7.0 - 7.9	1670	3.5%	95.6%
8.0 - 8.9	848	1.8%	97.4%
9.0 - 9.9	429	0.9%	98.3%
Greater than 10	805	1.7%	100.0%
Grand Total	47613	100.0%	100.0%

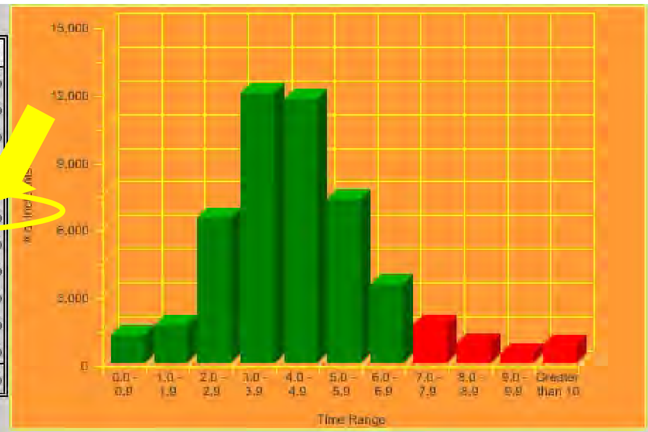


Figure 14: 2015 TFD Fractile Response Times

One of the department's performance goals, or Key Performance Indicators (KPI), is to arrive on scene within six minutes 90% of the time (from time of 911 call). The department's fractile response time performance has been decreasing for some time. Figure 15 shows the department's performance with respect to the six minute response time KPI.

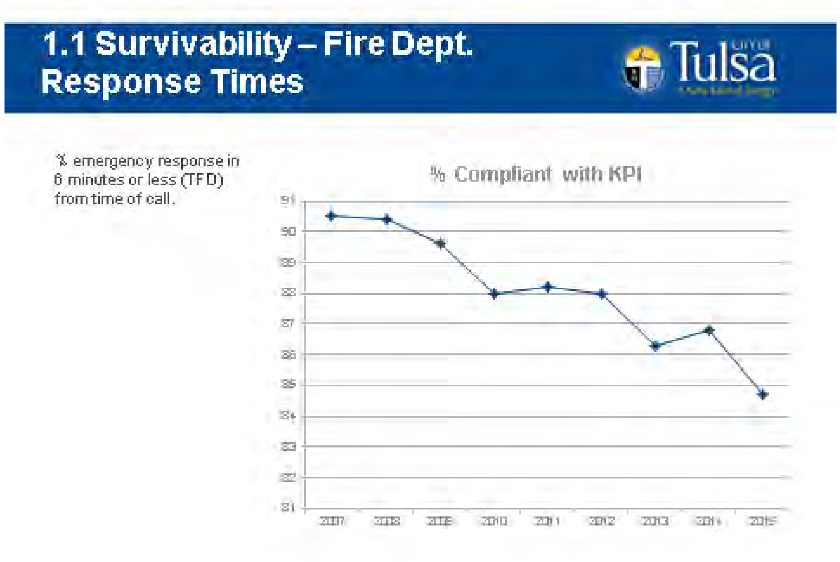


Figure 15: TFD Six Minute Response Time Performance

Response Mode (Emergency/Non-Emergency)

TFD's statistics with regard to response times consider only emergency incidents. The determination of which response mode to use (emergency/hot or non-emergency/cold) is made based on one of two sources. For medical calls, the determination is made by OMD based on the call's MPDS code. For all other calls, this determination is a function of fire department policy. In 2007, the department considered each call type and researched the risk versus benefit for responding emergency status. As a part of this research, a non-emergency response policy was developed for certain types of calls (Figure 16). The policy was first issued as an Administrative Order and was then incorporated into the department's Emergency Operating Guidelines in 2009.

300.8.1 Non-Emergency Response Policy:

It is the policy of the TFD to respond without lights and sirens, obeying all traffic laws, whenever it has been determined that a true emergency does not exist.

The FAO has an index of call types that have been coded as non-emergency responses. On dispatch, the FAO will indicate to the fire company that "this call has been coded as a non-emergency response."

Officers have the ultimate authority to determine if a call warrants an emergency or non-emergency response based on an evaluation of the information available.

When multiple resources are committed to an assignment, the IC may choose to downgrade the response of later arriving companies if conditions warrant.

Call Type	***Assignment***	***Hot/No***
Animal Locked in Car	1 Company	NO
Assist TPD, EMSA, OHP, TCSO	1 Company	NO
Assist citizen	1 Company	NO
BFA: School/Daycare/THA	2E/1L – 1st E Hot, Rest NO	Hot/NO
RFA	1Engine	NO
CO – No Symptoms	1 Ladder	NO
Elevator Rescue – No Medical	1E/1L	NO
Fluid Spill	1 Company	NO
Investigate (Smoke Detector/Odor of Smoke)	1 Company	NO
Alert 1 – Jones	1 Engine	NO
Assist w/Lifting	1 Company	NO
Assist w/Lifting w/Injury	1 Company	Hot
Natural Gas Leak	1 Engine or Quint/Hazmat	Hot
Shut Off Water	1 Ladder	NO
Transformer	1 Engine	NO

Figure 16: TFD Non-Emergency Response Policy (EOG 300.8.1)

Fire Station Location Methodologies

Fire departments, insurance interests, and consulting firms have used a variety of methods to locate fire stations. During the early period of organized fire protection (1900 to mid-century), fire station spacing recommendations placed stations as close as three-quarters of a mile from each other in downtown districts. Over time the spacing requirements for fire stations have changed due to a variety of factors such as the onset of urban sprawl, improvements to road infrastructure, the implementation of fire codes, and improvements in fire apparatus and firefighting techniques. One of the earliest standardized methodologies used circles with three mile diameters to depict coverage radius. Figure 17 shows this methodology used in Tulsa (1993) for the "Comprehensive Resource Utilization Study of the Fire Department"[4].

[4] As a result of this study, Tulsa closed two downtown stations (Station 8 and Station 9) and a total of three downtown fire companies (Engine 8, Engine 9, and Ladder 1). Since this time, Fire Station 1 has been closed and the staffing was moved to another part of the city. Fire Station 7 was also moved eastward. The combination of these moves eliminated the historical legacy spacing and redeployed assets to better cover Tulsa. The remaining downtown stations (Stations 2, 4, and 5) are well placed when compared to the risk (See Evaluation of TFD Current Station Locations).

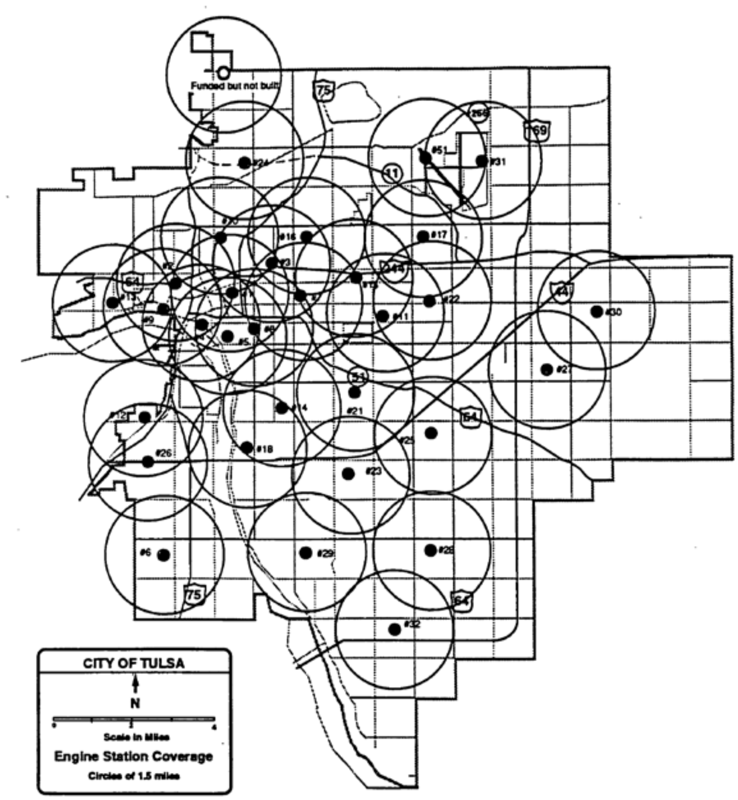


Figure 17: Consulting Firm's use of Circles for Tulsa Fire Station Spacing Determination (1993)

A more accurate station location methodology was developed using the concept of taxicab geometry (Figure 18)[5]. Taxicab geometry simulated the travel of a vehicle on a network of roadways. This led to the most commonly accepted methodology of using a diamond shape overlaid on a map to determine the approximate coverage area for a fire station (Figure 19)[6]. The standard diamond size is three miles wide, which is based on a four minute travel time goal. Through calculation and experience, this methodology has been determined to produce the desired travel time. The diamond methodology has returned reliable results for many jurisdictions. Theoretically, when using this model a city's fire station arrangement should look similar to a chain link fence (Figure 20). The geography of Tulsa is relatively flat, and the streets of the city have been built on a square grid, lending itself to the diamond methodology. Figure 21 shows the current layout of Tulsa fire stations when overlaid with three mile diamonds.

[5] The modern concept of Taxicab Geometry references the 1987 book by Eugene F. Krause.
[6] The same concept, when later combined with actual city street layouts and varying street speeds led to polygons which show the most accurate depiction of a fire station's coverage area for a given pre-determined response time.

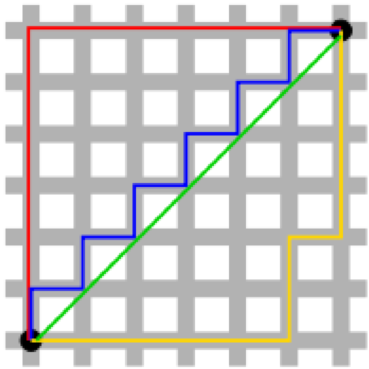


Figure 18: Taxicab Geometry (Graphic https://en.wikipedia.org/wiki/Taxicab_geometry)

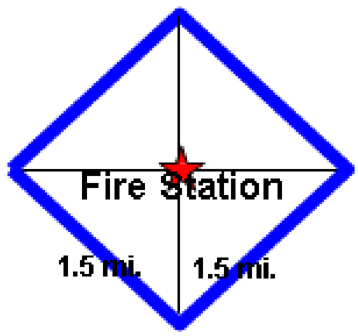


Figure 19: Standard 3 Mile Diamond for Fire Station Spacing

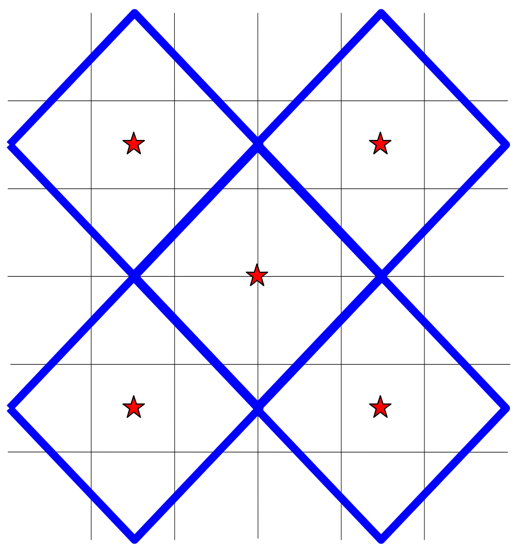


Figure 20: “Chain Link Fence” Arrangement of Fire Stations using Three Mile Diamond Spacing

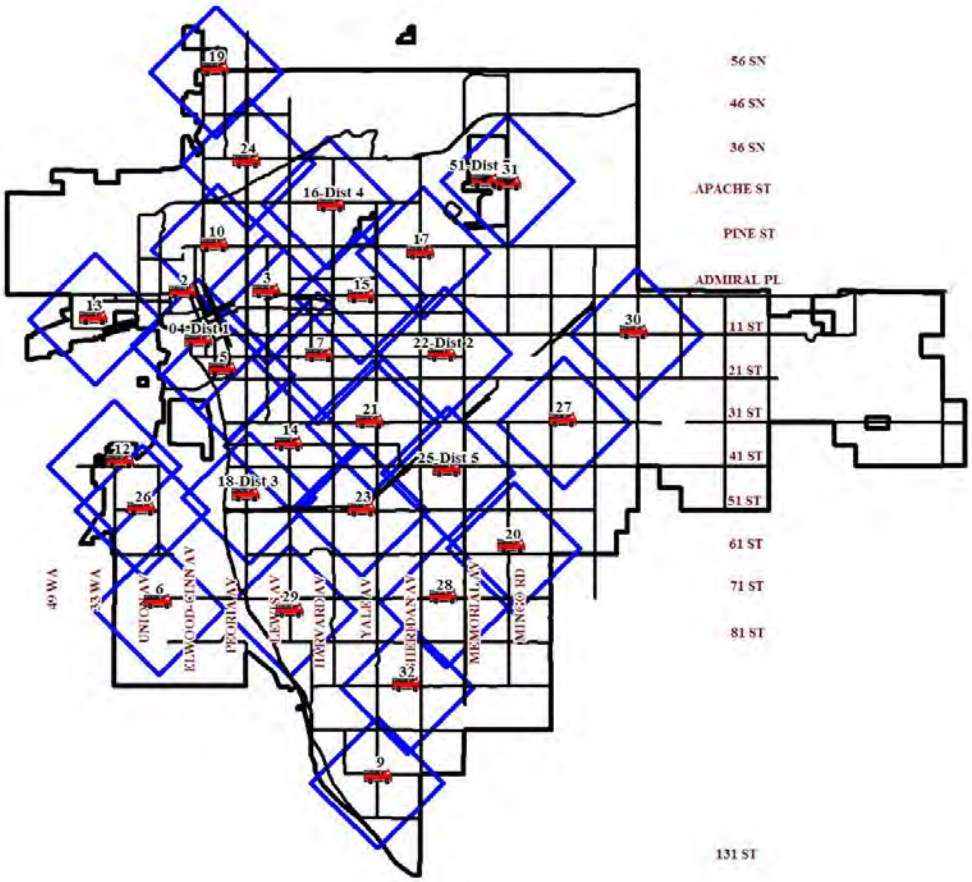


Figure 21: Three Mile Diamond Spacing of 2017 Tulsa Fire Stations

Use of three mile diamonds is a mainstay and first step for TFD planning efforts. However, if the department relied solely on this methodology, Tulsa would require an additional 15 fire stations to cover the city (Figure 22). This is both unrealistic and unnecessary. Somewhere, there must be a method to objectively and systematically consider risk factors. The key to such a methodology is reproducibility and removing as much subjectivity as possible. This statement must be qualified in that the final step of any fire station location effort is a subjective look by subject matter experts, such as the TFD Deployment Committee. Subject matter experts must be relied upon to add the input of experience that an objective methodology cannot give.

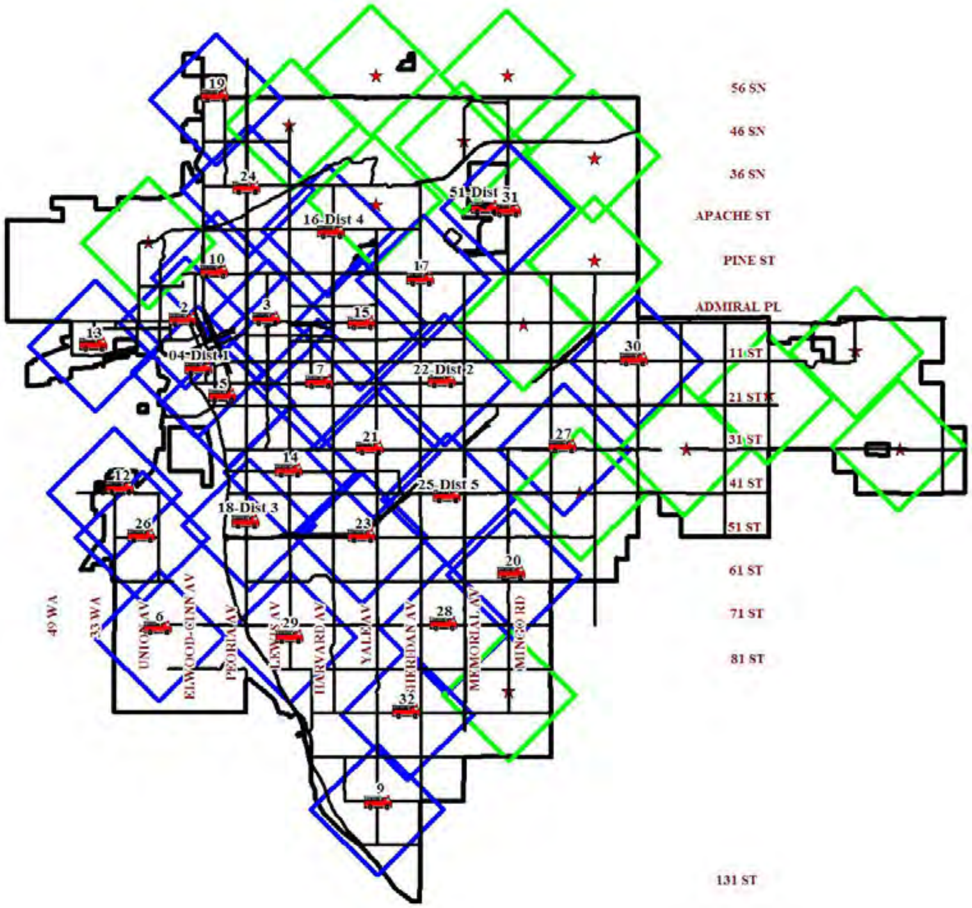


Figure 22: City of Tulsa Coverage Relying Solely on Three Mile Diamonds

TFD Methodology for Fire Station Location

Modern GIS capabilities allow for a more sophisticated fire station location methodology that uses the concept of the three mile diamond coupled with the definition of risk (See *Appendix C – TFD First-In Risk Calculation Methodology*). The ability to calculate risk ensures that stations are not spaced too closely or too far apart based on the attributes of the response area. Since 2000, the department has used such a methodology to work on realigning historic fire station coverage in Tulsa as well as address the sparse fire station spacing around the perimeter of the city. The TFD Resource Allocation Methodology uses life safety as its primary consideration. Risk is defined as:

Risk = Probability + Severity + Failures

Risk Inputs

1. Probability of an incident – population density in a fire station's area. This measure considers residential population and accounts for either homes or apartments. It considers high-rise residential development by identifying residents that are living vertically instead of horizontally. The data source for this measure is the United States Postal Service data on single- and multi-family dwelling units. This is mainly a consideration of static population.

2. Severity - actual number of incidents within an existing or proposed fire station's first in area. In addition to identifying the number of actual incidents, this element accounts for transient population (which drives the number of incidents) in an area such as a shopping district or downtown district.

3. Failures - ratio of runs that the department cannot make within four minutes travel time in an existing or proposed fire station's area. This factor takes into account travel distance and provides adjustment for how often a fire station has to travel a long way to an incident. It allows some areas to exceed the limits of a diamond pattern in sparsely populated or low demand areas.

Experience has shown that this model lends itself to the following fire station spacing:

- Metropolitan downtown spacing – closely spaced stations with overlapping coverage – 1 to 1.5 driving miles between stations
- Urban – standard spacing – three driving miles between stations
- Suburban - low density spacing – up to four driving miles between stations depending on risk
- Rural – up to 10 driving miles between stations

Steps

1. Identify assumptions and/or parameters.
2. Determine risk of current station configuration.
3. Identify the norm, or acceptable risk.
4. Identify areas of high or low risk.
5. Determine which areas of high or low risk need to be addressed. For instance, stations on the perimeter of the city will often cover large areas that are sparsely populated and experience fewer incidents than those in the urban core. It is acceptable and expected that these stations will have a lower risk than the norm.
6. Use standardized diamonds to "guess" the location of station additions or moves to address high or low risk areas based on the factor that is causing the high or low risk. In this step, the goal is to propose the minimum number of additions or moves of fire stations to address the issues. It requires a strategic look by expert eyes that know the true dynamics of each station to make these determinations. During this step, several configurations will be considered. At times, test scenarios will be run to determine negatives.
7. Identify risk changes for each scenario created in step above.
8. Evaluate the risk changes and adjust, run more scenarios as necessary.
9. Once a near-final proposal is produced, the subject matter experts must take a final look at the proposal using a standardized list of considerations.

Tulsa Fire Department Subjective/Expert Considerations

- Future development (growth trends and/or future growth trends, land ownership/intention)
- Target hazards
- Expressway coverage
- Demographics/socioeconomic
- Insurance rating – most direct cost savings for citizens
- Other factors or intricacies by subject matter expert input

Evaluation of Current TFD Station Locations

Current Risk

Figure 23 shows the current location of fire stations with incidents and three mile diamonds overlaid. There are several items of note when consideration is given to the diamond coverage pattern:

- Midtown and north Tulsa look like the "chain link fence" described above.
- The downtown area of Tulsa has three stations in close proximity to each other.
- The west side has two stations in close proximity to each other.
- The stations on the south side of Tulsa are spaced farther apart than midtown, leaving gaps in four minute travel time coverage.
- The east side has large gaps in four minute travel time coverage.
- There are sparsely covered areas around the perimeter of the city. Certain perimeter areas are experiencing more incidents than others.

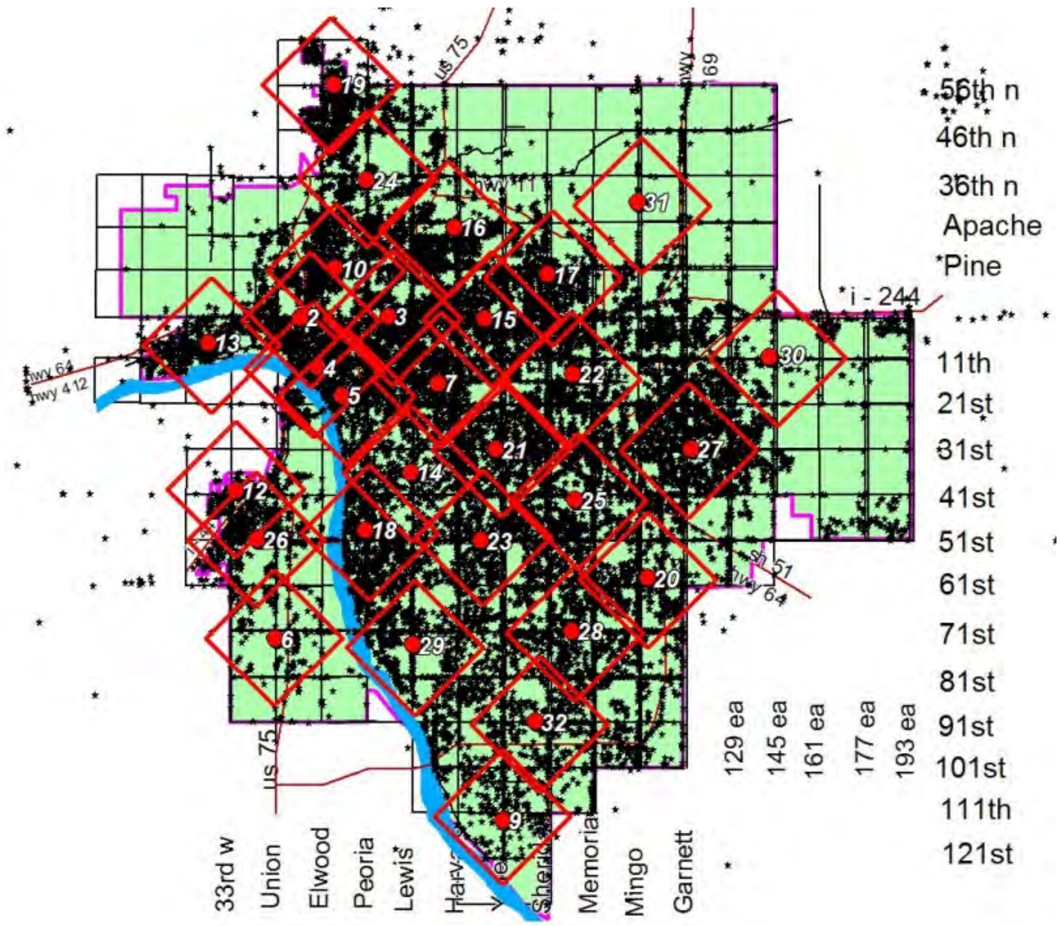


Figure 23: Current TFD Station Locations and Incidents with Three Mile Diamonds Overlaid

Figure 24 shows the same station configuration using the department's resource allocation methodology. Using this model, the norm or acceptable risk is the category with relative risk numbers 1.0 and 2.0. These areas are found throughout Tulsa. Station 21 is a good example of a perfect intersection of the three mile diamond and the application of risk (Risk Factor 1.75). In the case of Station 21, the two methodologies coincide (diamonds and risk). However, Station 4 has the same risk category as Station 21, but it has a much smaller coverage area. This is identified by the application of risk. Station 4 has a higher risk in a smaller area due to population density and number of runs.

Another example is Station 30, which covers a large area that is sparsely populated on its east side. Station 30 makes a comparable number of incidents to Stations 21 and 4; however, the risk evaluation allows it to have a greater coverage area.

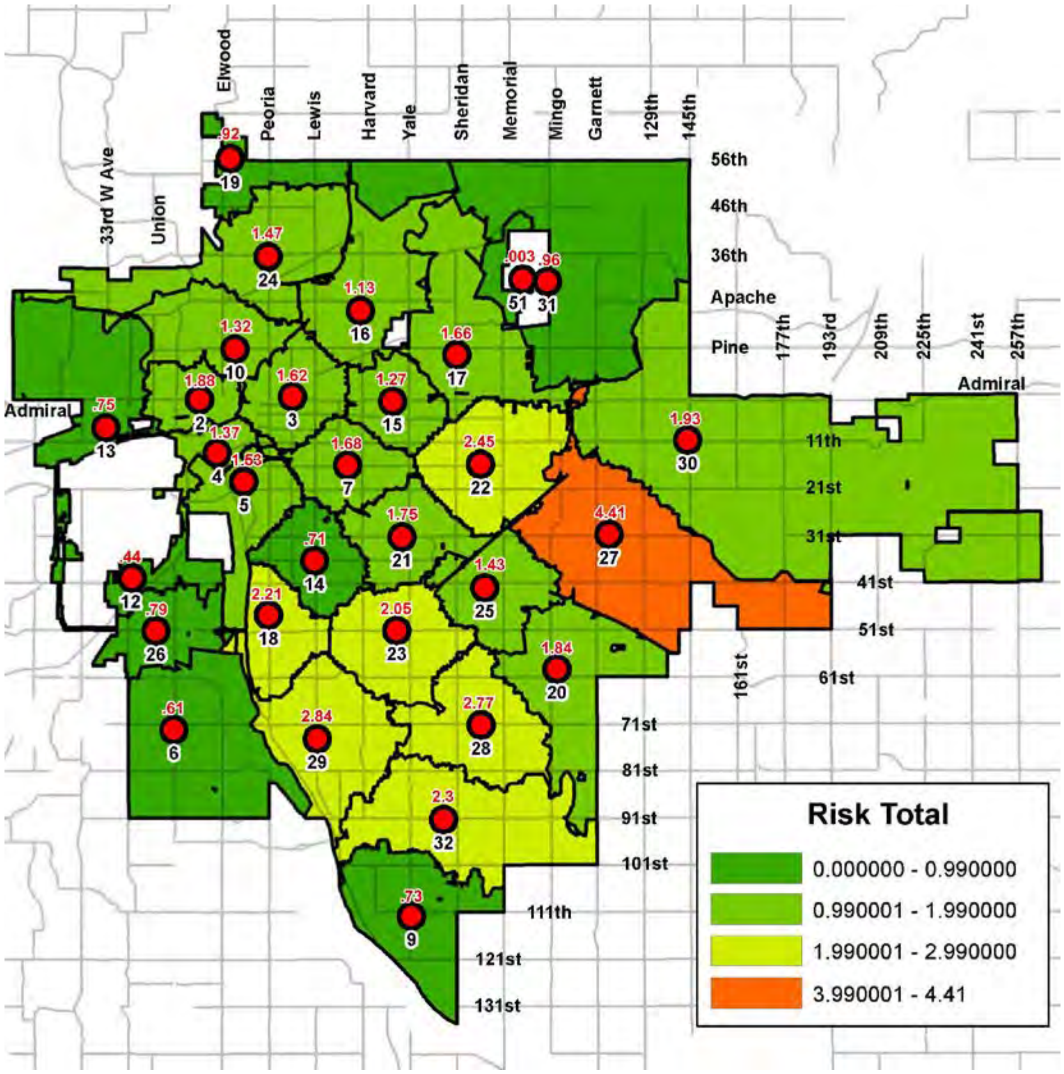


Figure 24: Risk Totals of Current TFD Stations

When considering the current location of fire stations in Tulsa and the combination of three mile diamonds and risk factors, the following influenced the scenarios that the Deployment Committee considered:

1. Eastside - Stations 22 and 27 have high risk totals and have large coverage areas. Station 27 has an extremely high risk total and a very large coverage area.
2. Downtown - Stations 2, 4, and 5 have relatively small coverage areas. Confirmation was needed that these stations are appropriately spaced.
3. Midtown - Station 14, a midtown station, has a low risk total and is closely spaced to Station 18.

4. Southside - Stations 18, 23, 28, 29, and 32 have a high risk total. Among these, Stations 28, 29, and 32 have very large coverage areas.
5. Westside - Stations 12 and 26 are closely spaced and each has a low risk total.

Scenarios

The Deployment Committee considered a total of 16 scenarios. The following scenarios were considered:

EAST
Scenario 1:
New Station 33 at 4800 S. 129th E. Ave.

Scenario 2:
New Station 34 at 10400 E. Admiral Pl.

Scenario 3:
New Station 33 at 4800 S. 129th E. Ave.
Move Station 27 to 10400 E. 31st St.

Scenario 4:
New Station 33 at 4800 S. 129th E. Ave.
New Station 34 at 10400 E. Admiral Pl.
Move Station 27 to 10400 E. 31st St.

DOWNTOWN
Scenario 5:
Move Station 2 to 1500 W. Apache St.

Scenario 6:
Remove Station 2

Scenario 7:
Remove Station 5

MIDTOWN AND SOUTH
Scenario 8:
Remove Station 14

Scenario 9:
Move Station 18 to 5600 S. Peoria Ave.

Scenario 10:
Move Station 23 to 5900 S. Yale Ave.

Scenario 11:
Move Station 18 to 5600 S. Peoria Ave.
Move Station 23 to 5900 S. Yale Ave.

WEST
Scenario 12:
Remove Station 12

Scenario 13:
Move Station 12 to 8400 S. Mingo Rd.

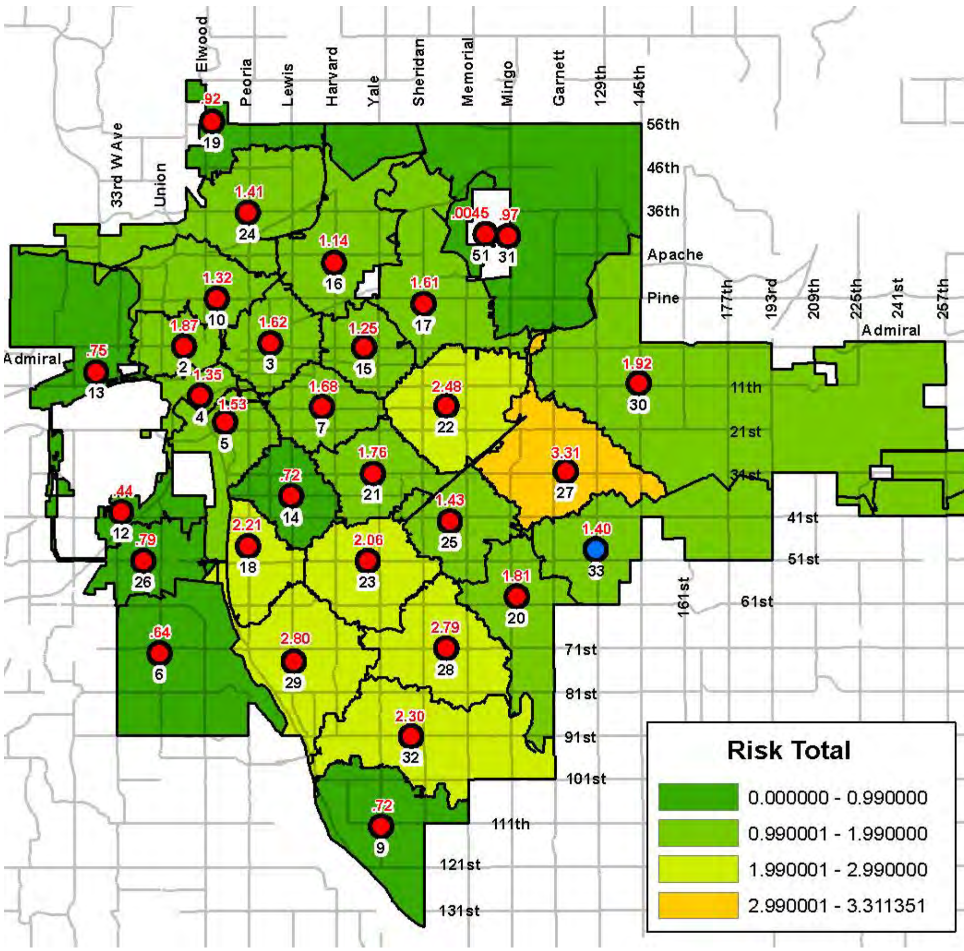
CITYWIDE
Scenario 14:
Move Station 2 to 1500 W. Apache St.
New Station 33 at 4800 S. 129th E. Ave.
New Station 34 at 10400 E. Admiral Pl.
Move Station 12 moved to 8400 S. Mingo Rd.
Move Station 18 to 5600 S. Peoria Ave.
Move Station 23 to 5900 S. Yale Ave.
Move Station 27 to 10400 E. 31st St.

Scenario 15:
New Station 33 at 4800 S. 129th E. Ave.
New Station 34 at 10400 E. Admiral Pl.
Move Station 12 moved to 8400 S. Mingo Rd.
Move Station 18 to 5600 S. Peoria Ave.
Move Station 23 to 5900 S. Yale Ave.
Move Station 27 to 10400 E. 31st St.

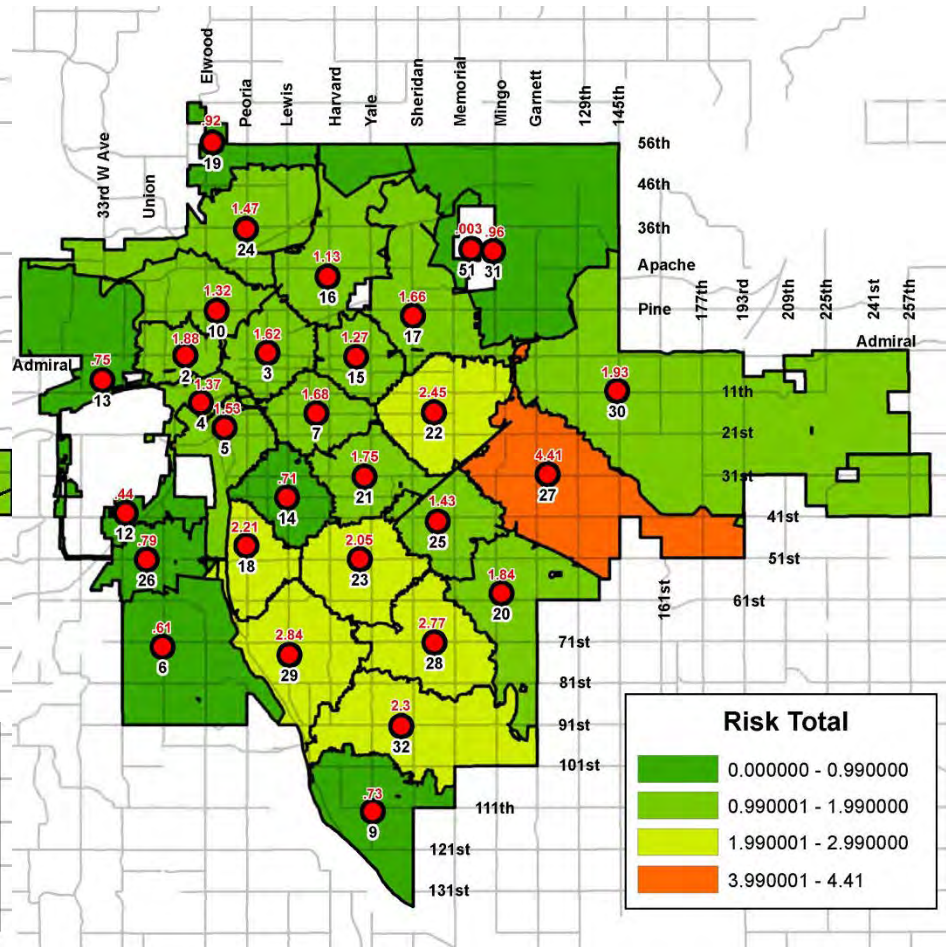
Scenario 16:
New Station 33 at 4800 S. 129th E. Ave.
New Station 34 at 10400 E. Admiral Pl.
Move Station 18 to 5600 S. Peoria Ave.
Move Station 23 to 5900 S. Yale Ave.
Move Station 27 to 10400 E. 31st St.
New Station 35 at 8400 S. Mingo Rd.

Fire Station Location Scenarios

Scenario 1 (EAST)



New Station 33 at 4800 S. 129th E. Ave.



Current Fire Stations

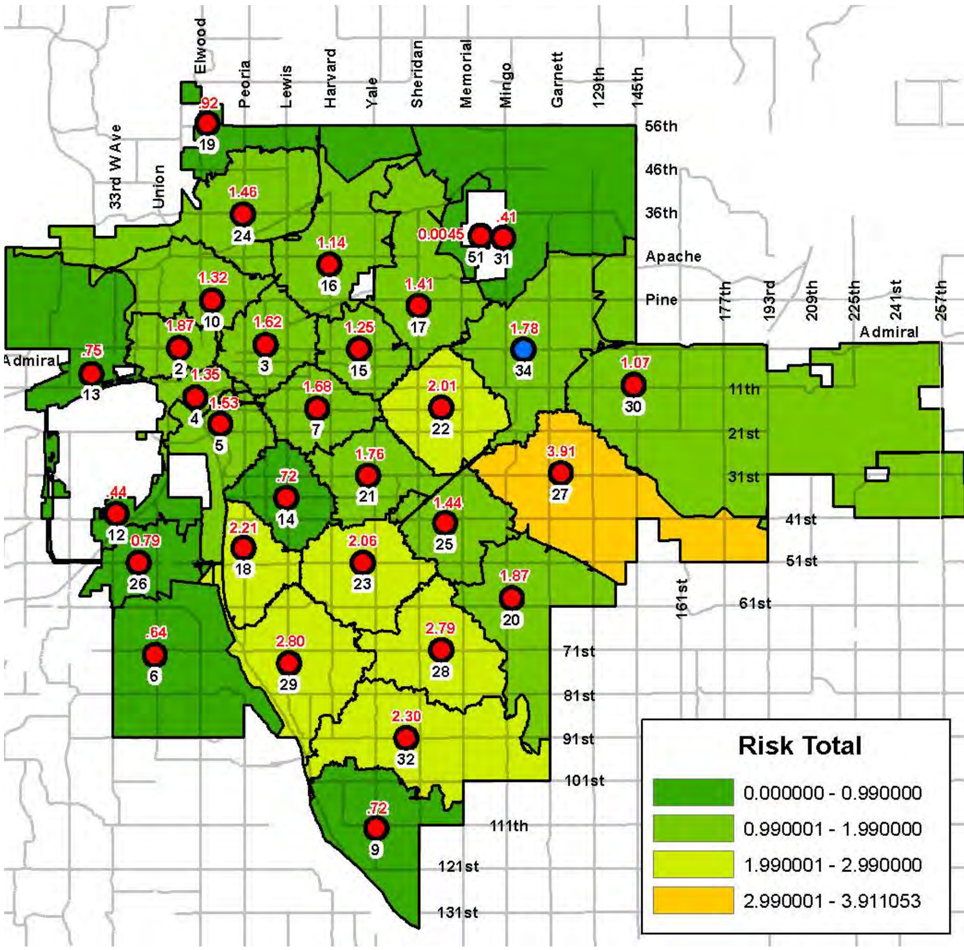
Scenario 1 Discussion:

Scenario 1 considers placement of one of the fire station additions/moves to alleviate the highest risk area in Tulsa. This area generally ranges from is from 11th Street south to 51st Street from Memorial to 145th E. Ave. Placement of a fire station in this area achieves an immediate risk reduction in Station 27's first-in area. Subsequent scenarios consider the other moves/additions needed to bring this area of the city close to an acceptable risk level.

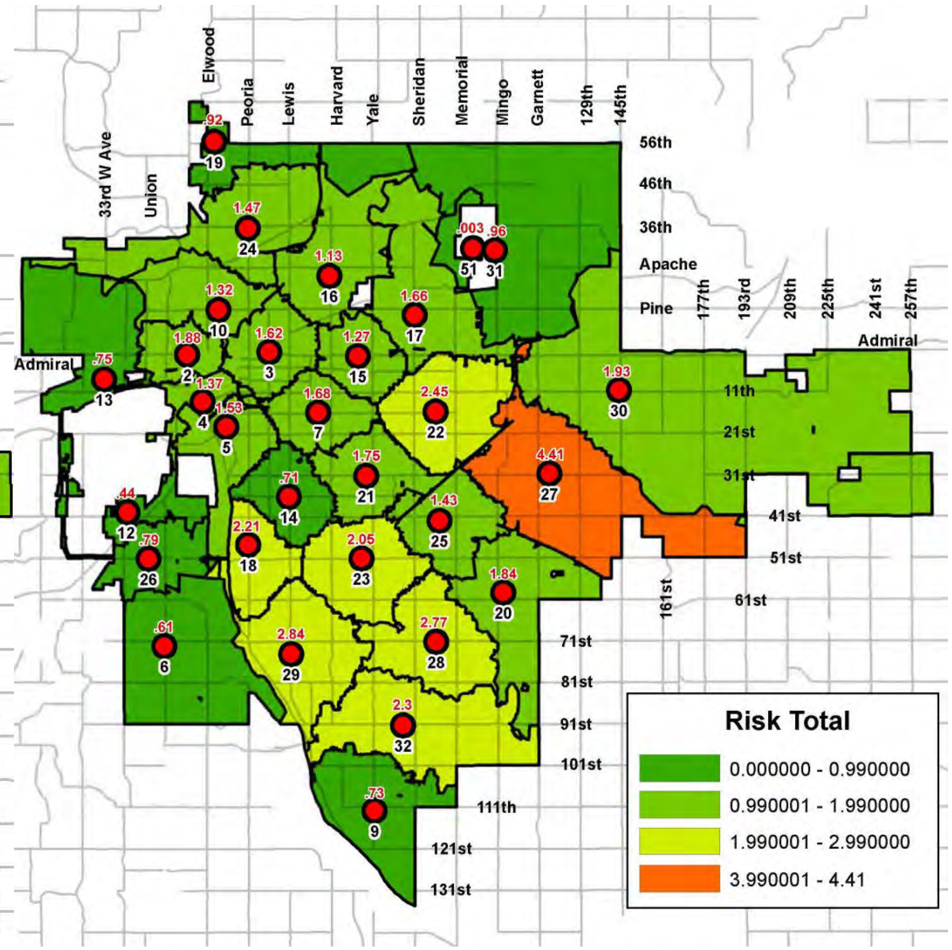
Scenario 1 specifically considers the placement of a new fire station funded in a 2006 General Obligation Bond. Based on the 2000 TFD Resource Allocation Report, this station, originally termed as "Station 8", was intended to be placed at 12500 E. 41st Street in conjunction with moving Station 27 to 10400 E. 31st. The original location would still be a valid, if not preferred location. However, since the 2000 report, the City of Tulsa annexed 13 square miles east of 193rd E. Ave. Subsequent attempts have been made to move the location of the station proposed for 12500 E. 41st as far east as 177th E. Ave for insurance rating purposes caused by home density outside of five driving miles from a Tulsa fire station. By geography alone, more than one station will be needed in far eastern area of Tulsa in the future pending development trends. However, the number of incidents and population density do not support a fire station in this area at this time.

Much time as passed without resolution; however, the best solution for the placement of Station 8, which has been re-designated as Station 33 appears to be moving it approximately one mile east on 41st Street from its original intended location. The risk figures above place the station at 4800 S. 129th E. Ave. After review by subject matter experts, the location has been adjusted to approximately 13500 E. 41st St. This was done in consideration of insurance rating requirements for the current and anticipated areas with the most population north and south of 41st St and eastward to 193rd E. Ave. This recommendation is also made in consideration with plans for future Broken Arrow fire stations. Geographically this area of the city is long and thin, so there will inevitably be the need to place facilities near city borders. While there is no intent to erode the individual services of either city, consideration must be given to preventing two cities from duplicating services (i.e., placing fire stations right next to each other on either side of a city border). This discussion then drives the recommendation for increased coordination in the areas of radio and dispatch technology between Tulsa and Broken Arrow as well as coordination of equitable interagency response in this area.

Scenario 2 (EAST)



New Station 34 at 10400 E. Admiral Pl.



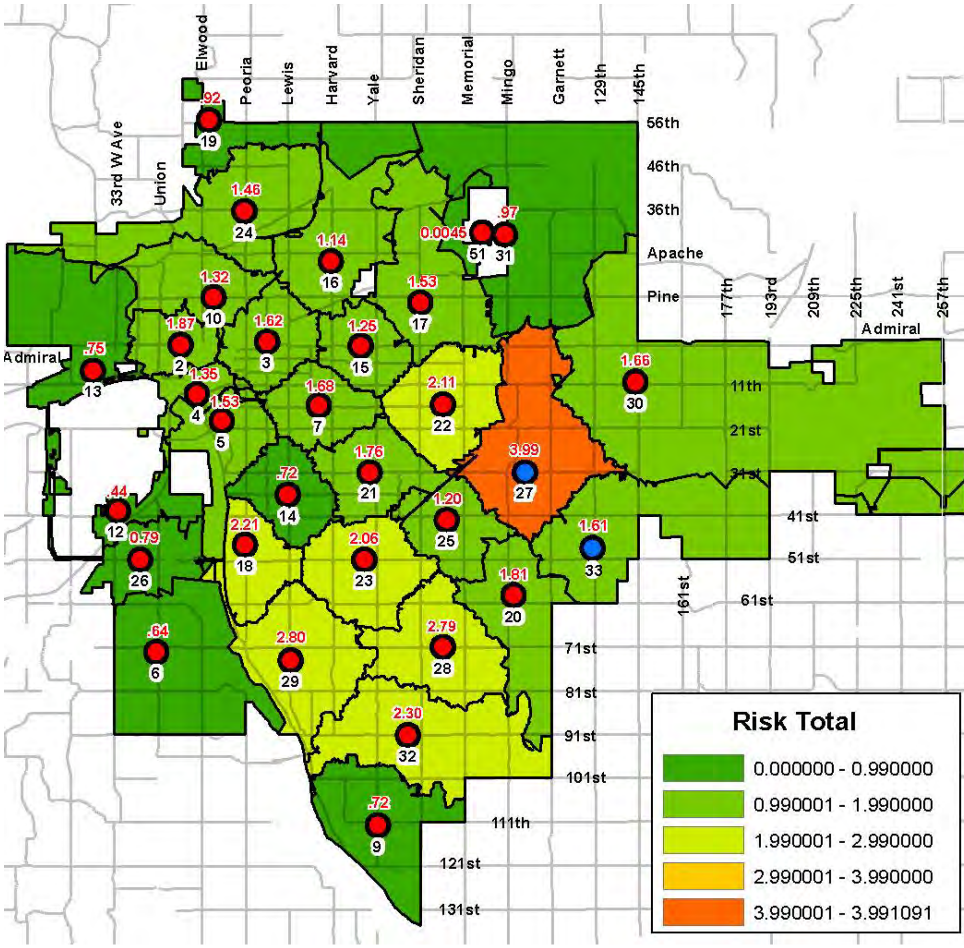
Current Fire Stations

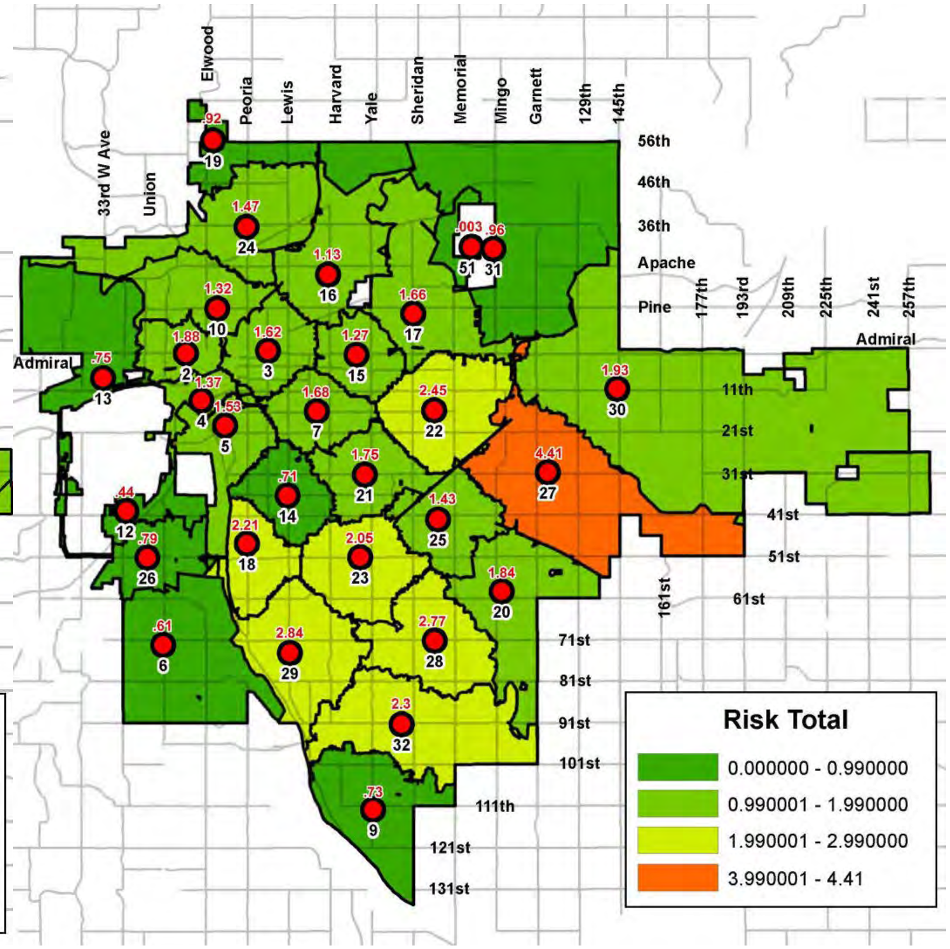
Scenario 2 Discussion

Scenario 2 considers placement of a Fire Station 34 at approximately 10400 E. Admiral Pl. This station has significant impact on the risk total in two of the higher risk first-in districts in Tulsa, Stations 27 and 22. Scenario 2 also considers a large spacing gap in this area that has approximately 1500 incidents each year that are outside of a four minute drive time (six minute total response time) from any fire station.

Construction of Station 34 is second in priority to Station 33.

Scenario 3 (EAST)





New Station 33 at 4800 S. 129th E. Ave.

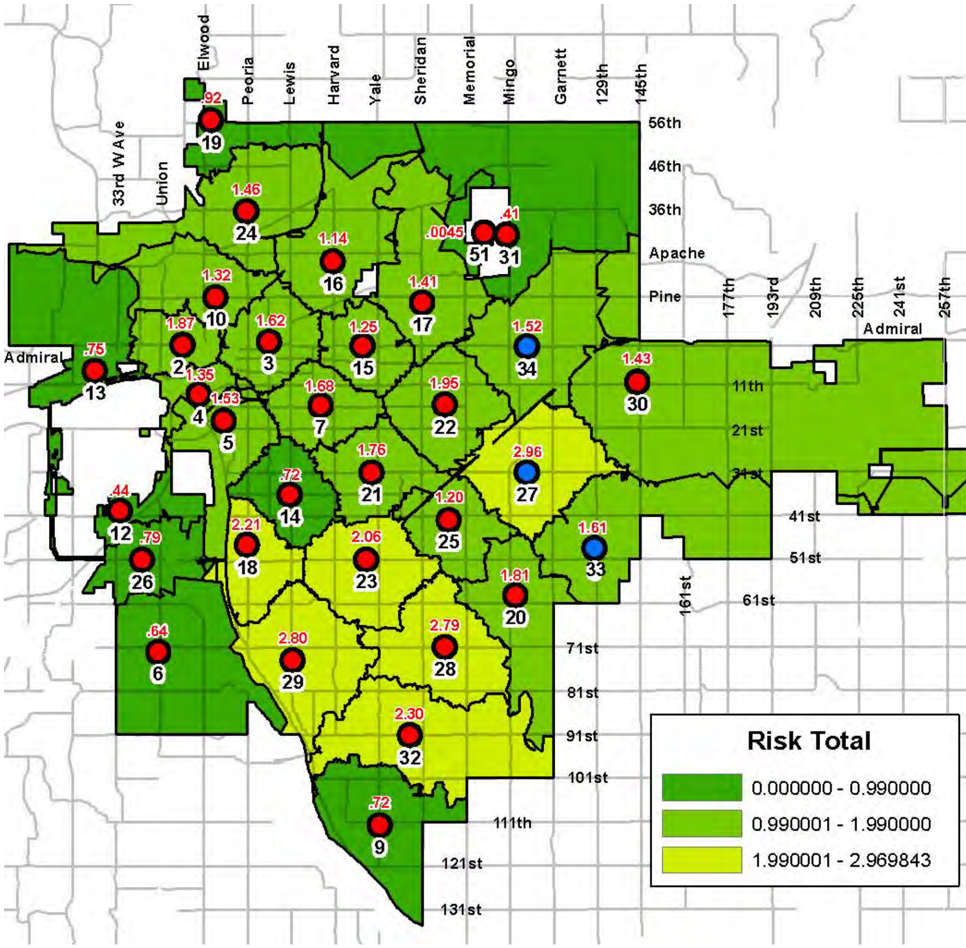
Move Station 27 to 10400 E. 31st St.

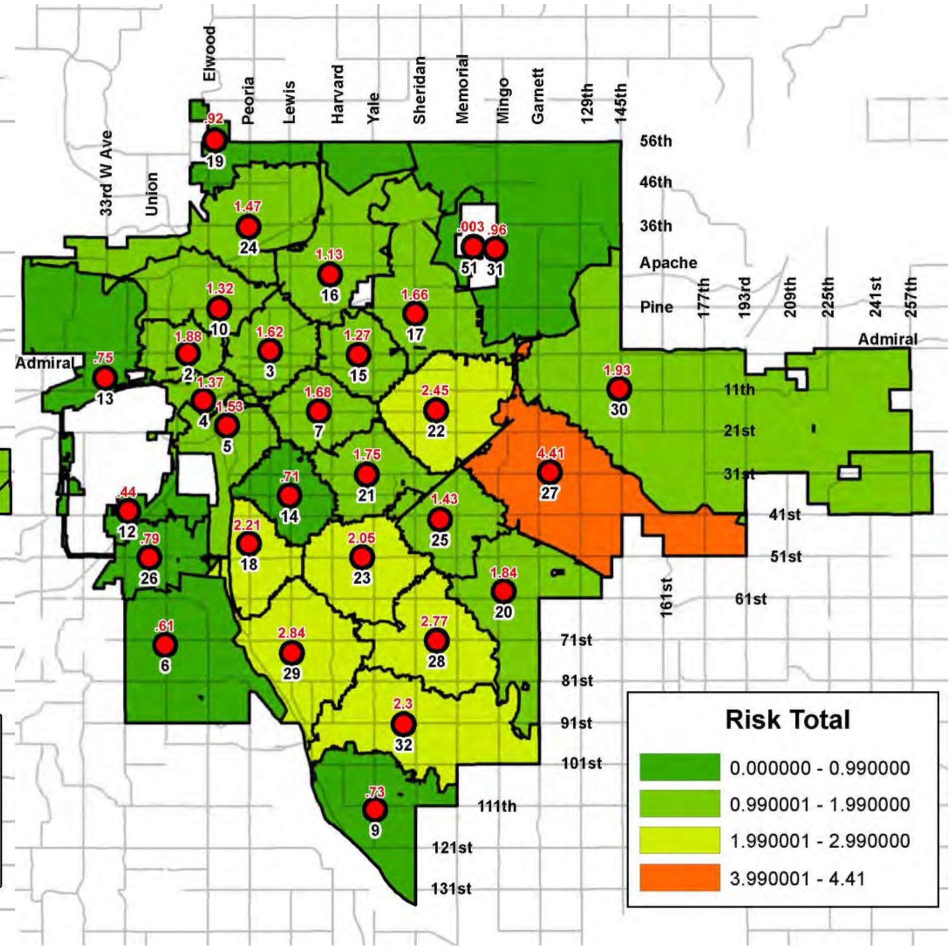
Current Fire Stations

Scenario 3 Discussion

Scenario 3 considers construction of new Station 33 as well as the subsequent move of Station 27 to adjust its spacing west. The combination of these two stations bring this part of the city more in line with spacing found in other populous areas of Tulsa. Comparing Scenario 3 and Scenario 4 shows that Station 27 should not be moved until both Stations 33 and 34 are in place. Moving Station 27 prior to building Station 34 will compound the high run volume issue currently experienced at Station 27.

Scenario 4 (EAST)





New Station 33 at 4800 S. 129th E. Ave.

Current Fire Stations

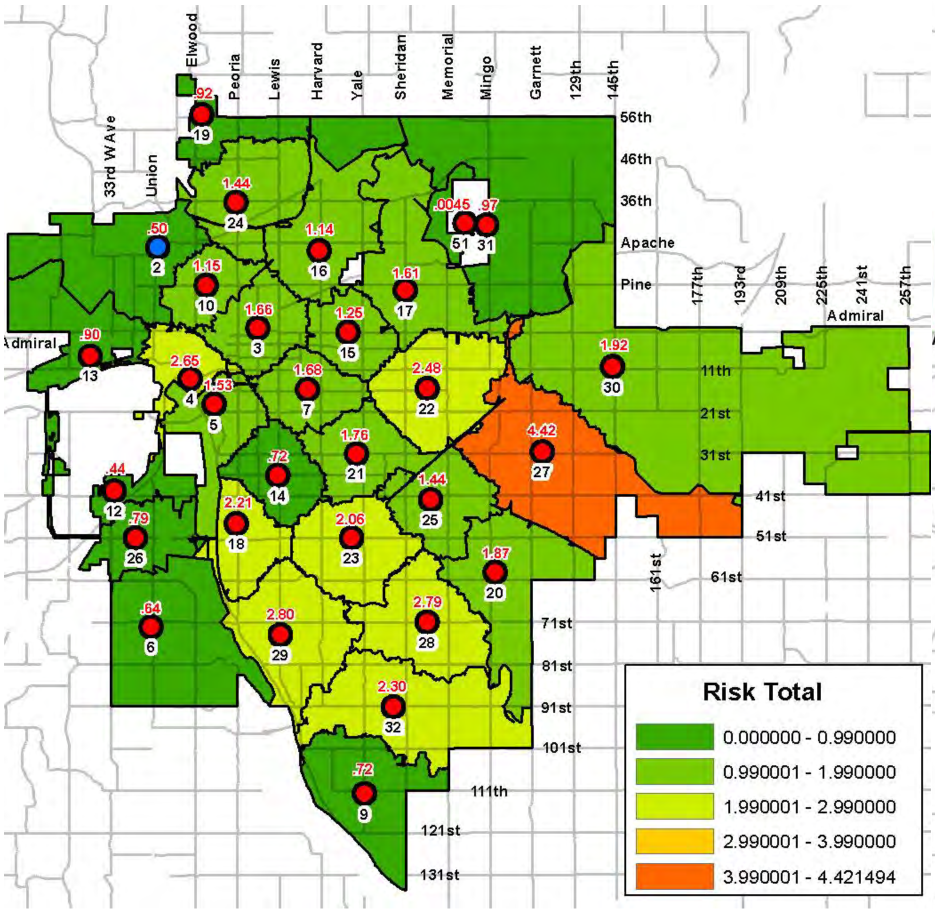
New Station 34 at 10400 E. Admiral Pl.

Move Station 27 to 10400 E. 31st St.

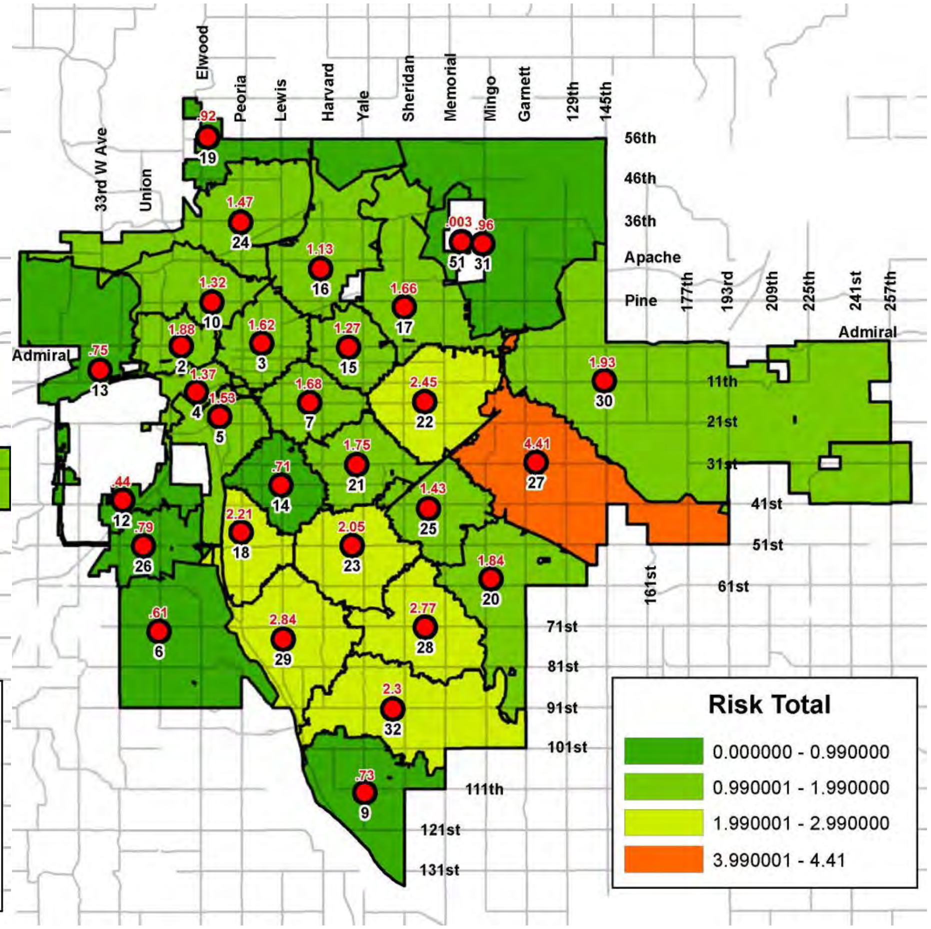
Scenario 4 Discussion

Scenario 4 is considered the near optimal solution for the highest risk corridor in east Tulsa. With Station 33 being currently funded, the addition of Station 34 and move of Station 27 should occur simultaneously. Construction of these stations is an immediate priority.

Scenario 5 (DOWNTOWN)



Move Station 2 to 1500 W. Apache St.



Current Fire Stations

Scenario 5 Discussion

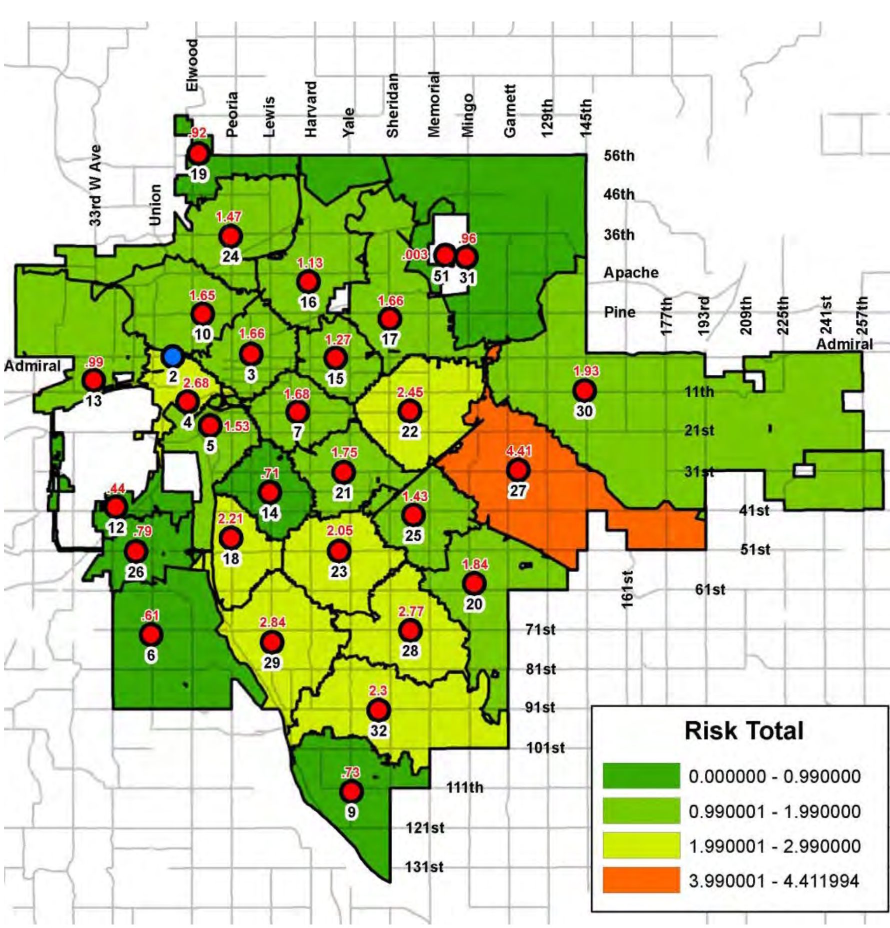
Scenario 5 considers the spacing of Station 2 in the downtown area. The department has repeatedly been scrutinized for the spacing of three downtown fire stations – Stations 2, 4, and 5. In general, the time period of the early 1960's through the mid- to late 1980's were considered "the war years" by the American fire service. Others refer to this as a time of "urban renewal," with a marked increase in building fires. The trend has now normalized and Tulsa is now generally and consistently experiencing the same level of fires and structure fires seen before this time. Hence, in somewhat recent history, the fire service has seen a decline in structure fires. This has fueled many discussions about the pertinence of fire department resources in many cities.

In 1966 Tulsa annexed 175% of its land area at the time and made its largest historical growth. The fire department saw a marked growth in the number of stations as a result. As fires declined in the urban core in the late 1980's and early 1990's and as the mission of the department changed, resources have been shifted away from downtown to adjust for population growth in the more suburban areas of the city. Since this time five fire stations have either been closed or moved from the downtown area.

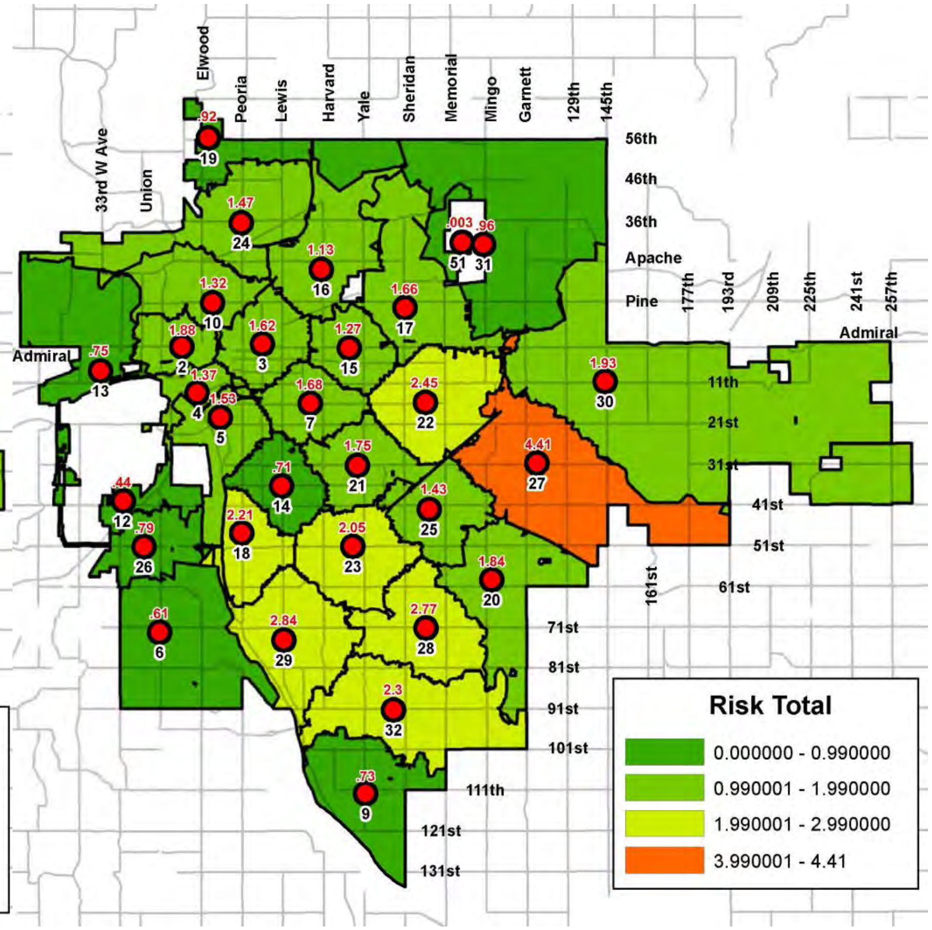
In recent times, Tulsa has seen a marked resurgence in both commercial and residential occupancy in the downtown area. The purpose of this study is to ensure a balance of resources. Downtown cores of cities have population that is vertical instead of horizontal, thereby compressing the size of fire station first-in areas. Fires in either high rise buildings or legacy construction downtown buildings require significantly more resources to control than single family dwelling fires or garden apartment fires. Figure 5 shows that downtown Tulsa still experiences the highest incident density in the city.

Scenario 5 also considered that the area north and west of downtown has a considerable gap in fire station spacing. An attempt was made to see the results of moving one of the commonly questioned stations out of downtown and use it to fill this gap. The risk results of this theoretical move show that this would not be a wise investment. First the proposed location would result in a fire station being built in an area with low demand. Second, vacating the current area covered by Station 2 would cause a significant increase in demand on Station 4. It should be noted that there is some concern about the current workload placed on Station 4, because it is a high volume station in its own right. In addition to that, it houses the technical rescue team for the entire city. Station 4 is also the location of the heavy-duty ladder company responding to downtown. Basically six personnel at any given time carry this load. Moving Station 2 only compounds this issue.

Scenario 6 (DOWNTOWN)



Remove Station 2

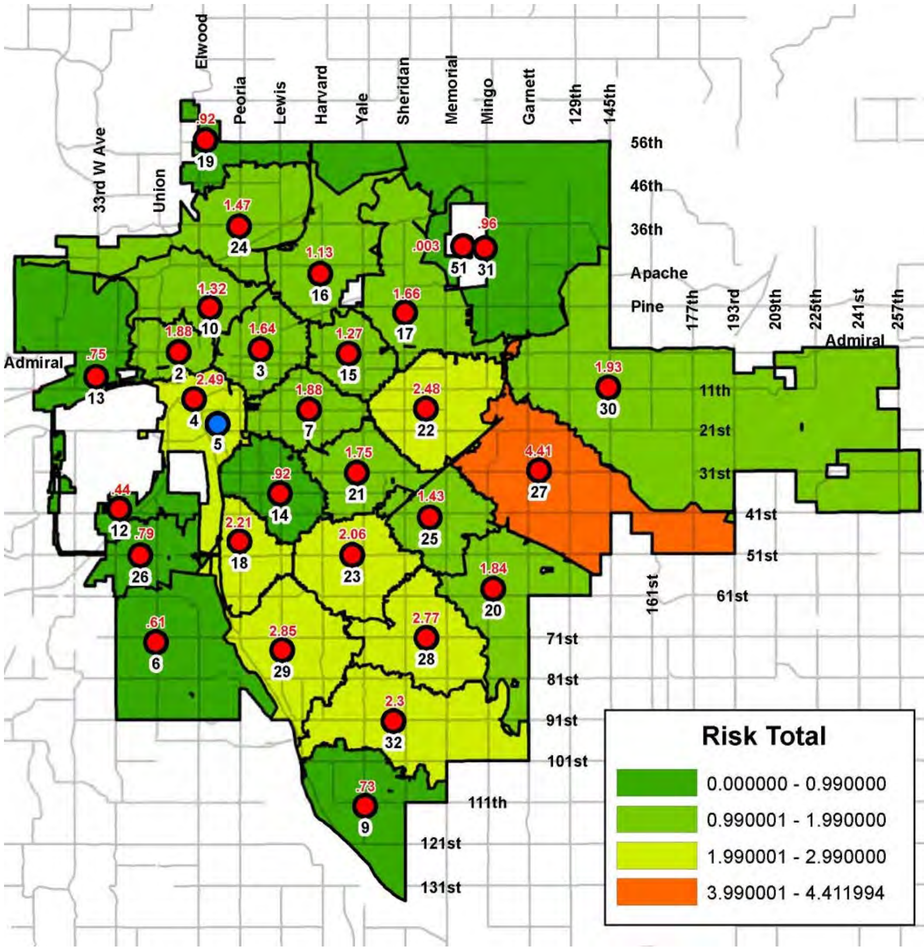


Current Fire Stations

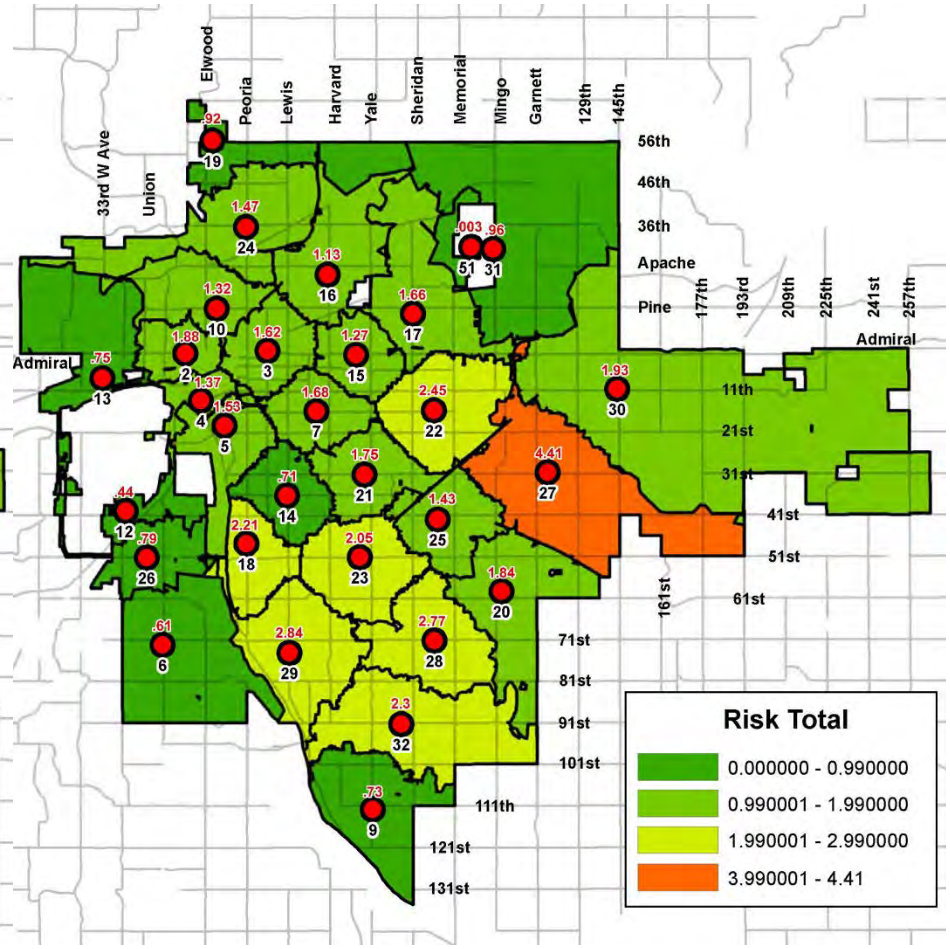
Scenario 6 Discussion:

Scenario 6 considers removing Station 2. See comments for Scenario 5.

Scenario 7 (DOWNTOWN)



Remove Station 5



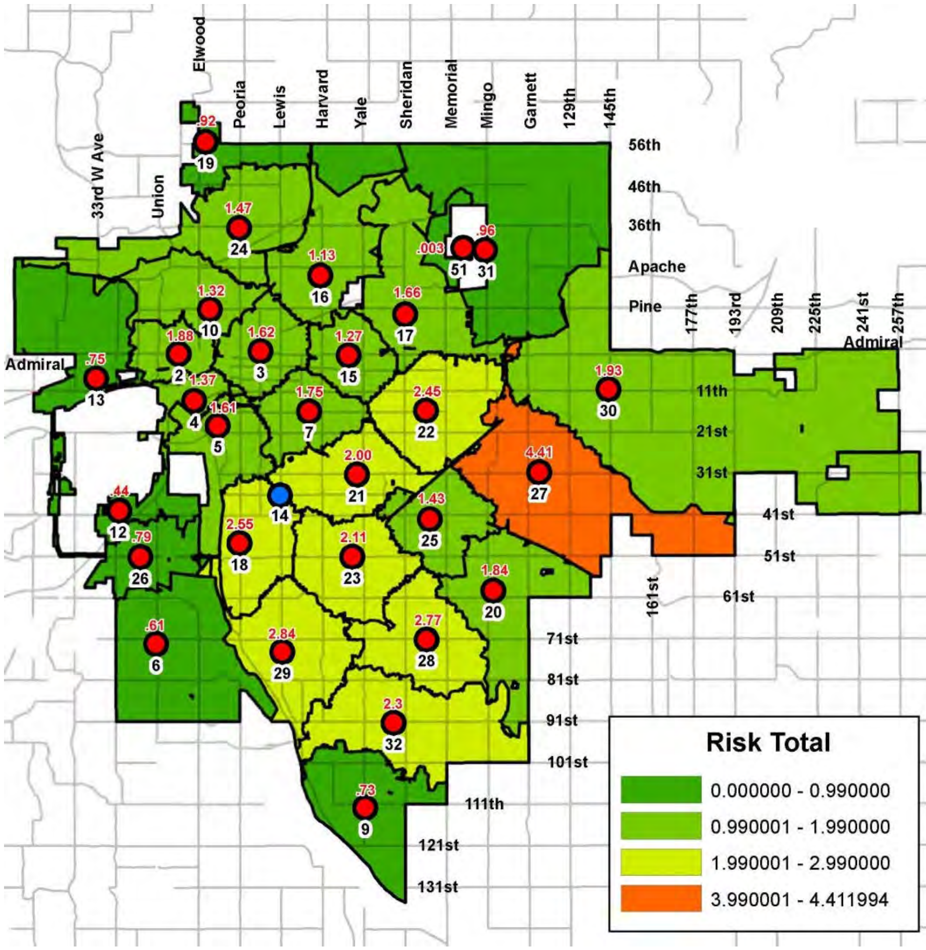
Current Fire Stations

Scenario 7 Discussion

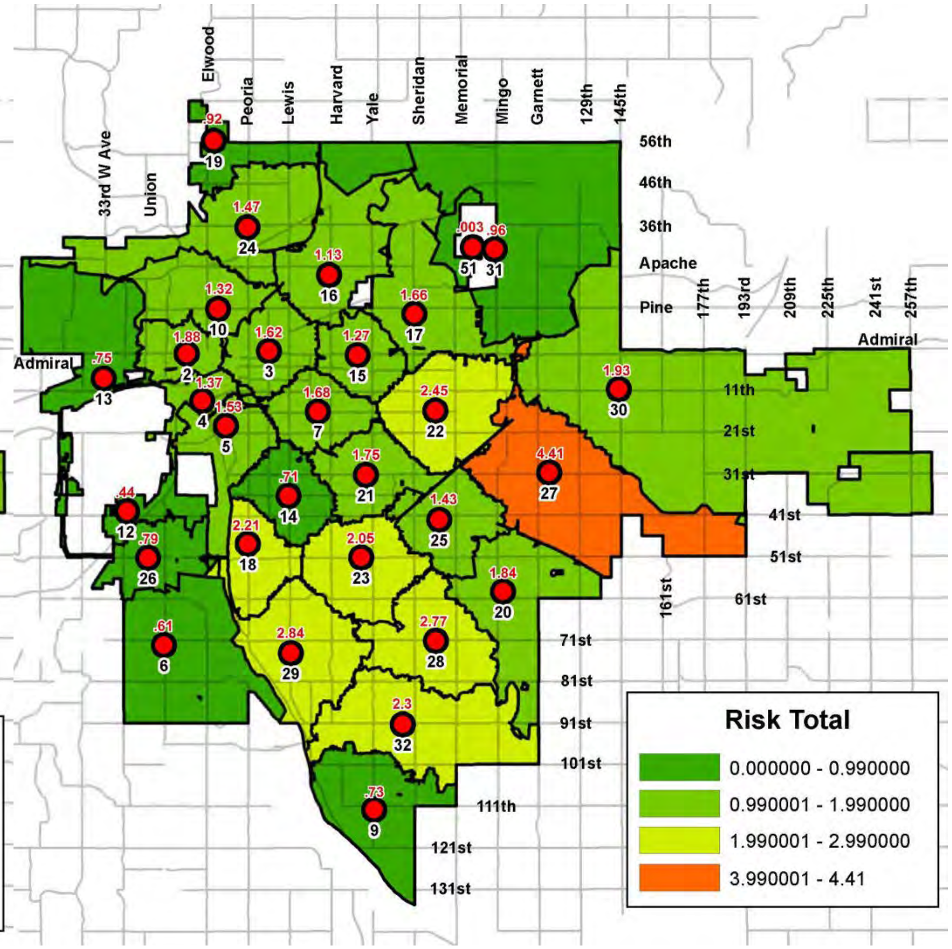
Scenario 7 considers much of the same comments as Scenario 5, except the issue would occur to the south of Station 4 as opposed to north. Station 5 is the oldest working fire station in the city, and is located in a very popular development area and has been targeted many times by developers. Station 5 has weathered many attempts at closing it for political reasons.

Station 5 has a very diverse response area. Located on the south edge of downtown, it is first-due to a tremendous number of target hazards such as hospitals and high rise apartments. It is also adjacent to a large neighborhood that is a mix of single- and multi-family dwellings built of historic construction. The single family dwellings vary from small bungalows to large mansions. Station 5 is also in close proximity Zink Lake on the Arkansas River, which experiences the largest percentage of water rescue incidents in the city. Engine 5 personnel are part of the city’s technical rescue team. In addition, the station is adjacent to the section of the city’s trail system that leads to The Gathering Place. Consequently, future plans for the station include the addition of a utility response vehicle that can quickly access medical patients deep in the park using the trail.

Scenario 8 (MIDTOWN)



Remove Station 14



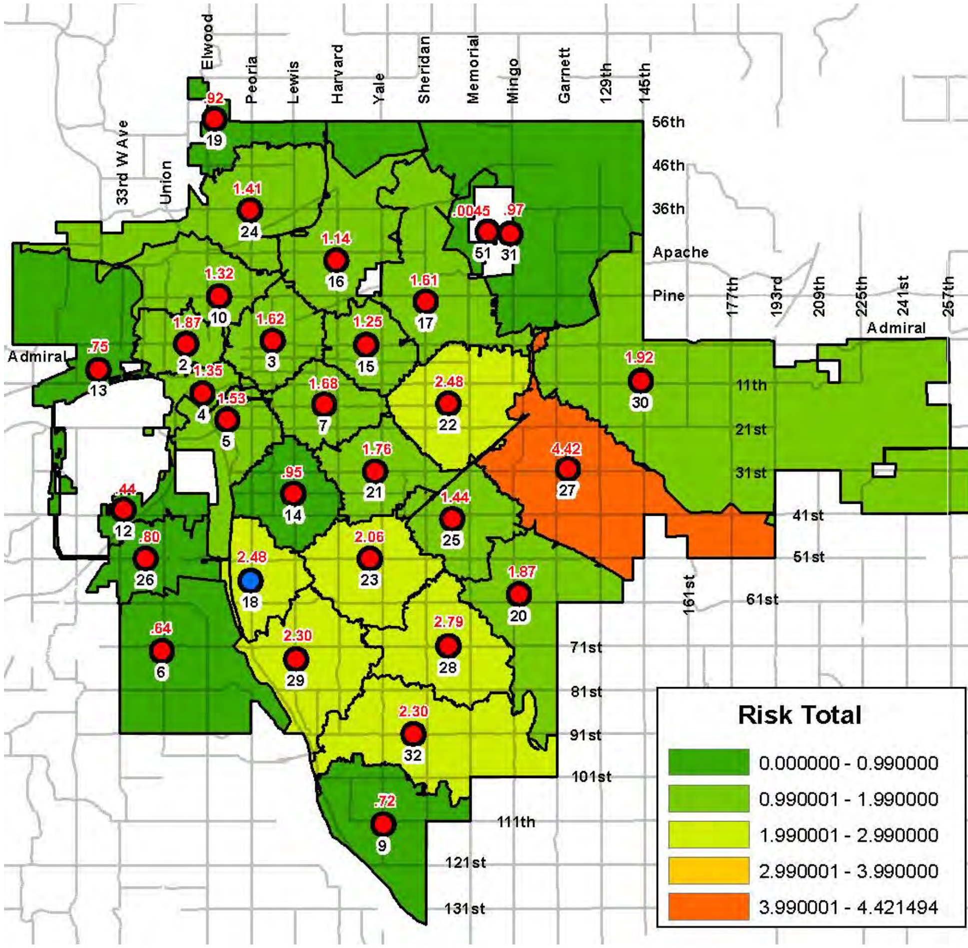
Current Fire Stations

Scenario 8 Discussion

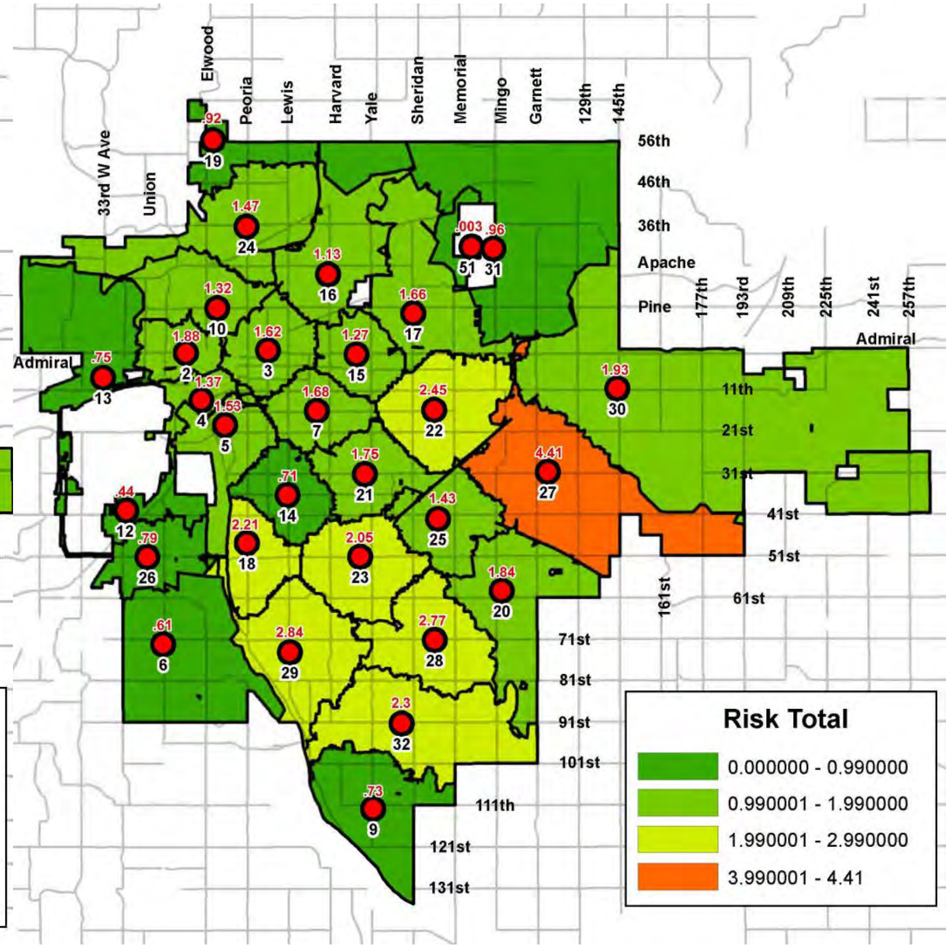
Scenario 8 considers removing Station 14, whose necessity has been scrutinized in the past. Station 14 is in a lower risk category compared to many of the stations in Tulsa which are in the acceptable risk category. This scenario shows that removing Station 14 moves Station 21 into a high risk category and further compounds the risk experienced in Station 18's area.

The issue lies not in the location of Station 14, but that Stations 18 and 23 are somewhat north their ideal locations. Scenarios 9, 10, and 11 consider these stations. To the north, Station 14 responds into an area of mansions built of historical construction, and to the south it responds to a mixed residential area. Station 14 also provides coverage to the Brookside area, a very historic and popular entertainment venue.

Scenario 9 (MIDTOWN and SOUTH)



Move Station 18 to 5600 S. Peoria Ave.



Current Fire Stations

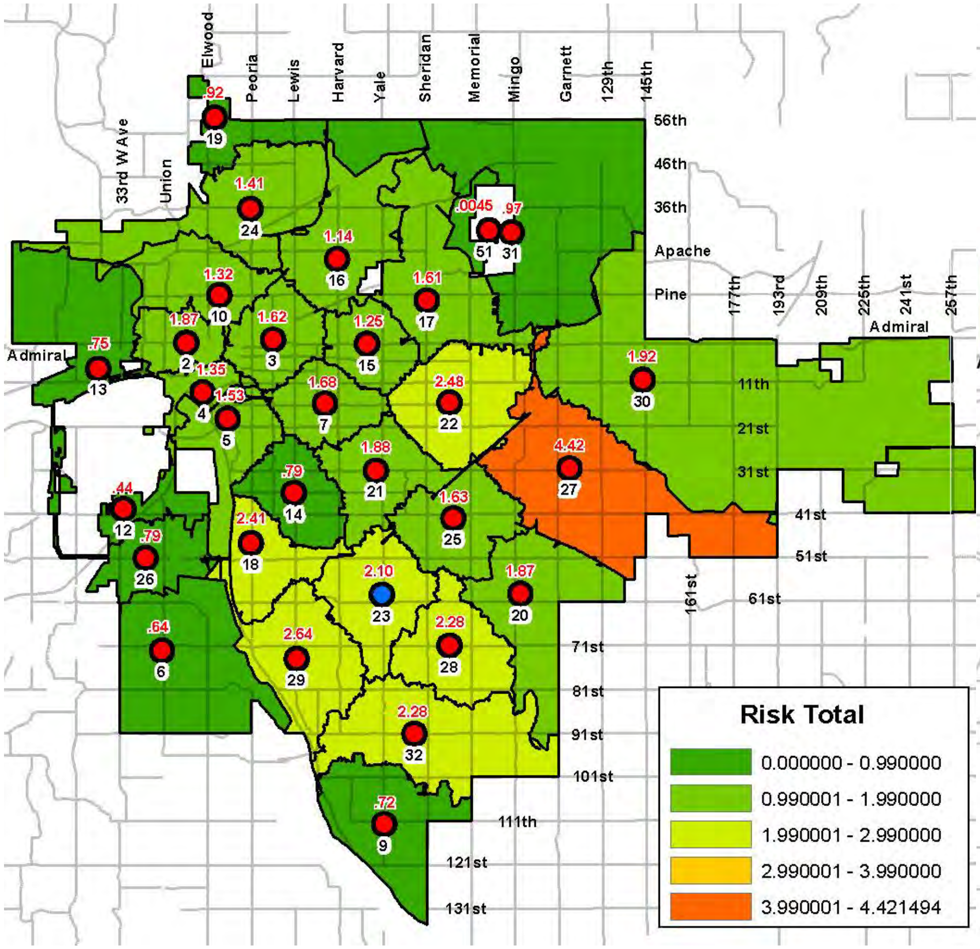
Scenario 9 Discussion

Scenario 9 considers moving Station 18 southward, which would allow Station 14 to absorb additional risk as well as reduce the risk and response area of Station 29. This move is considered a high priority move.

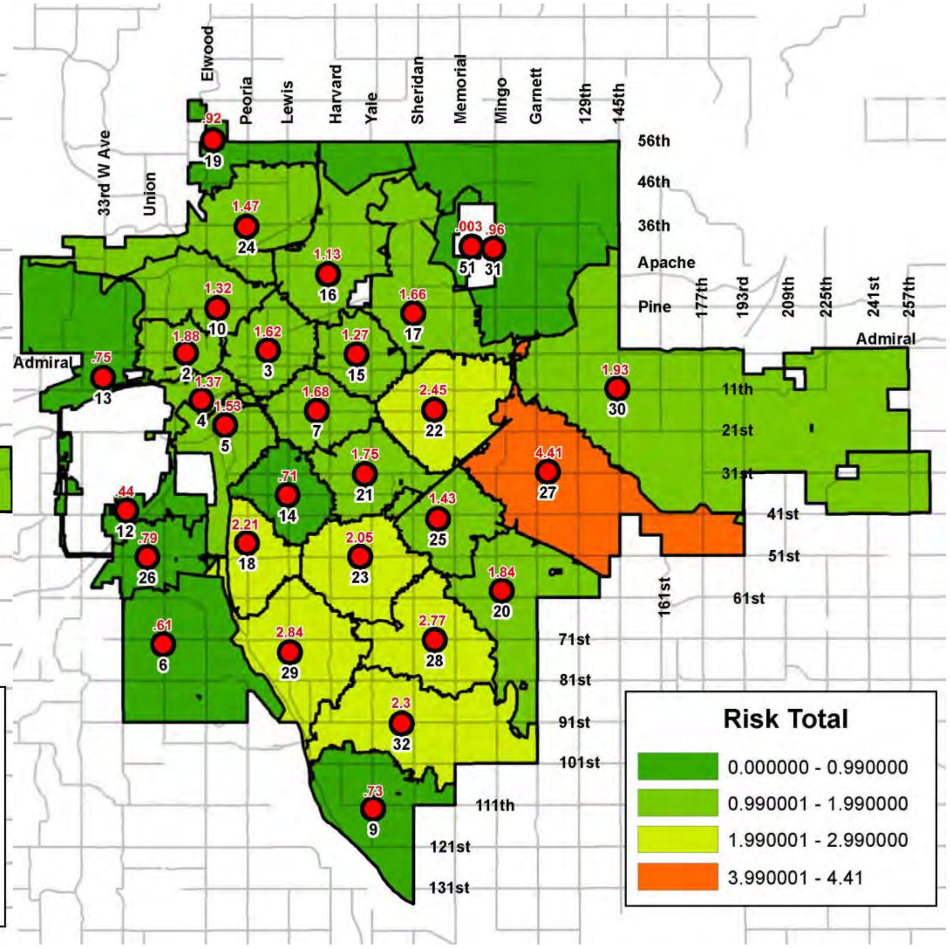
Station 18 was constructed in 1955 and is generally considered one of, if not the most dilapidated stations in the city. Its construction style is truly unique and does not lend itself to rehabilitation.

Consideration was given to moving Station 18 to the area of 5600 to 6100 S. Riverside Drive. Two issues prevent this relocation. First, the reconstruction of I-44 in the Riverside/Peoria area eliminated direct access to I-44 from Riverside. Placing a fire station on Riverside would add significantly to expressway response times, as well as response times across the river. Engine 18 has historically been a key response asset for fires on the west side. The additional response time across the river caused by placing Station 18 on Riverside causes the effective firefighting force for a significant part of the west side to decrease below needed levels. The second issue with placing Station 18 on Riverside can be seen in Section 3.

Scenario 10 (MIDTOWN and SOUTH)



Move station 23 to 5900 S. Yale Ave.



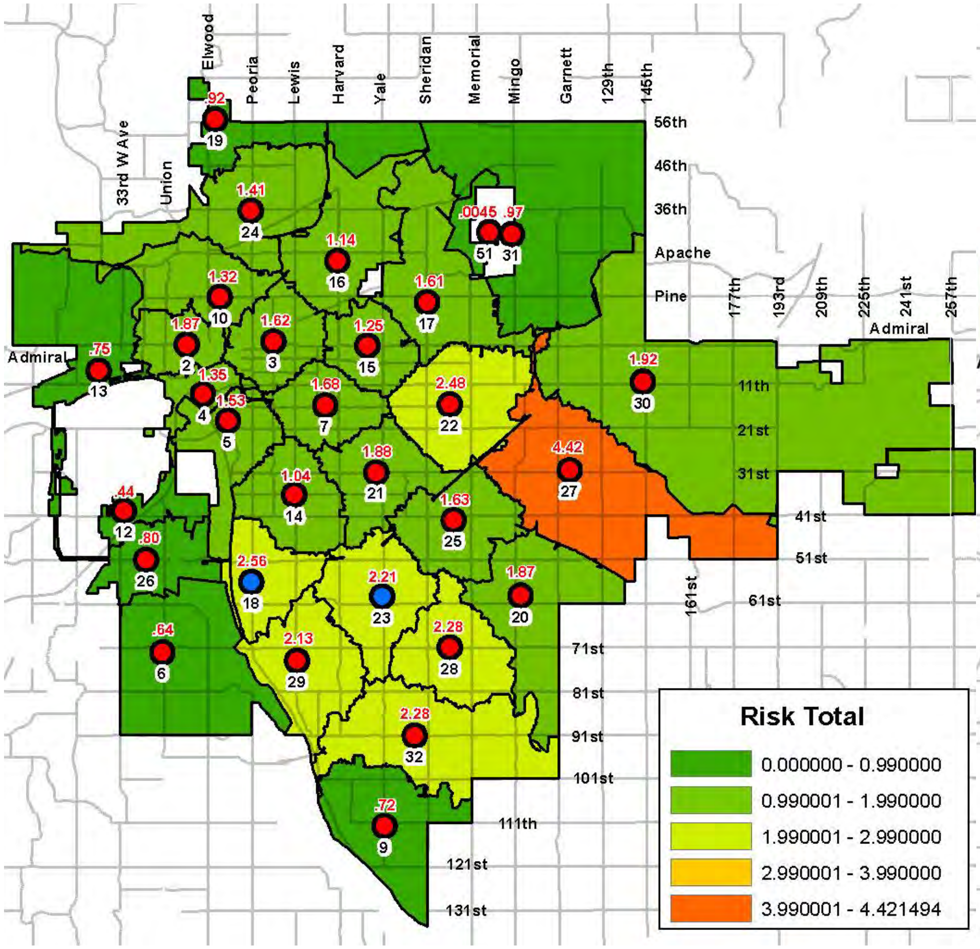
Current Fire Stations

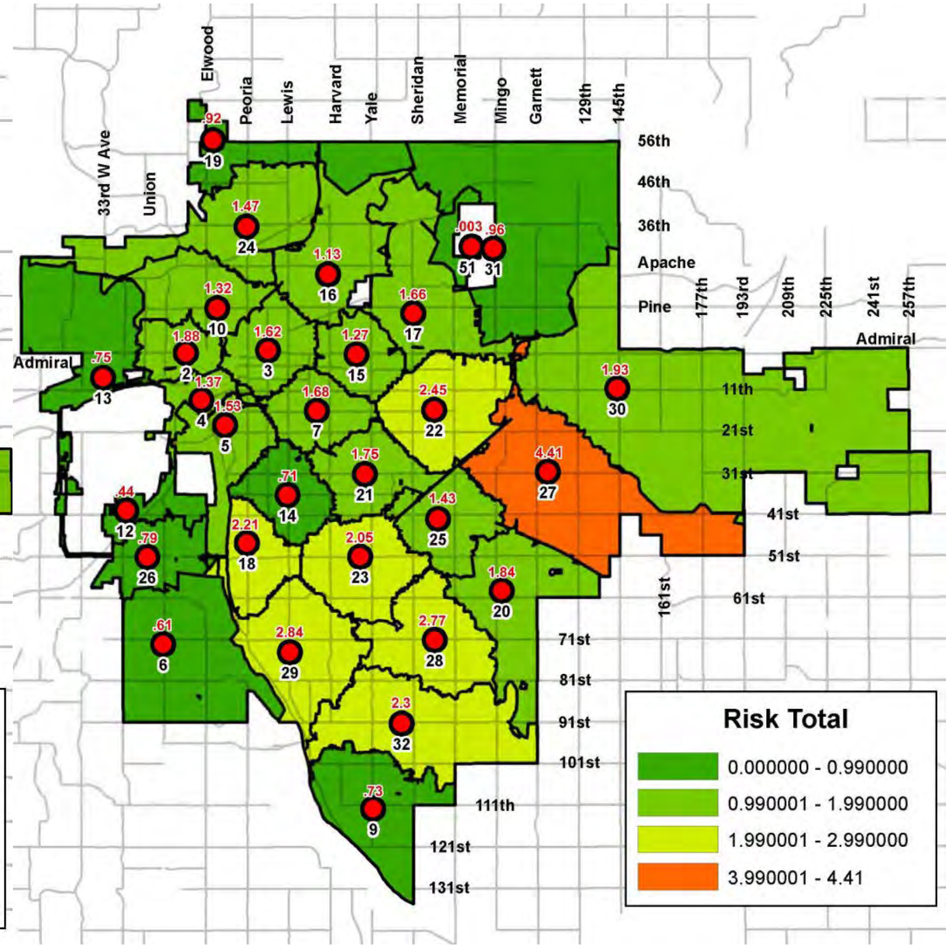
Scenario 10 Discussion

Scenario 10 considers moving Station 23 to the south. This move is considered a medium priority move. It was considered when looking at increasing pertinence of station 14 as well as reducing risk in the first due areas of Stations 28 and 29. Moving Station 23 to the south will have little effect on Station 14, however, it would significantly improve risk in Station 28 and 29's areas.

A disadvantage of such a move would be loss of proximity to I-44.

Scenario 11 (MIDTOWN and SOUTH)





Move Station 18 to 5600 S. Peoria Ave.

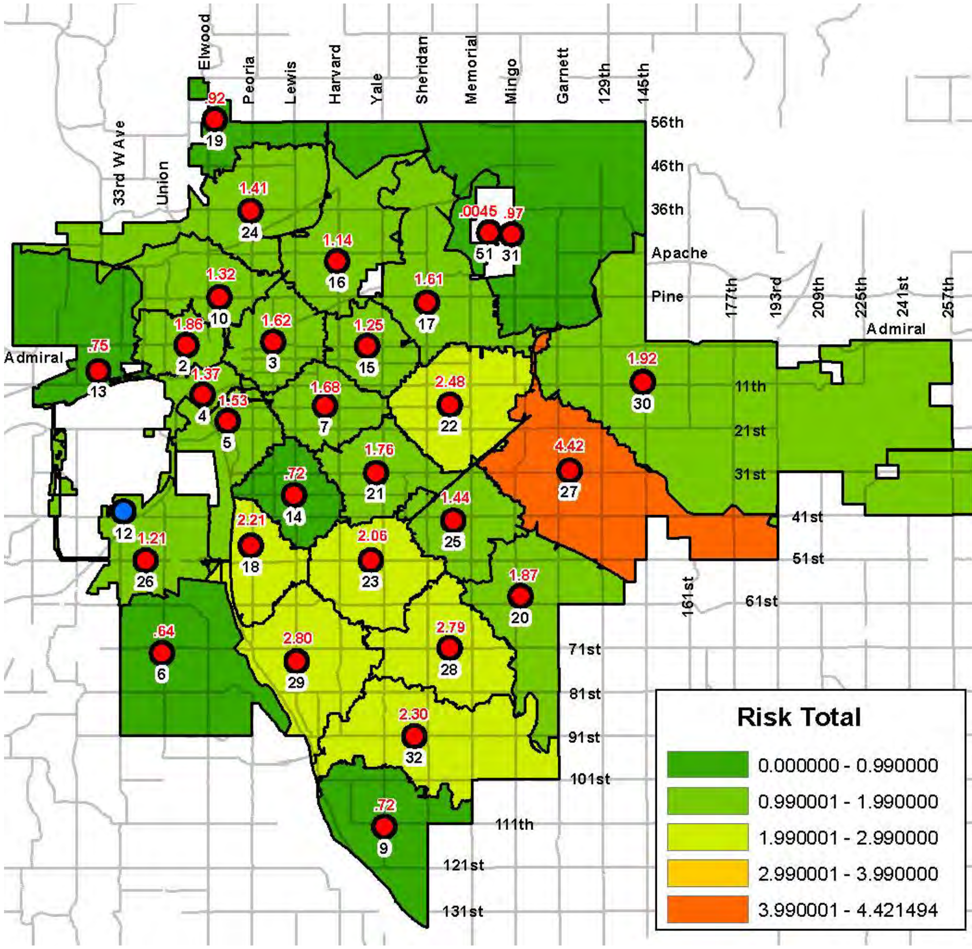
Move Station 23 to 5900 S. Yale Ave.

Current Fire Stations

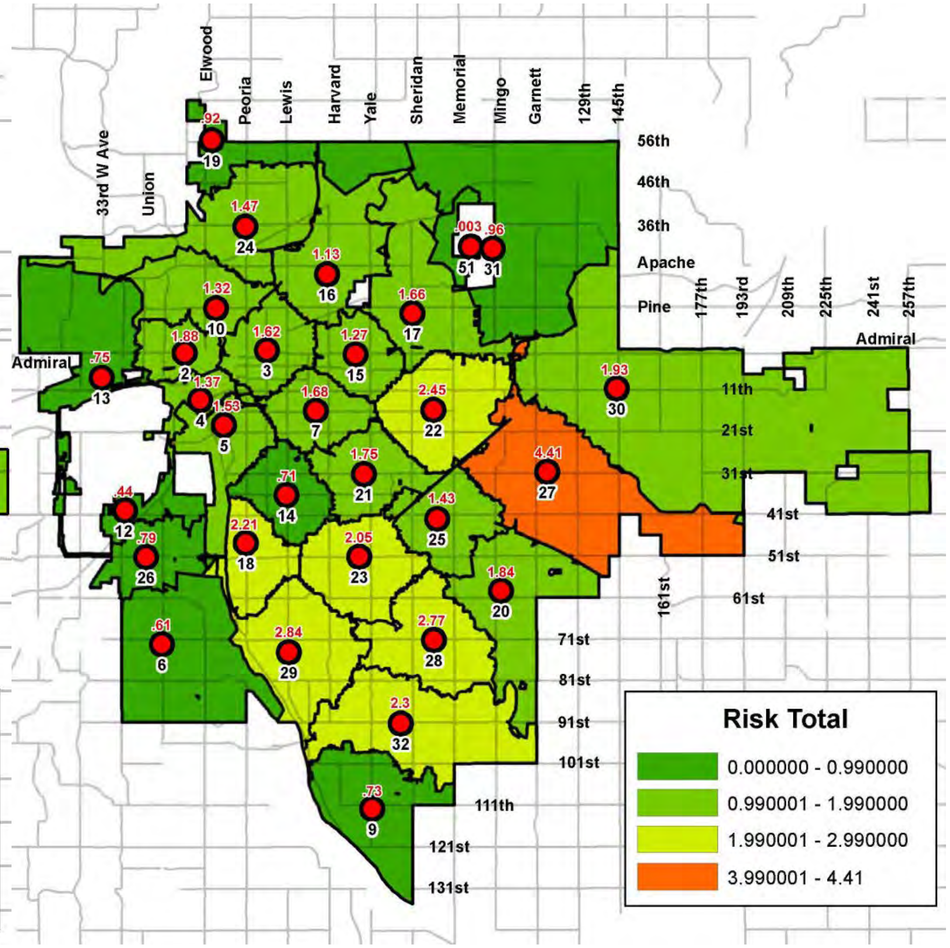
Scenario 11 Discussion

Scenario 11 considers the combination of moving stations 18 and 23 to the south. These moves help balance the effectiveness of Fire Stations 14, 18, 21, 23, and 29. Both are key moves that help with the issue of effective firefighting force found in the southern portion of the city, where fire stations were historically spaced at far greater distances.

Scenario 12 (WEST)



Remove Station 12



Current Fire Stations

Scenario 12 Discussion

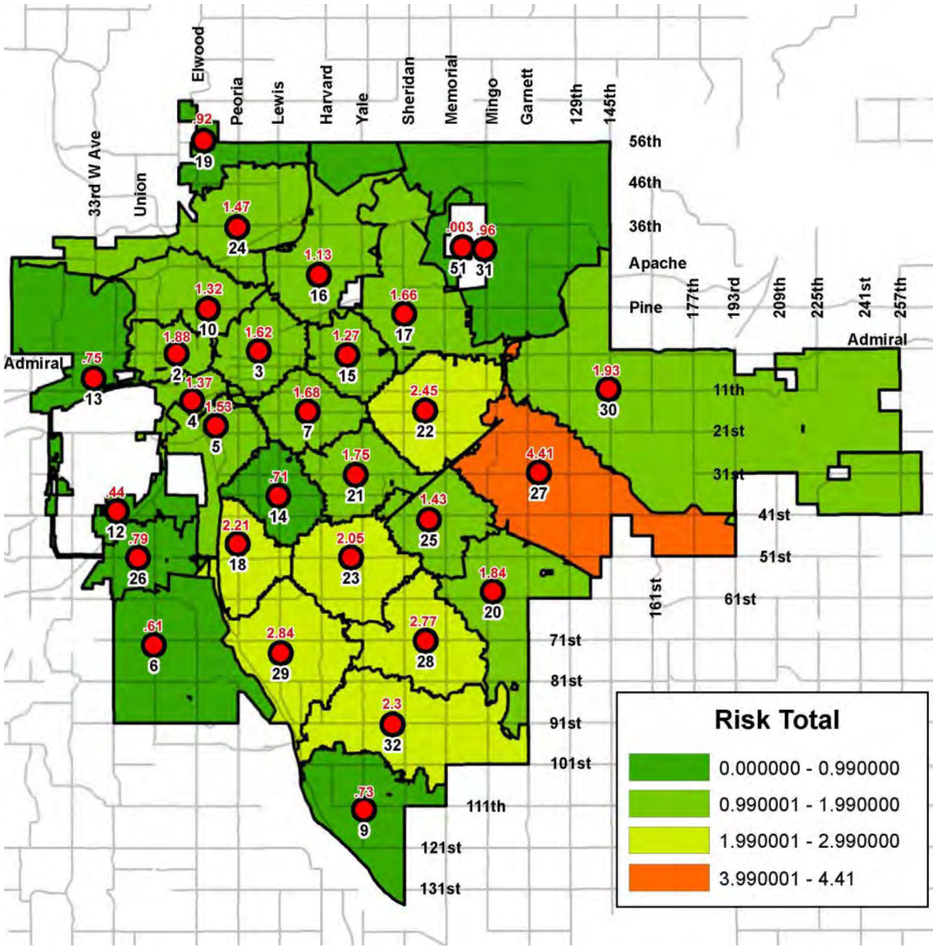
Scenario 12 considers the isolated effect of removing Station 12. Station 12 is unique in several ways. It has the lowest risk total of any station in the city; however, it sits in one of the most population dense areas. Historically, Station 12 is known for not making a tremendous volume of runs; however, the ones they do make are situations for which the fire department is truly needed. Firefighters who work in this area often associate this with the predominant demographic factors of the residents in the area.

Station 12 is one of three stations that are bounded by a major natural barrier – the Arkansas River. Between 21st Street and 51st Street, there are two ways to get over the river, neither of which provides direct and quick access to the Red Fork neighborhood. A second compounding access problems to this part of the city is the triangle created by I-44, I-244, and US 75, all of which are limited access. Additional boundary features that create unusual access problems are the Burlington Northern Santa Fe rail yard and associated rail lines, and Lookout Mountain, which is directly north of the fire station.

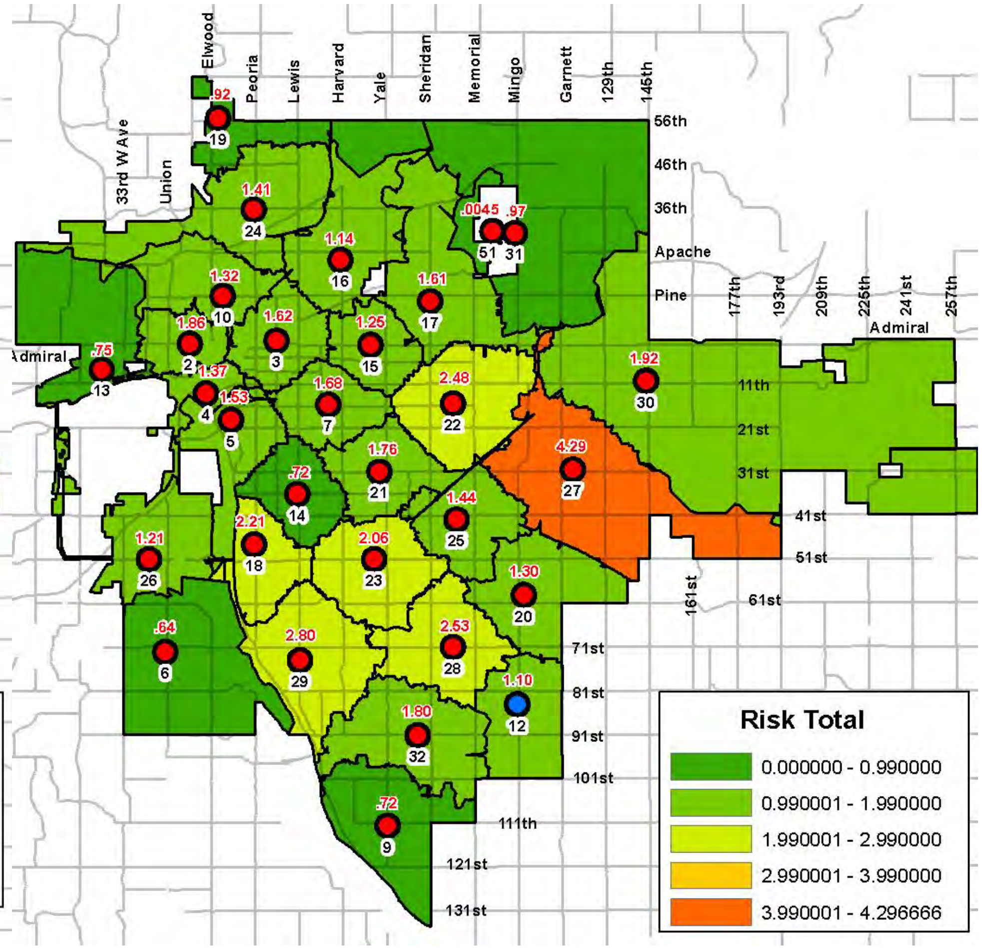
When oil was discovered in Red Fork in the late 1800s, this area might easily have become the metropolitan city known as Tulsa. Bounded by the Arkansas River to the east and north and Lookout Mountain to the north, the city fathers chose instead the area of what is now downtown Tulsa as the place to set up a commerce center.

The City of Tulsa and the State of Oklahoma have considered an infrastructure project known as the “Gilcrease Extension” that would connect I-44 to northwest Tulsa along the general area of 57th W. Ave. The road and easements are in currently part of the City of Tulsa. During the course of this study, the city and state officials began making plans for construction of the Gilcrease Extension. A final decision was pending when this report was published. Such an infrastructure project could have significant effect on this part of Tulsa. After weighing all these factors, the Deployment Committee recommended that Station 12 not be considered for closure or a move at this time.

Scenario 13 (WEST and SOUTHEAST)



Move Station 12 to 8400 S. Mingo Rd.

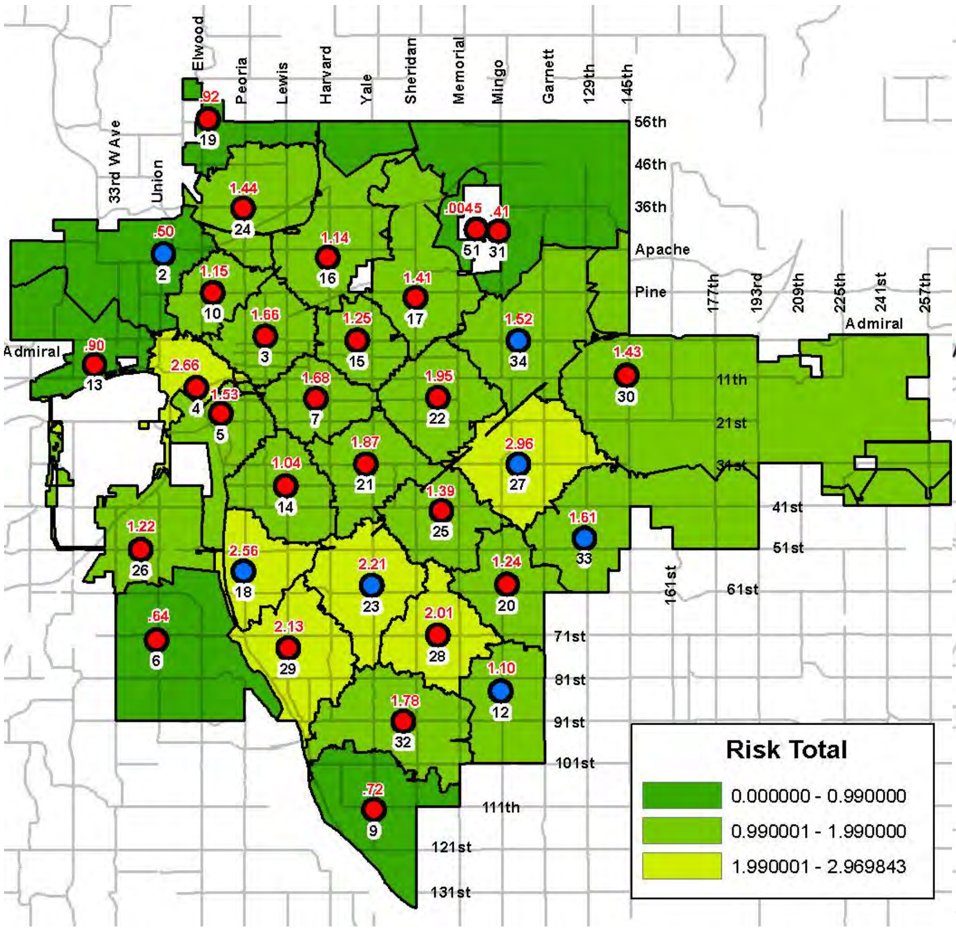


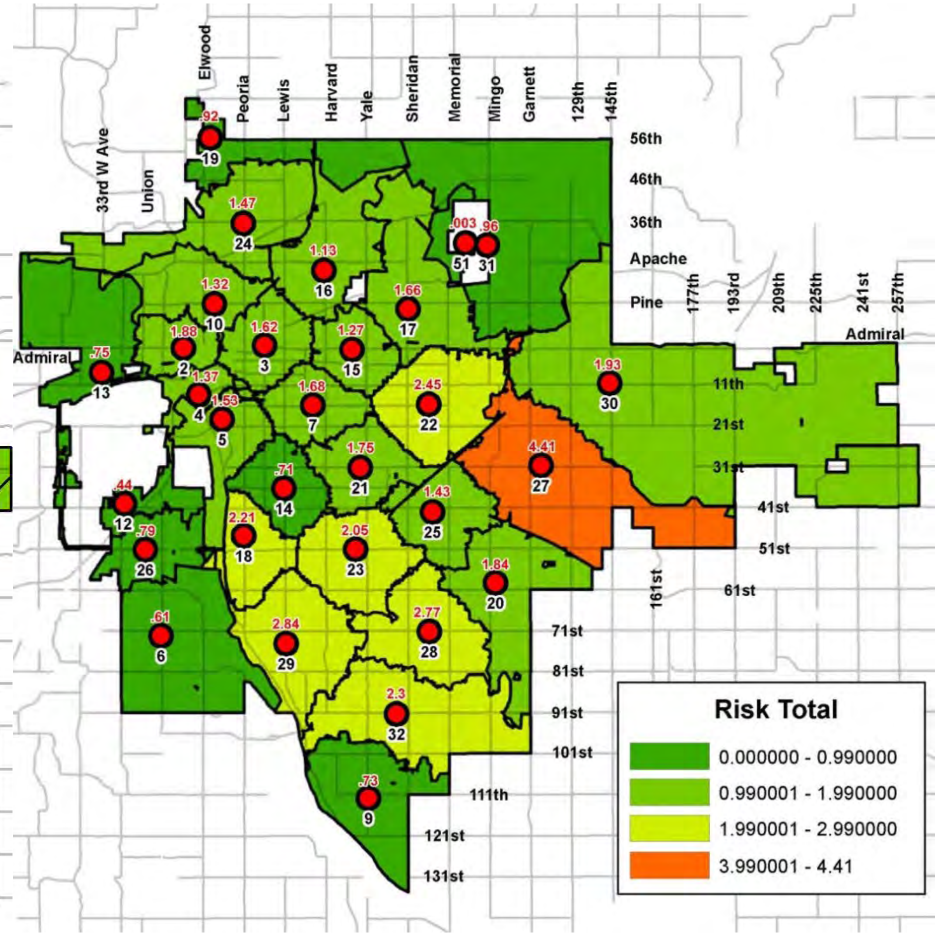
Current Fire Stations

Scenario 13 Discussion

See Scenario 12 comments.

Scenario 14 (CITYWIDE)





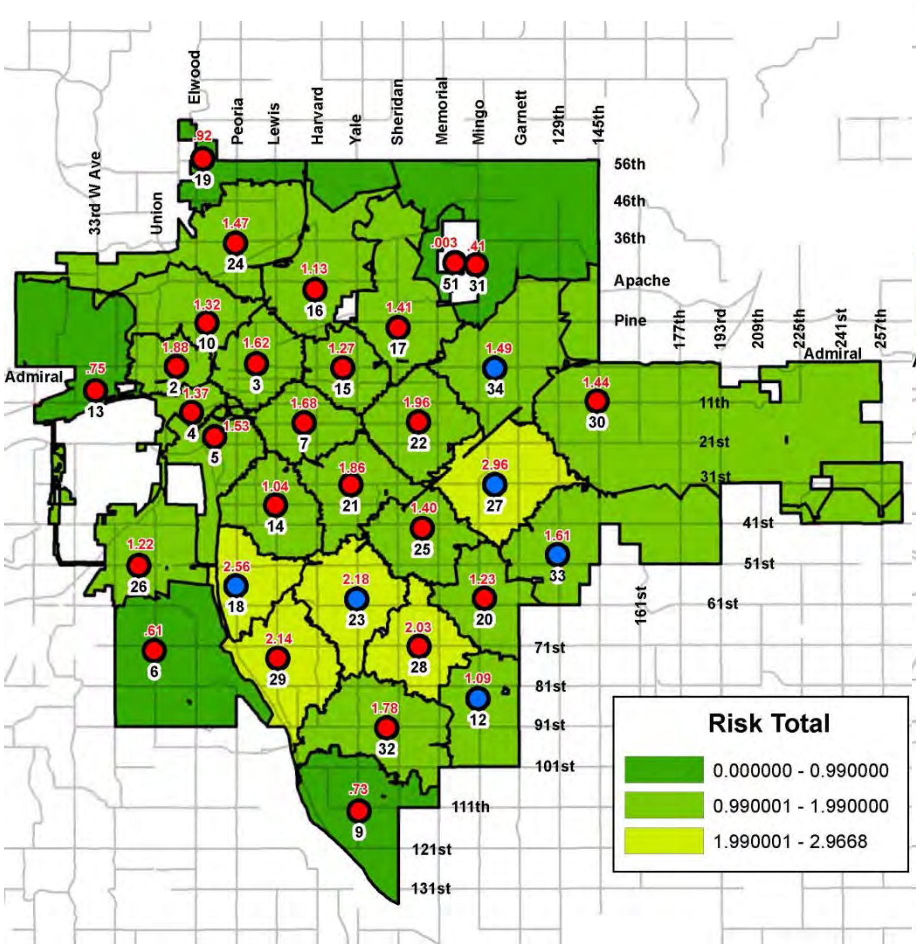
Move Station 2 to 1500 W. Apache St.
New Station 33 at 4800 S. 129th E. Ave.
New Station 34 at 10400 E. Admiral Pl.
Move Station 12 moved to 8400 S. Mingo Rd.
Move Station 18 to 5600 S. Peoria Ave.
Move Station 23 to 5900 S. Yale Ave.
Move Station 27 to 10400 E. 31st St.

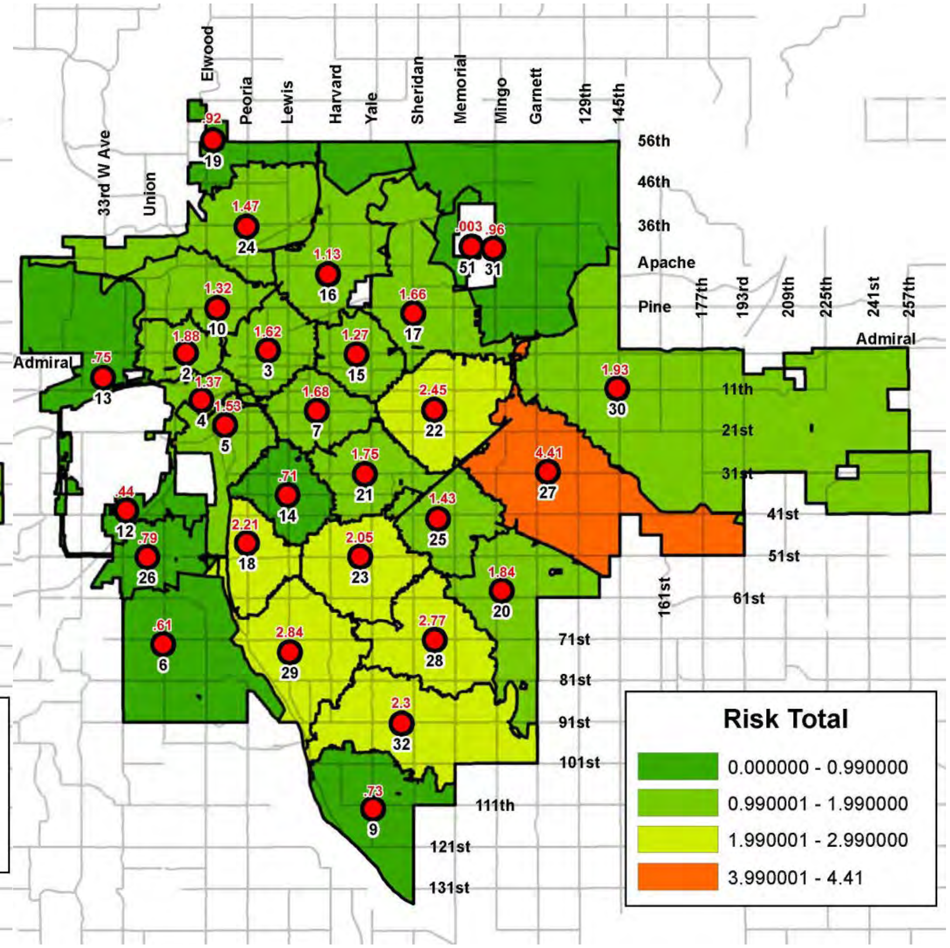
Current Fire Stations

Scenario 14 Discussion

See Scenario 16. Scenario 14 was an initial citywide scenario considering moves of Stations 2 and 12. Subsequently, committee determined that these moves are not recommended.

Scenario 15 (CITYWIDE)





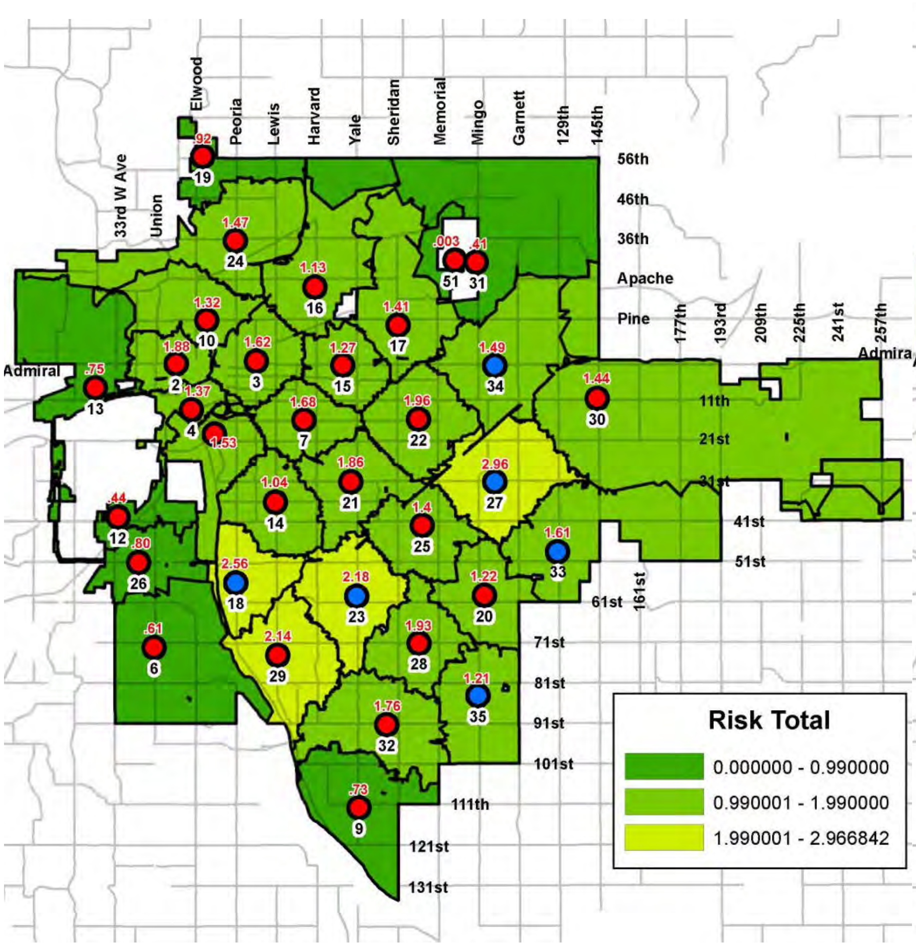
New Station 33 at 4800 S. 129th E. Ave.
New Station 34 at 10400 E. Admiral Pl.
Move Station 12 moved to 8400 S. Mingo Rd.
Move Station 18 to 5600 S. Peoria Ave.
Move Station 23 to 5900 S. Yale Ave.
Move Station 27 to 10400 E. 31st St.

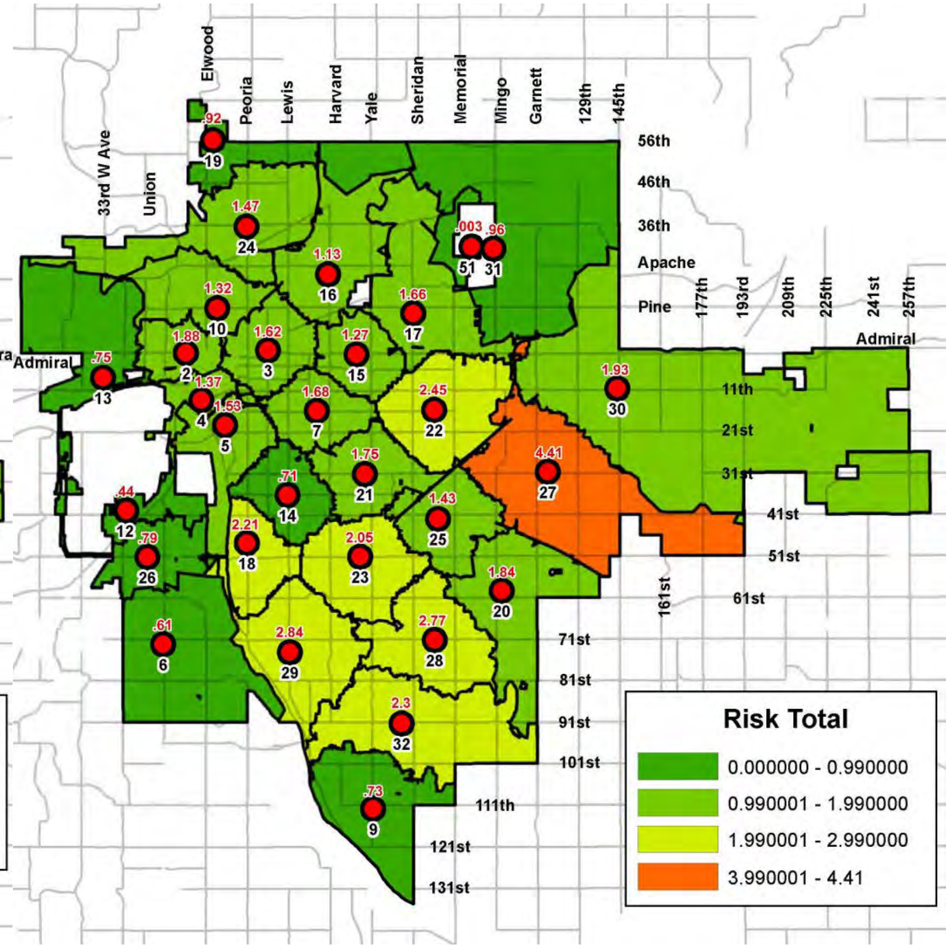
Current Fire Stations

Scenario 15 Discussion

See Scenario 16. Scenario 15 was a citywide scenario considering moving Station 12. Subsequently, the committee recommended that Station 12 not be moved at this time.

Scenario 16 (CITYWIDE)





New Station 33 at 4800 S. 129th E. Ave.
New Station 34 at 10400 E. Admiral Pl.
Move Station 18 to 5600 S. Peoria Ave.
Move Station 23 to 5900 S. Yale Ave.
Move Station 27 to 10400 E. 31st St.
New Station 35 at 8400 S. Mingo Rd.

Current Fire Stations

Scenario 16 Discussion

Scenario 16 is considered by the committee as the scenario that makes the most significant impact on the highest risk response areas with the fewest number of fire station moves. This scenario considers the risk data as well as significant events and other factors that have occurred since the time the study began.

Two areas of the city remain in a higher risk category; however, no stations remain in the two highest risk categories. All but four stations (18, 23, 27, and 28) are in the acceptable risk categories.

It is known that far eastern sections Tulsa will likely need more than one fire station as development progresses. Consideration of the stations in this scenario will show the stations in a negligible risk category at this time. This is because of two factors: lack of actual incidents and lack of population density. A similar situation exits in northwest Tulsa and northeast Tulsa. However, prioritizing fire stations in these areas at this time would ignore serious risk issues in other parts of the City of Tulsa that have existed for many years.

Recommended Fire Station Moves/Additions

Priority	Sequence/Funding	Station	Location	Staffing
High	1 Funded	33 New "East" Station	13500 E 41st St.	New staffing, Public Safety Funding
High	2 Unfunded	Move 27 (11707 E 31st St.)	10400 E. 31st St.	Move E27 and L27
High	2 Unfunded	New 34	10400 E. Admiral Pl.	Move one company from Station 31
High	2 Unfunded	Move 18 (4802 S. Peoria Ave.)	5600 S. Peoria	Move E18 and C643
Medium	3 Unfunded	Move 23 (4348 E. 51st St.)	5600-5900 S. Yale Ave.	Move SQ23 and L23
Medium	3 Unfunded	New 35	8400 S. Mingo	Move one company from Station 28 (funded by Public Safety Funding) (See Section 4 Recommendations)
Low	4 Unfunded Projected need (7-10 years) Economic Development Related Far East Tulsa	New 36	3300 S. 177th E. Ave.	New staffing Unfunded

Mutual Aid/Automatic Aid

The City of Tulsa is not an island, nor are any of the other cities and other entities that make up the metro area. TFD has mutual aid agreements with each of the communities surrounding Tulsa, and routinely works together with its neighbors in emergency response. The State of Oklahoma also has statewide mutual aid legislation that establishes a permanent mutual aid agreement between all fire response agencies in Oklahoma. Traditionally TFD has relied on mutual aid for water tenders and grass rigs from other areas.

In 2001, Tulsa annexed a 13 square mile area on the east side from 193rd E. Ave east to 257th E. Ave (Figure 25). This annexation created a long, thin area on the east side of the city with generally low population density and low incident numbers for the fire department. However, the area east of current Stations 27 and 30 and eastward to the Creek Turnpike contains structures that are greater than five miles from a Tulsa fire station and are, in some cases, greater than 1000 feet from a hydrant. When either of these conditions occurs, it has the potential to severely affect the homeowner's insurance ISO rating. While the majority of the city's ISO rating is 3, some homeowners in the east Tulsa area have previously reported receiving an ISO Class 9 or 10 rating, depending on their specific situation. Depending on the insurance provider, this rating disparity has been known to increase homeowner's insurance costs by a factor of two or more.

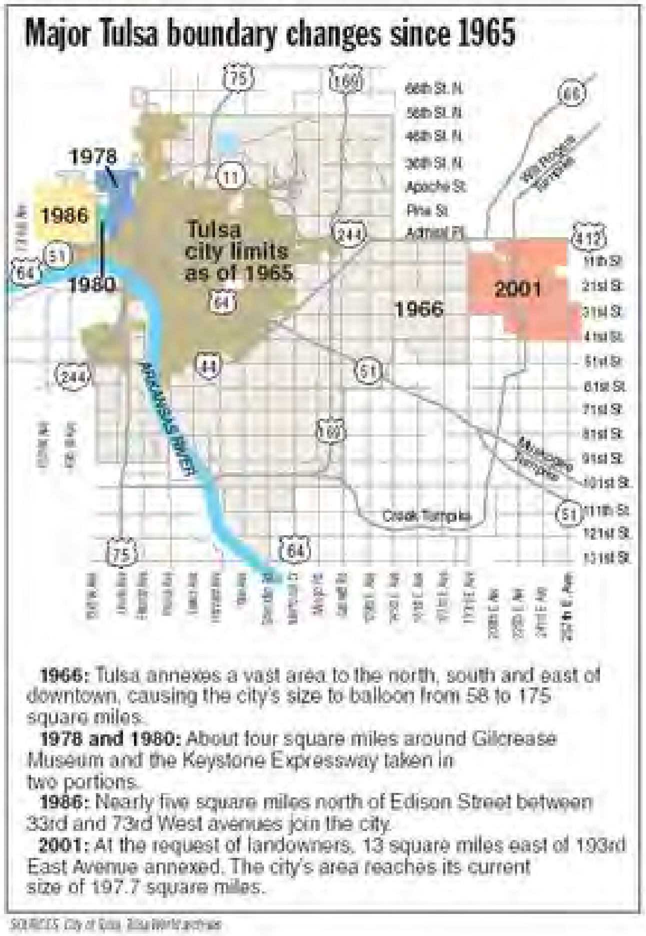


Figure 25: Major Tulsa Boundary Changes Since 1965 (Evatt, 2004)

Two square miles of the area east of 161st E. Ave on the northern edge of Broken Arrow are filled by subdivisions and some commercial and multi-family residential structures. Parts of these subdivisions are receiving ISO Class 9 protection ratings due to their distance from a Tulsa fire station. Even though some of these homes are greater than 5 miles from a Tulsa fire station, most are within two miles of a Broken Arrow fire station (BA station 6).

Most of this situation can be addressed with an automatic fire protection agreement between Broken Arrow and Tulsa until the population density in this part of our city justifies construction of a fire station in the area of 3300 S. 177th E. Ave. In 2012, Tulsa and Broken Arrow entered into a mutual aid agreement for fire protection and first response in this area. This helped with the real and critical issue of response times; however, it did not address the day-to-day concern of many homeowners – insurance rating and costs.

Several issues surround the 2012 agreement and the establishment of an automatic aid agreement. These include equity between departments, radio system compatibility, and dispatching. None of these issues are simple to address. Each has technical and political implications; and for many years it has been thought that solutions were associated with high costs for both cities. This is not necessarily the case.

At the time of this report, Tulsa and Broken Arrow Fire Departments have been working together to establish an equitable agreement.

Mutual Aid Radio Communications – Operability and Interoperability

Radio communications between agencies has been a local, state, and national issue for many years, and agencies in the Tulsa area have shared these challenges. No other incident responses in the history of the United States highlighted these issue more than the multi-agency responses to the 9/11 attacks and Hurricane Katrina. These two incidents have been the impetus for a monumental effort nationwide to connect response agencies via radio.

The United States Department of Homeland Security provides guidance for this process in a document called The Interoperability Continuum (DHS, n.d). The key takeaways from this guidance are that interoperable radio communications have both technical aspect and human aspects. The technical aspect has been an issue in the Tulsa area for many years.

In the fall of 2016, Tulsa began upgrading its radio system to the P25 interoperability platform. Prior to implementation of the P25 platform, solutions to the technical aspect of linking radio systems were more difficult, cumbersome, and possibly expensive. Post-implementation, a series of options for solutions exist which are of varying costs and levels of use.

Operability and Interoperability

Operability between agencies generally refers to the ability for two or more agencies to communicate with each other during day to day operations. If TFD is at a building fire or car wreck and another agency is coming into Tulsa to assist, the assisting agency should have the capability to switch to Tulsa's operating channel without relying on any human assistance, such as a radio patch by a dispatcher. The Tulsa units on scene will already be busy and should not have to change channels.

Interoperability between agencies also refers to the ability for multiple agencies to communicate on large-scale incidents such as natural disasters and large wildland fires. On these types of incidents, resources may be responding from across a state or nation versus across a city or county.

Key to this report is the issue of operability and the ability for the City of Tulsa and its neighboring departments to communicate on day to day incidents. With the implementation of P25, agencies in the Tulsa area are able to use a concept called "Dual-ID," which allows agencies such as Tulsa and Broken Arrow who are using radio systems from different manufacturers to program their radios to work on each other's systems. While there is no perfect solution, for the interface between TFD and BAFD, this is a low cost fix that solves 80% of the problem. The other part of the solution comes through the human aspect – procedures and training. This option may not be acceptable to all first responder disciplines; however, for the purposes of coordinating fire response along the border between Tulsa and Broken Arrow, it is a solution.

Finding a solution to interoperability problems has quickly become a statewide issue. The City of Tulsa has been an avid partner in these discussions. Limited solutions already exist, but are beyond the scope of this study.

Dispatching

In the area of dispatching for mutual and automatic aid operations, multiple options exist. When agencies are dispatched by different communications centers, the simplest method of notification is a communication center to communication center phone call. This is an effective and reliable method which can qualify fire response agencies for mutual aid credit under the ISO rating system. However, the issue in far east Tulsa is that credit for an automatic aid agreement is needed with Broken Arrow (Station 6) until such time that one or more Tulsa fire stations are warranted.

Currently Tulsa and Broken Arrow have incompatible fire station alerting systems and computer aided dispatch systems (CAD). While disparate systems are not ideal, a solution does exist in the realm of automatic aid for this area. Tulsa and Broken Arrow Fire Departments are currently in discussions regarding this solution.

As the City of Tulsa makes future investments in fire station alerting systems and CAD, consideration should be given to compatibility and/or interfacing with neighboring departments.

Mutual Aid/Automatic Aid/Coordination Recommendations

In general, TFD should continue to foster relationships and work closely with all of its neighbors to make the most of each other's resources where applicable.

Specifically, TFD should work with BAFD to modify the 2012 Mutual Aid Agreement to meet the needs of both departments and ensure equity between departments. The 2012 agreement is often considered one-sided in Tulsa's favor. While that was never the intent, the intricacies surrounding the medical response portion of the agreement ultimately created this unintended consequence.

Water Supply

Tulsa is fortunate to have one of the most robust and resilient water systems in the country. During its 2011 ISO evaluation, Tulsa's water supply was rated at 37.56 of 40 possible points. However, three areas of the city would benefit substantially from the addition of mobile water supply apparatus – East Tulsa, Northeast Tulsa, and Northwest Tulsa. In the past the fire department has operated without mobile water supply apparatus. The only exception to this was a short period of time when south Tulsa was developing very quickly. At that time, a single unique apparatus assigned to Station 32 covered the entire area of the city south of 81st Street. Engine 32 was a combination pumper/tender that carried 2000 gallons of water.

When ISO rates a city, the rating applies to the entire city, except for any locations that are either 1000 feet from a qualifying fire hydrant or five or more miles from a fire station. Figure 26 shows the substantial areas of Tulsa which are more than 1000 feet from a fire hydrant.

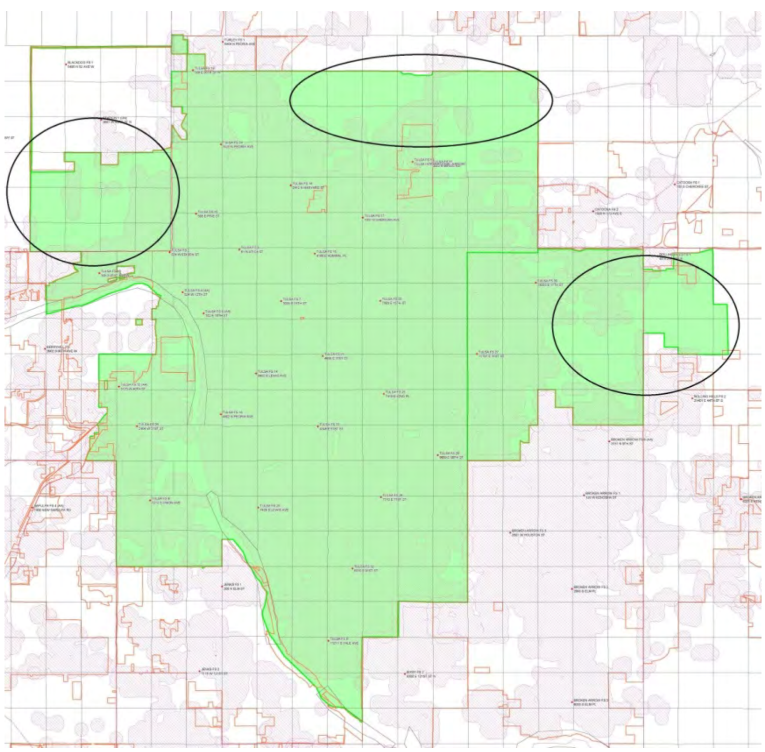


Figure 26: City of Tulsa Hydrant Coverage (1000 ft. Radius)

Recommendations for Section 1

Station Moves/Additions (and corresponding company moves)

Table 2 shows the final recommendations for fire station moves/additions based on the scenarios and data considered in Section 1.Table 2

Table 2: Recommended Fire Station Additions/Moves with Funding Priority

Automatic Aid Agreement

The City of Tulsa and the City of Broken Arrow should consider modifying the 2012 Mutual-Aid Agreement for Fire Protection and Fire Response to provide true automatic aid in far east Tulsa and ensure that the agreement is equitable and beneficial to both cities.

Mobile Water Supply Apparatus (Water Tenders)

TFD should purchase and implement two mobile water supply apparatus at Fire Stations 19 and 33. Consequently, both stations should be constantly staffed with four personnel.

Coordination with Neighboring Agencies

As the City of Tulsa and other agencies make improvements to public safety infrastructure such as moving or adding fire stations or upgrading or replacing communications, agencies in the Tulsa Metro Area should work together to coordinate the provision of services to the citizens.

Section 2: Advanced Life Support Stations

Methodology for the Selection of TFD ALS Apparatus Placement

The fire department's EMS mission is comprised of providers credentialed for two levels of pre-hospital care, Advanced Life Support (Paramedic) and Basic Life Support (EMT/EMR). TFD paramedics provide the highest level of medical care. They are equipped with the same level of items provided on the ambulance transport units and provide care under the same EMS system protocols.

Of the 29 fire stations across the city, 15 are designated as ALS locations and deliver service from a total of 16 ALS fire companies. These companies represent 36% of the frontline apparatus. Since all apparatus do not provide care at the ALS level, determining the placement of these apparatus requires a comprehensive review of both demand and station location. The department utilizes both clinical and geographic methods to evaluate the EMS response profile of fire apparatus and determine the level of service provided.

Clinical Determination

In order to determine the most effective placement of fire department resources and ensure that the level of EMS response positively impacts both mortality and morbidity, the department utilizes elements of system designed as recommended by the National Association of EMS Physicians (NAEMSP). The NAEMSP cites a list of five specific diseases that can be impacted by appropriate EMS system design. TFD has chosen to base the clinical determination of apparatus placement on the following items that comprise the "First-Hour Quintet" as adopted from the European Resuscitation Academy in 2002 (Bass, Brice, Delbridge, & Gunderson, p. 153, 2009).

- Out-of-hospital cardiac arrest
- Severe respiratory difficulties
- Severe trauma
- Chest pain, including acute coronary syndrome
- Stroke

When using the First-Hour Quintet, a second factor must be weighed in the determination – number of calls with care transferred to EMSA. This is an important measure because it sorts out the number of calls where the patient needed actual care from TFD. Ideally, for a unit to be deemed an ALS unit, it should rate high on both the number of First-Hour Quintet calls and the number of times the unit transferred care to EMSA on First-Hour Quintet calls. If a fire department unit makes 1000 calls that are First-Hour Quintet, but they only need to transfer care to EMSA on 300 of these calls, it is an indication that the fire department unit and EMSA are arriving at nearly the same time. This can indicate that the TFD ALS capability may be better used elsewhere in the city.

2016 Calls – Stations Ranked by First-Hour Quintet Calls

Station	# of First-Hour Quintet Calls	# of Calls with Care Transferred
27	2257	1363
22	1962	798
29	1872	1041
23	1726	709
20	1547	700
3	1271	334
24	1245	995
25	1229	428
28	1229	784
21	1204	662
18	1174	625
2	1055	636
5	1036	330
30	993	659
15	917	441
4	846	536
10	846	711
7	790	407
32	783	328
17	754	679
19	684	598
13	679	500
26	629	495
16	512	550
6	396	251
14	369	235
31	346	214
12	224	246
9	180	104

2016 Calls – Stations Ranked by Transfer of Care on First-Hour Quintet Calls

Station	# of First-Hour Quintet Calls	# of Calls with Care Transferred
27	2257	1363
29	1872	1041
24	1245	995
22	1962	798
28	1229	784
10	846	711
23	1726	709
20	1547	700
17	754	679
21	1204	662
30	993	659
2	1055	636
18	1174	625
19	684	598
16	512	550
4	846	536
13	679	500
26	629	495
15	917	441
25	1229	428
7	790	407
3	1271	334
5	1036	330
32	783	328
6	396	251
12	224	246
14	369	235
31	346	214
9	180	104

Geographic Determination

Additional consideration for unit placement is the geographic location of the station. The department places ALS capable units in locations that are a significant distance from primary ambulance posts and hospitals. As a result, ALS units are generally positioned toward the perimeter of the city and in those areas that have extended ambulance response times.

ALS Station Recommendation

Based on the two criteria above, the following companies should be staffed at the paramedic level and provide ALS first response.

Station Priority	Clinically Significant Apparatus	Station Priority	Geographically Significant Apparatus
1	Engine 27	15	Engine 4
2	Ladder 27	16	Squad 26
3	Engine 29		
4	Squad 22		
5	Engine 24		
6	Squad 23		
7	Engine 17		Alternate/Future ALS
8	Engine 18		Engine 25
9	Engine 28		Engine 15
10	Engine 21		Engine 16
11	Engine 30		Ladder 29
12	Engine 20		
13	Engine 19		
14	Engine 10		

The priorities indicated above call for moving ALS capability from Stations 2 and 32 to Stations 4 and 10. After consideration of the data and the establishment of the priorities above, the Deployment Committee considered other factors related to implementation. Specifically, moving ALS capability from Station 2 to Station 4 with the current deployment model at Station 4 (technical rescue team) creates potential labor contract issues that prevent this move without negotiations or reassigning the TRT to another station. If only one of the moves was made, such as moving ALS capability from Station 32 to Station 10, it put near-duplicate ALS coverage on the north side of downtown. The committee also considered the geographical significance of moving ALS from Station 32. While the data shows that there is not a significant need for ALS coverage in the response areas of Stations 32 and 9, moving the coverage from this area would leave a tremendous gap south of 81st St. For these reasons, the committee decided that no moves were warranted under present conditions.

It should be noted that the landscape changes drastically if two conditions are altered:

- Increase ALS capability by one (17 ALS units instead of 16)
- Negotiation to place ALS capability at Station 4

Recommendations for Section 2

Current ALS Locations

After consideration of data and SME review no ALS moves are recommended for the calendar year 2017.

Annual Review

The TFD EMS Branch should conduct an annual review of first hour quintet and transfer of care data each fall and consider any needed shifts in ALS capabilities for implementation calendar year.

Additional ALS Capabilities

The TFD EMS Branch should implement additional ALS capabilities on current apparatus to address geographically significant stations.

Section 3: Multi-Company Stations

First-in coverage (*Section 1* of this report) is a measure of the department's ability to respond one unit with appropriate capabilities to any type of call (fire, medical, or other) within four minutes' drive time (six minutes of the call) 90% of the time. First-in coverage establishes the need for fire station locations, or what the department refers to as its "footprint". *Section 2* of this report determined which stations should have apparatus that respond with an advanced level of EMS care.

The methods used in this section aim to use a reproducible methodology to determine which of the department's 29 stations should be single company stations and which stations should have a second apparatus (multi-company stations). There are several variables involved which must be considered simultaneously:

1. Tulsa currently has 29 fire stations. Looking at the highest priority fire station additions and moves recommended in *Section 1* (Stations 33, 34, 27, and 18), this would increase to 31. Of these 31 locations, all are assumed to have at least one unit, normally a fire engine.
2. Of the 31 stations, six stations (Stations 5, 12, 14, 15, 17, and 21) are not physically able to accommodate a second apparatus.
3. Of the 31 stations, five of them must house an EMS squad as their second apparatus. These stations may either house a combination of an engine company and a squad or a ladder company and a squad. Since inception, the department's squads have been two person ALS units. Each squad station has a primary unit (either an engine or ladder) carrying a fourth person to supplement for the two person squad on a fire scene. The committee has not ruled out the possibility that squads may either be ALS or BLS. The committee has also not ruled out the possibility of moving the fourth person on the engine or ladder at squad stations onto the squads. Current squad apparatus are only designed to carry two personnel; however, two squad apparatus are due for replacement and could be designed to carry more than two personnel.
4. Engine company spacing per ISO uses diamonds with three mile diagonals. Ladder company spacing per ISO uses diamonds with five mile diagonals. These two patterns do not coincide, so at some point there has to be overlap and/or gaps in coverage. The goal is for overlaps to occur in areas such as downtown areas or other areas where ladder coverage is critical. Ideally any gaps in ladder coverage should be in areas where engine companies can handle the primary needs of the incident until a ladder can arrive from a greater distance.

The overall goal of all variables considered in this section is the ability to deploy a standardized set of personnel and equipment (a full alarm assignment) to a structure fire within eight minutes' drive time. The number of personnel and equipment is based on the type/size of the structure. This section addresses the capabilities of the department to provide the following:

Effective Firefighting Force – Ability to get the appropriate number of personnel and equipment with the appropriate capabilities on the scene of a fire incident in a predetermined time. Effective firefighting force is measured by the ability of a department to get a predetermined number of personnel on scene within eight minutes' drive time (10 minutes and 20 seconds from time of the call) 90% of the time. The predetermined number of personnel is based on the predominant hazard/type of the building. Generally, buildings are classified as one of the following: single-family residence, garden apartment, strip mall, commercial, industrial, or high rise.

Aerial Ladder Coverage - Meet insurance rating requirements for aerial ladder apparatus coverage. To receive full credit for aerial coverage, the city is required to have aerial ladders (minimum of 100 feet in height) spaced on five mile diamonds throughout the city.

Resilience - Provide for resilience of operations in times of peak demand. Resilience means not only covering for the fire department's response needs, but also covering for peak ambulance service times and disaster response needs.

Safety - Allow Tulsa's firefighters to operate in a safe workplace with the help and support they need to conduct firefighting operations. The end goals are life safety, or the ability to quickly conduct a rescue from a fire, and property conservation. Property conservation first considers the ability to prevent fire spread to adjacent buildings followed by minimizing the damage to the involved building.

Effective Firefighting Force

Two primary sources give guidance in the area of effective firefighting force: ISO and NFPA.

ISO Engine Company Coverage

ISO provides requirements for scoring a department's effective firefighting force using one of two methods. First, a department may place engine and ladder companies using prescribed intervals (diamonds with three mile diagonals for engine companies, and five mile diagonals for ladder companies). With the 2012 revision of the ISO Fire Suppression Rating Schedule, departments are allowed to use a second methodology: a deployment analysis using CAD data based on NFPA 1710 requirements.

Figure 27 shows the current arrangement of the city's engine company coverage. It should be noted that Stations 22, 23, 26, and 32 have a squad and a ladder. The current ladder apparatus at these stations are 65-foot aerial devices with fire pumps and water tanks (quints)[7]. For ISO purposes they can count as both an engine and a ladder; however, they may only receive full credit for their primary purpose (engine or ladder). Then they receive half credit for their secondary purpose. Any ladder apparatus in the city receives a deduction if it is under 100 feet in length. The areas of most concern in Figure 27 are built upon areas without engine coverage. In its most recent ISO evaluation (2012), ISO indicated that the city should have 37 engine companies. In the 2012 ISO evaluation, four of the city's 13 ladder companies (Ladders 22, 23, 26, and 32) where counted as engine companies as their primary purpose, giving the city credit for 29 engine companies.

[7] As of date of this report, all TFD front line ladder apparatus are quints. One cross-staffed ladder remains at Station 2 that is not a quint; however, this ladder is currently on the list for replacement.

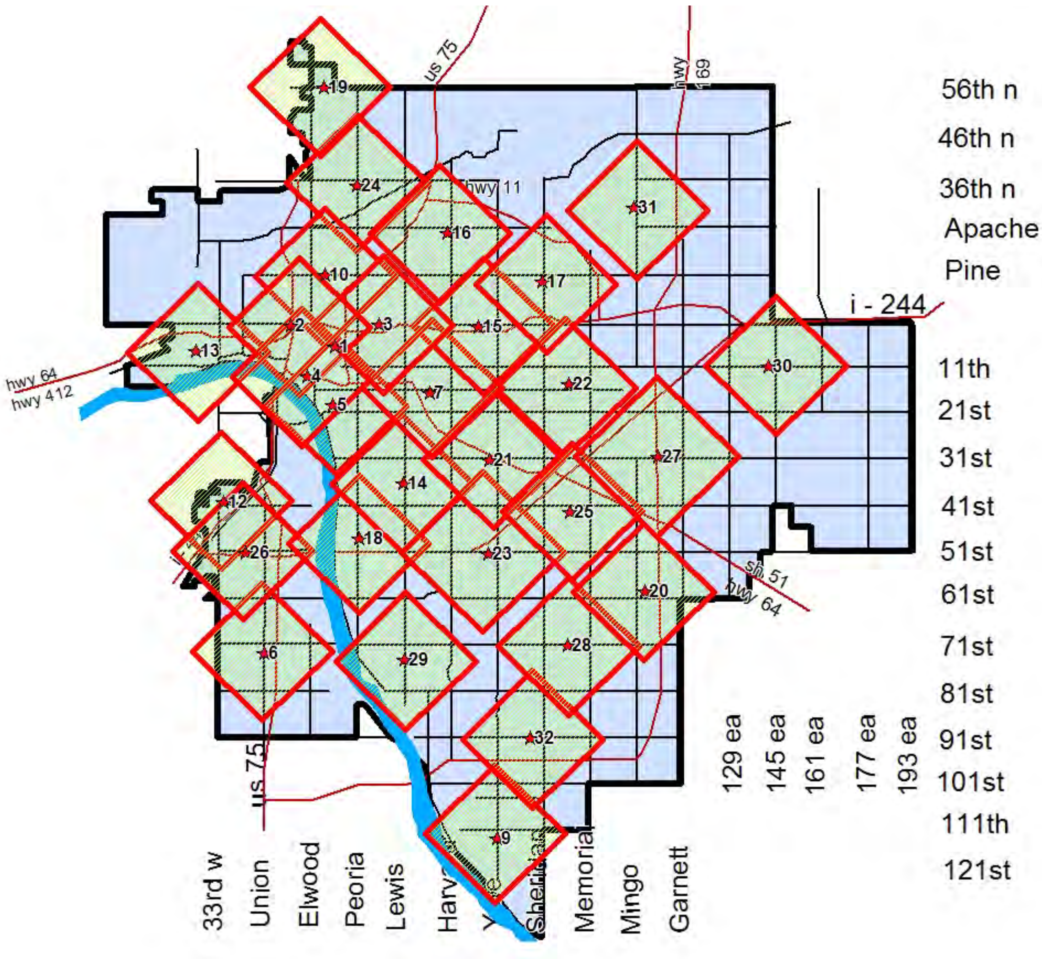


Figure 27: TFD Engine Coverage (2016)

ISO Ladder Company Coverage

Figure 28 shows Tulsa's current ladder company coverage. The coverage is generally consistent in the populated areas of Tulsa except for the areas between Stations 15 and 16 and Stations 14 and 18. Both areas have distinct commercial areas that necessitate ladder coverage. For ISO purposes, four of these diamonds are receiving 50% credit because the apparatus' primary purpose is being used to count as engine coverage. Each of these four apparatus is further receiving a reduction in credit for being less than a 100-foot ladder. The ISO grading system is somewhat complex, and the choice of the primary function of each apparatus is determined at each grading to provide maximum advantage to the city. The take away from this is that the City of Tulsa, both in reality and in ISO grading, generally has adequate ladder coverage. The exception to this statement has been the type of ladder apparatus the fire department is using. Ladders 7, 20, 22, 23, 24, 26, 27, 30, and 32 are all 65-foot quints. While there is an allowance for a limited number of these apparatus to remain in their current type of apparatus where it makes sense both practically and for purposes of ISO rating (Ladders 24, 26, and 30), the remaining ladders should, upon replacement, be outfitted with 100-foot aerials. Figure 29 shows the parcels in the City of Tulsa which contain three story or greater buildings. Any buildings greater than five stories (yellow or red) are beyond the effective reach of the current 65-foot ladders. At the time of this report TFD was in the process of replacing four of the 65-foot units.

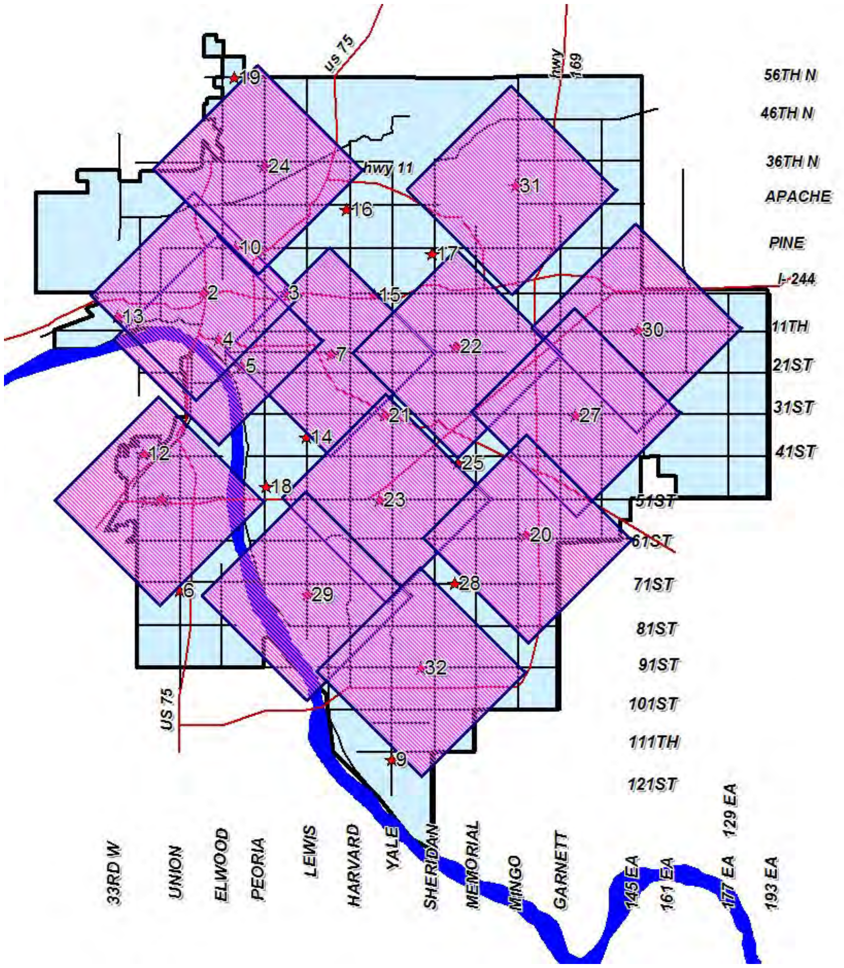


Figure 28: TFD Ladder Coverage (2016)

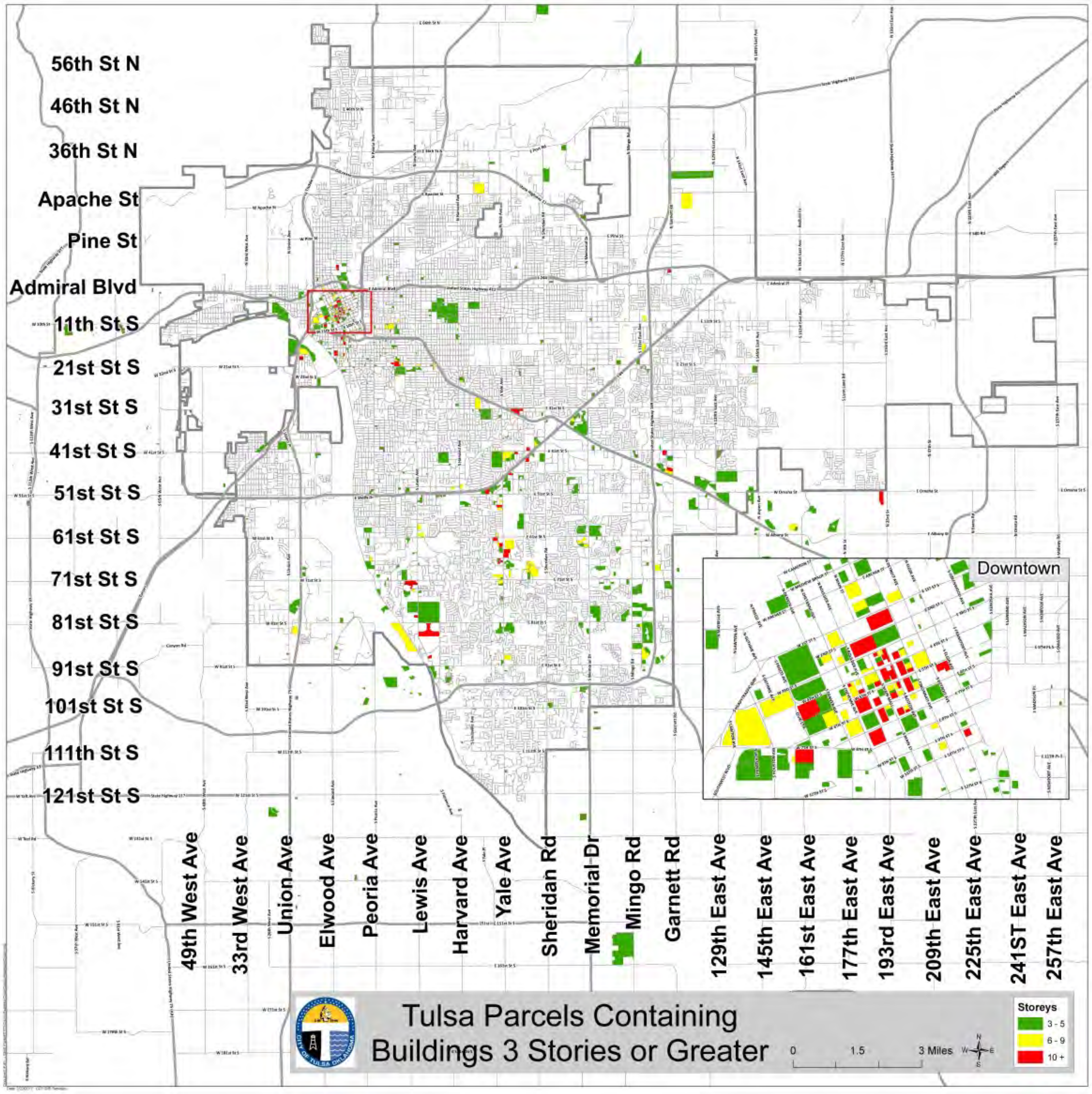


Figure 29: Buildings Three Stories and Greater

Figure 30 shows the department's coverage by specialty ladder apparatus. These apparatus are 114-foot or 118-foot articulating aerial apparatus. The diamonds in Figure 30 have 10 mile diagonals. The 10 mile diagonals do not correspond to any specific standards. Rather they show the anticipated coverage range of these units when needed for special purposes. The locations of these apparatus are also included in Figure 29. Placement of these apparatus corresponds with target hazards. As a matter of practicality, these apparatus are more expensive and more complicated than standard 100-foot straight aerial quints. Their reliability has been questionable. The department has had a number of high profile and critical incidents where these apparatus have excelled. In most, if not all, cases the same function could have been performed by an equivalent length heavy-duty aerial platform (quint). As these apparatus are replaced, aerial platforms should be considered.

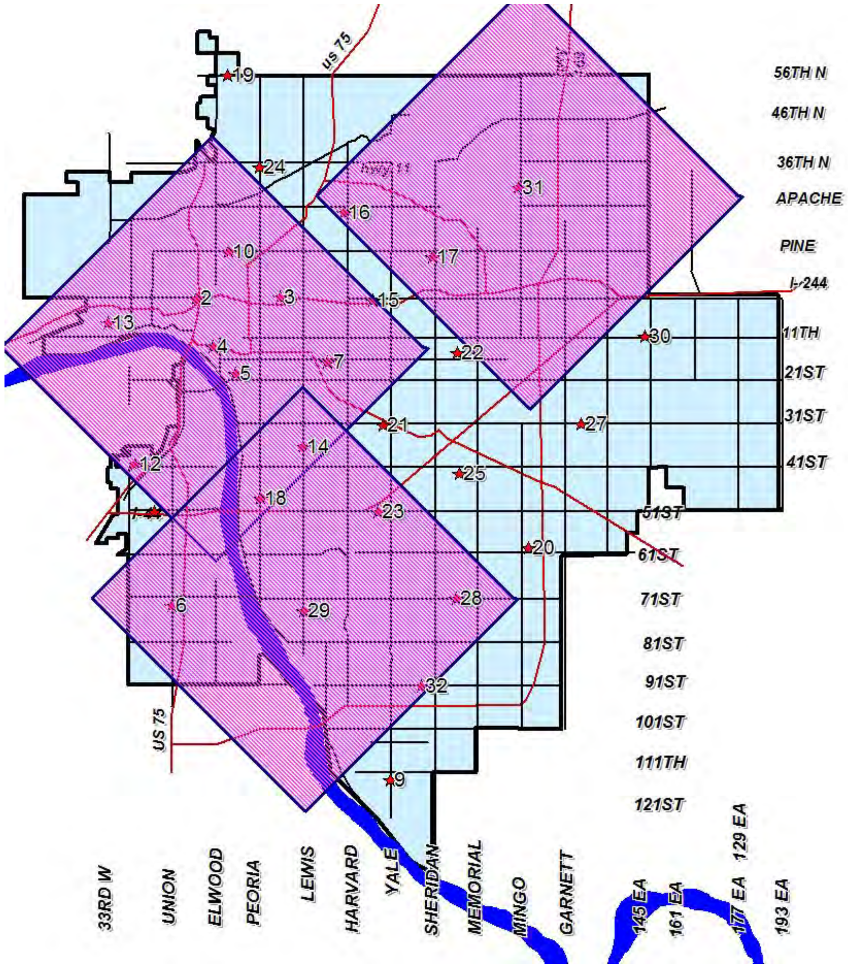


Figure 30: TFD Specialty/Heavy-Duty Ladder Coverage

NFPA Effective Firefighting Force

NFPA 1710 provides the most detailed guidance on effective firefighting force. This standard details effective firefighting force requirements using four defined occupancy types:

- Single-family dwelling
- Open-air strip shopping center
- Apartment
- High rise

NFPA 1710 lists a functional description of the tasks required to be completed by the initial alarm assignment. The time constraints (eight minute drive time 90% of the time[8]) allow departments to determine the type of apparatus and staffing needed for compliance. Below are tables detailing the NFPA 1710 effective firefighting force for each of the four types of structures defined by NFPA (Table 3, Table 5, Table 7, and Table 9). Following each table is a similar table detailing the department's staffing requirements based on actual experience and conditions found in Tulsa (Table 4, Table 6, Table 8, and Table 10). It is important to remember that these tables (either NFPA or TFD) are only the number of firefighters required on scene initially. If an incident is escalating or is not quickly controlled, additional alarm assignments and personnel must be called. With each additional request for apparatus and

[8] High-Rise response allows 610 seconds/10.2 minutes' drive time.

personnel, the travel time increases because the incident has depleted the concentric rings of resources closest to the incident. Getting enough resources early in the incident is critical to both life safety and property conservation.

NFPA Single Family Task	Personnel
Command	1
Water Supply/Pump Operator	1
(2) Hoselines	4
Hoseline Support (1 per line)	2
Search/Rescue	2
Ventilation/Ladders/Aerial Operator	3
Initial Rapid Intervention Crew	2
Total	**15**
Staff Aid for IC (Safety Officer) (5.2.2.2.5) No Time Defined	1
Escalating Incident - Add	
EMS	2
Rapid Intervention – Supplement	2
Total	**20**

Table 3: Initial Effective Firefighting Force - NFPA 1710 Minimum Staffing Requirements within 8 Minute Travel Time for 2000 Square Foot Single Family Home with no Basement and no Exposures. (5.2.4.1, p. 10-11)

TFD Single Family Task	Personnel
Command	1
Safety Officer	1
Water Supply/Pump Operator	2
(2) Hoselines	4
Hoseline Support (1 per line)	2
Search/Rescue	3
Ventilation/Ladders/Aerial Operator	3
Initial Rapid Intervention Crew and Back-up Water Supply	3
EMS Crew	2
Total	**21**

Table 4: Initial Effective Firefighting Force - Actual Functions and Personnel Required by Tulsa Fire Department within 8 Minute Travel Time for a 2000 Square Foot or Less Single Family Home with no Basement and no Exposures.

NFPA Strip Mall Task	Personnel
Command	2
Water Supply/Pump Operator	2
(3) Hoselines	6
Hoseline Support (1 per line)	3
Search/Rescue	4
Ventilation/Ladders/Aerial Operator	5
Initial Rapid Intervention Crew	4
EMS	2
Total	**28**
Staff Aid for IC (Safety Officer) (5.2.2.2.5) No Time Defined	1
Total	**29**

Table 5: Initial Effective Firefighting Force - NFPA 1710 Minimum Staffing Requirements within 8 Minute Travel Time for Open-Air Strip Shopping Center of 13,000 Square Feet to 196,000 Square Feet. (5.4.2.2, p. 11)

TFD Strip Mall Task	Personnel
Command	1
Safety Officer	1
Water Supply/Pump Operator	2
(3) Hoselines	6
Hoseline Support (1 per line)	3
Exposure Protection	3
Search/Rescue	6
Ventilation/Ladders/Aerial Operator	3
Initial Rapid Intervention Crew and Back-up Water Supply	3
EMS Crew	2
Total	**30**

Table 6: Initial Effective Firefighting Force – Actual Functions and Personnel Required by Tulsa Fire Department within 8 Minute Travel Time for Open-Air Strip Shopping Center of 13,000 Square Feet to 196,000 Square Feet

NFPA Apartment Task	Personnel
Command	2
Water Supply/Pump Operator	2
(3) Hoselines	6
Hoseline Support (1 per line)	3
Search/Rescue	4
Ventilation/Ladders/Aerial Operator	5
Initial Rapid Intervention Crew	4
EMS	2
Total	**28**
Staff Aid for IC (Safety Officer) (5.2.2.2.5) No Time Defined	1
Total	**29**

Table 7: Initial Effective Firefighting Force - NFPA 1710 Minimum Staffing Requirements within 8 Minute Travel Time for 1200 Square Foot Unit in a Three-Story Garden Apartment. (5.4.2.3, p. 11)

TFD Apartment Task	Personnel
Command	1
Safety Officer	1
Water Supply/Pump Operator	2
(3) Hoselines	6
Hoseline Support (1 per line)	3
Exposure Protection	3
Search/Rescue	6
Ventilation/Ladders/Aerial Operator	3
Initial Rapid Intervention Crew and Back-up Water Supply	3
EMS Crew	2
Total	**30**

Table 8: Initial Effective Firefighting Force – Actual Functions and Personnel Required by Tulsa Fire Department within 8 Minute Travel Time for 1200 Square Foot Unit in a Three-Story Garden Apartment.

NFPA High-Rise Task	Personnel
Command	2
Water Supply/Pump Operator Standpipe/Fire Pump Monitor	2
(3) Hoselines	6
Initial Rapid Intervention Crew	4
Search/Rescue	4
Entry Point Officer (Fire Attack)	1
Evacuation	4
Elevator Control	1
Safety Officer	1
Staging Officer	1
Rehab Crew	2
Ventilation	4
Lobby Control	1
Equipment Transport	2
Base Officer	1
EMS	4
Total	**40**

Table 9: Initial Effective Firefighting Force - NFPA 1710 Minimum Staffing Requirements within 8 Minute Travel Time for High-Rise Building. (5.4.2.4, p. 11-12)

TFD High-Rise Task	Personnel
Command	1
Safety	1
Water Supply/Pump Operator Standpipe/Fire Pump Monitor	3
(3) Hoselines	6
Support for Hoseline Crews	3
Initial Rapid Intervention Crew	3
Search/Rescue and Evacuation	6
Entry Point Officer (Operations)	1
Staging Crew	3
Rehab Crew	3
Ventilation	3
Lobby Control/Elevator Crew	3
Equipment Transport	3
Base Crew	3
EMS	4
Total	**46**

Table 10: Initial Effective Firefighting Force – Actual Functions and Personnel Required by Tulsa Fire Department within 8 Minute Travel Time for High-Rise Building

NFPA requirements and TFD experience do not vary greatly. NFPA numbers are certainly more conservative. For the purposes of measurement in this study, the department has chosen to use the following NFPA numbers[9]:

Single family dwelling: 15 firefighters/8 minutes travel time (Table 3)

Strip mall/apartment: 28 (27[10]) firefighters/8 minutes travel time (Table 5, Table 7)

Table 11shows the actual initial alarm assignments that dispatched to each of seven classes of building fires. Additionally, this table shows the standard set of additional resources for second and third alarms. From this table, it can be seen that even with a substantial commitment of resources to each of these fire types, TFD is only meeting NFPA requirements for staffing on the initial deployment to small single-family house fires.

[9] TFD's ability to provide adequate personnel to confirmed high-rise fires is an area for future study.
[10] Due to the granularity of the measurement tools, the number 27 was the closest conservative measurement available. The intent of this measurement has been to err on the conservative side to avoid any agendas. The next closest granulation is 30.

Structure Type	Alarm Class	Apparatus	Personnel
House Fire <2000SF	Class C	4 Engines/1 Ladder/1 Chief	17
House Fire>2000SF	Class A	5 Engines/2 Ladders/1 Chief	23
Strip Mall	Class A	5 Engines/2 Ladders/1 Chief	23
Apartment	Class A	5 Engines/2 Ladders/1 Chief	23
Commercial	Class A	5 Engines/2 Ladders/1 Chief	23
Industrial	Class A	5 Engines/2 Ladders/1 Chief	23
High-Rise	Class A	5 Engines/2 Ladders/1 Chief	23
Second Alarm		2 Engines/1 Ladder	9
Third Alarm		2 Engines/1 Ladder/1 Chief	11

Table 11: Tulsa Fire Department Effective Firefighting Force – Initial Full Alarm Assignment to Structure Fires

Table 11 considers three additional types of structures[11] to which the department routinely responds:

1. Single family dwelling, greater than 2000 square feet
2. Commercial
3. Industrial

For purposes of this study, these three classifications have been equated to either a strip mall or apartment NFPA classifications, both of which require the same number of responders – 28.

Table 3 through Table 11 do not indicate the time it takes to get personnel on scene, only the number of personnel required, and in the case of Table 11, the number of TFD personnel initially dispatched. The second consideration of effective firefighting force is the time it takes to get these apparatus and personnel to the scene. The fractile times it takes to get the initial alarm assignment on scene are easily obtained from CAD data. CAD data provides historical data on the department's performance (i.e., historically what percentage of incidents TFD has been able to get the entire first alarm assignment on scene within eight minutes' drive time). There are limitations to using CAD data. For instance, if the department has not had a structural fire incident in a certain part of the city during the measurement period, there will be no data for assessment. Further, if an anomaly occurred in actual deployment due to units not being available (thereby increasing deployment time), the data will not be accurate for predictive modeling. More useful for resource planning is a predictive tool that is able to count the number of personnel that can respond to each part of the city within eight minutes' drive time. The next part of this report discusses the methodology the department uses to determine effective firefighting force requirements and modifications.

Methodology

The TFD methodology to determine effective firefighting force is based on an assumption that all populated areas of Tulsa should receive a minimum response of 15 firefighters within eight minutes' drive time 90% of the time. This assumption is grounded in both NFPA and ISO requirements for a single family dwelling. From this baseline assumption, the department has identified certain parts of the city that have other predominant building types, and therefore, require greater resources within eight minutes' drive time.

[11] The 2016 version of NFPA 1710 added staffing requirements for three types of structures (open-air strip mall, garden apartment, and high-rise). Prior editions only considered <2000SF single family dwelling fires. It is anticipated that NFPA will continue to add staffing requirements for more classes of structures with new editions of NFPA 1710.

Figure 31 shows a GIS analysis of Tulsa's personnel response capability.

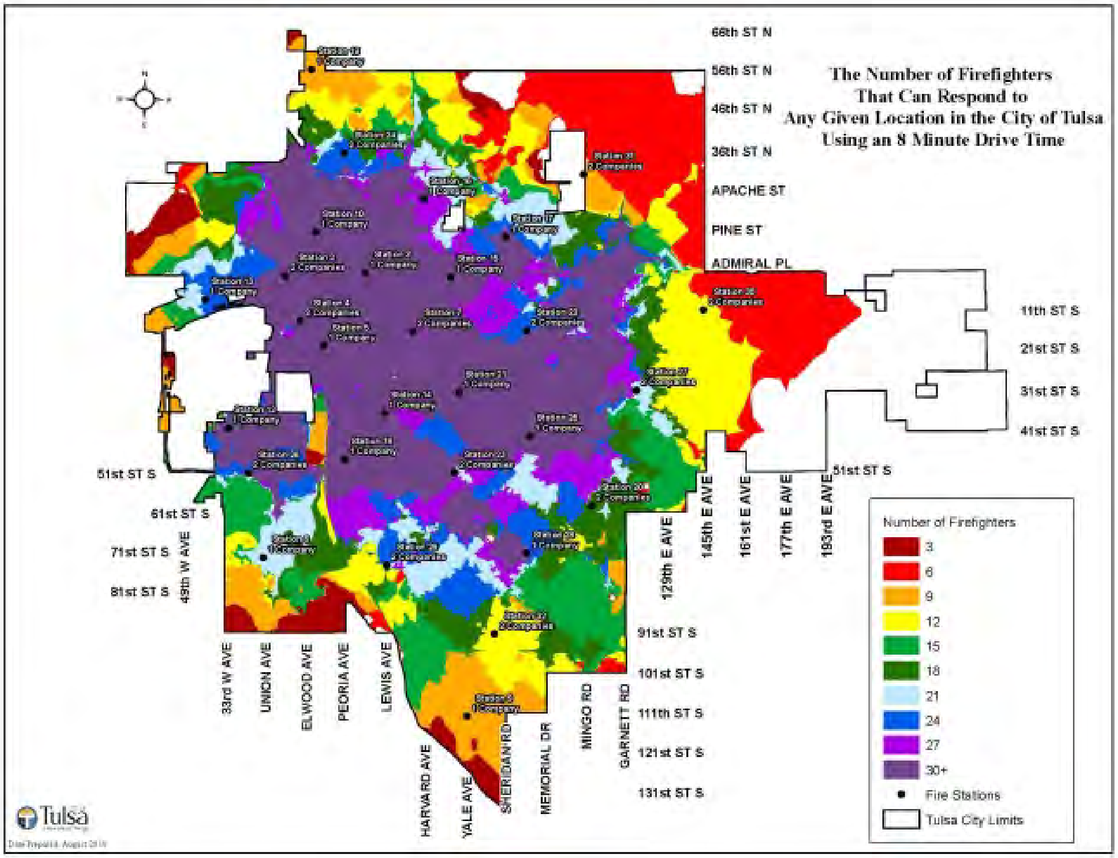


Figure 31: TFD Personnel Available within Eight Minutes' Drive Time (2016 Stations)

Predominant Structure Type:

Two numbers have been considered for measuring the department's ability to meet the predominant hazard in various areas of the city.

1.	Single family dwelling, less than 2000 square feet	15 firefighters/8 minutes travel time (Table 3)
2.	Strip mall/apartment industrial/commercial/ dwelling of more than 2000 square feet	28(27) firefighters/8 minutes travel time (Table 5, Table 7)

It is assumed that all populated areas of Tulsa have single family residences and hence require a minimum of 15 personnel. Figure 32 shows an aerial image of Tulsa with the predominant structure types (larger than single family dwelling) for each area. Please note that structures of all types exist in nearly all areas of the city. The committee attempted to define the areas of Tulsa where there was a distinct concentration of a certain type of structure. This is a subjective determination by subject matter experts. The intent was to be conservative. For example, one could say that every part of Tulsa needs 28 firefighters within eight minutes' drive time because there are open-air strip malls on virtually every main thoroughfare in Tulsa. This would be an unrealistic expectation.

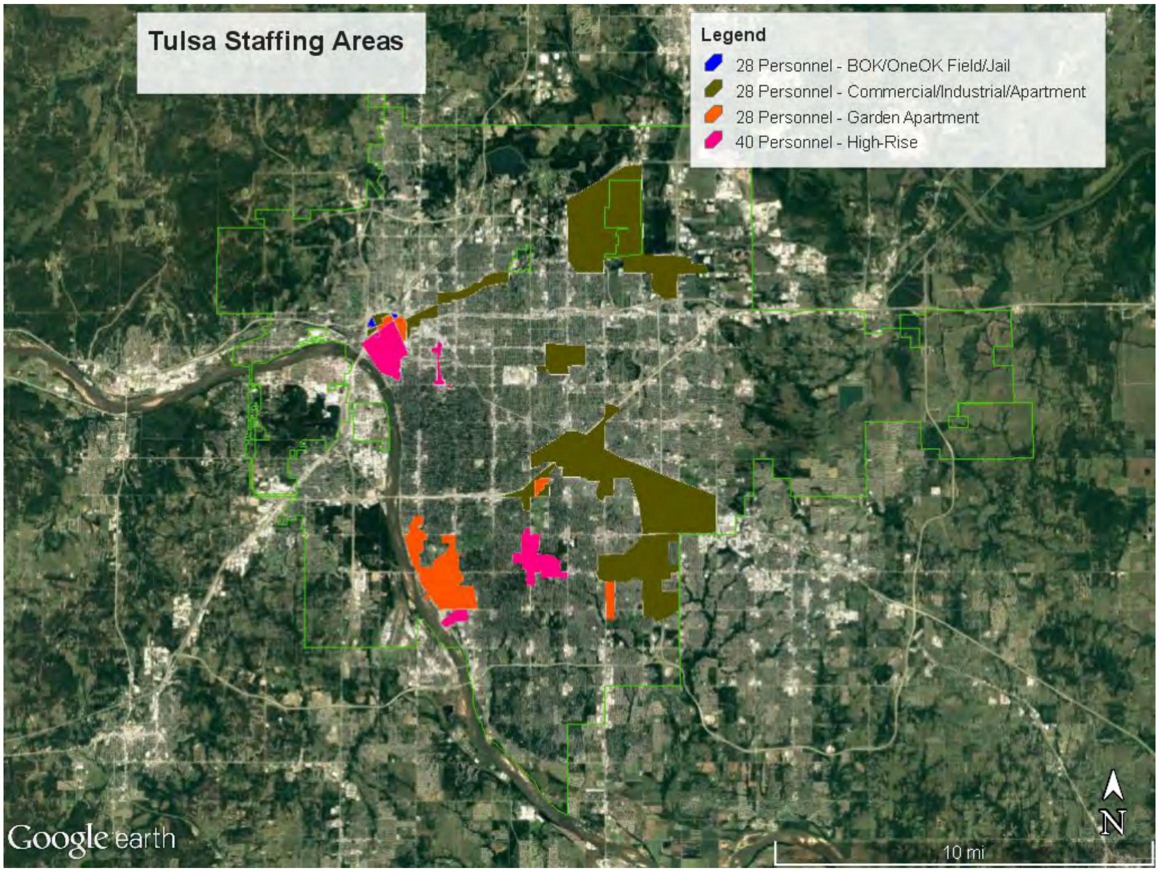


Figure 32: City of Tulsa Predominant Structure Types

Single Family Dwelling Coverage – 15 Personnel

Figure 33 shows the areas where TFD can provide an adequate response to a single family dwelling of less than 2000 square feet. The chalked in areas of this figure indicate the portions of the city to which the department can respond 15 personnel within an eight minute drive time. A frame of reference bounded by 36th St. North, 91st St., 33rd W. Ave, and 145th E. Ave has been provided in all figures. Two areas in Figure 33 are of most concern when compared to the populated areas of Tulsa and the areas experiencing incidents (Figure 4). First is the eastern part of Tulsa from 129th E. Ave to 193rd E. Ave and south of Admiral Pl. The second area is the corridor south of 91st St. between Harvard and Memorial.

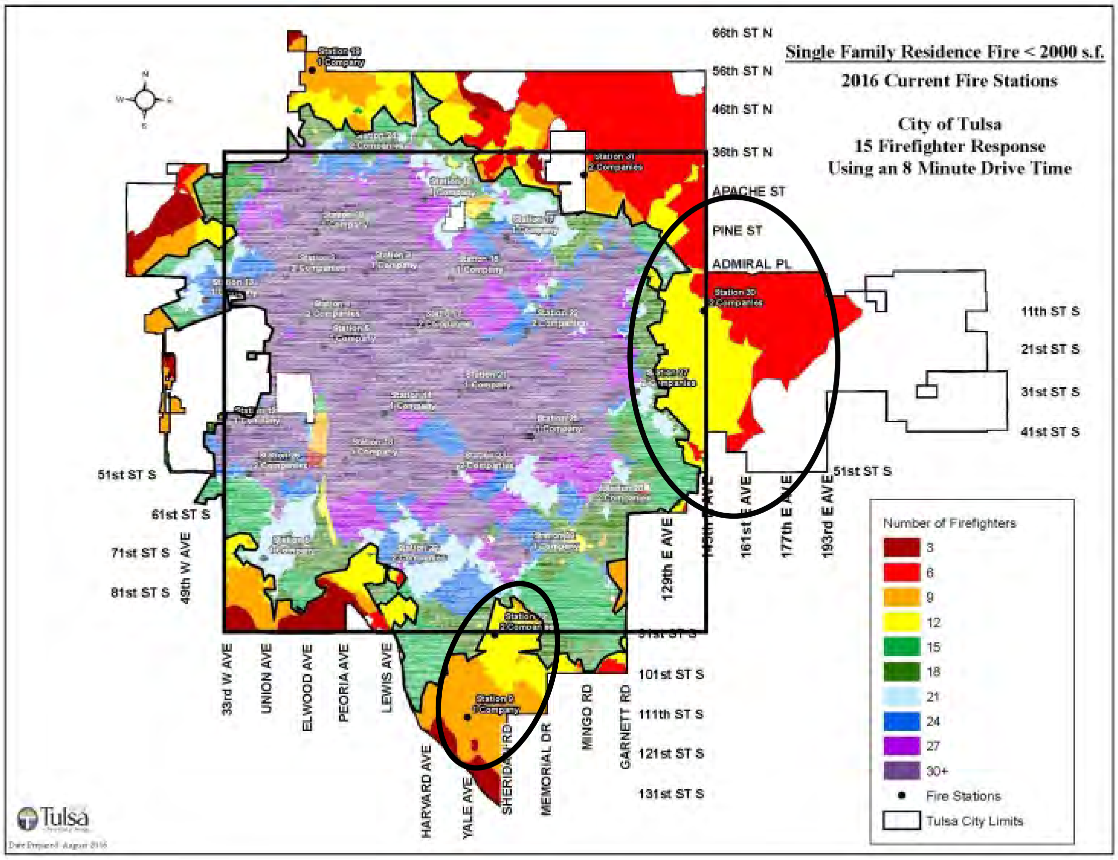


Figure 33: City of Tulsa 15 Firefighter Response Using Eight Minute Drive Time – Chalked in Areas (2016). Central Square is Frame of Reference.

The Deployment Committee considered a total of seven scenarios considering the fire station moves/additions from *Section 1* (Table 12/Table 13). Graphic representations of all single family dwelling (less than 2000 square feet) scenarios can be found in Appendix D. Of the scenarios considered, Scenario 6 yielded the most cost effective and readily achievable solution (Figure 34). This scenario included the highest priority fire stations recommended by *Section 1* (Stations 33, 34, 27, and 18) and the addition of an additional fire company at Station 28.

Station Funding and Construction Phase	**Location**
1	New Station 33 at 13500 E. 41st St.
2	New Station 34 at 10400 E. Admiral Pl.
2	Move Station 27 to 10400 E. 31st St.
2	Move Station 18 to 5600 S. Peoria Ave.
3	Move Station 23 to 5900 S. Yale Ave.
3	New Station 35 at 8400 S. Mingo Rd.
4	New Station 36 at 3300 S. 177th E. Ave.

Table 12: Proposed Fire Station Funding/Construction Phases

Scenario:	Description:
1	Station Move/Construction Phases 1 and 2
2	Station Move/Construction Phases 1, 2, and 3
3	Station Move/Construction Phases 1, 2, 3and 4
4	Station Move/Construction Phases 1 and 2 with 4 person staffing of single company perimeter stations
5	Station Move/Construction Phases 1, 2, and 3 with 4 person staffing of single company perimeter stations
6	Station Move/Construction Phases 1 and 2 with new company at Station 28
7	Station Move/Construction Phases 1 and 2. Move Squad 32 to Station 28 and staff E28 and L32 with 4 personnel.

Table 13: Effective Firefighting Force Scenarios

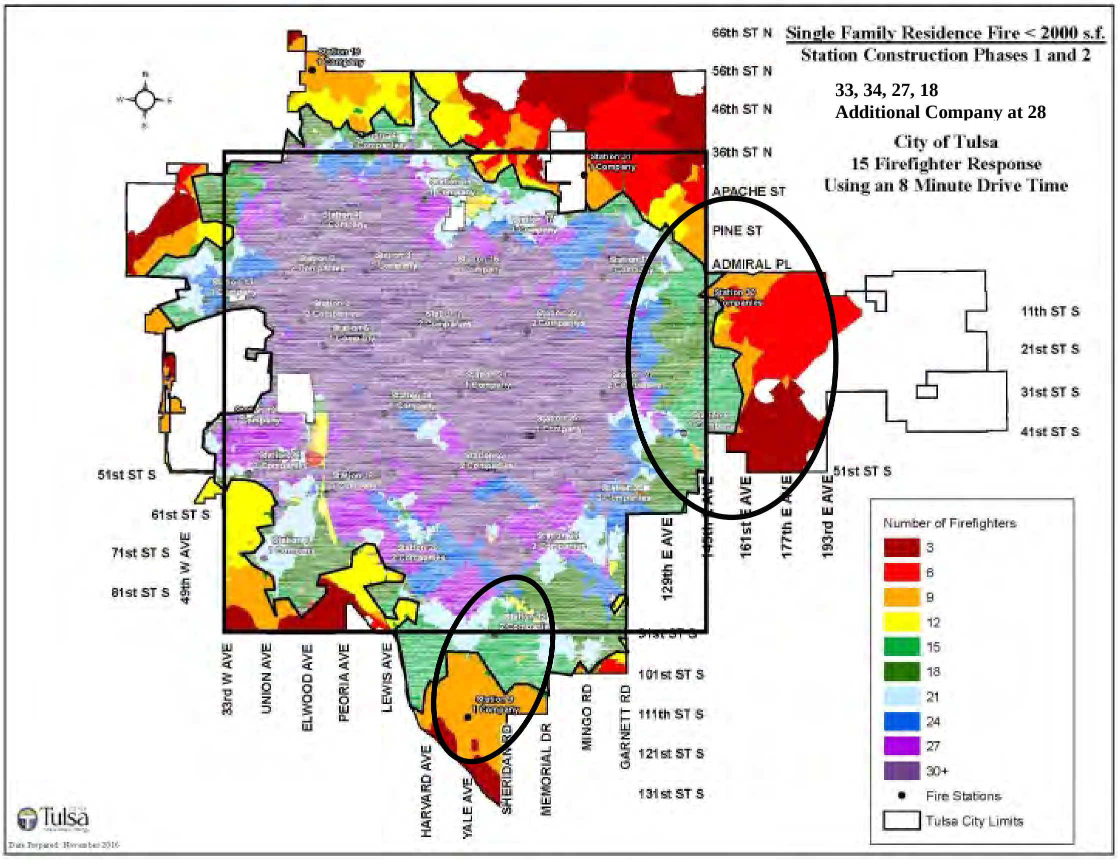


Figure 34: Single Family Residence Staffing Scenario 6

Strip Mall/Apartment and Other Large Structures – 28(27) Personnel

Figure 35 shows the areas where TFD can provide an adequate response to a strip mall, apartment, or other large structure. The chalked in areas of this figure indicate the portions of the city to which the department can respond 27 personnel within an eight minute drive time. A frame of reference bounded by 36th St. North, 91st St., 33rd W. Ave, and 145th E. Ave has been provided in all figures. Two areas in Figure 35 are of most concern when compared to the areas of higher staffing need in Figure 32. First is the corridor from 41st St. to 61st St. between Mingo Rd. and 129th E. Ave. The second is from 61st St. to 81st St. from Riverside Drive/Parkway to Garnett Rd.

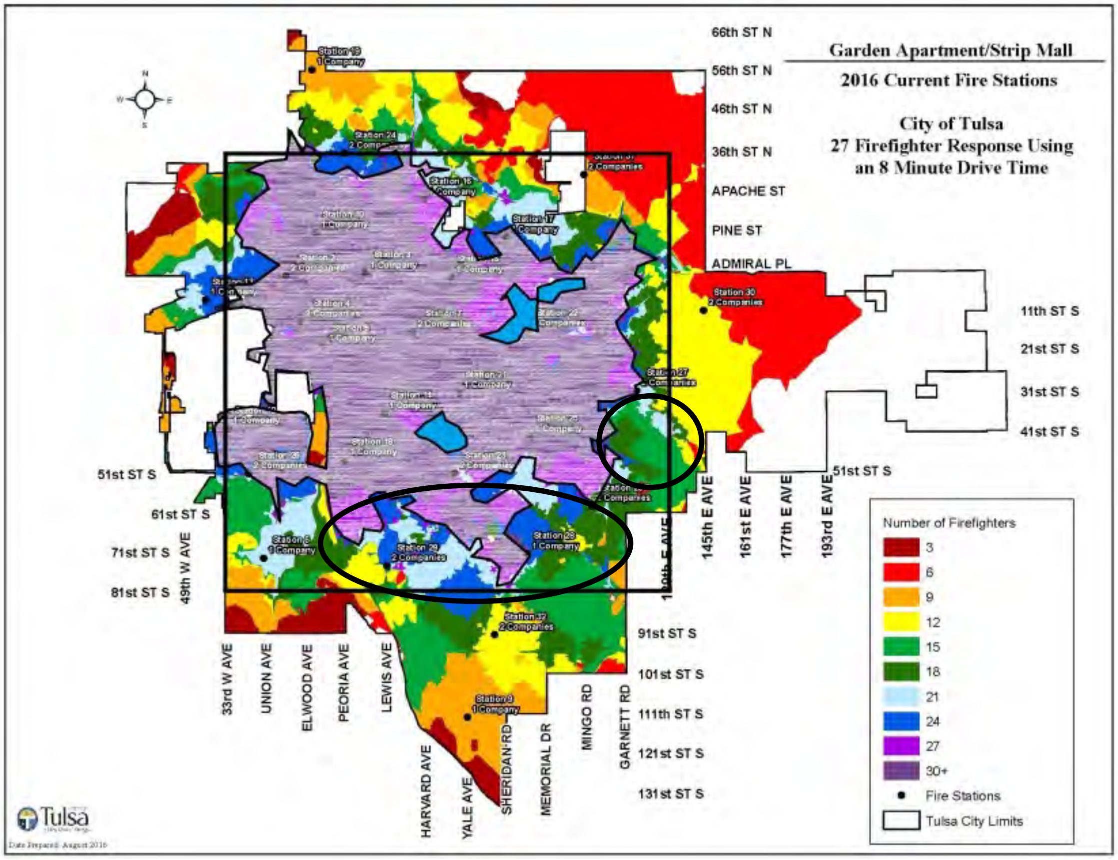


Figure 35: City of Tulsa 27 Firefighter Response Using Eight Minute Drive Time – Chalked in Areas (2016). Central Square is Frame of Reference.

The Deployment Committee considered a total of seven scenarios considering the fire station moves/additions from *Section 1*. Graphic representations of all strip mall/apartment and other large structures scenarios can be found in Appendix D. Of the scenarios considered Scenario 6 yielded the most cost effective and readily achievable solution (Figure 36). This scenario included the highest priority fire stations recommended by *Section 1* and the addition of an additional fire company at Station 28.

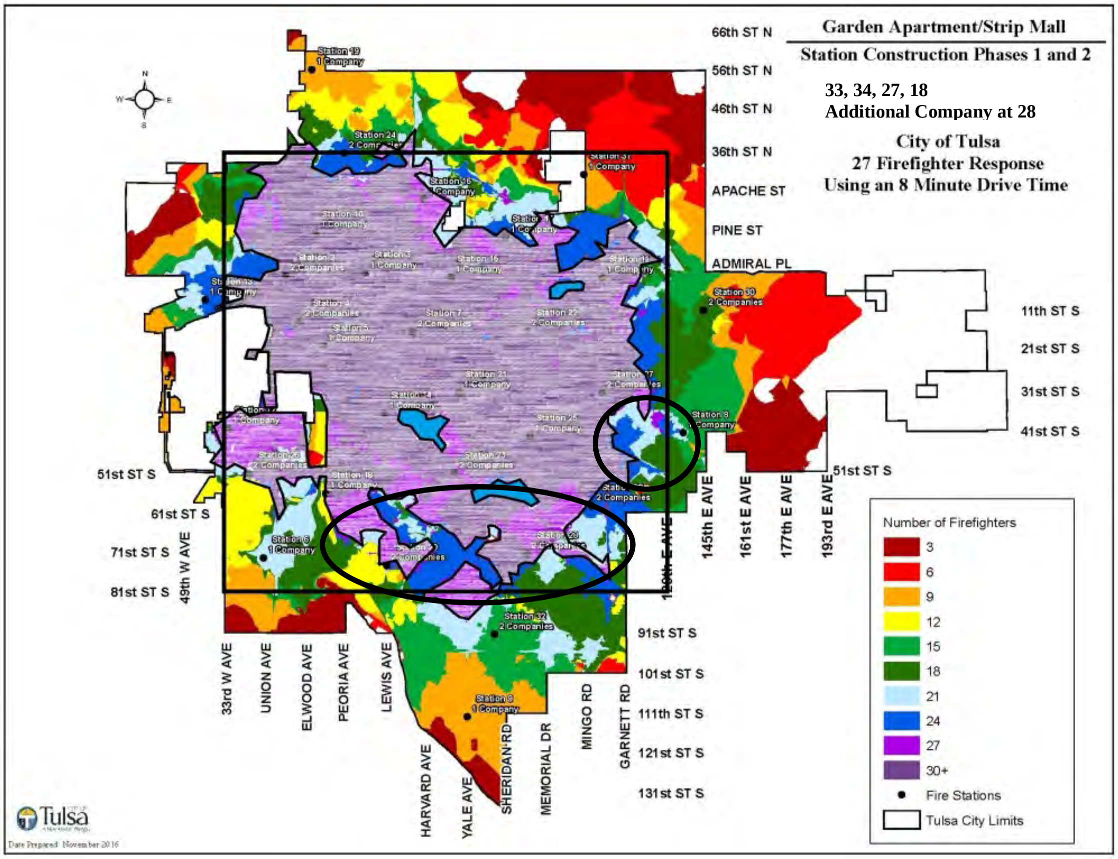


Figure 36: Strip Mall/Apartment/Large Structure Staffing Scenario 6

Resilience and Redundancy

In a world where the concepts of efficiency and government accountability have become mainstays, the concepts of resilience and redundancy have almost become unacceptable costs. A commonly heard phrase is that “Governments should operate like a business”. While most organizations, including TFD, look for ways to be more efficient, operating like a business that relies on just in time supply chains and logistics is a dangerous concept in public safety.

In addition to being a fire suppression and technical rescue department, TFD is the key underlying service that allows the Tulsa EMS system operate to operate using a dynamic deployment model. Further, TFD houses and staffs the key assets for Tulsa (and the eastern part of the state) for all-hazard responses such as major rescue and hazardous materials incidents and weather events.

In general TFD experiences a pattern of incidents that has increased calls during the normal waking day; however, there is no way to predict or pattern calls for an all-hazard response agency like a single purpose agency can. This is especially true for fires and all-hazard related responses such as rescues, hazardous materials calls, and weather events.

Figure 37, Figure 38, Figure 39, Figure 40, and Figure 41 demonstrate what happens to the fire department coverage when one first alarm fire call occurs in five areas of the city.

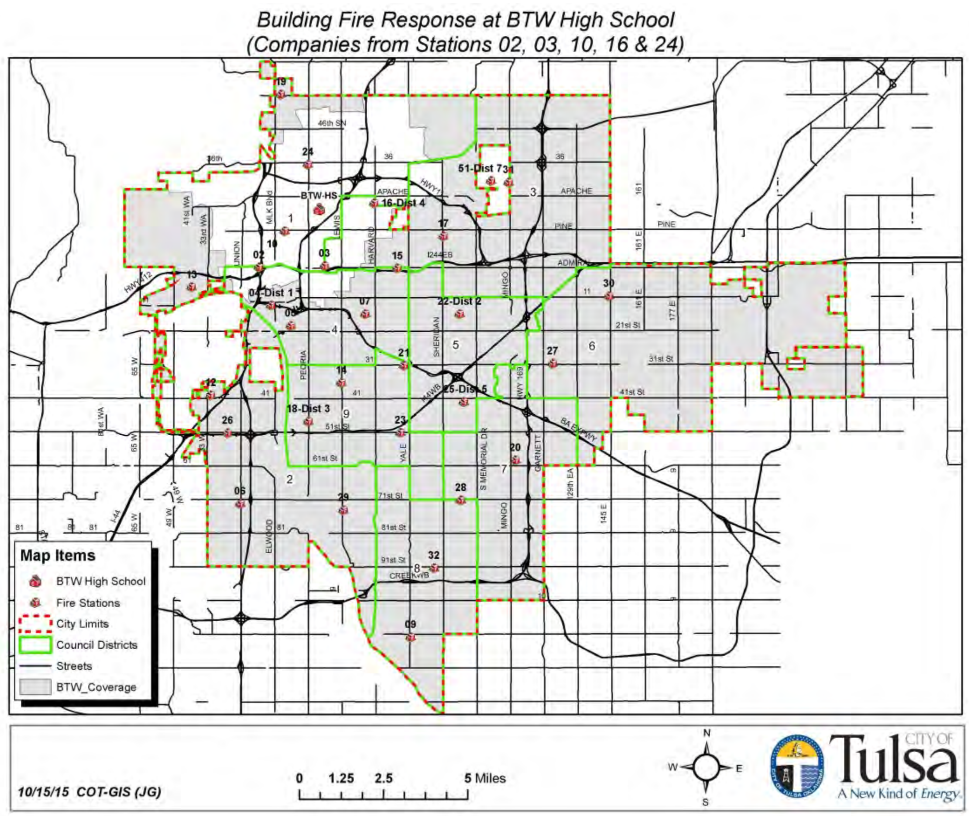


Figure 37: Effect on Citywide Fire/EMS Coverage – Single Incident - North Tulsa Building Fire

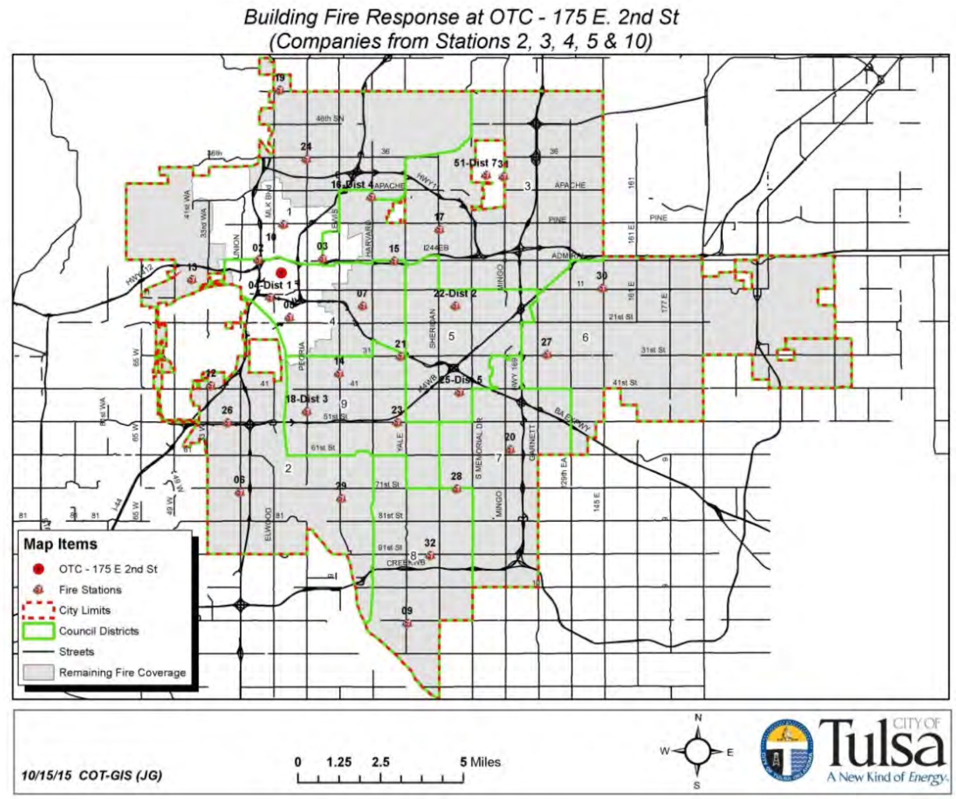


Figure 38: Effect on Citywide Fire/EMS Coverage – Single Incident - Downtown Tulsa Building Fire

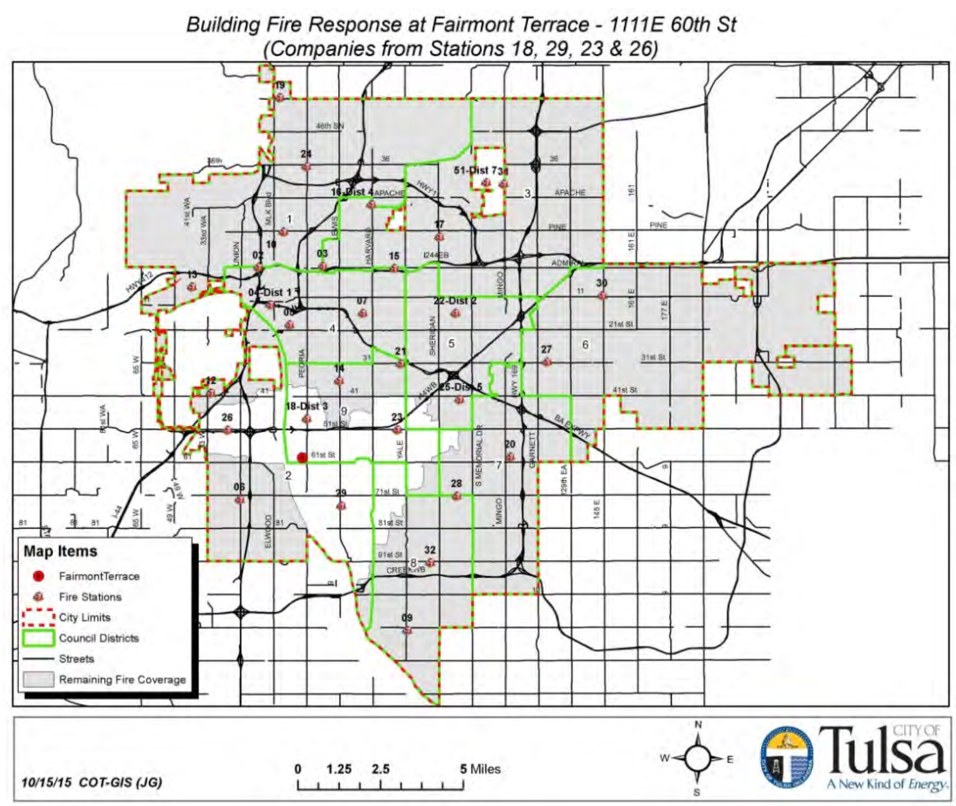


Figure 39: Effect on Citywide Fire/EMS Coverage – Single Incident - Southwest Tulsa Building Fire

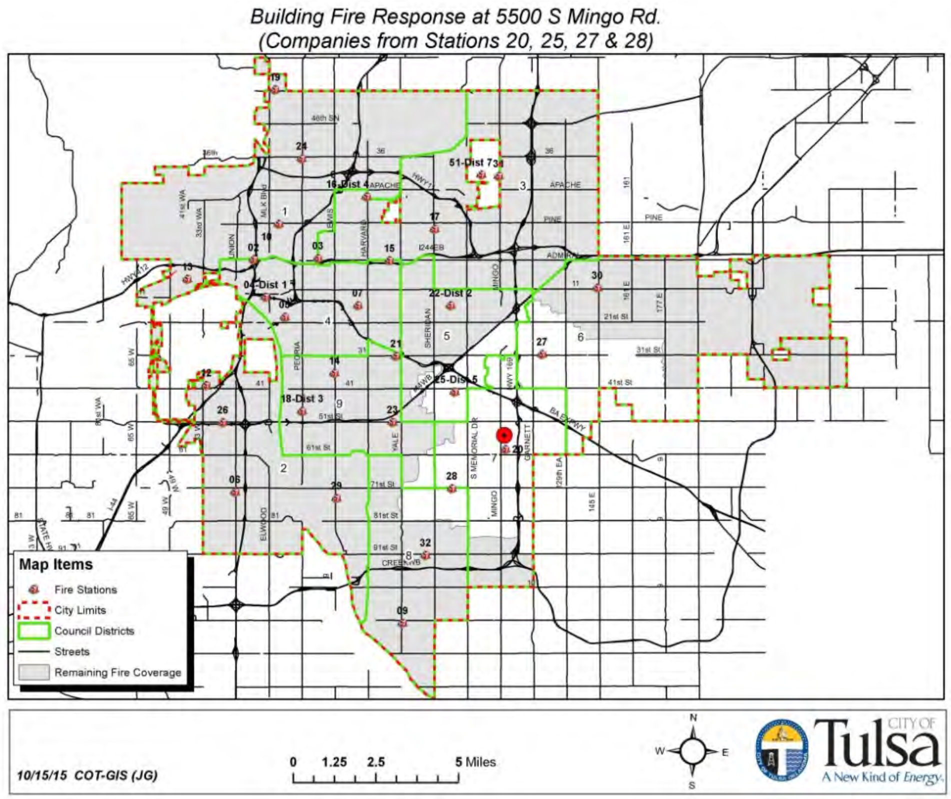


Figure 40: Effect on Citywide Fire/EMS Coverage – Single Incident - Southeast Tulsa Building Fire

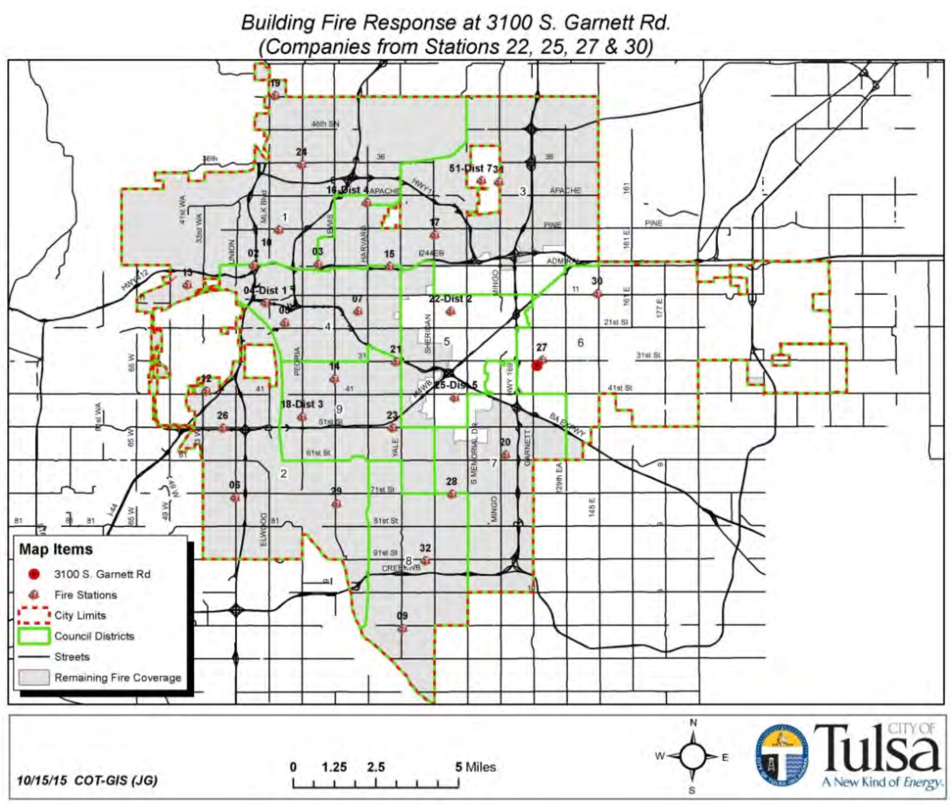


Figure 41: Effect on Citywide Fire/EMS Coverage – Single Incident - East Tulsa Building Fire

The maps above display a first alarm fire call. If a confirmed fire beyond the room of origin is found, the fire will require additional units to respond, creating an even larger gap in coverage. When gaps in coverage occurs at any time of the day, the on-duty Assistant Chief of Field Operations begins moving units from other parts of the city into stations in the affected area. This creates small but manageable coverage gaps in other parts of the city. However, it is very seldom that the City of Tulsa is experiencing only one call. Figure 42 shows an example of two simultaneous structure fires and several motor vehicle accidents (MVAs) requiring response from 22 of the city's 42 front-line apparatus.

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Street Closings Calls/Cases PSCWeb Reports

Your Calls (If Dispatched)

Dispatched

Unit	Call Type	Status	Time	Incident	Inc	Address	Issue
C641	APT	UC	17:15	TFD2016000022885	0392	2417 S Maybelle Ave	Apartment Fire
C644	HOUSE	OS	17:45	TFD2016000022892	0495	712 N Xanthus Ave	House Fire
C768	APT	EN	17:15	TFD2016000022885	0392	2417 S Maybelle Ave	Apartment Fire
ENG10	HOUSE	OS	17:45	TFD2016000022892	0495	712 N Xanthus Ave	House Fire
ENG12	APT	OS	17:15	TFD2016000022885	0392	2417 S Maybelle Ave	Apartment Fire
ENG15	HOUSE	OS	17:45	TFD2016000022892	0495	712 N Xanthus Ave	House Fire
ENG16	HOUSE	OS	17:45	TFD2016000022892	0495	712 N Xanthus Ave	House Fire
ENG18	MVACYCLE	OS	17:34	TFD2016000022890	0455	3920 S PEORIA AVE	MVA- Motorcycle/Bicycle/A
ENG2	APT	OS	17:15	TFD2016000022885	0392	2417 S Maybelle Ave	Apartment Fire
ENG24	HOUSE	OS	17:45	TFD2016000022892	0495	712 N Xanthus Ave	House Fire
ENG3	HOUSE	OS	17:45	TFD2016000022892	0495	712 N Xanthus Ave	House Fire
ENG4	APT	EN	17:15	TFD2016000022885	0392	2417 S Maybelle Ave	Apartment Fire
ENG5	APT	OS	17:15	TFD2016000022885	0392	2417 S Maybelle Ave	Apartment Fire
ENG7	APT	OS	17:15	TFD2016000022885	0392	2417 S Maybelle Ave	Apartment Fire
L23	MVA	OS	16:42	TFD2016000022871	0269	6100 E 51st St S	Motor Vehicle Accident
L24	HOUSE	OS	17:45	TFD2016000022892	0495	712 N Xanthus Ave	House Fire
L26	APT	OS	17:15	TFD2016000022885	0392	2417 S Maybelle Ave	Apartment Fire
L32	MVA	OS	17:12	TFD2016000022883	0381	6000 E 101ST ST S	Motor Vehicle Accident
L4	APT	OS	17:15	TFD2016000022885	0392	2417 S Maybelle Ave	Apartment Fire
L7	APT	OS	17:15	TFD2016000022885	0392	2417 S Maybelle Ave	Apartment Fire
SQ2	APT	OS	17:15	TFD2016000022885	0392	2417 S Maybelle Ave	Apartment Fire
SQ32	MVA	OS	17:12	TFD2016000022883	0381	6000 E 101ST ST S	Motor Vehicle Accident

Figure 42: Simultaneous Incidents - 1745 Hours/Weekday

Case Studies

Any incident that goes beyond the routine medial call or small fire will consume a tremendous amount of City of Tulsa response resources. Appendix E contains three case studies of recent seemingly routine or isolated incidents that quickly absorbed a tremendous number of resources.

1. Single Family Residence Fire – S. 33rd W. Ave
2. U-Haul Building Fire – Downtown
3. North Tulsa Tornado (EF-2).

TFD Apparatus

TFD operates several classes of front-line apparatus. Front-line apparatus are staffed with personnel 24 hours a day, seven days a week.

Front-Line Apparatus Consist of:

- 25 Engine Companies
- 12 Ladder Companies (13th ladder, Ladder 2, is cross staffed by Squad 2)
- 5 EMS Squads
- 1 Hazardous Materials Task Force (4-5 personnel with 2 apparatus)
- 2 Air & Light Support Units
- 5 District Chiefs
- 1 Assistant Chief
- 1 EMS Shift Officer

TFD also maintains an inventory of specialty apparatus and equipment. Incidents requiring these resources often occur at lower frequency than fires and EMS calls. Many times these incident are either highly technical and/or high-consequence incidents. Specialty apparatus are not normally staffed. Staffing for specialty units comes from taking on-duty personnel from front-line units (cross-staffing) or, in the case of state and regional level incidents, calling in off-duty personnel.

Cross Staffed Specialty Units:

- 1 Heavy Rescue Unit
- 7 Rescue Boats
- 6 Grass Rigs

Unstaffed Specialty Units/Staffed by Callback

- Urban Search and Rescue Task Force – Regional and State Deployable
- Hazardous Materials Response Units - Regional and State Deployable

Following is a brief description of TFD Staffed Front-Line Units.

Engine Companies

Fire engines are the mainstay of the fire department (Figure 43). They have the ability to provide EMS, fight fire, and perform light rescues. The city’s TFD engine companies are staffed with three personnel: an officer, an operator, and a firefighter. Key features of Tulsa’s TFD engine companies are:

Engine Company Feature/Capabilities:

- Fire pump - 1500 gallons per minute
- Water tank - 500 gallons
- Hose (1000’ of 5”, 1000’ of 3”, 200’ of 2 ½”, 100’ of 2”, 400’ of 1 3/4”, and 400’ of 1”)
- Small complement of ground ladders (24’ extension ladder, 14’ roof ladder, 10’ attic ladder)
- Forcible entry tools
- Light rescue equipment
- Jaws of Life (if equipped)
- EMS equipment (BLS or ALS)

Figure 43: Engine 13

Ladder Companies

TFD operates two types of ladder apparatus: three articulating aerial platforms (Figure 44) and nine 65'"Telesquirts" (Figure 45). The key feature of ladder apparatus is the ability to provide an elevated water stream and/or perform elevated rescue. TFD's nine Telesquirts are not rescue-capable.

Ladder Company Features/Capabilities

- Fire pump – 1500 or 2000 gallons per minute
- Water tank – 280 or 500 gallons
- Hose – Ladder apparatus carry a much smaller complement of hose due to space and weight restrictions caused by the ladder boom.
- Ground ladders (35' extension ladder, 24' extension ladder, 14/16' roof ladder, 10' attic ladder, combination ladder)
- Forcible entry tools
- Light rescue equipment
- EMS equipment (BLS or ALS)

Figure 44: Ladder 4 - 114' Articulating Aerial Platform/Quint

Figure 45: Ladder 7 - 65' "Telesquirt" Ladder/Quint

EMS Squads

TFD operates five EMS squad companies (Figure 46). Squad companies are smaller vehicles with fewer personnel. EMS squads are single purpose vehicle. EMS squads do respond in place of one engine on structure fires; however, their purpose is generally limited to EMS standby or patient care of victims.

Figure 46: TFD EMS Squad

EMS Squad Features

- EMS Equipment
- SCBAs for personnel

Hazardous Materials Task Force

TFD operates a Hazardous Materials Task Unit consisting of two specialty apparatus staffed by four to six personnel (total) each day.

Air & Light Support Units

TFD operates two logistical support units called “Air & Light” units (Figure 47). One of these units will respond to every fire in the city to provide additional SCBA cylinders, firefighter rehabilitation equipment, scene lighting, and other specialty equipment. When not responding to fires, these units are tasked with delivering SCBA cylinders and oxygen cylinders thought the city to support other in-service units.

Figure 47: Air & Light 27

Air & Light Unit Features

- 85 SCBA cylinders
- On-board SCBA cylinder refill capacity (approximately 30 cylinders)
- 40 Oxygen cylinders
- 50K Onboard generator
- Light mast and lighting equipment
- Firefighter rehab canopy and other equipment
- Insulation vacuum

District Chief/Assistant Chief

The City of Tulsa is divided into five fire districts. Each district has approximately eight fire companies and 40 personnel per shift. Each fire district has a chief officer whose primary role is command at fires. District Chiefs are also for administrative operations of each district.

TFD has one Assistant Chief on duty each day. The Assistant Chief oversees response operations of the entire city.

Figure 48: Fire District 1 Chief, Car 641

EMS Shift Officer

Car 835, or the EMS Shift Officer, provides EMS support to the 42 operating companies each day. C835 is tasked with administrative and logistical support as well as responding to every major incident in the city.

Figure 49: Shift EMS Officer - Car 835

Recommendations for Section 3

Effective Firefighting Force

The Deployment Committee recommends implementing Scenario 6 examined in this Section which incorporates the following:

- Move/construction of Fire Stations 33, 34, 27, and 18.
- Addition of a new Fire Company at Station 28

TFD Aerial Apparatus

Upon replacement of the following apparatus, the TFD Deployment Committee recommends the following apparatus for each of Tulsa's ladder companies:

Ladders 4, 29, 31	100'+ Heavy Duty Aerial Platform/Quint
Ladder 2	100'+ Heavy-Duty Aerial Ladder/Quint
Ladders 7, 20, 22, 23, 27, 32	100'+ Medium-Duty Aerial Ladder/Quint (preferably single rear axle)
Ladders 24, 26, and 30	60-65'Meduim-Duty Aerial Ladder/Quint

Resilience and Redundancy

Resilience and redundancy for the City of Tulsa should remain a consideration when making TFD deployment considerations.

Section 4: Apparatus Staffing

Several sources address the topic of apparatus staffing levels. The two most recent and notable are *NFPA 1710, Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments* (NFPA 1710) and the *Report on Residential Fire Ground Experiments* by the National Institute of Standards and Technology (NIST). NFPA 1710 is an industry consensus standard. The NIST Report is a federally funded empirical study to establish data related to residential structural firefighting operations. Several other sources are included below.

Standards and Studies Related to Staffing Efficiency and Safety

NFPA 1710

National consensus standards, like those developed by the National Fire Protection Association (NFPA), contain specific performance-based measurements, or benchmarks, which are used and accepted across many organizations. According to NFPA:

> The NFPA standards development process encourages public participation in the development of its standards. All NFPA standards are revised and updated every three to five years, in revision cycles that begin twice each year. Normally a standard's cycle takes approximately two years to complete. Each revision cycle proceeds according to a published schedule which includes final dates for each stage in the standards development process. The four fundamental steps in the NFPA standards development process are:
>
> 1. Public Input
> 2. Public Comment
> 3. NFPA Technical Meeting (Tech Session)
> 4. Standards Council Action (Appeals and Issuance of Standard)
>
> NFPA Technical Committees and Panels serve as the principal consensus bodies responsible for developing and updating all NFPA codes and standards. Committees and Panels are appointed by the Standards Council and typically consist of no more than 30 voting members representing a balance of interests. NFPA membership is not required in order to participate on an NFPA Technical Committee. Appointment to a Technical Committee is based on such factors as technical expertise, professional standing, commitment to public safety, and the ability to bring to the table the point of view of a category of interested people or groups. Each Technical Committee is constituted so as to contain a balance of affected interests, with no more than one-third of the Committee from the same interest category. The Committee must reach a consensus in order to take action on an item.
>
> Standards developed by NFPA and similar standards development organizations (SDOs) are "voluntary consensus standards," created through procedures accredited for their consensus decision-making, openness, balance of interests represented, and fairness by the American National Standards Institute (ANSI). Because of their credibility and reach, independent SDOs are able to attract thousands of volunteer experts to serve on their standards drafting committees.
>
> SDOs are standards development organizations which work to formulate health and safety standards. The term "standard' includes a wide variety of technical works that prescribe rules, guidelines, best practices, specifications, test methods, design or installation procedures and the like. The size, scope and subject matter of standards varies widely, ranging from lengthy model building or electrical codes to narrowly scoped test methods or product specifications.
>
> NFPA is by no means the only independent, public service organization that develops health and safety standards used by government. Many not-for-profit professional societies, testing organizations and other 501(c)(3) organizations also develop consensus-based health and safety standards for private and government use. NFPA is part of a small but significant group which serves the public through the creation of standards that promote reliability, interoperability and quality thus bringing economic and other societal benefits to the country. (NFPA, 2016)

NFPA 1710 establishes specific benchmarks in the area of deployment. Section 1 of this report addressed the areas in NFPA 1710 related to dispatch times and response times. Section 2 of this report addressed the topic of effective firefighting force, or the number of firefighters on scene within a time benchmark. A third requirement, addressed in this section, is the number of personnel on specific apparatus.

NFPA 1710 requires a minimum staffing of four members on fire suppression companies on engine companies and ladder companies (Sections 5.2.3.1.1 5.2.3.1.2, 5.2.3.2.1, 5.2.3.2.1).

NFPA 1710 requires additional staffing above four personnel for quint companies expected to perform the role of an engine company and a ladder company, such as those at TFD stations with squads where the apparatus is serving as an engine and a ladder (Sections 5.2.3.4.2).

NIST - *Report on Residential Fire Ground Experiments*

The NIST Residential studies sought to fill a research gap in the fire service. NIST was funded through a Federal Emergency Management Agency grant to investigate the effects of varying crew size, first apparatus arrival time, and response time on firefighter safety, overall task completion, and interior residential tenability. Experiments were conducted using a realistic burn facility and repeatable burns. NIST was a neutral ground to bring in the critical stakeholders in the industry as well as a team of subject matter experts. Modern instrumentation and statistical methods were employed. The end result was to advise the NFPA 1710 Technical Committee, as well as public officials. (Robinson 2010). The results of the NIST residential study indicated (containing 22 fireground tasks) that the on-scene time for the simulation was 5.1 minutes (or 25%) faster for a four person crew versus a three person crew. The NIST study further showed safety in crews of greater size due to the reduced fire spread because crews where putting out the fire faster.

> Service expectations placed on the fire service, including Emergency Medical Services (EMS), response to natural disasters, hazardous materials incidents, and acts of terrorism, have steadily increased. However, local decision-makers are challenged to balance these community service expectations with finite resources without a solid technical foundation for evaluating the impact of staffing and deployment decisions on the safety of the public and firefighters. For the first time, this study investigates the effect of varying crew size, first apparatus arrival time, and response time on firefighter safety, overall task completion, and interior residential tenability using realistic residential fires. This study is also unique because of the array of stakeholders and the caliber of technical experts involved. Additionally, the structure used in the field experiments included customized instrumentation; all related industry standards were followed; and robust research methods were used. The results and conclusions will directly inform the NPFA 1710 Technical Committee, who is responsible for developing consensus industry deployment standards. This report presents the results of more than 60 laboratory and residential fireground experiments designed to quantify the effects of various fire department deployment configurations on the most common type of fire—a low hazard residential structure fire. For the fireground experiments, a 2,000 sq ft (186 m2), two-story residential structure was designed and built at the Montgomery County Public Safety Training Academy in Rockville, MD. Fire crews from Montgomery County, MD and Fairfax County, VA were deployed in response to live fires within this facility. In addition to systematically controlling for the arrival times of the first and subsequent fire apparatus, crew size was varied to consider two-, three-, four-, and five-person staffing. Each deployment performed a series of 22 tasks that were timed, while the thermal and toxic environment inside the structure was measured. Additional experiments with larger fuel loads as well as fire modeling produced additional insight. Report results quantify the effectiveness of crew size, first-due engine arrival time, and apparatus arrival stagger on the duration and time to completion of the key 22 fireground tasks and the effect on occupant and firefighter safety. (Robinson, 2010)

The full version of the NIST study is available at: https://www.nist.gov/news-events/news/2010/04/landmark-residential-fire-study-shows-how-crew-sizes-and-arrival-times

The Executive Summary from the NIST study can be found in Appendix F.

Columbus OH Study

In 1980, the Columbus, Ohio, Fire Division conducted a study using actual fire data. The Columbus “Report on Firefighter Effectiveness” showed that the proportion of incidents with greater than $5000 loss and 25ft^2 horizontal fire spread were greater if set levels of firefighting forces were not present. These forces were 15 members for residential fires and 23 members for “high-hazard” fires (Backoff 1980 in Robinson 2010). Interestingly enough, these numbers concur very closely with TFD’s Resource Allocation Report (17 and 23 personnel respectively). The Columbus numbers were later validated in live experiments using a residential site. The experiments showed that larger crews (over 15) had quicker time-to-task completion and less property loss (Gerard 1981 in Robinson 2010). Another result of the Columbus study was that “firefighter injuries occurred more often when the total number of personnel on the fire ground was less than 15 at residential fires and 23 at large-risk fires” (Backoff 1980 in Robinson 2010.).

Dallas FD Study

A 1977 study by the Dallas Fire Department considered time to task completion and physical exertion of fire crews with three, four, and five members. The conclusion of the study was that increases in crew size markedly reduced the time to task and physical exertion with each added member. (NFA 1981, in Robinson 2010). A second Dallas Fire Department study using simulations in a residential house, a high-rise office, and an apartment also showed that increasing the number of fire fighters per fire company improved the coordination and effectiveness of the fire suppression tasks (McManis 1984 in Robinson 2010).

Seattle Fire Department Study

Seattle Fire Department conducted a review of the severity of injuries based on the number of personnel per company. They found that “the rate of firefighter injuries expressed as total hours of disability per hours of fire ground exposure were 54 % greater for engine companies staffed with three personnel when compared to those staffed with 4 firefighters, while

companies staffed with five personnel had an injury rate that was only one-third that associated with four-person companies” (Cushman 1982, in Robinson 2010).

NFA

A National Fire Academy Study, using results from the Dallas Fire Department Study (see above – Dallas Fire Department), showed that, in smaller departments, a company staffed with four personnel could perform rescue of victims 80% faster than a company staffed with three people (Morrison 1990 in Robinson 2010).

IAFF/Johns Hopkins University

A study by the International Association of Fire Fighters in conjunction with Johns Hopkins University showed that U.S. cities with populations of 150,000 or more had firefighter injury rates for crews of less than four firefighters nearly twice the percentage of jurisdictions operating with crews of four (IAFF, JHU 1991 in Robinson 2010).

Austin Fire Department

The Austin Fire Department conducted simulations to assess the physiological impact and injury rates among three and four person crews. Further they reviewed the injury reports for the previous four years and concluded that injury rates for three person crews were one and one half times the rate of four person crews The results of these simulations yielded a noticeable increase in not only safety (i.e. reduced injuries), but also quicker time to task completion, less property damage, and reduced loss of life when going from a three person crew to a four person crew. (Robinson 2010).

Ontario, CA, Office of the Fire Marshal

The Office of the Fire Marshal of Ontario, Canada performed simulations and concluded that three-person companies could not safely perform the essential functions of a fire ground. They required either extra time or assistance to do so. They also noted that exhaustion was more prevalent with three person crews. From this data, they recommended a minimum staffing level of four (Robinson 2010).

Tulsa Fire Department Apparatus Staffing

The topic of apparatus staffing has been a controversial topic on both the local and national level. At the heart of the issue lies the question of whether fire apparatus should be staffed with three or four personnel. Organizations that represent cities and counties tend to be on the opposite side of the issue than those that represent firefighters. Several other factions provide guidance and information based on either a consensus standards making process and/or empirical data. This is compounded by a current agenda from national level organizations representing cities and counties that claim that fire departments are more EMS providers and less of a fire department. This argument is leveraged to reduce firefighting resources. Even with good data, there will always be interpretations. At the heart of the issue in any municipality, is the issue of funding. Many cities have been trying to sustain what they have for so long. This has been especially true in metropolitan cities. Often as budgets began to erode, public safety was given priority for sustainment. After many years of this pattern; however, cities have cut so many areas that there is nothing left.

Tulsa has seen the same pattern. In 2009-2010, firefighters took a series of furloughs and pay cuts culminating in a large pay cut to preserve 147 firefighter positions. Since then, in order to maintain services, TFD has received two large federal grants. One grant in 2011 funded fifty firefighters for three years and the other in 2016 funded 27 firefighters for three years. During this time TFD has also had a third large grant, $880,000 for basic firefighting personal protective equipment. This funding replaced dollars lost in 2009-2010.

TFD has the goal of staffing four personnel on all apparatus; however, the expectation of being able to do this and sustain it is not realistic without significant change in the revenue infrastructure at the local and state level. TFD currently has five of 42 apparatus that have four person staffing. This is a bit deceiving however. This staffing is based on a negation in 2009 that abolished 27 firefighters and officer positions to implement an EMS Squad Program. This program removed five fire companies (four engines and one ladder) and put them in two person EMS response vehicles. To preserve the firefighting capabilities at these five stations and maintain the daily staffing number at the current level, the third person from the original company was added to each of the other apparatus at each of these stations making them a four person crew. These four person crews have been under scrutiny for reduction since the original staffing reduction occurred.

Priorities for Future Four Person Staffing

TFD currently has three personnel per apparatus each day on all apparatus except those at the five squad stations. Squad stations have six personnel between two apparatus. TFD has operated with three person staffing for many years. It is not ideal, but TFD has sustained the pattern for so long, it has become the norm. TFD has remained an effective and recognized department.

Assuming a department is able to operate under current conditions (i.e., they have three person staffing instead of two person staffing on fire apparatus) there are fundamental questions/options when improving the department's service level. A key question is whether it is best to:

1. Add personnel to each apparatus
2. Add apparatus with three personnel
3. Build more stations (which may or may not indicate more apparatus/personnel)

This is a very local decision. Varying subjective factions almost prevent a "right" answer. Therefore TFD has relied on data to demonstrate the benefit to the end user, the citizen, as the key decision-making tool

When considering the current arrangement of multiple factors in Tulsa, the answer the TFD Deployment Committee has arrived at considers a combination of all three options above. Preference is given to arrangement of fire stations followed by adding apparatus where voids exist. The final priority is adding personnel to apparatus.

Public Safety Tax Funding

In April of 2016, Tulsa voters approved a permanent funding package which included an additional sixty firefighters. In consideration of these sixty positions as well as the conclusions reached in Sections 1 and 2 of this report, the TFD Deployment Committee recommends the following placement and priorities for these sixty positions.

Purpose	Assignment	# Personnel
Perimeter Fire Company Staffing	Perimeter/Large Coverage Area Fire Stations	33
New Fire Company	Fire Station 28	12
Fire Prevention Officers	Code Enforcement/Public Education	5
New Fire Company	Fire Station 33 (new east station)	15

Perimeter Fire Stations

An area of concern for both fire station location (first-in coverage) and effective firefighting force is the location and staffing of fire stations around the perimeter of the city. This is an area for which there is no correct or easy answer. One side will contend that stations should not be placed close to the perimeter of the city because that station will have a smaller coverage area and will only be responding one direction - into the city (i.e. a waste of resources). This camp is driven by the assumption that a station on the perimeter of the city will experience a low hazard/low run volume environment. A second view considers what happens when a fire incident occurs. This view contends that the perimeter of the city will be waiting longer for apparatus and staffing; and therefore, perimeter stations should have multiple companies and extra personnel regardless of the number of incidents.

The Deployment Committee recommends prioritizing four person staffing at single company stations on the perimeter of the city. This recommendation is grounded in two concepts. First, most fire stations around the perimeter of the City of Tulsa often cover large response areas. This often means they are faced with being at a fire without assistance for quite some time. Having one more person on these apparatus is critical to efficiency and safety in the first seconds and minutes after arrival. The second consideration is that OSHA regulations do not allow an interior fire attack until four personnel are present.

Data showing the coverage benefit of four personnel at single company perimeter stations is next to impossible to show. The numbers of personnel on the perimeter of the city are low to begin with, so four person staffing at sparsely spaced companies is hard to detect on maps such as those found in Section 3.

Recommendations for Section 4

Apparatus Staffing

TFD should strive for four person staffing on all fire companies. Four person staffing should be prioritized as follows:

1. Maintain four person staffing on each Ladder/Engine Company Tulsa's five fire stations that house Squads.
2. Four person constant staffing of each single-company station on the perimeter of the City.
3. Four person constant staffing of each single-company station.
4. Four person constant staffing of all fire companies.

When considered in conjunction with recommendations from previous sections of this report and the 2016 Public Safety Funds, the Deployment Committee recommends the following:

Purpose	Assignment	# Personnel
Perimeter Fire Company Staffing	Perimeter/Large Coverage Area Fire Stations	33
New Fire Company	Fire Station 28	12
Fire Prevention Officers	Code Enforcement/Public Education	5
New Fire Company	Fire Station 33 (new east station)	15

Section 5: Summary of Recommendations

1. Station Moves/Additions

The following table shows the final recommendations for fire station moves/additions based on the scenarios and data considered in Section 1.

Priority	Sequence/Funding	Station	Location	Staffing
High	1 Funded	33 New "East" Station	13500 E 41st St.	New staffing, Public Safety Funding
High	2 Unfunded	Move 27 (11707 E 31st St.)	10400 E. 31st St.	Move E27 and L27
High	2 Unfunded	New 34	10400 E. Admiral Pl.	Move one company from Station 31
High	2 Unfunded	Move 18 (4802 S. Peoria Ave.)	5600 S. Peoria	Move E18 and C643
Medium	3 Unfunded	Move 23 (4348 E. 51st St.)	5600-5900 S. Yale Ave.	Move SQ23 and L23
Medium	3 Unfunded	New 35	8400 S. Mingo	Move one company from Station 28 (funded by Public Safety Funding) (See Section 4 Recommendations)
Low	4 Unfunded Projected need (7-10 years) Economic Development Related Far East Tulsa	New 36	3300 S. 177th E. Ave.	New staffing Unfunded

2. Automatic Aid Agreement

The City of Tulsa and the City of Broken Arrow should consider modifying the 2012 Mutual-Aid Agreement for Fire Protection and Fire Response to provide true automatic aid in far east Tulsa and ensure that the agreement is equitable and beneficial to both cities.

3. Mobile Water Supply Apparatus (Water Tenders)

TFD should purchase and implement two mobile water supply apparatus at Fire Stations 19 and 33. Consequently, both stations should be constantly staffed with four personnel.

4. Coordination with Neighboring Agencies

As the City of Tulsa and other agencies make improvements to public safety infrastructure such as moving or adding fire stations or upgrading or replacing communications, agencies in the Tulsa Metro Area should work together to coordinate the provision of services to the citizens.

5. Advanced Life Support Fire Companies

After consideration of data and SME review no ALS moves are recommended for the calendar year 2017.

6. Annual Review of Advanced Life Support Companies

The TFD EMS Branch should conduct an annual review of first hour quintet and transfer of care data each fall and consider any needed shifts in ALS capabilities for implementation the following calendar year.

7. Additional Advanced Life Support Capabilities

The TFD EMS Branch should implement additional ALS capabilities on current apparatus to address geographically significant stations.

8. Effective Firefighting Force

The Deployment Committee recommends implementing Scenario 6 (Section 3) which incorporates the following:

- Move/construction of Fire Stations 33, 34, 27 and 18.
- Addition of a new Fire Company at Station 28

9. TFD Aerial Apparatus

Upon replacement of the following apparatus, the TFD Deployment Committee recommends the following apparatus for each of Tulsa's ladder companies:

Ladders 4, 29, 31	100'+ Heavy Duty Aerial Platform/Quint
Ladder 2	100'+ Heavy-Duty Aerial Ladder/Quint
Ladders 7, 20, 22, 23, 27, 32	100'+ Medium-Duty Aerial Ladder/Quint (preferably single rear axle)
Ladders 24, 26, and 30	60-65'Meduim-Duty Aerial Ladder/Quint

10. Resilience and Redundancy

Resilience and redundancy for the City of Tulsa should remain a consideration when making TFD deployment considerations.

11. Apparatus Staffing

TFD should strive for four person staffing on all fire companies. Four person staffing should be prioritized as follows:

1. Maintain four person staffing on each Ladder/Engine Company Tulsa's five fire stations that house Squads.
2. Four person constant staffing of each single-company station on the perimeter of the City.
3. Four person constant staffing of each single-company station.
4. Four person constant staffing of all fire companies.

When considered in conjunction with recommendations from previous sections of this report and the 2016 Public Safety Funds, the Deployment Committee recommends the following:

Purpose	Assignment	# Personnel
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New Fire Company	Fire Station 33 (new east station)	15

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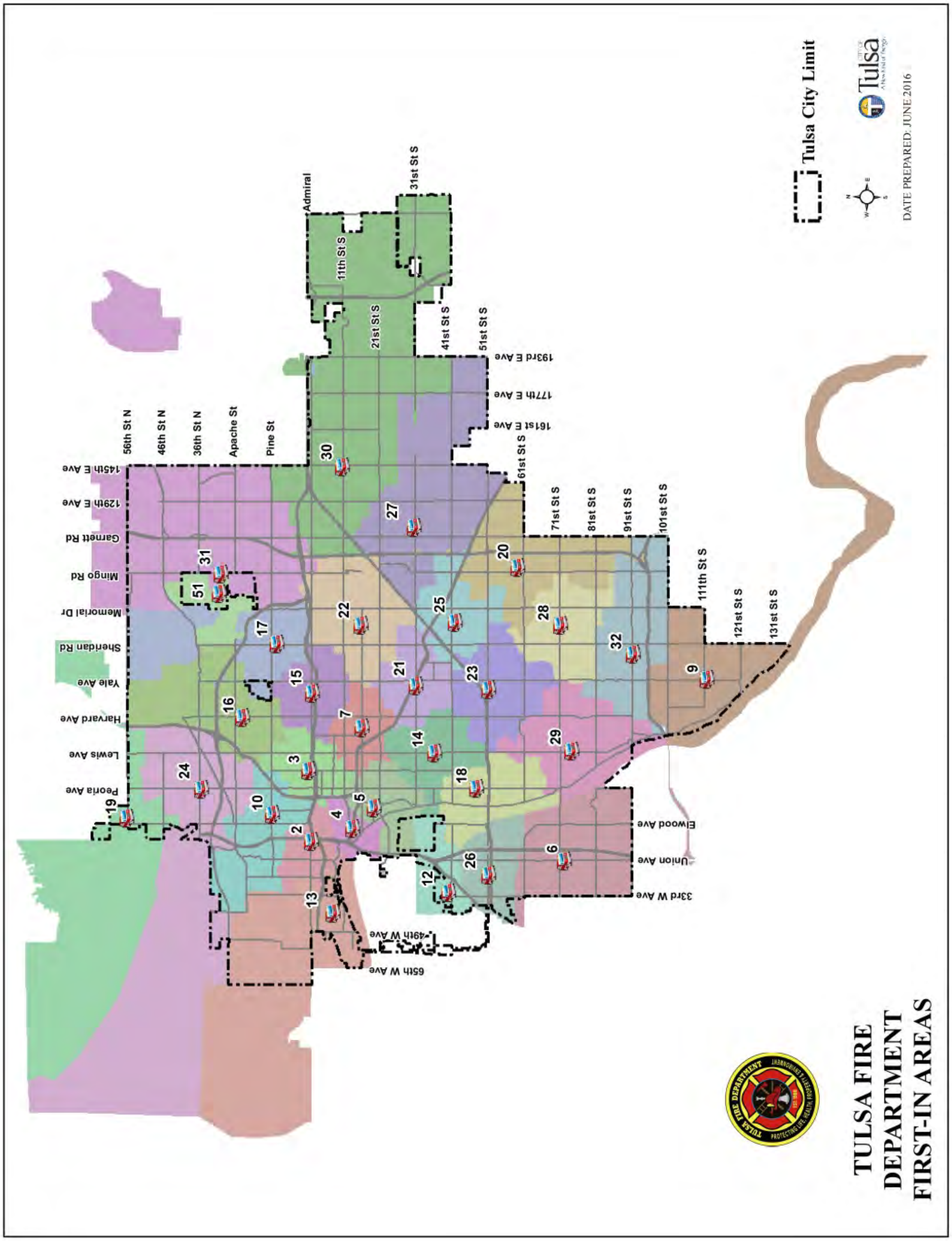
Appendix A: Tulsa Fire Stations

2017 Fire Station Map



2017 Fire Station Information

STATION	ADDRESS	# of Bays	Bay 1	Bay 2	Bay 3	Bay 4	Bay 5
Fire Station 2	524 W. Edison	3	Engine 2	Ladder 2	Squad 2		
Fire Station 3	61 N. Utica	2	Engine 3	Reserve Engine 63			
Fire Station 4	524 W.12th	5	District 1 Chief, C641	Engine 4	Ladder 4	Rescue 4	Air 4, Boat 4, and Boat 041
Fire Station 5	102 E. 18th	2	Engine 5	Reserve Car 603			
Fire Station 6	7212 S. Union	3	Engine 6	HazMat 1	HazMat 2		
Fire Station 7	3005 E. 15th St	2	Engine 7	Ladder 7			
Field Operations, Old 9	1420 Charles Page Blvd	2	Shift Commander, Car 640	Shift EMS Supervisor - C835			
Fire Station 9	11211 S. Yale	3	Engine 9	HazMat 4	Reserve Ladder 69		
Fire Station 10	508 E. Pine	2	Engine 10	Grass Rig 10			
Fire Station 12	3123 W. 40th	1	Engine 12				
Fire Station 13	345 S. 41st W. Ave	2	Engine 13	Reserve Engine 73			
Fire Station 14	3602 S. Lewis	2	Engine 14	Reserve Engine 74			
Fire Station 15	4168 E. Admiral Pl.	1	Engine 15				
Fire Station 16	2412 N. Harvard	3	District 4 Chief, C644	Engine 16	Reserve Engine 76		
Fire Station 17	1351 N. Sheridan	1	Engine 17				
Fire Station 18	4802 S. Peoria	2	District 3 Chief, C643	Engine 18			
Fire Station 19	509 E. 56th St. N.	2	Engine 19	Reserve Ladder 79			
Fire Station 20	9827 E. 59th	2	Engine 20	Ladder 20			
Fire Station 21	4606 E. 31st	2	Engine 21	Reserve Engine 81			
Fire Station 22	7303 E. 15th	3	District 2 Chief, C642	Squad 22	Ladder 22		
Fire Station 23	4348 E. 51st	3	Squad 23	Ladder 23	Engine 83		
Fire Station 24	3520 N. Peoria	4	Engine 24	Ladder 24	Reserve Ladder 84	Boat 24, GrassRig 24	
Fire Station 25	7419 E. 42nd Pl.	3	District 5 Chief, C645	Engine 25	Reserve Engine 85		
Fire Station 26	2404 W. 51st	3	Ladder 26	Squad 26	Grass Rig 26, Boat 26, ATV-26		
Fire Station 27	11707 E. 31st	3	Engine 27	Ladder 27	Air 27		
Fire Station 28	7310 E. 71st	3	Engine 28	Reserve Engine 88	Reserve Ladder 88		
Fire Station 29	7429 S. Lewis	3	Engine 29	Ladder 29	Boat 29		
Fire Station 30	14333 E 11th St	3	Engine 30	Ladder 30	Grass Rig 30, Boat 30		
Fire Station 31	3002 N. Mingo	3	Engine 31	Ladder 31	Grass Rig 31		
Fire Station 32	6010 E. 91st	3	Squad 32	Ladder 32	Grass Rig 32, Boat 32		
Fire Station 51	Tulsa International Airoport	5	Unit 50	Unit 52			

Fire Station 2

Address	524 W. Edison St
Year Constructed	1981
2015 Incidents	3892
Staffed Units	E2, SQ2
Unstaffed Units	L2

Comments from Fire Station 2 Crew:

Tulsa fire Station 2 has been at 524 W Edison since 1981. It is a two story station built into the side of a hill with living quarters above ground and three apparatus bays below. Station 2 houses a Crimson Spartan “Engine 2”, an E-One 118 foot aerial platform “Ladder 2”, and a Ford F-550 “Squad 2” equipped with a CAFS pump. Assigned to Fire Station 2 are one Captain, two Fire Equipment Operators, and five Firefighters per shift. On a normal day Engine 2 is operated as a BLS company with four personnel, Squad 2 is a Paramedic unit with two personnel, and Ladder 2 is not staffed but is available on an as needed basis.

Fire Station 2 protects one of the most diverse run areas in the city of Tulsa. Residential structures in the area include the oldest standing home in the city, early century Victorians, historic mansions, apartments (new and old), and modern ranch style homes. The size of the structures in the 2 square miles station 2 covers range from 900 square foot residences all the way up to some of the tallest skyscrapers in the state of Oklahoma. Occupancy and property usage in station two’s first due covers the entire spectrum such as:

- Industrial occupancies
- Chemical Processing
- Railways
- Restaurants
- 5 miles of State Highway 412

- One mile of the Arkansas River
- Museums
- A Television Station
- “Taxpayers” (mixed occupancy)
- Minor League baseball stadium
- Hotels
- County Jail and Avalon Correctional facitlites
- Four homeless shelters
- Night clubs
- Entertainment venues such as the early century Brady Theater, Historic Cains Ballroom, and the BOK center

Fire station 2 provides ALS coverage for District 1 and an portion of District 4. Squad 2, the paramedic unit makes approximately 2000 runs per year. It provides ALS first response to the diverse run area listed above, with the majority of those medical runs being on Tulsa’s homeless population as well as the David L Moss and Avalon correctional facilities. Response to medical scenes at station 2 can be a challenge because in addition to the shelters, the homeless population is spread out among “tent cities” and impromptu shelters spread out along the Katy jogging trail that has limited access at best. Outside of the homeless population, Station 2 responds to a fair amount of gang related violent crimes, as well as general illness among every age group in our local residents.

Fire Station 3

Address	61 N. Utica Ave
Year Constructed	1967
2015 Incidents	2844
Staffed Units	E3
Unstaffed Units	N/A

Comments from Fire Station 3 Crew:

Fire Station 3 has been in service since 1910. It has had 3 locations within 1 mile of current location east of downtown Tulsa. The current station, built in 1966, is located at Archer & Utica. Its first-in area stretches from Pine to 15th (north / south) and from Cincinnati to Delaware (west/east).

The station has one fire company assigned, Engine 3.

Engine 3 is currently a 2007 model Spartan pumper. The station responds to 2800 runs per year, an average of 7.5 incidents per 24 hour shift. Engine 3 is in top 10 most active fire companies.

The station's location, situated on 2 major highways, I-244 & Hwy-75, gives it exceptional access to a large response area. Because of this, Engine 3 is assigned to alarms as far west as 65th West Ave and east to Yale. Station 3 is the first-due company to a large portion of downtown Tulsa. These areas include the East Village, Brady District, Blue Dome District, Pearl District, OneOk Field, and most of the new residential high-rise developments.

Station 3 responds to a high volume and very wide range of incidents. Regarding structure fires, residential structure fires are common in the station's first-in area. The industrial area south of the station has occasional structure fires which present an elevated risk to the public, as the industrial areas are nested inside residential areas. A prime example of this hazard is the case of the AirGas explosion which claimed 2 residential structures.

Station 3 responds to a many EMS calls including a large number to the homeless population in the area. Requests for service from physically limited citizens is high due to the station's proximity to Murdoch Villa.

Station 3 responds to motor vehicle accidents on the IDL, highway 75 and I-244. Engine 3 has been designated a jaws company for this reason. Fast response to these incidents is achieved and further loss prevented due to the ability of multiple fire companies to converge quickly to the accident scene. The recent semi-truck wreck on the south leg of the IDL is an excellent example of this.

Fire Station 4

Address	524 W.12th St
Year Constructed	1978
2015 Incidents	3820
Staffed Units	E4, L4, C641, AL4
Unstaffed Units	R4

Comments from Fire Station 4 Crew:

Station 4 is the primary fire station for downtown Tulsa. Station 4 houses the most apparatus of any other stations in the Tulsa Fire Department. These apparatus include Engine 4, Ladder 4, Rescue 4, Car 641, Air and light 4, Boat 4, Boat 41, and Truck 4. The minimum personnel per shift at Station 4 is 9. All personnel assigned to Station 4 are dual trained as Rescue Technicians. Rescue Technicians have the extra responsibility of training for and responding to all water rescues, structural collapses, trench rescue, high-angle rescue, heavy machinery extrications, and advanced auto extrications.

Station 4 first-in run area is primarily all of downtown Tulsa, with 3 adjoining neighborhoods, one to the south of downtown, one to the west of downtown, and one to the west of the Arkansas River. The run area is approximately 1 square mile. Downtown Tulsa's population is estimated to be 4,000 with a daytime population estimated at 36,000. The population also increases significantly due to an abundance of festivals, sporting events, and concerts downtown hosts. The majority of Tulsa's homeless population is also in downtown with estimates ranging from 1000 to 4000 individuals. Downtown includes 18 high-rise buildings over 200' tall, with the BOK Tower at the top of the list standing 52 floors and 667' in height. The age of the buildings downtown range from over 100 years old to newly constructed structures. Station 4's first-in also includes Tulsa's oldest church buildings, 19 apartment complexes, the Arkansas River, Tulsa's railroad yard, and the inner dispersal loop of Tulsa's highway system.

Run data per Station 4's logbook:

Engine 4 – 2482 runs

Ladder 4 – 1091 runs

Rescue 4 – 91 runs

C641 – 387

Station 4 runs include all types of runs including medical, fire, and rescue runs. Most of the runs are overwhelmingly medical calls. The majority of medical calls include runs to multiple Section 8 housing units, 2 bus stations, and the homeless population. Station 4 also runs on a high number of MVA's around the inner-dispersal loop. MVA's increase at commuting times to and from work i.e. around 8 AM and around 5 PM. Most fire runs include being 3rd, 4th, and 5th in to support other surrounding stations. Most fires occur at night. Fire alarms are consistent at Station 4, daily responding to 2 different Tulsa Housing Authority apartments, hotels, and the other buildings downtown. Rescue runs average about 100 per year and are responded to anywhere in the city limits of Tulsa. The majority of the runs at Station 4 are in the daylight hours. However, rarely at Station 4 is there a silent night and calls after bedtime continue to increase.

Fire Station 5

Address	102 E. 18th St
Year Constructed	1932
2015 Incidents	1810
Staffed Units	E5
Unstaffed Units	N/A

Comments from Fire Station 5 Crew:

Station 5 is currently located at 102 E. 18 St. S. It has been in service at its present location since 1932, making it the oldest fire station still in service within the City of Tulsa. The original Station 5 was located directly north of the current station on what is now the front apron of Station 5. Original Station 5 was constructed in 1917 and torn down in 1932 when "new" Station 5 was built.

Station 5 is a 2 story station approximately 3500 sq feet in size with a 400 square ft basement. It currently houses E-5 which is a 2007 Spartan Pumper. It also houses a reserve staff vehicle in its second apparatus bay.

Station 5 currently covers an extremely diverse "first in" area. This area is from approximately 15th St. S. to 31 St. S and Southwest Blvd to Utica Ave. When responding south and or east of 5's you are in the wealthiest zip code within the City of Tulsa. It is primarily very large residential dwellings mostly constructed in the 1920's and 1930's. Also included to the east are 2 large hospital campuses (St John and Hillcrest). When responding north of 5's you are in downtown with high-rises and large commercial occupancies. When responding west of 5's you have the most used portion of the Arkansas River in Tulsa. 5's responds to a large number of static and swift water rescues on the river along with numerous small wildland fires associated with the park system that surrounds the river. After crossing the Arkansas River Bridge you enter an extremely impoverished area. It is mainly small residential homes with several large low income apartment complexes. Currently one of the largest recreational parks in the nation is being constructed just south and west of 5's. This will no doubt add to the run numbers and diversity of incident types.

Station 5 made 1900 runs in 2015, which is slightly down from previous years. Approximately 70% of those runs were medical in nature. Approximately 30% were Fire/BFA/MVC/Rescue Task Force/ Other… About 60% of the above runs happened during the day the rest occurred after dark. E-5 is part of the TFD's Rescue Task Force. E-5 responds in any and all areas of the city for heavy rescue, swift water, structural collapse, trench, high-angle, etc..

Fire Station 6

Address	7212 S. Union Ave
Year Constructed	1990
2015 Incidents	2204
Staffed Units	E6, HM1/2
Unstaffed Units	N/A

Comments from Fire Station 6 Crew:

Fire Station 6 was built in 1990. At this time, for over a decade this station has been the house of Engine 6, as well as Hazardous Materials Unit 1 and 2. All 3 of the apparatus here are staffed every shift. This station is located at 7212 S. Union Avenue. Near 71st South and only one block from Highway 75. Engine 6 is a 2001 Luverne pumper. It responds to a myriad of the typical fire engine type assignments, such as structure fires, car fires, grass fires and medical calls. Engine 6 is also a part of the HazMat Taskforce. Engine 6 will respond with HazMat 1 and 2 on any Hazardous Materials incidents that they are requested by HazMat to assist. Engine 6 first in area is from 91st to 58th Street and 33rd west Avenue to South Peoria. Although, as a part of the HazMat Task force, will cover the entire city as well as outside of Tulsa.

Engine 6 responds to near 900 calls per year. Approximately 35% of these occur during the nighttime hours. Along with various Haz Mat calls throughout the year. Along with this response, Engine 6 and HazMat are required to complete an additional 192 hours of Hazardous Materials training, on top of any fire department annual training.

Engine 6 response area encompasses a very diverse area. Being that it is situated one mile east of Creek County, and less than 2 miles from the city of Jenks. Many calls will be with outlying departments. Engine 6 is the first in company to Jones-Riverside airport. Jones Airport is the busiest airport in the state, and in the top 100 busiest airports in the nation, with 6 different flight schools on site, as well as Tulsa Community College on site. This response area also encompasses Turkey Mountain urban wilderness area, a 300 acre wilderness area with over 20 miles of trails. This area is very busy, and host to many races and events. The wilderness area also abuts the Arkansas River. Several rescues with in the wilderness area and river (water rescue), are performed yearly by Engine 6. Station 6 is located one block from highway 75, and 2 miles from I-44. These are both heavily traveled thoroughfares. Engine 6 is a JAWS of Life company, and assigned to all motor vehicle accidents in these areas, and beyond. The Tulsa Hills is a quarter mile from station 6. The fastest growing shopping area in the city. What was once empty pastures is now almost 2 square miles of shopping centers, restaurants, hotels, clinics and hospitals. This area is continuing to grow, and the incident volume will continue to grow in the near and distant future.

Along with the previously mentioned diverse areas, Station 6 is surrounded by residential housing, old and new, section 8 housing, apartments and many industrial buildings. Within this first in area is also many sections of heavily forested areas, some areas being hundreds of acres, which account for many wildland fires per year.

Engine 6 at station 6 is a company that responds to typical fire/ems incidents, as well as many diverse specialized incidents. Station 6 location is a good location to make response times very minimal, as well as near highways for the sometimes long hazardous materials task force incidents.

Fire Station 7

Address	3005 E. 15th St
Year Constructed	2005
2015 Incidents	3064
Staffed Units	E7, L7
Unstaffed Units	N/A

Comments from Fire Station 7 Crew:

Station 7 is probably a 50/50 split between residential and commercial occupancies that is densely populated. Most of the structures in our area are made up of older construction components. Our first-in also consists of a section of HWY 51, the Tulsa Fair Grounds, St. John Medical Center, a psychiatric/drug rehabilitation hospital as well as the University of Tulsa. Station 7 is home to Engine 7 (2007 Crimson) and Ladder 7 (2001 65' Tele Squirt). Both apparatus are equipped with BLS and firefighting (water and hose) capabilities. Station 7 was built in 2001. Geographically, our first response area approximately runs East-West from Yale Avenue to Utica Avenue and North-South from 5th Street to 25th Street. The socio-economic aspect is extremely diverse.

Approximately 70% of our calls are EMS related. 20% are business fire alarms. 10% are actual fires or MVA's. The majority of our runs are between 7:00 AM and 10:00 PM. Station 7 is unique with its location in that we will make runs with District 1, District 2, District 3, District 4 and District 5 depending on what type of incident and location is dispatched.

Fire Station 9

Address	11211 S. Yale Ave
Year Constructed	2006
2015 Incidents	634
Staffed Units	E9
Unstaffed Units	N/A

Comments from Fire Station 9 Crew:

Fire Station 9 has been in service since 1925 at the original location of 105 W. Phoenix. It has had 3 locations. The current station, built in 2007, is located at 11211 S Yale Ave. Its first-in area encompasses approximately 8 square miles stretching from the Arkansas River on the west (121 St. South) , to Memorial on the east, and from 121 St. South on the southside to 96th Street South as a northern boundary.

Engine 9 is currently a 2001 model Spartan pumper. The station responds to 625 runs per year.

The station's location is situated in an economically affluent neighborhood where the home values range from $200,000 to $1+ million . The first-in district is a mixture of residential homes and commercial/business areas. The area is continuing to grow with new residential communities and commercial businesses.

Station 9 responds to a variety of incidents, including residential fires, EMS calls, motor vehicle accidents, invalid assistance, as well as public education and community contacts. Station 9 is a designated JAWS company.

All personnel assigned to station 9 are trained to a Hazardous Material Technician which allows us to assist Hazmat in any Hazardous Materials incident.

In 2015 E9 responded to 625 incidents and approximately 100 community contacts, which include "show-n-tells", block parties, parade procession, station dinners, station tours and children's birthday parties. Approximately 75-80% of our runs are medical in nature, including physically disabled assistance, and motor vehicles accidents with injuries. The other 20-25% of incidents consists of structure or grass fires and residential or business fire alarms. The majority of our incidents occur between the hours of 0800 and 2200 hours.

Fire Station 10

Address	508 E. Pine St
Year Constructed	1964
2015 Incidents	2143
Staffed Units	E10
Unstaffed Units	GR10

Comments from Fire Station 10 Crew:

Station 10 was built in 1964. It housed the District 4 Chief along with Engine 10 until 2010. It now houses Engine 10 and Grass Rig 10. The station is located on Pine St at Frankfort Ave and is surrounded by a mixture of residential, commercial, and industrial properties. Practically all of the apartment complexes nearby are low income/government subsidized. As with most fire companies in Tulsa, the station is surrounded by mostly single-family residences. These range from very large historic homes built during Tulsa's later oil-boom years in the 1910's and 1920's, to new homes that are typical of current trends. The commercial and industrial properties range from occupancies with extremely hazardous materials, to the world's largest collection of Native American and Western art and artifacts at Gilcrease Museum. In addition, there are many abandoned properties that are deteriorating, and therefore present their own unique hazards.

Engine 10 primarily responds to incidents from Apache to Archer (N/S), and from 25th West Ave to Utica (W/E). Although structure fires are relatively common in the area compared to the rest of the city, Engine 10 predominantly responds to incidents involving various medical emergencies. We average about 2200 calls per year, of which about 70% are medical in nature. Approximately 30-40% of all calls are at night.

Grass Rig 10 is used on about 100 calls each year. We respond from the northern city limits to Archer (N/S), and from the western city limits to Harvard (W/E). It is also not uncommon to run Grass Rig 10 out of the city limits both to the north and the west.

Fire Station 12

Address	3123 W. 40th St
Year Constructed	1958
2015 Incidents	728
Staffed Units	E12
Unstaffed Units	N/A

Comments from Fire Station 12 Crew:

In 1958, Fire Station 12 was relocated to its current location at 3123 West 40th Street. Originally, Station 12 was built in 1929, and located in the 2800 block of West 40th Street. Station 12 is situated on Tulsa's West side, in the heart of the Red Fork area near the location where oil was first discovered in Tulsa County at the beginning of oil boom. Fire Station 12 serves a proud community, and diverse population of mostly working class, high school educated citizens. The apparatus currently assigned as Engine 12 is a 1995 E-One protector TC Fire Engine.

To the East, Station 12 covers to the West bank of the Arkansas River. This area is a close knit mix of commercial, residential, industrial structures. These include the following:

- The Public Service Company of Oklahoma's, Tulsa power plant.
- Schools: Daniel Webster High School, Clinton Middle School, Porter early childhood development center
- Parks: Reed Park, Philpot Park, The River West trail system and the West Bank Sports Complex south of PSO.
- A Major industrial area Situated east of Highway 75: Tulsa Public schools bus barn, Kincaid Coaches, various manufacturing shops, and Hazardous Material distribution centers.
- We cover Highway 75 from 23rd Street to the interstate 44 interchange.
- Many of the homes in this area were built in the 1920s era, and have basements.

To the West, the Station 12 coverage area stops at 41st West Avenue, where it meets the Berryhill Fire Protection District. Station 12 commonly responds to the west city limits of Tulsa, which is fence at 57th West Avenue. This area is a mostly rural, residential area and includes Rice hill, a residential area little known to most of Tulsa, but is significant to the Tulsa Fire Department. Rice hill is one of very few areas in Tulsa without water mains, where most homeowners have potable water delivered to personally owned tanks. Station 12 provides mutual aid to areas outside of the City to the West. This area has a huge potential for growth, including the Gilcrease Expressway extension from Highway 412 to the North and Interstate 44 to the South with a future bridge across the Arkansas River.

- Residences are mostly working class, with an increase in section 8 housing in recent years.
- We provide mutual aid to Berryhill Fire Department.
- We provide mutual aid to Sapulpa Fire Department.
- Future growth in this area includes the completion of the Gilcrease Expressway connecting South West Tulsa to North West Tulsa.

To the North, Station 12 covers West 21 Street South. This area includes Scattered Residential, Industrial, and rural area. A major mutual aid concern is the Holly Frontier oil Refinery.

- The KTUL Channel 8 station on Lookout Mountain.
- The Burlington Northern Santa Fe Rail yard.
- Park Elementary school
- Waste to Energy plant
- Both Holly Frontier oil refineries (which are out of the city but are located in a mutual aid area. If they have issues, they will affect areas in Tulsa's City limits).
- Major Pipe lines Run to and from the refineries.
- The rural area has the potential for major wild land fires.

To the South, We covered a jagged run area that we share with Station 26. The reason behind the highly varied coverage line is limited access in the area, caused by the convergence of the railroad tracks and Interstate 244 / interstate 44 Split. This area is mostly residential and commercial.

- The Crystal City shopping center.
- Interstate 244
- Interstate 44
- A major concern for this area is limited access, which is caused by the convergence of Two Arterial Highways, and Two of Tulsa's busiest rail lines.
- A residential area that covers more than a full square mile.

Engine 12 responds a multitude of diverse alarms. Those alarms include responses from the Tulsa Hill Shopping area, to the Oklahoma State Medical Center South West of downtown Tulsa. When breaking down Engine 12's responses, a majority of our alarms are medical emergencies, of those emergencies cardiac arrest responses seem to be above average in our area compared to the rest of the city. Many of those can be attributed to the aging demographics of the area. Engine 12's second most frequent alarm would be motor vehicle accidents on US highway 75 between the Inner Dispersal loop and the Interstate 44 interchange. These responses are much more prevalent during rush hour. When considering building fires, Engine 12 makes as many first in building fires as any Tulsa Fire company south of Admiral Boulevard. Engine 12 is also responsible for one of the largest life rescues in Fire Department history, this occurred in February of 2015.

A common, department wide statement, when referring to Station 12 is: "You might not make the most runs at Station 12, but when you make something you will be needed."

Fire Station 13

Address	345 S. 41st W. Ave
Year Constructed	1964
2015 Incidents	1284
Staffed Units	E13
Unstaffed Units	N/A

Comments from Fire Station 13 Crew:

- We have one BLS engine assigned and house Reserve Engine 73
- Our response area covers west of downtown Tulsa on the north side of the Arkansas river to 65 west avenue. We respond north to 41 St North.
- Engine 13 averages around 1200 calls a year with 25 to 30 of those calls being structure fires.
- Most of our calls are to single family residences along Charles Page Boulevard, homes average 900 to 1500 square feet. Most are run down and in need of repair.
- The population in this area is very poor .
- We cover
- 2-elementry schools
- 1-high school
- 2- apartment complexes
- 2-patrolem industry companies Troco Oil and Oils Unlimited
- Arkansas River
- Keystone Expressway
- Run mutual aid with Sand Springs Fire Department
- Large undeveloped area north of Keystone Expressway
- Industrial area along Charles Page
- Tulsa County Shelter
- Juvenile Detention Center

Fire Station 14

Address	3602 S. Lewis Ave
Year Constructed	1950
2015 Incidents	1426
Staffed Units	E14
Unstaffed Units	N/A

Comments from Fire Station 14 Crew:

Station 14 is located at 3602 South Lewis. It was erected in 1950 and sits in the heart of Tulsa, an area currently known as the Midtown Brookside district. The Brookside District is one of Oklahoma's well known dedicated historic landmarks. Being this area is one of the oldest (in the State of Oklahoma and The City of Tulsa) and was once known as "the oil capital of the world", Engine 14 serves and protects some of the oldest and largest mansions in this city/state. Our first in area has the highest per capita residential value in the State of Oklahoma.

Station 14 houses 1 engine company, Engine14. Engine 14 makes between 1500-1600 runs annually. Our runs are broken up into medical and fire runs, with 50% of them in the day time and 50% in the night time. Approximately 70% of our runs are categorized as medical emergencies with the remaining 30% house fires, business fires, car fires and business fire alarms etc. Engine 14 also serves two major expressways (I-44 and the Broken Arrow Expressway). Major structures within the first in area include Cascia Hall (a well know preparatory school), The Philbrook Museum of Arts (a world known arts museum) and Edison High School (a premier City of Tulsa public school). Also within Engine 14 first in boundaries lives the current Mayor of our City, as well as former mayors, a few current and retired Supreme Court Justices and several CEO's and entrepreneurs.

Fire Station 15

Address	4168 E. Admiral Pl
Year Constructed	1948
2015 Incidents	2201
Staffed Units	E15
Unstaffed Units	N/A

Comments from Fire Station 15 Crew:

The station is located at 4168 Admiral Pl., it was built in 1948 making it the second oldest station in the city. It is a single story white building with concrete floors and is approximately eighteen hundred square feet, including the bay for the apparatus. It is only one of five stations that require you to back into, which requires the blocking of traffic every time. We have a chain link fence with a locked gate that enables us to enclose our vehicles. We have a crematory to the south and east of us a cemetary north of the station. We have one of the smallest run areas in the city, approximately three square miles, but we are the third busiest company in District 4 with 2356 runs last calendar year. We are a basic medic apparatus. Each of the three shifts run close to eight hundred runs per calendar year. We are at 1012 runs so far this year.

The apparatus housed here is a single engine; it is a 2007 model Pierce with 113935 miles on it. It is in overall good shape, but is starting to show its age with all the miles put on it.

Our run area as previously stated id approximately three square miles. In those three square miles we have a major interstate (I244), a retirement home, several apartment complexes, a half-way house for the homeless, a Salvation Army rehabilitation center for the homeless and part of the University of Tulsa campus. We are also included on some airport responses. We have a very diverse demographic group of people we run on. We get up approximately 2-4 times per night for runs. Our runs are as diverse as the demographic in our area, they consist of cardiac arrest, car wrecks, breathing problems, gun shots, suicides, general not feeling well needing medical assistance and fires. We make numerous runs to Yale manor and have a few regular patients we see on a weekly basis. We have a good reputation with the people in our run area; they seem to enjoy our presence in the community.

Fire Station 16

Address	2412 N. Harvard Ave
Year Constructed	2009
2015 Incidents	1888
Staffed Units	E16, C642
Unstaffed Units	N/A

Comments from Fire Station 16 Crew:

Station 16 is located on North Harvard near Apache in the northeastern quadrant of the City of Tulsa's area of operations and responds to approximately 2000 calls per year. It houses D4 Chief (car 644), E-16 and Reserve E-76. It is a predominantly suburban environment, but with some high-density housing areas. Of the 4172 addresses in this district, 92% are residential (3887) and the remaining 8% are a mix of commercial, industrial, & manufacturing (285). While there is some undeveloped property, none is zoned as rural. More than 70% of house in this response area were built before 1959. The majority of residential properties are single-story, wood-frame residential construction.

This response district has the highest percentage of residents in Tulsa living below the poverty line (27%). There is also a significant population that is under 18 years of age (34%), as well as those over the age of 65 years old (12%). It is also worth noting that more than 40% of the residences with children are single-parent households. Within this response area are two elementary schools, a large high school, and a community college. The area is very densely populated with single- family dwellings, various apartment complexes, including Apache Manor, industrial & manufacturing that includes Bama Pie. There are several busy train tracks that run through this area along with The City of Tulsa's water treatment plant & its water source Lake Yahola. The Tulsa Zoo is another attraction with in the run area and E-16 is the 3rd arriving Engine to the Tulsa International Airport. The Tulsa Fire & Safety Training Center & TCC's North East Campus is also located in this area.

The population in this geographic area is also quite diverse. Based on 2010 Census Data, the community is 47% Caucasian, 26% Hispanic, 18% African-American, and 8% Native American. Most notably, the

Hispanic population has more than tripled in size since the year 2000. To further breakdown the potential isolation of this community, 80% of this population still speak Spanish at home and 60% of them were foreign-born. Station 16 averages 2300 runs a year. Approximately 70% of these calls each year are EMS-related, while 7% are structure fires.

In 2013, there were 12 fatalities in the City of Tulsa that resulted from 181 incidents of pedestrians being struck by motor vehicles. These are joined by the more than 5,000 who died nationally. Of these, 17% were children under 18 years of age. While structure fires and fatalities in this area continue to be problematic, there are multiple programs and community risk reduction efforts that are currently addressing these hazards. In the last quarter of 2014 and the first quarter of 2015, there have been six documented motor vehicle versus pedestrian incidents that resulted in serious injury or death in the response district of Station 16.

First in area covers from about 46st N to the north, Independence to the South, West to approx. Yorktown & East to approx. Darlington. Including one of the most hazardous portions of Hwy 75 between Pine & Apache where the highway makes a couple of curves. Station 16 also covers a portion of Hwy 11 from Hwy 75 to Tulsa International Airport.

Fire Station 17

Address	1351 N. Sheridan Rd
Year Constructed	1953
2015 Incidents	2493
Staffed Units	E17
Unstaffed Units	N/A

Comments from Fire Station 17 Crew:

Fire Station 17, 1351 N Sheridan Rd. is a single company, single story, approx. 1000 Sq ft Firestation. It was built in 1953 and is 63 years old.

Engine 17 is a 2007 Crimson Gladiator Class A Pumper.

Engine 17's response area includes approx. 4 square miles of residential area and extends north to include all of Mohawk Park and the Tulsa Zoo. E-17 is also the first assigned company to the terminal at Tulsa International Airport, and is the first assigned structural apparatus to aircraft emergencies (Alerts) at the TIA. We also have a large percentage of Tulsa's general aviation businesses in our area on N Sheridan Rd. including maintenance, manufacturing, and FBO's. Interstate 244 and State Hwy 11 also run through our response area.

E-17 is an ALS company which is manned by 1 Captain, 1 Fire Equipment operator, and 2 Firefighters. 2 of which are Paramedic level trained. We respond to a high level of medical emergencies including cardiac arrests, shootings, and MVA's. E-17 also responds to a higher level of structure fires as compared to other companies in the city.

E-17 responds to an average of 7-10 calls per 24hr shift with a few generally coming after midnight.

E-17 also participates in training programs and fire safety programs such as community contacts, Show-N-Tells, and Smoke detector installation programs.

Fire Station 18

Address	4802 S. Peoria Ave
Year Constructed	1955
2015 Incidents	2984
Staffed Units	E18, C643
Unstaffed Units	N/A

Comments from Fire Station 18 Crew:

Tulsa Fire station 18 was built in 1955 located at 48th St South and Peoria. Station 18 is home for 1 Engine (Engine 18) and 1 District Chief car (Car 643). Located in the central area of District 3, Station 18 makes first due runs from 36th st South to 64th St South, from Riverside to just East of Lewis in some areas. E18 is a Spartan pumper built in 2007 with approximately 130,000 miles.

The station is located just off I44 and also has very quick access to Highway 75 both northbound and southbound at the I-44 junction, therefore Engine 18 has been designated a JAWS company for its higher probability of high speed collisions. This highway access also give Engine 18 access to be included in house fire/building fire alarms from 21st South all the way to 91st South, 33rd W Ave and to East of Yale. Station 18 serves a wide variety of Tulsa's population including some of the highest value homes north of Station 18, common residential property west of the station, and larger residential apartments for lower income families South of Station 18. Station 18 also serves the Brookside area full of shops, night life and bars. We also serve as the first in fire company for 5 different schools, 3 nursing homes, and several different churches/large gathering spots.

Station 18 makes around 3000 runs per year, this year the runs seem above average and on track to make about 3400 for the year of 2016. Engine 18 has Advanced Life Support (ALS) capabilities. We respond for all medical emergencies, lift assists, vehicle accidents and building fires. The first due fires for Engine 18 range from a 1000 sq. foot single story house, to duplexes, up to 6 story high rises with multiple apartments in a building. Notable fires Engine 18 has been the first to respond in the last 3 months are Fairmont Terrace, Royal Arms, Swiss Rolanda and multiple house fires. Engine 18 usually makes 8-10 runs per shift. Usually the runs will spread out throughout the day with an even split of 4-5 runs during the day and 4-5 runs from 11pm to 6am.

Fire District 3

TFD District 3 is stationed at 4802 South Peoria. It is located in Station 18, alongside Engine 18. The current station was built in 1955. District 3 is responsible for daily operations of 10 fire companies, which include 5 engines, 2 Ladders, 1 squad, and 2 Hazardous Materials Units. These 10 companies are comprised of 30 (at minimum strength) to 43 (at maximum strength) firefighters. All operations, both operationally and administratively, of these 30-43 members are managed by the District 3 Chief.

The geographical area for which District 3 is responsible operationally spans approximately 23 square miles. The District 3 Chief responds to 250-300 fire calls per year. Although, not one of the busier Chief Stations, District 3 has a disproportionately high number of apartments within its boundaries. Therefore, many of the fires are complex and involve high property values and high life risk potential which subsequently require a higher number of personnel. With 20-30% of these fires occurring during nighttime hours, the life safety/rescue concerns are elevated. Several historic fires in TFD history occurred in District 3.

Demographically, District 3 is one of the most diverse in the City of Tulsa. Although primarily residential in nature, the Arkansas River, Jones Airport and several industrial occupancies lend to the variety of incidents that are possible. To the near south exists a low income, government housing area. Further south is a very affluent part of Tulsa. Many of the homes in this area are valued at greater than $600,000. To the west, runs the Arkansas river. Although mostly a calm river, it is responsible for 15-30 river rescues each year. Beyond the river and further to the west is an older part of Tulsa. This area is moderately populated with single family dwellings and open fields. Within this area resides a regional Pepsi Cola Bottling Company and Jones Riverside Airport. Additionally to the west, is Turkey Mountain Urban Wilderness. A 300 acre wilderness areas with over 20 miles of trails where 15-20 times per year hikers or bicyclists become injured and require a search and rescue effort to rescue them. It has also been the scene of prolonged wildfires. To the north, the response area includes Brookside. Brookside is one of the several primary night life areas in Tulsa. Many of the homes in this area are high value and have historic value. Within Brookside is Philbrook Art Museum. Philbrook sits on 23 acres and sees about 160,000 visitors each year. Many exhibits within the Museum are considered “priceless”. Within the eastern boundary of District 3, lie many high value, historic homes. Lastly, the Grass Rigs and other apparatus from District 3, often support surrounding communities with a mutual aid response. Considering the wide range of occupancies within District 3, it becomes easy to understand the diversity within its boundaries.

Fire Station 19

Address	509 E. 56th St. N
Year Constructed	1995
2015 Incidents	1505
Staffed Units	E19
Unstaffed Units	N/A

Comments from Fire Station 19 Crew:

Station 19 is a single story building approximately 2500 square feet. It houses E19 and L79.

E19 covers approximately 4 square miles on single company responses, which mainly consists of single family residential homes. HWY 75 also goes through our area. E19 also routinely covers approximately 4 more square miles when providing mutual aid to Turley and sometimes Sperry. E19 also provides mutual aid to Owasso. If E19 travels East or West on an emergency call, there are no other TFD resources close by to assist us. The closest TFD resources are E24 and L24 located at 36 St. N. and Peoria Ave.

E19 is a 2002 model Luverne Class A Pumper.

L79 is a 1988 model E One Quint and is a reserve apparatus.

E19 is an ALS company and responds to medical emergencies of all types with a higher than normal percentage of them being trauma related such as shootings, stabbings, assaults and MVA with injury.

E19 also makes a higher percentage of structure and grass fires compared to most other companies.

E19 has 5 members assigned: 1 captain, 1 fire equipment operator, 2 paramedic firefighters, 1 EMT firefighter. Generally the crew operates with only 3, sending the other crew members to help staff other apparatus.

E19 generally has at least 3 patients at any given time who tend to call for us repetitively, more than once a week and sometimes more than once during a 24 hr. period. This number of patients fluctuates up and down but 3 is about average.

On average E19 runs 2-3 calls after midnight.

E19 participates in special events such as show and tells for neighborhood kids and adults at block parties and elementary schools. E19 provides stand by medical and fire coverage at the TPD training facilities during bomb squad training. E 19 also installs many smoke detectors for residents in our area.

Fire Station 20

Address	9827 E. 59th
Year Constructed	2000
2015 Incidents	3999
Staffed Units	E20, L20
Unstaffed Units	N/A

Comments from Fire Station 20 Crew:
Fire Station 20 was built in 2000 and it is located at 9827 E 59th St South. It is a two bay fire station that houses two companies.

Fire Station 20 has an Engine that is a 2007 Spartan Crimson. E20 has approximately 135,000 miles on it currently. It serves as an Advance Life Support response apparatus. E20 also carries the Jaws of Life due to being located close to highway 169 and Broken Arrow Expressway. The second fire apparatus is a 2000 Pierce Telesquirt Ladder. L20 has approximately 111,000 miles on it currently.

These two trucks cover nearly 9 square miles. The boundaries are from 91st St S to 41st St S and from 129th East Ave. to 72nd East Ave. Encompassed in this area there are several schools, churches, businesses, apartment complexes, two main highways along with several large residential housing neighborhoods. Also, 71st St S, which is one of Tulsa's highest traffic areas, runs through Station 20's first in area.

South of the station includes: Union High School, Union 9th Grade Center, several Union Elementary Schools, 4 new large apartment complexes along with several nursing/ assisted living centers. This area produces the largest number of runs for station 20.

North of the station includes: Industrial areas with some residential housing. Also, the B.A. Expressway is one of the two main highways we cover. Motor Vehicle Accidents and fires come from this area with some medical calls.

West of the station includes: Primarily residential, along with nursing/ assisted living centers and apartment complexes. We mostly run on medical calls in this area.

East of the station includes: Highway 169 is the second main highway, industrial, apartment complexes and some residential. We also run with station 27 in this area due to the higher call volume. This area produces the most fire runs for station 20.

The bulk of our calls come during the daytime, Monday through Friday, as our first in area is heavily populated with traffic due to the schools and businesses.

In 2015, Station 20 responded to 3091 calls. 2259 of the calls were medicals in which 57 were cardiac arrests 1547 were high priority. Station 20 arrived first on medicals 700 times. 832 of our calls were either fires or other calls, not medical in origin.

With a two company station, including an engine pumper and ladder, station 20 is prepared to handle most any emergency response.

Fire Station 21

Address	4606 E. 31st St
Year Constructed	1957
2015 Incidents	2766
Staffed Units	E21
Unstaffed Units	N/A

Comments from Fire Station 21 Crew:

Fire Station 21 was established in 1957 which makes it 59 years old. It is one of the smaller stations in the city. It is unique that it still has one of the old hose towers, that was used for drying hose. It also has a butterfly roof, which is unique to the area. It houses fire engine 21, and reserve fire engine 81.

Fire Engine 21 is a 2002 Spartan, and E-81 is a 1992 Pierce.

Fire Station 21 is located at 4606 E. 31st. We cover as far south as 4200 South Yale, to the east 3100 and Memorial, to the west 3100 south Florence, and to the North 21oo south Yale. We also provide coverage on the Broken Arrow Expressway From 2100 to 8100 converging both eastbound and west bound lanes.

E-21 makes a variety of runs from medical calls, assisting with lifting call, motor vehicle accidents, and structure fires.

Medical calls- E-21 is a Paramedic company. We make multiple calls where these types of skills are used and quality service is delivered. We have a high population of the elderly in our area and being able to arrive quickly and start care helps in treating them. We also run cardiac arrest calls, again quick response and advanced lifesaving treatment helps in positive outcomes. These types of runs are all directions from our station. Methodist Manor, Wildwood Care Center and Companion Care are the 3 nursing facilities that we run to, with Methodist Manor being the most frequent. Methodist Manor is neighboring us to the west located at 4134 E. 31st.

Assist with Lifting- there is a higher population of the elderly, and they fall quite often. They are either unable to get up themselves or their spouse is unable to help them up. There are many times that they are in a tight position, in the bath tub, beside the toilet, behind a door in a bathroom, between the car and the garage wall, etc. Sometimes it takes all 3 members to effectively get the person back to the chair, bed, or after assessing call for EMSA. These runs as well are all directions from our station.

Motor Vehicle Accidents- E-21has great access to the Broken Arrow Expressway going either west bound or east bound. For this reason we make the majority of our traffic accidents there. We also have some busy intersections to the west at 3100 s. Harvard. To the east 3100 s. Yale, and 3100 s. Sheridan. To the south 4100 s. Yale. To the north 2100 s. Yale. E-21 also has the Jaws of Life to deliver quality service to remove victims from vehicles that otherwise it would be impossible to get them out.

Structure Fires- E-21 has made multiple structure fires in the past couple of years, due to our location we have been able to get to, and effectively make interior fire attack saving property and lives.

To the South a house had a garage fully involved with part of a living area. We were able to stop the fire and the house was remodeled and the resident is still living there.

North of the station a home had fire showing from the living room front window, and again a quick response we were able to get in put out the fire and save property. The house is been restored and the resident is still there.

North of the station again another fire this time with the garage fully involved and fire extending into the house, we were able to get a quick response and were able to find and rescue a young girl who was in the front room of the house near the doorway.

East of the station we have made multiple house fires and Apartment fires.

The least amount of fires have been to the west of the station.

Station 21 is a busy station due to the runs on the B.A. Expressway, the elderly population, and the types of Residential- homes, du-plex, apartments. Commercial- multiple business, Promenade Mall, Southroads Mall, and multiple strip centers.

Fire Station 22

Address	7303 E. 15th St
Year Constructed	2000
2015 Incidents	4401
Staffed Units	L22, SQ22, C642
Unstaffed Units	N/A

Comments from Fire Station 22 Crew:

Station, Equipment and Staffing

Station 22 is an approximately 16 year old fire station located at 7303 East 15th Street. Station 22 houses Ladder 22, Squad 22 and Car 642. The personnel assigned to Station 22 include one Fire Captain, two Fire Equipment Operators and five firefighters as well as the District Two District Chief and the Management Intern.

Ladder 22 is a 2005 Spartan Telesquirt with 108,355 miles and 9,151 engine hours. It has a 65 foot aerial and a 500 gallon water tank. Ladder 22 is a BLS company with a minimum staffing of four personnel. Squad 22 is a 2008 Ford F-550 Super Duty with 89,396 miles; it has no pump or firefighting capabilities and is an Advanced Life Support Unit with a minimum staffing of two personnel, one of which must be a Paramedic and the other a Company Officer. Car 642 is a 2006 Ford F-250 with 89,997 miles and 4,694 engine hours.

Station 22 is also a facility utilized by the EMS Department to house an EMS supply vending machine; it is a location that participates in the Emergency Infant Services "Baby Box Program" as well as being the station used by the Tulsa Safe Kids Coalition for child seat installation on the third Thursday of each month. Due to those circumstances and the fact that Station 22 is located near an elementary school and is surrounded by residential neighborhoods on all sides, Station 22 usually receives a steady amount of civilian walk-in visitors during normal business hours and on weekends.

Station and Apparatus Condition

Station 22

Due to the efforts and dedication of TFD personnel assigned to Station 22, the general cleanliness and appearance of the station is very good. However, there are some needed repairs that fall outside the capabilities of the station personnel that need to be addressed. For example there are two large cracks in the wall on the inside of the station; one located near the door to the female locker room and the other located in the Northwest corner of the station underneath a large window in the Captain's bunkroom. There are also several locations in the station roof that leak during heavy rainfall, the parking lot needs to be restriped and the dishwasher was removed for repair on Feb. 5th 2016 and has never been returned.

Also on 4/26/16 Station 22's power was knocked out by severe weather and the emergency generator failed to operate properly and had to be jump started. Soon after that occurrence, a solar power trickle charger was installed on the generator as a "temporary fix" and still remains connected to the generator to this day (6/16/16). The needed repairs listed above have been submitted in the past during routine station inspections conducted by the District Two Chief.

Ladder 22 Apparatus and Equipment

It is my opinion that the condition of Ladder 22 is consistent with what is to be expected from an apparatus of its age (11+ years) and mileage (100,000+ miles). For the most part the apparatus seems to be reliable however since January 1st 2016 there have been a number of needed repairs made on either the apparatus itself or the equipment that is assigned to it.

For example on 1/24/16 it was noted in the logbook that the generator would not start and was in need of repair. On 2/2/16 an air leak was reported. On 2/8/16 a needed repair caused the apparatus to be traded out with Reserve Ladder 84 and was not put back in service until 3/4/16. It should be noted that while RL84 was being used it was recorded that it overheated on 2/12/16, it had an air/water leak repaired on 2/26/16 and a window repaired on 2/22/16.

After L22 was returned it was recorded on 3/10/16 that the apparatus had "acceleration issues, low air alarms, broken oil-dry valve handle and the aerial strobe light was intermittent". It was also recorded on 3/10/16 that the truck radio would not automatically turn on when the apparatus was started and needed to be manually turned on each time. For the last few months it has sometimes been noted that L22 has trouble accelerating early in the morning (either during truck check or when dispatched on an early run) when on the night before the apparatus was not started because they were not dispatched on any incidents.

On 5/19/16 L22 was in for ground ladder and aerial testing when it was noted that it had broken springs and was taken out of service until 5/27/16 and Reserve Engine 63 was put into service in its place. On 5/31/16 the ground ladder rack was damaged and the locking devises were removed for welding repair and have not been replaced by the date of this report (6/16/16). Since 5/31/16 L22 has been unable to carry any ground ladders on the apparatus except for an attic ladder that is secured in the 3-inch hose bed.

The piece of equipment that consistently has the most operational issues is the Eagle X Thermal Imagining Camera. According to the logbook, in the last six months it was reported as "dead" on 4/15/16, 5/23/16 and 6/1/16 as well as having issues on 6/16/15. On 6/1/16 Acting DC Bob Peters took the TIC to Supply and had the battery replaced but the operational status of this piece of equipment seems to be "hit and miss" at best. E-mails have been sent to Supply in the past to try to correct this issue but repair attempts have not successfully corrected this issue.

Squad 22 Apparatus and Equipment

Generally speaking, Squad 22's dependability also seems to be consistent with a vehicle of its age (8+ years) and mileage (89,000+ miles). Perhaps due to its less complicated construction compared to that of apparatus like L22, it does not seem to be out of service or in need of repair as much as L22. However, one consistent issue that Squad 22 has is the need to be put out of service about once a shift so it can be driven on the expressway in order to clean the exhaust. The time out of service during this time is typically about 20 to 30 minutes.

Coverage Area

Generally speaking, Station 22's first-in coverage area might be best described as being south of Admiral Boulevard, north of 31st Street South between Yale Avenue and Mingo Road. Station 22 will also respond to motor vehicle accidents and other emergencies on I-244 and Highway 169.

Station 22's coverage area has multiple types of structures and occupancies including single family residential, multi-family residential (approx.. 37 apartment complexes), nursing homes and assisted living, large warehouses, small strip malls and many older building used for various businesses. Many commercial structures in Station 22's first-in do not have a fire sprinkler system as noted by L22 personnel while conducting the two mandatory walk-throughs per month.

It has also been noted during these surveys that there are potential forcible entry challenges to TFD personnel when responding to many of the small strip malls in our first-in area. It has been observed that most of the rear entrances of the stores in these strip malls are steel doors with multiple dead bolt locks as well as drop bar locking systems. It has been learned from talking with the owners of these stores that due to multiple break-ins, the owner has taken extra measures to secure their property and livelihoods. While these actions do help secure this property from crime, it does have the potential for making the task of forcible entry (or exit) much more labor intensive and challenging for TFD personnel. An example of this occurred on Oct. 18th 2015 at 0508 hours when L22 was the first-in company on a strip mall fire at 1619 South Memorial Drive. L22 arrived on scene to find heavy fire coming from the front of the structure. After the fire brought under control, ventilation of the other stores in the strip mall was attempted but hindered by the amount of security locks placed on the rear entrances/exits.

Call Volume and Description

Station 22's call volume and type seems to be consistent with the rest of the fire department as a whole, with the majority of the calls being of the medical emergency type. One thing that should be noted is that the age of residents in Station 22's first-in area seems to be gradually getting older and has caused our number of "assist with lift" calls to increase recently. Also there are several residents in our first-in who are physically disabled and require the same assistance as the elderly patients. This is not to say that the number of "assist with lift" calls is excessive or cumbersome for Station 22 but it is interesting to note that this call type has increased in conjunction with the demographics of the neighborhoods that we provide service to.

From January 1st to June 16th 2016, Ladder 22 has been dispatched on 840 calls and Squad 22 has been dispatched on 1309 calls. The following is a summary of calls received during the day shift and night shift during April and May of 2016. This should provide a small window of how incidents at Station 22 are divided by company and time of day.

April 2016

Ladder 22: 0800 – 1800 hrs. - 98 1800 – 0800 hrs. - 50

Squad 22: 0800 – 1800 hrs. - 122 1800 – 0800 hrs. - 93

May 2015

Ladder 22: 0800 – 1800 hrs. – 98 1800 – 0800 hrs. – 55

Squad 22: 0800 – 1800 hrs. – 110 1800 – 0800 hrs. – 109

Fire Station 23

Address	4348 E. 51st St
Year Constructed	1964
2015 Incidents	3849
Staffed Units	L23, SQ23
Unstaffed Units	N/A

Comments from Fire Station 23 Crew:

Fire Station 23 was built and opened in 1964 and is located at 4348 E. 51st St. It's first-in areas outer limits stretch from 71st to 41st Street north/south and Lewis to 74th E. Ave east/west. The station has one ladder truck and one squad truck assigned. Centrally located between district 5 and district 3, we respond to incidents in both districts on a regular basis.

Ladder 23 is currently a 2000 model Pierce Tele-Squirt. Squad 23 currently responds in a 2009 Ford 550 with rescue utility bed and grass-rig pump and is manned with at least one paramedic at all times. The station responded to 3,849 runs in 2015; an average of 10.5 incidents per 24-hour shift. Station 23 is in the top five most active fire stations in Tulsa.

Station 23 is located adjacent to I-44, which gives us good access to a large response area. Going west, we respond on incidents as far as Hwy 75 West and going east, as far as Hwy 51. We have a large first-in area with various occupancies from residential to high-rise buildings.

Station 23 responds to a high run volume and very wide range of incident types. Station 23's first-in area includes forty apartment complexes, many of which are low-income housing. We also have large, high-income single-family dwellings. Station 23 is first-in to St. Francis Hospital complex, Laureate Behavioral Health Center, three elementary schools, one middle school, one high school, two nursing homes, and one assisted-living center. Regarding structure fires, there is an elevated potential for high-risk incidents in our first-in area.

Among Station 23’s 3,849 total runs in 2015, 2,133 calls were EMS-related responses due to a highly-populated first-in area. We also have a large number of citizen-assist calls. Due to our proximity with I-44 and other heavy-traffic areas, station 23 responds to a large number of motor vehicle accidents.

Fire Station 24

Address	3520 N. Peoria Ave
Year Constructed	1985
2015 Incidents	3448
Staffed Units	E24, L24
Unstaffed Units	GR24, B24

Comments from Fire Station 24 Crew:

Station 24 covers an expansive and diverse first in area that spans two counties (Tulsa and Osage Counties). Our first in area carries a west border of Osage Drive, north to 51st street north, east to Lewis Ave, and as far south as Virgin street. We serve a population whose average household income is well below the poverty line. Single family residences are the primary structures we respond to with an average square footage of 800 to 1,000 square feet. We have several subsidized large multi-family dwellings in our area as well as a fair share of commercial structures. We typically care for patients who have no insurance and their primary health care provider is the Tulsa Fire Department along with EMSA. We respond to a high number of violent crimes incidents as well as a high number of cardiac arrests due to our aging population and a lack of primary health care.

Station 24 responded to 3,358 calls in 2015. Approximately 80% of those runs were medical in nature, MVA's, lift assists, or other assistance. Approximately 20% of our runs were structure fires, car fires, and grass fires. Station 24 makes approximately 51% off our runs during the day and 49% during the night. Station 24 also responds to calls in Turley, OK via mutual aid along with mutual aid calls with county volunteer fire departments such as Osage Hills and Black Dog.

Station 24 was built in 1985 and is approximately 31 years old. Station 24 houses an ALS engine that was manufactured by Spartan in 2007 and has 146,144 miles. Ladder 24 is housed here and is a 2002 Pierce that has 110,879 miles. Grass Rig 24 and Boat 24 are the other apparatus housed at station 24.

Fire Station 25

Address	7419 E. 42nd Pl
Year Constructed	1966
2015 Incidents	2391
Staffed Units	E25, C645
Unstaffed Units	N/A

Comments from Fire Station 25 Crew:

Station 25 is located at 7419 E 42nd Pl the station was built in 1966. The station has approximately 2200 square foot of living space and three apparatus bays. Station 25 houses three apparatus Engine 25, Car 645 and a reserve apparatus, Engine 85 (used as a reserve apparatus if another engine in the city is inoperable). Station 25 has 4 personnel assigned to Engine 25 per shift and 2 personnel assigned to the District Chief's car per shift. The rank of these six personnel total 1 District Chief, 2 Captains, 1 Fire Equipment Operator and 2 Firefighters per shift.

Engine 25 is a 2007 Spartan fire engine with approximately 135,000+ miles and 10,300+ hours. The pump on the engine has roughly 700 pumping hours. Engine 25 carries a large amount of equipment used at fire scenes, vehicle extrications, as well as medical equipment, for emergency medical service incidents. Engine 85 is a 1998 E-One with 157,658 miles, 4,172 hours and 978 pump hours. C645 is a 2008 Ford F-250 with 72,241 miles.

Station 25 covers roughly 4 square miles of first in run area which is comprised of light industrial, residential, apartments, hotels, rehab facilities, large businesses, nursing homes and restaurants. There are three major highways that intersect engine 25's first in run area. Interstate 44, HWY 169 and the Broken Arrow expressway are three of the most traveled thoroughfares in the City of Tulsa. This allows Engine 25 a quick response time to assist other companies when needed. Station 25 is located just off of Memorial; the main arterial street in the city of Tulsa.

Engine 25 has responded to roughly one thousand one hundred and seventy-one emergency calls at the time of this report (06-16-2016). These emergency calls range from structure fires, building fires, car fires, motor vehicle accidents with extrication, motor vehicle accidents with injuries, motor vehicle accidents with fluids and no injuries, HAZMAT emergencies, animal rescues, lift assists and a broad spectrum of medical emergencies. In short, more run types than could possibly be listed. Medical emergencies range from high priority calls such as cardiac arrest, shootings, stabbings, overdose, shortness of breath, traumatic injuries, etc. The remainder of medical emergencies also includes low priority calls. Approximately 80% of the time, E-25 is on the scene first at medical emergencies and makes the initial patient contact. The fire department is also dispatched any time there is a perceived emergency by a citizen of the city of Tulsa or someone visiting our city. Of these One thousand one hundred and seventy-one emergency calls roughly 34% of these runs are after 8:00 PM and before 8:00 AM (these calculations were taken from the last 30 days of service). Concerns in our first in area, due to the down turn in the economy, are vacant and abandon buildings that are locked down and have no property representatives.

Fire Station 26

Address	2404 W. 51st St
Year Constructed	1967
2015 Incidents	1980
Staffed Units	L26, SQ26
Unstaffed Units	GR26, B26

Comments from Fire Station 26 Crew:

Fire Station 26 has been in service since 1967. It is in the original location southwest of downtown Tulsa. The station is located at 2404 W. 51st St. Its first-in area stretches from 43rd Street South to 6300 South (north / south) and from Elwood to 59th West Avenue (west/east).

The station has two fire companies assigned, Ladder 26 and Squad 26. Squad 26 is an advanced life support apparatus (ALS) and is staffed with a paramedic; both are the only of their kind west of the Arkansas River.

Ladder 26 is currently a 2000 model Pierce dash 65 foot Telesquirt. Squad 26 is a custom built 2011 F-550 conversion with a fire pump. Additional equipment assigned to Station 26 includes ATV 26, Grass Rig 26 and Boat 26. These apparatus illustrate the wide variety of emergency potential in our response area. The station responds to 1944 runs combined per year, an average of 5.3 incidents per 24 hour shift. Approximately 15-20% of these runs occur during nighttime hours.

The stations location, situated near 3 major highways, I-244, I-44 & Hwy-75, gives it access to a large response area. Because of this, Ladder 26 is assigned to alarms as far east as Harvard as far west as Sapulpa on mutual aid. Ladder 26 is the first-due ladder to all of west Tulsa. These areas include residential, apartment complex and business/industrial areas.

Station 26 responds to a broad spectrum of incidents. Regarding structure fires, residential structure fires are common in the station’s first-in area. The industrial area north east of the station have occasional structure fires which present an elevated risk to the public, as these areas are mixed with residential and commercial occupancies. This area includes Holly Refinery.

Station 26 responds to EMS calls primarily in lower income areas. Requests for service from physically limited citizens are high due to the station's aging population. Service includes a treatment for respiratory distress, cardiac arrest and other serious medical conditions

Station 26 responds to motor vehicle accidents on the highway 75, I-44 and I-244. Squad 26 is ALS for this reason. Fast response to these incidents is critical to patient stability, also the ability of multiple fire companies to converge quickly to the accident scene provides for scene safety.

Fire Station 27

Address	11707 E. 31st St
Year Constructed	1972
2015 Incidents	5690
Staffed Units	E27, L27, AL27
Unstaffed Units	N/A

Comments from Fire Station 27 Crew:

Fire Station 27 has been in service since 1972. It has only been one station at its current location at 11707 E. 31st. The station consists of three apparatuses including Engine 27, ladder 27 and Air and Light 27. Its first in area stretches from Admiral and Highway 169 to 51st St. and as for east as County Line Rd and west as just east of Memorial Dr. The coverage area is approximately 14 sq miles. The population it serves is the largest at a staggering 60,000 customers. The station averages 6000 calls for service per year with 7 members per shift.

Engine 27 was placed in service in 2007. It is a Crimson custom. The Engine has 168,000 miles with 12,716 engine hours. The pump has 894 hours. The Engine had 3800 calls for service last year. It has capability of advanced life support which consists of a cardiac monitor, O2, advanced airway supplies, cardiac medications, and a paramedic. It also has the Jaws of Life due to its close proximity to Highway 169.

Ladder 27 is a 14 year old Pierce that was placed in service in 2002. The ladder has 138,000 miles with 815 pump hours. The ladder has a 75 foot aerial with a water system that allows it to flow water. The Ladder has 2,000 calls for service last year. Ladder 27 is the only Advanced life support ladder in the city. It has the same equipment as the engine. The ladder is also equipped with ventilation equipment which consists of a large portable fan.

Air and Light 27 is a 13 year old International that was placed in service in 2003. It has 86,000 miles. The Air and Light has bottles to refill cylinders on scene with 82 cylinders on the apparatus at one time. It also has O2 cylinders to refill stations with medical grade oxygen. The air and light has a functioning cascade system that allows firefighters to actually refill bottles on scene. It has a multitude of lights and rehab equipment for use on scene as well.

Due to its strategic positioning on the east side of Tulsa, Station 27 has a large first in area. The area includes industrial parts that are in its Southern first in response area, high rises, a very large number of apartments and a substantial presence of private homes with large communities of diverse cultures within that first in area. The cultures include Vietnamese, Hmong, and Hispanic cultures with a growing population of geriatric patients as well. The runs are just as diverse as the culture with EMS calls, MVCs, and a growing number of house fires as well. The number of critical trauma and medical calls are increasing in our area calls as well. Station 27 is the busiest station not only in the city of Tulsa but in the state of Oklahoma as well. A large number of the calls are during the daylight with an average of 3-4 calls per night for the station.

Fire Station 28

Address	7310 E. 71st St
Year Constructed	1972
2015 Incidents	2675
Staffed Units	E28
Unstaffed Units	N/A

Comments from Fire Station 28 Crew:

Fire Station 28 was built in 1972. The address is 7310 E 71st St S, just east of a traffic signal at 73rd E Ave. Station 28 is a single story firehouse with an apparatus bay to house three apparatus.

Station 28 is a single company station, housing the crew for a single Engine that is capable of meeting many of the city's emergency needs. Engine 28 is a 2007 Spartan with approximately 116,000 miles. In addition, Engine 28 is an ALS company providing nearly every treatment that an EMSA ambulance can provide, with a four minute or less response time within our service area. Engine 28 is also a "Jaws" company, carrying cutters, spreaders, and ram on our apparatus.

Station 28 also houses two reserve apparatus, Engine 88 and Ladder 88, which are maintained by the crews of Station 28 to be ready when needed by another company, or for emergency callback deployment. Engine 88 is a 1995 E-One Protector with approximately 144,000 miles, while Ladder 88 is a 1991 E-One with approximately 123,000 miles. Ladder 88 is currently on the front line at Station 2.

The first in coverage area for Station 28 is approximately 6 square miles from 61st and Yale to near 81st and Mingo. We have contact with citizens from all walks of life including Section 8 apartment complexes, to million dollar homes. There are multiple nursing homes in our first in response area, as well as many commercial properties of all sizes, including Woodland Hills Mall. Engine 28 ran 2,661 calls in 2015, 1,901 of which were medical calls. Of those medical runs, 1,229 were classified as Priority 1. Engine 28 ran on 52 Cardiac Arrests in 2015. Engine 28 typically runs an average of two calls per night. We run MVA's often, as well as a variety of all types of medical calls. With the wide range of property, residential and commercial, there is no "typical" fire run that we make. Engine 28 is prepared for any type of fire or medical response.

Responding to the west we have multiple large apartment complexes that our last three structure fires on A Platoon have come from. To the south we have two of the largest apartment complexes in Tulsa. Woodland Hills Mall and many restaurants are east of our station which can add a concentration of over 4,000 people to our first in response area. In addition, when responding to the east, Engine 28 crosses the intersection of 71st and Memorial, which has repeatedly been named one of the most dangerous intersections in the city. There are nursing homes in all directions. During weekends and Holiday seasons, the traffic around our station increases drastically, more MVAs occur, and emergency response can occasionally be challenging.

Fire Station 29

Address	7429 S. Lewis Ave
Year Constructed	1974
2015 Incidents	4411
Staffed Units	E29, L29
Unstaffed Units	B29

Comments from Fire Station 29 Crew:

Station 29 is located at 7429 S. Lewis Ave and was constructed in 1974. This station houses Engine 29, Ladder 29, Squad 29 and Boat 29. Engine 29 is a 2007 Crimson Pumper. This truck has 142,156 miles and 12,688 hours at this time. Engine 29 has Advanced Life Support capabilities as well as a jaws unit. Ladder 29 is a 2012 E-One Bronto with a 114 ft. aerial. This truck has 18,050 miles and 2,262 hours at this time. Ladder 29 has Basic Life Support capabilities. The average annual call volume for Station 29 is around 4,500 calls (over 12 calls per shift), with approximately 1,100 of those occurring during nighttime hours.

Station 29 covers a wide variety of demographics and properties. This first-in run area is approximately 9 square miles and ranges 55th St. to 91st St. going North to South; and Riverside to Yale going from West to East. Engine 29 is the first out truck for medical emergencies, which makes up a large portion of our call volume. This station also makes structure fires that range from single family dwellings to large apartment buildings. With respect to apartment complexes, Station 29 boasts the highest number of complexes when compared to any other station's first-in run area. There are multiple high-rises, large retirement facilities, and nursing homes in the area. We are also responsible for a section of the Arkansas River, which Boat 29 is prepared to respond to if necessary.

Significant occupancies within our response area include the City-Plex Towers, a three tower high-rise set of buildings (one of which is the second tallest high-rise in Oklahoma). One of the towers has a specialty hospital located inside. University Village, Prairie Rose, Tulsa Jewish Center and the Villages of Southern Hills are some of the larger retirement homes that we respond to on a regular basis for various reasons, such as medical emergencies, lift assist, and business alarms. There are other smaller nursing homes in the area as well in which we respond to for various reasons. River Spirit Casino is a large occupancy that is located in our first-in area that is in the process of adding a large, multistory resort hotel. Jones Riverside airport, the busiest non international airport in Oklahoma, also lies within our response area. Oral Roberts University is also located less than half a mile from this station and during the semester has a student enrollment of around 3,500.

Fire Station 30

Address	14333 E.11th St
Year Constructed	1975
2015 Incidents	2713
Staffed Units	E30, L30
Unstaffed Units	GR30, B30

Comments from Fire Station 30 Crew:

First-in run area for station 30 includes east as far as 257th E Ave, west as far as highway 169, north as far as Pine St, south as far as 31st and 193rd E Ave. Also respond out of city runs to Cherokee Casino in Catoosa and mutual aid responses with Broken Arrow.

Most emergency responses include several general EMS calls. MVA's on highway I44, I244, and hwy 169. Several calls include responding to Cherokee Casino for medical emergencies with mutual aid for Catoosa Fire and Pafford EMS. L30 has a Grass Rig and Boat. Grass Rig 30 responds to approximately 30 calls per year for grass fire related emergencies.

Station 30 covers a large first-in area with several types of occupancies from single-family residential, multi-family apartments, industrial, and manufacturing facilities along with large rural open land areas.

L30 has also filled for BA Fire during larger emergencies within Broken Arrow.

Most calls are received during daylight hours but over the last few years the calls during overnight hours has increased substantially.

E30 is an ALS engine that has experienced a larger call volume with several cardiac arrest incidents and a larger quantity of EMS calls due to the aging community demographics. The area is densely populated in residential single-family and multi-family apartments with many of the families having numerous occupants within the Hispanic and Asian population.

The area has increasingly became more violent and active with incidents including gunshots, assaults, stabbings and an increase in traffic has caused a rise in MVA incidents. The area has also experienced an increasingly aging population requiring more medical attention along with aging occupancies and dilapidation of building structures.

With the reopening and restructuring of the old Eastland Mall, now called the Eastgate Metroplex, several large companies have taken up business there with employee numbers ranging into several thousand. In recent months Alorica has increased their employee numbers by 1250 and is a business that we frequently run to. The Eastgate Metroplex has also just entered contracts with a large rental car agency, Coca-Cola and other businesses.

Fire Station 31

Address	3002 N. Mingo Rd
Year Constructed	1970
2015 Incidents	1468
Staffed Units	E31, L31
Unstaffed Units	GR31

Comments from Fire Station 31 Crew:

Located at 3002 North Mingo station 31 is a two company station with three apparatus. We have an engine, an aerial apparatus and a grass rig. Station 31's primary response area is very diverse with some residential, some light industrial, and the heaviest industrial area being the Port of Catoosa. We also cover the airport and highways 169, 244, and 11. Our runs have no specific pattern to time of day but increase due to weather changes as they affect traffic.

Fire Station 32

Address	6010 E. 91st St
Year Constructed	1982
2015 Incidents	2749
Staffed Units	L32, SQ32
Unstaffed Units	GR32

Comments from Fire Station 32 Crew:

The first in run area is approximately 8 square miles, Garnett from the east to Riverside Dr to the west, and 81st south to 105th south.

We have residential section 8 apartments to multi-million dollar 20,000 sq. ft. single family homes. Our mercantile consist of strip centers, large box stores, automotive dealerships, and office buildings. Some are between 4 to 8 floors high.

We also have two hospitals and several medical complexes.

We cover two school districts-Jenks Elementary and Middle School, Union Elementary, and Holland Hall School Pre K to High School.

The industrial is very light, but we have a very high Hazmat priority at the Conlee Corp located at 91st and Delaware.

Most of our runs are medical or MVA related and occur mainly during the day, although are nighttime runs have increased to around two or three a night. Most of our MVA are on Memorial or Yale, and we also cover the Creek TPK from Riverside Dr to Hwy 169 and 81st street south.

Sq32 is a 2011 Ford F550 with approximately 38,000 miles. It was placed in service July 2010. In the first complete year it made 1110 runs and has increased to 1417 runs in 2015.

L32 is a 2000 Pierce Telesquirt with 29,000 miles on the current odometer. The speedometer has been replaced twice, so the actual mileage is unknown. In 2010 they made 956 runs and has increased to 1350 in 2015.

GR32 is a 2002 Ford with 5500 miles. It makes about 20 runs a year.

Fire Station 51

Address	7777 East Apache St
Year Constructed	1995
2015 Incidents	276
Staffed Units	U51, U52
Unstaffed Units	N/A

Comments from Fire Station 51 Crew:

Fire Station 51 is a Federal Aviation Administration (FAA) regulated fire station located on Tulsa International Airport (TUL). TUL according to FAA statistics moved over 2.8 million passengers in 2016.

FS 51 is a C Index rated airport according to Federal Aviation Regulation 139. It is solely dedicated to providing Aircraft Rescue and Firefighting ARFF services to TUL and its tenants that are within the airport grounds. The airport is approximately 4 square miles and is bordered by Apache Street, 46th Street North, Mingo Rd and Sheridan Rd.

The current FS51 is located on airport grounds northwest of the main taxiway. As the airport has grown and expanded so has FS51 and the current station was occupied in 1995. FS51 has 17 people assigned. 5 firefighters per shift with a required minimum staffing of 4 per 24 hour shift. There are two 40 hour positions consisting of an Airport Chief and an Airport Training Officer. The equipment housed in FS51 consists of two frontline ARFF vehicles and one reserve ARFF vehicle. It also houses Tulsa Fire Departments Mass Causality Unit MC51.

FS51 makes approximately 200 emergency calls a year. The calls range from Aircraft emergency alerts to medical emergency calls within the grounds of the airport. Another major responsibility is inspecting fuel farms and fuel trucks. Airport and aircraft familiarization is a major responsibility of the firefighters to comply with Federal requirements. FS51 is also the most popular stop on the many tours given by the Airport marketing department.

FS51 protects some of the most valuable resources in the City of Tulsa. The Tulsa International Airport is home to many businesses and Airplane Hangars and a few of our major ones are:

> TUL is the headquarters for all Maintenance and Engineering activities at American Airlines worldwide, and is the maintenance base for the airline's fleet of Airbus A320, MD-80, Boeing 757, and Boeing 737 and some Boeing 767 aircraft – a combined total of nearly 600 airplanes.
>
> TUL's convenient location adjacent to three interstate highways, two major railways, and within ten minutes of the nation's largest inland ice-free sea port makes it an ideal location for efficient cargo operations. The following companies have cargo operations at TUL: Federal Express, UPS United Parcel Service, USPS United States Postal Service, American Airlines, Southwest Airlines, and United Airlines.

Appendix B: Tulsa History

Links to Documents and Sites with Tulsa History

A History of Tulsa Annexation

Tulsa City Council, Jack Blair, 2004

http://www.tulsacouncil.org/media/79331/Annexation%20History.pdf

Early History of Southwest Tulsa

Southwest Tulsa Planning Team, Southwest Tulsa Historical Society, and Tulsa Planning Department,

https://www.cityoftulsa.org/media/179548/6_Appendix%20D.pdf

Southwest Tulsa Chamber

http://www.southwesttulsa.org/images/History/SWTulsaHistoryBook2004.pdf

Tulsa Historical Society and Museum

http://tulsahistory.org/

Tulsa Preservation Commission

http://tulsapreservationcommission.org/

Timeline of Tulsa, Oklahoma

Wikipedia

https://en.wikipedia.org/wiki/Timeline_of_Tulsa,_Oklahoma

Appendix C: TFD First-In Risk Calculation Methodology and Tables

1. **Fire station 4 minute drive-time analysis.**
   a. Create 4 minute drive-time polygons from each existing fire station.
      i. 30 mph speed on surface streets (Constant Speed)
      ii. 45 mph on highways (Constant Speed)
      iii. CALCULATION: Percent of Tulsa city limits not covered by any 4 minute polygon.
   b. Create 4-minute drive-time polygons for each proposed station location:

2. **Fire station first-in areas: Existing & Proposed.**
   a. Create first-in polygons covering entire city limits, based on the nearest fire station. (Drive time, using same speeds – 30/45 mph street/highway) (Constant Speed)
   b. Unique, mutually exclusive polygons – no overlap
   c. A table for each variation (deployment models):
   d. CALCULATION: - count number of incidents in each first-in area
      i. DATA: TFD Incident data
      ii. All incidents – every "type situation found" code
      iii. Perform calculation for each "deployment model" provided by Deployment Committee.
   e. CALCULATION: - count number of residences in each first-in area.
      i. 3 values – Number of SFDU, MFDU & TOTAL (sum of SFDU & MFDU)
      ii. DATA: Compact Information Systems resident file.
         1. Includes Single Family Dwelling Units & Multi-Family Dwelling Units (SFDU/MFDU)
         2. MFDU – apartments; including each individual unit
         3. Data needs to be geocoded to rooftop level.
            a. Addresses are correctly formatted for highest geocode success
            b. Non rooftop geocode rate needs to be less than 1%.
      iii. Perform calculation for each "deployment model".
   f. CALCULATION: - "Response Time Ratio" - For each station's first-in area, calculate the percentage of that fall outside any 4 minute response polygon.
      - For example – this shows when a station like 27's has a big first-in area, and can only reach a percentage of the residences in time.
      - Count number of residences (SFDU + MFDU) within a 4 min polygon in each first-in area. Subtract from total to get count of residences OUTSIDE any 4 minute polygon.
      i. Calculate percentage - For each first-in area, divide this count by total number of residences of that first-in area. (Total already calculated in "e" above)
      ii. Perform calculation for each "deployment model".
   g. Calculation – First-in area "Risk Total".
      i. Residence ratio: TOTAL Residences / 10,000
      ii. Incidents ratio: TOTAL Incidents / 2,000
      iii. Response time ratio: Calculated above
      iv. Perform calculation for each deployment model above. (6 total)

DATA

1. INCIDENTS - ALL
2. NUMBER OF RESIDENCES
   - Actual number of Single family residences - every single address of homes in city of Tulsa. USPS updated weekly
   - Multifamily units - every single apartment unit in city of Tulsa -USPS weekly

Current Fire Stations Data Table

Fire Station	Residence Ratio	Incidents Ratio	Response Time Ratio	Risk Total
2	0.7333	1.1485	0.999181781	2.880982
3	0.4856	1.139	0	1.624600
4	0.3327	1.038	0	1.370700
5	0.6313	0.902	0	1.533300
6	0.2434	0.2695	0.900164339	1.413064
7	0.7747	0.9155	0	1.690200
9	0.3767	0.24	0.885319883	1.502020
10	0.4631	0.7475	0.880803282	2.091403
12	0.1324	0.2235	0.906344411	1.262244
13	0.2436	0.438	0.927339901	1.608940
14	0.3932	0.324	0	0.717200
15	0.5753	0.698	0	1.273300
16	0.3925	0.739	0.992356688	2.123857
17	0.5118	1.061	0.908167253	2.480967
18	0.9678	1.243	0.996073569	3.206874
19	0.2964	0.609	0.978407557	1.883808
20	0.7581	0.925	0.833531196	2.516631
21	0.7721	0.987	0	1.759100
22	0.9235	1.4105	0.876773146	3.210773
23	0.8462	1.1795	0.965965493	2.991665
24	0.3742	0.971	0.871459113	2.216659
25	0.4776	0.9345	0.975502513	2.387603
26	0.331	0.4665	0	0.797500
27	2.0364	2.15	0.772785307	4.959185
28	1.3275	1.3535	0.901318267	3.582318
29	1.2121	1.5135	0.875670324	3.601270
30	0.5782	0.848	0.487547561	1.913748
31	0.0828	0.2005	0.321256039	0.604556
32	1.2126	0.7185	0.627989444	2.559089
51	0	0.003	0	0.003000

Scenario 1 Data Table

Fire Station	Residence Ratio	Incidents Ratio	Response Time Ratio	Risk Total
2	0.7333	1.1365	0.000818219	1.8706
3	0.4856	1.1375	0	1.6231
4	0.3327	1.0265	0	1.3592
5	0.6313	0.9075	0	1.5388
6	0.2435	0.2785	0.12073922	0.6427
7	0.7747	0.9115	0	1.6862
33 (8)	0.563	0.5285	0.318294849	1.4098
9	0.3767	0.2375	0.11494558	0.7291
10	0.4631	0.7455	0.114446124	1.3230
12	0.1324	0.2205	0.093655589	0.4466
13	0.2436	0.441	0.072660099	0.7573
14	0.3965	0.322	0.008322825	0.7268
15	0.5753	0.682	0	1.2573
16	0.3925	0.7455	0.007643312	1.1456
17	0.5118	1.0485	0.056662759	1.6170
18	0.9678	1.241	0.003926431	2.2127
19	0.2964	0.61	0.021592443	0.9280
20	0.758	0.89	0.169920844	1.8179
21	0.7721	0.994	0	1.7661
22	0.9235	1.4375	0.123335138	2.4843
23	0.8462	1.181	0.034152683	2.0614
24	0.3742	0.965	0.077231427	1.4164
25	0.4776	0.9355	0.024497487	1.4376
26	0.331	0.4675	0	0.7985
27	1.4736	1.6985	0.139250814	3.3114
28	1.3297	1.363	0.100323381	2.7930
29	1.2119	1.471	0.124185164	2.8071
30	0.5781	0.836	0.512887044	1.9270
31	0.0828	0.2115	0.679951691	0.9743
32	1.2128	0.719	0.372114116	2.3039
51	0	0.0045	0	0.0045

Scenario 2 Data Table

Fire Station	Residence Ratio	Incidents Ratio	Response Time Ratio	Risk Total
2	0.7333	1.1365	0.000818219	1.870618
3	0.4856	1.1375	0	1.623100
4	0.3327	1.0265	0	1.359200
5	0.6313	0.9075	0	1.538800
6	0.2435	0.2785	0.12073922	0.642739
7	0.7747	0.9115	0	1.686200
9	0.3767	0.2375	0.11494558	0.729146
10	0.4631	0.7455	0.114446124	1.323046
34 (11)	0.6532	1.1175	0.016227802	1.786928
12	0.1324	0.2205	0.093655589	0.446556
13	0.2436	0.441	0.072660099	0.757260
14	0.3965	0.322	0.008322825	0.726823
15	0.5753	0.682	0	1.257300
16	0.3925	0.7455	0.007643312	1.145643
17	0.4709	0.9215	0.01847526	1.410875
18	0.9678	1.241	0.003926431	2.212726
19	0.2964	0.61	0.021592443	0.927992
20	0.7581	0.9535	0.166468804	1.878069
21	0.7719	0.994	0	1.765900
22	0.7903	1.2195	0.002910287	2.012710
23	0.8462	1.181	0.034152683	2.061353
24	0.3742	0.965	0.129075361	1.468275
25	0.4776	0.94	0.024497487	1.442097
26	0.331	0.4675	0	0.798500
27	1.8438	1.879	0.188252522	3.911053
28	1.3297	1.362	0.100323381	2.792023
29	1.2121	1.4715	0.124412177	2.808012
30	0.3704	0.469	0.238930886	1.078331
31	0.0043	0.086	0.325581395	0.415881
32	1.2126	0.7195	0.37250536	2.304605
51	0	0.0045	0	0.004500

Scenario 3 Data Table

Fire Station	Residence Ratio	Incidents Ratio	Response Time Ratio	Risk Total
2	0.7333	1.1365	0.000818219	1.8706
3	0.4856	1.1375	0	1.6231
4	0.3327	1.0265	0	1.3592
5	0.6313	0.9075	0	1.5388
6	0.2435	0.2785	0.12073922	0.6427
7	0.7747	0.9115	0	1.6862
33(8)	0.713	0.5485	0.356100982	1.6176
9	0.3767	0.2375	0.11494558	0.7291
10	0.4631	0.7455	0.114446124	1.3230
12	0.1324	0.2205	0.093655589	0.4466
13	0.2436	0.441	0.072660099	0.7573
14	0.3965	0.322	0.008322825	0.7268
15	0.5753	0.682	0	1.2573
16	0.3923	0.7455	0.007647209	1.1454
17	0.4883	1.003	0.043006349	1.5343
18	0.9678	1.241	0.003926431	2.2127
19	0.2964	0.61	0.021592443	0.9280
20	0.758	0.8865	0.169920844	1.8144
21	0.772	0.989	0	1.7610
22	0.8067	1.2795	0.025412173	2.1116
23	0.8462	1.181	0.034152683	2.0614
24	0.3742	0.965	0.129075361	1.4683
25	0.3798	0.8015	0.023696682	1.2050
26	0.331	0.4675	0	0.7985
27	1.5954	2.2205	0.175191175	3.9911
28	1.3297	1.363	0.100323381	2.7930
29	1.2119	1.471	0.124185164	2.8071
30	0.5447	0.644	0.474389572	1.6631
31	0.0828	0.2075	0.679951691	0.9703
32	1.2128	0.719	0.372114116	2.3039
51	0	0.0045	0	0.0045

Scenario 4 Data Table

Fire Station	Residence Ratio	Incidents Ratio	Response Time Ratio	Risk Total
2	0.7333	1.1365	0.000818	1.8706
3	0.4856	1.1375	0	1.6231
4	0.3327	1.0265	0	1.3592
5	0.6313	0.9075	0	1.5388
6	0.2435	0.2785	0.120739	0.6427
7	0.7747	0.9115	0	1.6862
33 (8)	0.713	0.5485	0.356101	1.6176
9	0.3767	0.2375	0.114946	0.7291
10	0.4631	0.7455	0.114446	1.3230
34 (11)	0.5304	0.977	0.013009	1.5204
12	0.1324	0.2205	0.093656	0.4466
13	0.2436	0.441	0.07266	0.7573
14	0.3965	0.322	0.008323	0.7268
15	0.5753	0.682	0	1.2573
16	0.3925	0.7455	0.007643	1.1456
17	0.4709	0.9215	0.018475	1.4109
18	0.9678	1.241	0.003926	2.2127
19	0.2964	0.61	0.021592	0.9280
20	0.758	0.8865	0.169921	1.8144
21	0.7719	0.989	0	1.7609
22	0.7659	1.1885	0	1.9544
23	0.8462	1.181	0.034153	2.0614
24	0.3742	0.965	0.129075	1.4683
25	0.3798	0.802	0.023697	1.2055
26	0.331	0.4675	0	0.7985
27	1.2644	1.6345	0.070943	2.9698
28	1.3297	1.363	0.100323	2.7930
29	1.2119	1.471	0.124185	2.8071
30	0.4819	0.5465	0.406101	1.4345
31	0.0043	0.086	0.325581	0.4159
32	1.2128	0.719	0.372114	2.3039
51	0	0.0045	0	0.0045

Scenario 5 Data Table

Fire Station	Residence Ratio	Incidents Ratio	Response Time Ratio	Risk Total
2	0.2095	0.236	0.064439141	0.5099
3	0.4872	1.177	0	1.6642
4	0.8942	1.7585	0.004585104	2.6573
5	0.6313	0.9075	0	1.5388
6	0.2435	0.2785	0.12073922	0.6427
7	0.7747	0.9115	0	1.6862
9	0.3767	0.2375	0.11494558	0.7291
10	0.3896	0.7645	0	1.1541
12	0.1324	0.2205	0.093655589	0.4466
13	0.288	0.563	0.057986111	0.9090
14	0.3965	0.322	0.008322825	0.7268
15	0.5753	0.682	0	1.2573
16	0.3925	0.7455	0.007643312	1.1456
17	0.5118	1.0485	0.056662759	1.6170
18	0.9678	1.241	0.003926431	2.2127
19	0.2964	0.61	0.021592443	0.9280
20	0.7581	0.9535	0.166468804	1.8781
21	0.7721	0.994	0	1.7661
22	0.9235	1.4375	0.123335138	2.4843
23	0.8462	1.181	0.034152683	2.0614
24	0.364	0.953	0.125549451	1.4425
25	0.4776	0.94	0.024497487	1.4421
26	0.331	0.4675	0	0.7985
27	2.0364	2.1595	0.225594186	4.4215
28	1.3297	1.362	0.100323381	2.7920
29	1.2121	1.4715	0.124412177	2.8080
30	0.5782	0.8355	0.51297129	1.9267
31	0.0828	0.2115	0.679951691	0.9743
32	1.2126	0.7195	0.37250536	2.3046
51	0	0.0045	0	0.0045

Scenario 6 Data Table

Fire Station	Residence Ratio	Incidents Ratio	Response Time Ratio	Risk Total
3	0.4872	1.177	0	1.664200
4	0.898	1.7595	0.008797327	2.666297
5	0.6313	0.9075	0	1.538800
6	0.2434	0.2785	0.099835661	0.621736
7	0.7747	0.9115	0	1.686200
9	0.3767	0.2375	0.11494558	0.729146
10	0.5702	0.976	0.108207646	1.654408
12	0.1324	0.2205	0.093655589	0.446556
13	0.3029	0.574	0.115879828	0.992780
14	0.3932	0.322	0	0.715200
15	0.5753	0.682	0	1.257300
16	0.3925	0.7455	0.007643312	1.145643
17	0.5118	1.0485	0.056662759	1.616963
18	0.9678	1.241	0.003926431	2.212726
19	0.2964	0.61	0.021592443	0.927992
20	0.7581	0.9535	0.166468804	1.878069
21	0.7721	0.994	0	1.766100
22	0.9235	1.4375	0.123335138	2.484335
23	0.8462	1.181	0.034152683	2.061353
24	0.3742	0.965	0.129075361	1.468275
25	0.4776	0.94	0.024497487	1.442097
26	0.331	0.4675	0	0.798500
27	2.0364	2.1595	0.225594186	4.421494
28	1.3275	1.36	0.092730697	2.780231
29	1.2121	1.4715	0.124412177	2.808012
30	0.5782	0.8355	0.95797302	2.371673
31	0.0828	0.2115	0.679951691	0.974252
32	1.2126	0.7195	0.37250536	2.304605
51	0	0.0045	0	0.004500

Scenario 7 Data Table

Fire Station	Residence Ratio	Incidents Ratio	Response Time Ratio	Risk Total
2	0.7333	1.1335	0.000818219	1.867618
3	0.4959	1.146	0	1.641900
4	0.7398	1.7425	0.006758583	2.489059
6	0.2434	0.2785	0.099835661	0.621736
7	0.8362	1.046	0	1.882200
9	0.3767	0.2375	0.11494558	0.729146
10	0.4631	0.7455	0.114446124	1.323046
12	0.1324	0.2205	0.093655589	0.446556
13	0.2436	0.4405	0.072660099	0.756760
14	0.5456	0.3715	0.006781525	0.923882
15	0.5753	0.682	0	1.257300
16	0.3925	0.7455	0.007643312	1.145643
17	0.5118	1.0485	0.056662759	1.616963
18	0.9678	1.2415	0.003926431	2.213226
19	0.2964	0.61	0.021592443	0.927992
20	0.7581	0.9535	0.166468804	1.878069
21	0.7721	0.994	0	1.766100
22	0.9235	1.4375	0.123335138	2.484335
23	0.8463	1.181	0.034266808	2.061567
24	0.3742	0.965	0.129075361	1.468275
25	0.4776	0.94	0.024497487	1.442097
26	0.331	0.4675	0	0.798500
27	2.0364	2.1595	0.225594186	4.421494
28	1.3275	1.36	0.092730697	2.780231
29	1.212	1.473	0.124009901	2.809010
30	0.5782	0.8355	0.95797302	2.371673
31	0.0828	0.2115	0.679951691	0.974252
32	1.2126	0.7195	0.37250536	2.304605
51	0	0.0045	0	0.004500

Scenario 8 Data Table

Fire Station	Residence Ratio	Incidents Ratio	Response Time Ratio	Risk Total
2	0.7333	1.1365	0.000818219	1.870618
3	0.4856	1.1375	0	1.623100
4	0.3327	1.0265	0	1.359200
5	0.672	0.9315	0.01860119	1.622101
6	0.2434	0.2785	0.099835661	0.621736
7	0.8063	0.94	0.001240233	1.747540
9	0.3767	0.2375	0.11494558	0.729146
10	0.4631	0.7455	0.114446124	1.323046
12	0.1324	0.2205	0.093655589	0.446556
13	0.2436	0.4405	0.072660099	0.756760
15	0.5753	0.682	0	1.257300
16	0.3925	0.7455	0.007643312	1.145643
17	0.5118	1.0485	0.056662759	1.616963
18	1.1498	1.3845	0.024699948	2.559000
19	0.2964	0.61	0.021592443	0.927992
20	0.7581	0.9535	0.166468804	1.878069
21	0.8908	1.0955	0.028850471	2.015150
22	0.9235	1.4375	0.123335138	2.484335
23	0.8664	1.2055	0.041204986	2.113105
24	0.3742	0.965	0.129075361	1.468275
25	0.4776	0.94	0.024497487	1.442097
26	0.331	0.4675	0	0.798500
27	2.0364	2.1595	0.225594186	4.421494
28	1.3275	1.36	0.092730697	2.780231
29	1.2121	1.4715	0.124412177	2.808012
30	0.5782	0.8355	0.95797302	2.371673
31	0.0828	0.2115	0.679951691	0.974252
32	1.2126	0.7195	0.37250536	2.304605
51	0	0.0045	0	0.004500

Scenario 9 Data Table

Fire Station	Residence Ratio	Incidents Ratio	Response Time Ratio	Risk Total
2	0.7333	1.1365	0.000818219	1.8706
3	0.4856	1.1375	0	1.6231
4	0.3327	1.0265	0	1.3592
5	0.6313	0.9075	0	1.5388
6	0.2435	0.2785	0.12073922	0.6427
7	0.7747	0.9115	0	1.6862
9	0.3767	0.2375	0.11494558	0.7291
10	0.4631	0.7455	0.114446124	1.3230
12	0.1324	0.2205	0.093655589	0.4466
13	0.2436	0.441	0.072660099	0.7573
14	0.5297	0.423	0.006229941	0.9589
15	0.5753	0.682	0	1.2573
16	0.3925	0.7455	0.007643312	1.1456
17	0.5118	1.0485	0.056662759	1.6170
18	1.0197	1.4675	0	2.4872
19	0.2964	0.61	0.021592443	0.9280
20	0.7581	0.9535	0.166468804	1.8781
21	0.7721	0.994	0	1.7661
22	0.9235	1.4375	0.123335138	2.4843
23	0.845	1.1825	0.033609467	2.0611
24	0.3742	0.965	0.077231427	1.4164
25	0.4776	0.94	0.024497487	1.4421
26	0.331	0.4715	0	0.8025
27	2.0364	2.1595	0.225594186	4.4215
28	1.3297	1.362	0.100323381	2.7920
29	1.0282	1.1385	0.141606691	2.3083
30	0.5782	0.8355	0.51297129	1.9267
31	0.0828	0.2115	0.679951691	0.9743
32	1.2126	0.7195	0.37250536	2.3046
51	0	0.0045	0	0.0045

Scenario 10 Data Table

Fire Station	Residence Ratio	Incidents Ratio	Response Time Ratio	Risk Total
2	0.7333	1.1365	0.000818219	1.8706
3	0.4856	1.1375	0	1.6231
4	0.3327	1.0265	0	1.3592
5	0.6313	0.9075	0	1.5388
6	0.2435	0.2785	0.12073922	0.6427
7	0.7747	0.9115	0	1.6862
9	0.3767	0.2375	0.11494558	0.7291
10	0.4631	0.7455	0.114446124	1.3230
12	0.1324	0.2205	0.093655589	0.4466
13	0.2436	0.441	0.072660099	0.7573
14	0.4211	0.359	0.01519829	0.7953
15	0.5753	0.682	0	1.2573
16	0.3925	0.7455	0.007643312	1.1456
17	0.5118	1.0485	0.056662759	1.6170
18	1.0618	1.3315	0.025616877	2.4189
19	0.2964	0.61	0.021592443	0.9280
20	0.7581	0.9535	0.166468804	1.8781
21	0.8184	1.0605	0.009164223	1.8881
22	0.9235	1.4375	0.123335138	2.4843
23	0.8497	1.219	0.031422855	2.1001
24	0.3742	0.965	0.077231427	1.4164
25	0.551	1.0595	0.023774955	1.6343
26	0.331	0.4675	0	0.7985
27	2.0364	2.1595	0.225594186	4.4215
28	1.1812	1.0595	0.041059939	2.2818
29	1.1337	1.4275	0.084943107	2.6461
30	0.5782	0.8355	0.51297129	1.9267
31	0.0828	0.2115	0.679951691	0.9743
32	1.1977	0.7145	0.368623194	2.2808
51	0	0.0045	0	0.0045

Scenario 11 Data Table

Fire Station	Residence Ratio	Incidents Ratio	Response Time Ratio	Risk Total
2	0.7333	1.1365	0.000818	1.8706
3	0.4856	1.1375	0	1.6231
4	0.3327	1.0265	0	1.3592
5	0.6313	0.9075	0	1.5388
6	0.2435	0.2785	0.120739	0.6427
7	0.7747	0.9115	0	1.6862
9	0.3767	0.2375	0.114946	0.7291
10	0.4631	0.7455	0.114446	1.3230
12	0.1324	0.2205	0.093656	0.4466
13	0.2436	0.441	0.07266	0.7573
14	0.5593	0.4675	0.014304	1.0411
15	0.5753	0.682	0	1.2573
16	0.3925	0.7455	0.007643	1.1456
17	0.5118	1.0485	0.056663	1.6170
18	1.0736	1.494	0.000652	2.5683
19	0.2964	0.61	0.021592	0.9280
20	0.7581	0.9535	0.166469	1.8781
21	0.8171	1.06	0.007588	1.8847
22	0.9235	1.4375	0.123335	2.4843
23	0.886	1.2755	0.048871	2.2104
24	0.3742	0.965	0.077231	1.4164
25	0.551	1.0595	0.023775	1.6343
26	0.331	0.4715	0	0.8025
27	2.0364	2.1595	0.225594	4.4215
28	1.1834	1.0615	0.04073	2.2856
29	0.9465	1.0945	0.096778	2.1378
30	0.5782	0.8355	0.512971	1.9267
31	0.0828	0.2115	0.679952	0.9743
32	1.1977	0.7145	0.368623	2.2808
51	0	0.0045	0	0.0045

Scenario 12 Data Table

Fire Station	Residence Ratio	Incidents Ratio	Response Time Ratio	Risk Total
2	0.7333	1.1335	0.000818219	1.8676
3	0.4856	1.1375	0	1.6231
4	0.3336	1.034	0.002697842	1.3703
5	0.6313	0.9075	0	1.5388
6	0.2435	0.2785	0.12073922	0.6427
7	0.7747	0.9115	0	1.6862
9	0.3767	0.2375	0.11494558	0.7291
10	0.4631	0.7455	0.114446124	1.3230
13	0.2436	0.441	0.072660099	0.7573
14	0.3965	0.322	0.008322825	0.7268
15	0.5753	0.682	0	1.2573
16	0.3925	0.7455	0.007643312	1.1456
17	0.5118	1.0485	0.056662759	1.6170
18	0.9678	1.241	0.003926431	2.2127
19	0.2964	0.61	0.021592443	0.9280
20	0.7581	0.9535	0.166468804	1.8781
21	0.7721	0.994	0	1.7661
22	0.9235	1.4375	0.123335138	2.4843
23	0.8462	1.181	0.034152683	2.0614
24	0.3742	0.965	0.077231427	1.4164
25	0.4776	0.94	0.024497487	1.4421
26	0.4625	0.6835	0.072648649	1.2186
27	2.0364	2.1595	0.225594186	4.4215
28	1.3297	1.362	0.100323381	2.7920
29	1.2121	1.4715	0.124412177	2.8080
30	0.5782	0.8355	0.51297129	1.9267
31	0.0828	0.2115	0.679951691	0.9743
32	1.2126	0.7195	0.37250536	2.3046
51	0	0.0045	0	0.0045

Scenario 13 Data Table

Fire Station	Residence Ratio	Incidents Ratio	Response Time Ratio	Risk total
2	0.7333	1.1335	0.000818219	1.8676
3	0.4856	1.1375	0	1.6231
4	0.3336	1.034	0.002697842	1.3703
5	0.6313	0.9075	0	1.5388
6	0.2435	0.2785	0.12073922	0.6427
7	0.7747	0.9115	0	1.6862
9	0.3767	0.2375	0.11494558	0.7291
10	0.4631	0.7455	0.114446124	1.3230
12	0.6078	0.4045	0.095590655	1.1079
13	0.2436	0.441	0.072660099	0.7573
14	0.3965	0.322	0.008322825	0.7268
15	0.5753	0.682	0	1.2573
16	0.3925	0.7455	0.007643312	1.1456
17	0.5118	1.0485	0.056662759	1.6170
18	0.9678	1.241	0.003926431	2.2127
19	0.2964	0.61	0.021592443	0.9280
20	0.5449	0.756	0.006423197	1.3073
21	0.7721	0.994	0	1.7661
22	0.9235	1.4375	0.123335138	2.4843
23	0.8462	1.181	0.034152683	2.0614
24	0.3742	0.965	0.077231427	1.4164
25	0.4776	0.94	0.024497487	1.4421
26	0.4625	0.6835	0.072648649	1.2186
27	2.0364	2.1595	0.100766058	4.2967
28	1.1718	1.2835	0.077316948	2.5326
29	1.2119	1.471	0.124185164	2.8071
30	0.5782	0.8355	0.51297129	1.9267
31	0.0828	0.2115	0.679951691	0.9743
32	0.9761	0.5915	0.23942219	1.8070
51	0	0.0045	0	0.0045

Scenario 14 Data Table

Fire Station	Residence Ratio	Incidents Ratio	Response Time Ratio	Risk Total
2	0.2095	0.236	0.064439141	0.509939141
3	0.4872	1.177	0	1.6642
4	0.8953	1.763	0.00558472	2.66388472
5	0.6313	0.9075	0	1.5388
6	0.2435	0.2785	0.12073922	0.64273922
7	0.7747	0.9115	0	1.6862
33 (8)	0.713	0.5485	0.356100982	1.617600982
9	0.3767	0.2375	0.11494558	0.72914558
10	0.3894	0.7645	0	1.1539
34 (11)	0.5304	0.977	0.01300905	1.52040905
12	0.6079	0.4055	0.095410429	1.108810429
13	0.288	0.563	0.057986111	0.908986111
14	0.5593	0.4675	0.014303594	1.041103594
15	0.5753	0.682	0	1.2573
16	0.3925	0.7455	0.007643312	1.145643312
17	0.4709	0.9215	0.01847526	1.41087526
18	1.0736	1.4945	0.000652012	2.568752012
19	0.2964	0.61	0.021592443	0.927992443
20	0.5448	0.689	0.006240822	1.240040822
21	0.8169	1.055	0.007589668	1.879489668
22	0.7659	1.1885	0	1.9544
23	0.886	1.2755	0.048871332	2.210371332
24	0.364	0.953	0.125549451	1.442549451
25	0.4532	0.9215	0.022727273	1.397427273
26	0.4625	0.687	0.072648649	1.222148649
27	1.2644	1.6345	0.07094274	2.96984274
28	1.0254	0.981	0.005461283	2.011861283
29	0.9465	1.0945	0.096777602	2.137777602
30	0.4819	0.5465	0.406100851	1.434500851
31	0.0043	0.086	0.325581395	0.415881395
32	0.961	0.587	0.23496358	1.78296358
51	0	0.0045	0	0.0045

Scenario 15 Data Table

Fire Station	Residence Ratio	Incidents Ratio	Response Time Ratio	Risk Total
2	0.7333	1.148	0.999181781	2.8805
3	0.4856	1.139	0	1.6246
4	0.3336	1.043	0	1.3766
5	0.6313	0.902	0	1.5333
6	0.2434	0.2695	0.900164339	1.4131
7	0.7747	0.9155	0	1.6902
33 (8)	0.7129	0.5445	0.643849067	1.9012
9	0.3767	0.24	0.88505442	1.5018
10	0.4631	0.7475	0.884690132	2.0953
34 (11)	0.5304	0.952	0.98699095	2.4694
12	0.6079	0.3925	0.904589571	1.9050
13	0.2436	0.438	0.927339901	1.6089
14	0.556	0.4765	0.991546763	2.0240
15	0.5753	0.698	0	1.2733
16	0.3925	0.739	0.992356688	2.1239
17	0.4709	0.9235	0.98152474	2.3759
18	1.0736	1.4905	0.999347988	3.5634
19	0.2964	0.609	0.978407557	1.8838
20	0.5448	0.682	0.993759178	2.2206
21	0.8169	1.0435	0.992410332	2.8528
22	0.7659	1.1965	0	1.9624
23	0.886	1.2525	0.951128668	3.0896
24	0.3742	0.971	0.871459113	2.2167
25	0.4532	0.932	0.977272727	2.3625
26	0.4625	0.691	0.927351351	2.0809
27	1.2644	1.6315	0.92905726	3.8250
28	1.0232	1.0025	0.994331509	3.0200
29	0.9465	1.1	0.903222398	2.9497
30	0.4819	0.558	0.593899149	1.6338
31	0.0043	0.0805	0.674418605	0.7592
32	0.961	0.5845	0.76503642	2.3105
51	0	0.003	0	0.0030

Scenario 16 Data Table

Fire Station	Incidents Ratio	Residence Ratio	Response Time Ratio	Risk Total
2	1.1485	0.7333	0.000818219	1.882618219
3	1.1405	0.4856	0	1.6261
4	1.038	0.3327	0	1.3707
5	0.902	0.6313	0	1.5333
6	0.2695	0.2434	0.099835661	0.612735661
7	0.914	0.7747	0	1.6887
33 (8)	0.5445	0.7129	0.356150933	1.613550933
9	0.24	0.3767	0.11494558	0.73164558
10	0.7475	0.4631	0.115309868	1.325909868
34 (11)	0.952	0.5304	0.01300905	1.49540905
12	0.2235	0.1324	0.093655589	0.449555589
13	0.438	0.2437	0.072219943	0.753919943
14	0.4765	0.556	0.008453237	1.040953237
15	0.698	0.5753	0	1.2733
16	0.739	0.3925	0.007643312	1.139143312
17	0.9235	0.4709	0.01847526	1.41287526
18	1.4905	1.0736	0.000652012	2.564752012
19	0.609	0.2964	0.021592443	0.926992443
20	0.68	0.5421	0.001291275	1.223391275
21	1.0435	0.8169	0.007589668	1.867989668
22	1.1965	0.7659	0	1.9624
23	1.2525	0.886	0.048871332	2.187371332
24	0.971	0.3742	0.128540887	1.473740887
25	0.932	0.4532	0.022727273	1.407927273
26	0.472	0.331	0	0.803
27	1.6315	1.2644	0.07094274	2.96684274
28	0.9565	0.9696	0.005672442	1.931772442
29	1.1	0.9465	0.096777602	2.143277602
30	0.558	0.4819	0.406100851	1.446000851
31	0.0805	0.0043	0.325581395	0.410381395
32	0.5825	0.9537	0.231204781	1.767404781
35 (33)	0.4425	0.6715	0.098734177	1.212734177
51	0.003	0	0	0.003

Appendix D: Effective Firefighting Force Scenarios

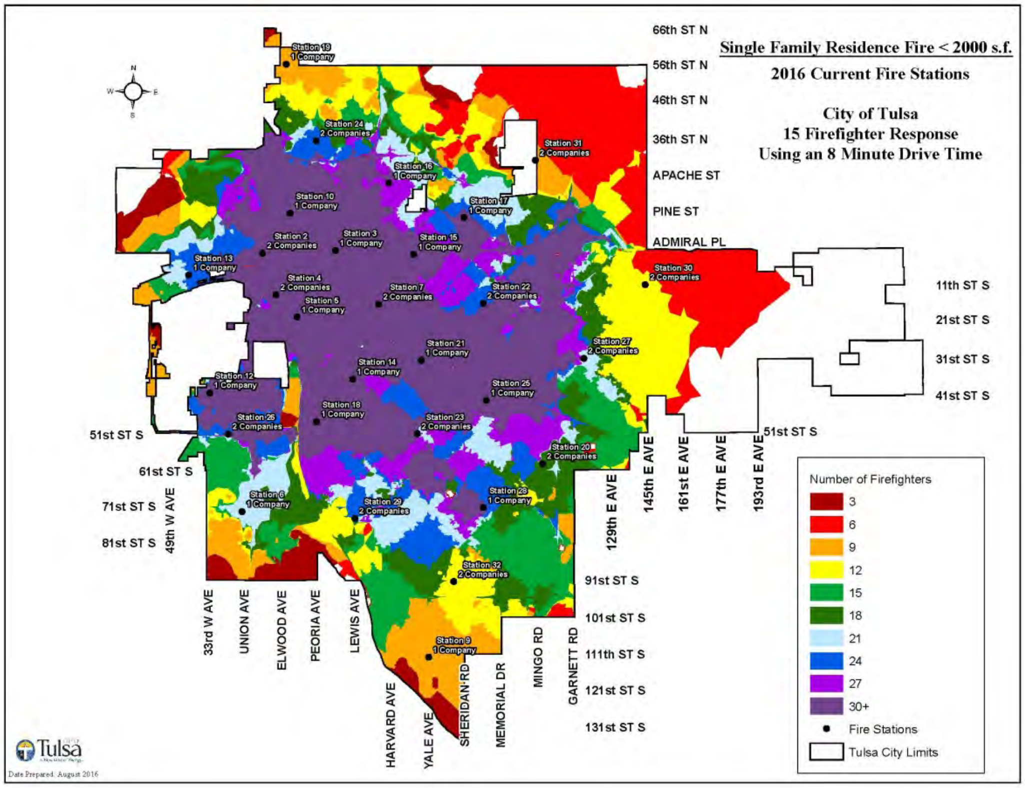
Proposed Fire Station Funding/Construction Phases

Station Funding and Construction Phase	Location
1	New Station 33 at 13500 E. 41st St.
2	New Station 34 at 10400 E. Admiral Pl.
2	Move Station 27 to 10400 E. 31st St.
2	Move Station 18 to 5600 S. Peoria Ave.
3	Move Station 23 to 5900 S. Yale Ave.
3	New Station 35 at 8400 S. Mingo Rd.
4	New Station 36 at 3300 S. 177th E. Ave.

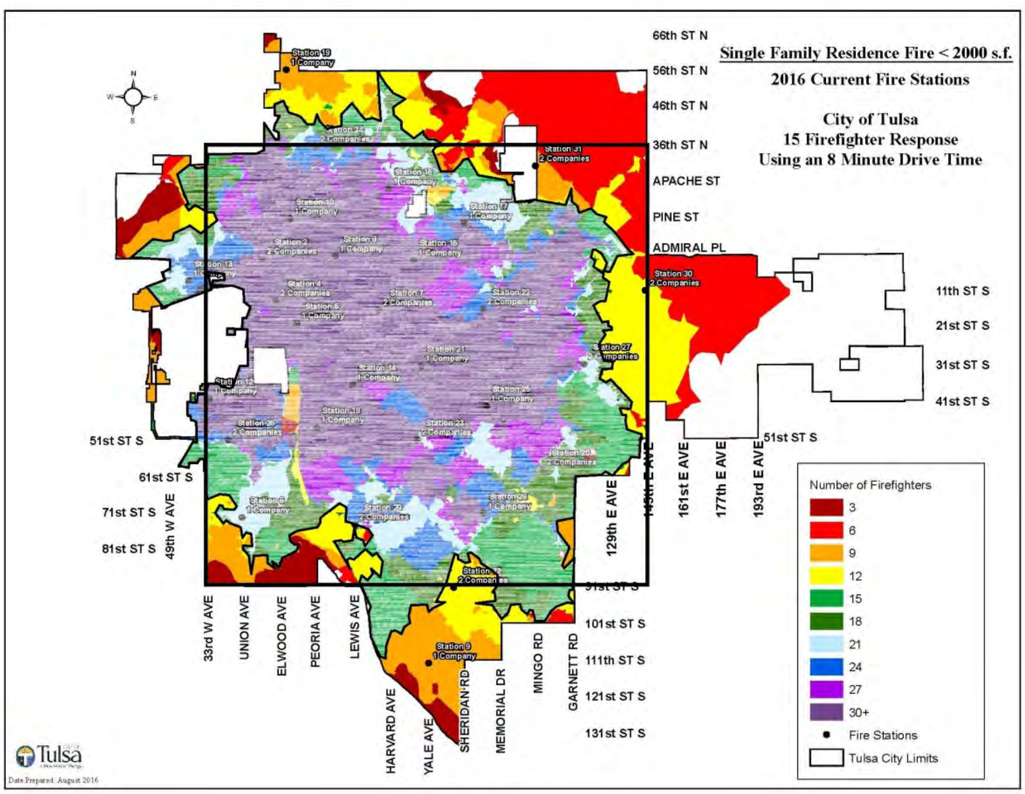
Effective Firefighting Force Scenarios

Scenario:	Description:
1	Station Move/Construction Phases 1 and 2
2	Station Move/Construction Phases 1, 2, and 3
3	Station Move/Construction Phases 1, 2, 3and 4
4	Station Move/Construction Phases 1 and 2 with 4 person staffing of single company perimeter stations
5	Station Move/Construction Phases 1, 2, and 3 with 4 person staffing of single company perimeter stations
6	Station Move/Construction Phases 1 and 2 with new company at Station 28
7	Station Move/Construction Phases 1 and 2. Move Squad 32 to Station 28 and staff E28 and L32 with 4 personnel.

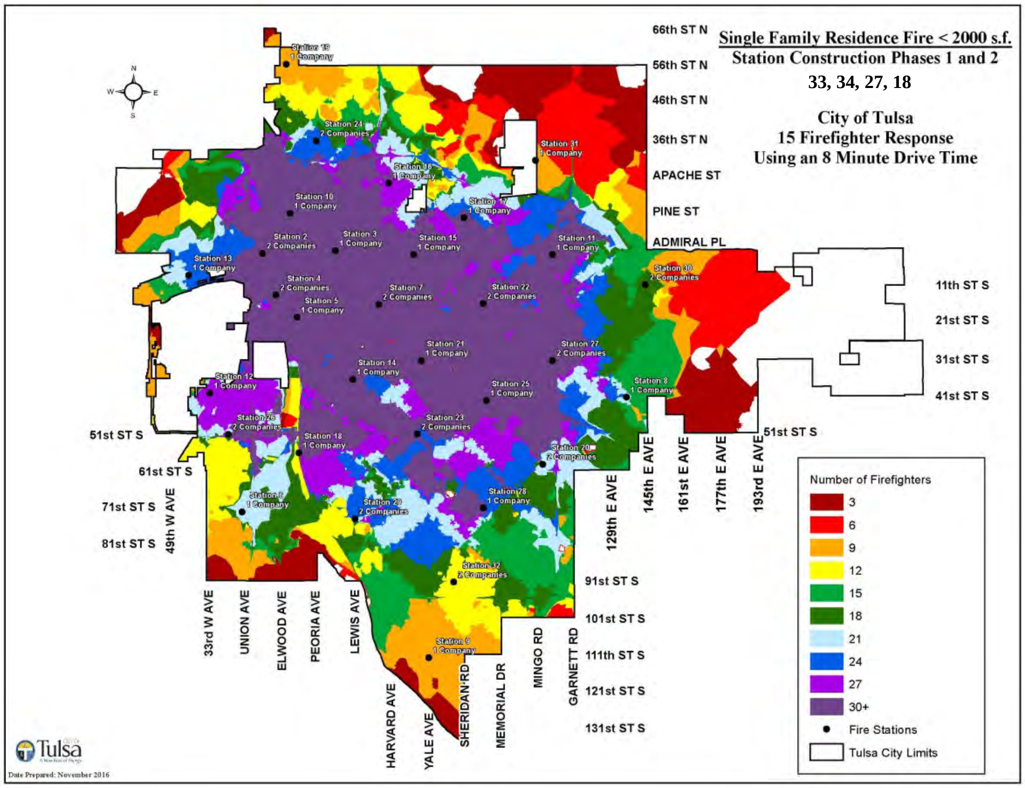
Effective Firefighting Force – Single Family Dwelling - TFD Current Stations



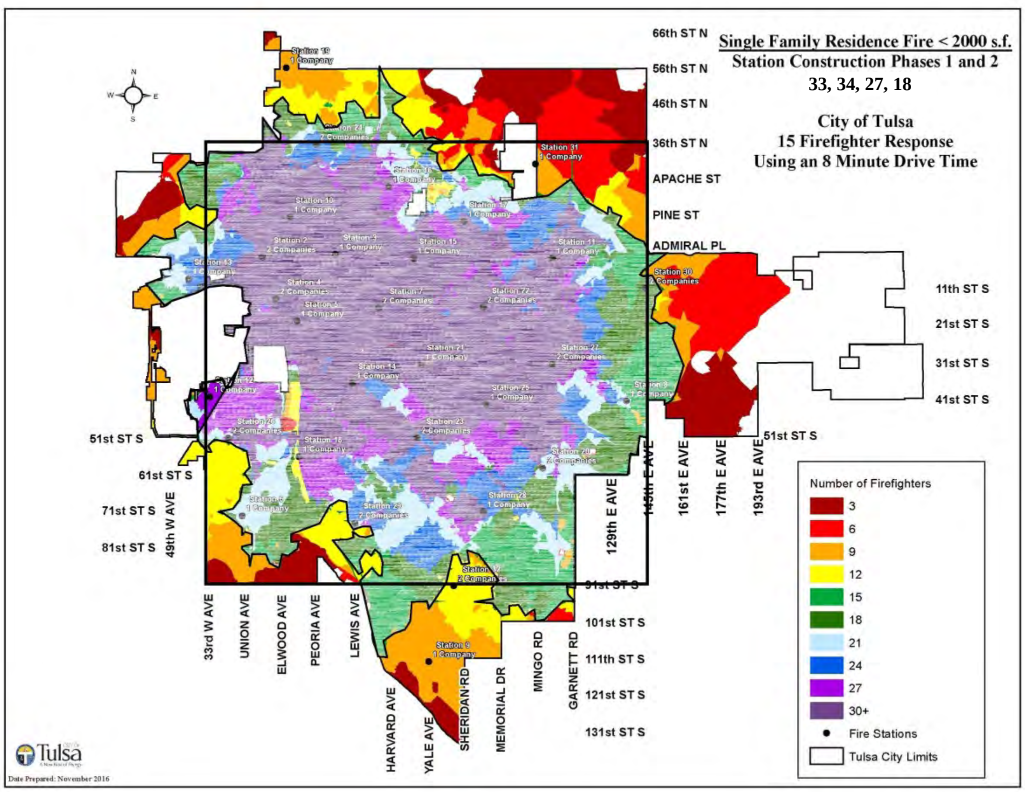
Effective Firefighting Force – Single Family Dwelling - TFD Current Stations (Shaded)



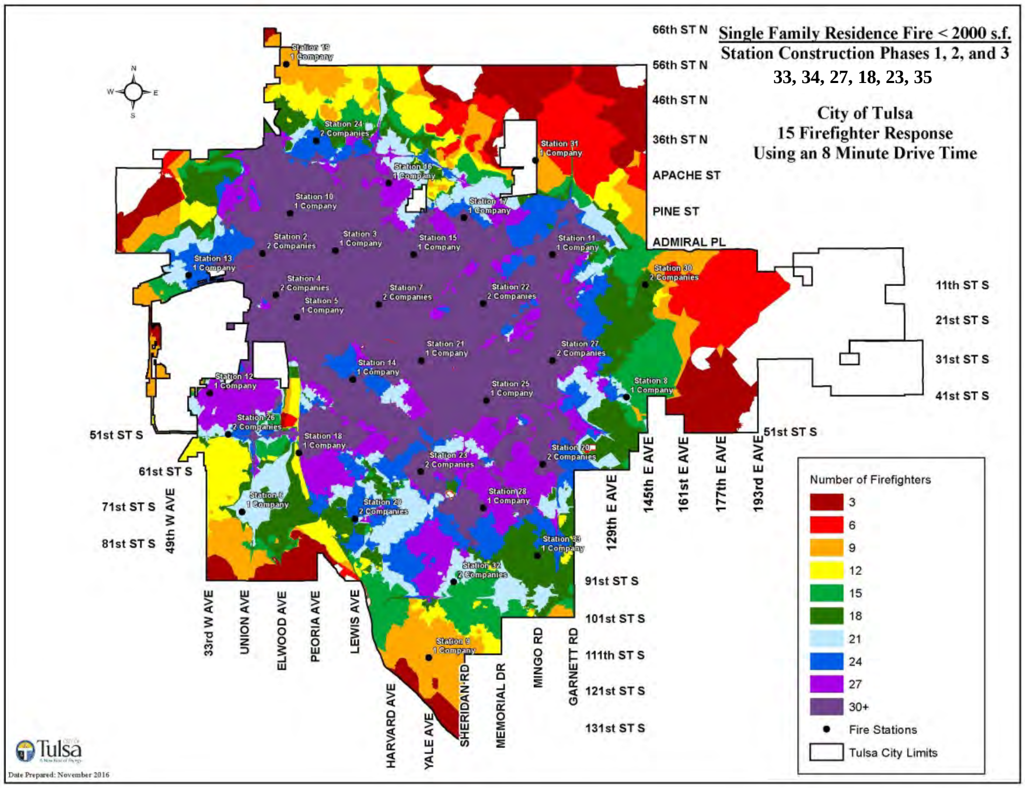
Effective Firefighting Force – Single Family Dwelling – Scenario 1



Effective Firefighting Force – Single Family Dwelling – Scenario 1 (Shaded)



Effective Firefighting Force – Single Family Dwelling – Scenario 2



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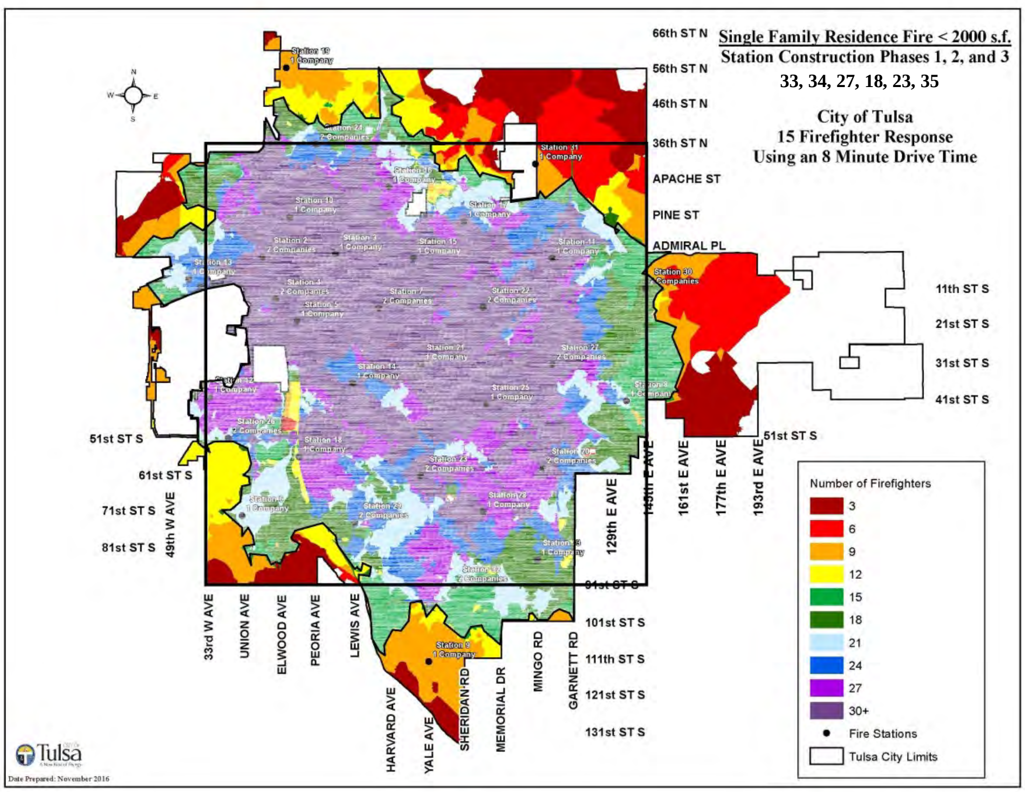
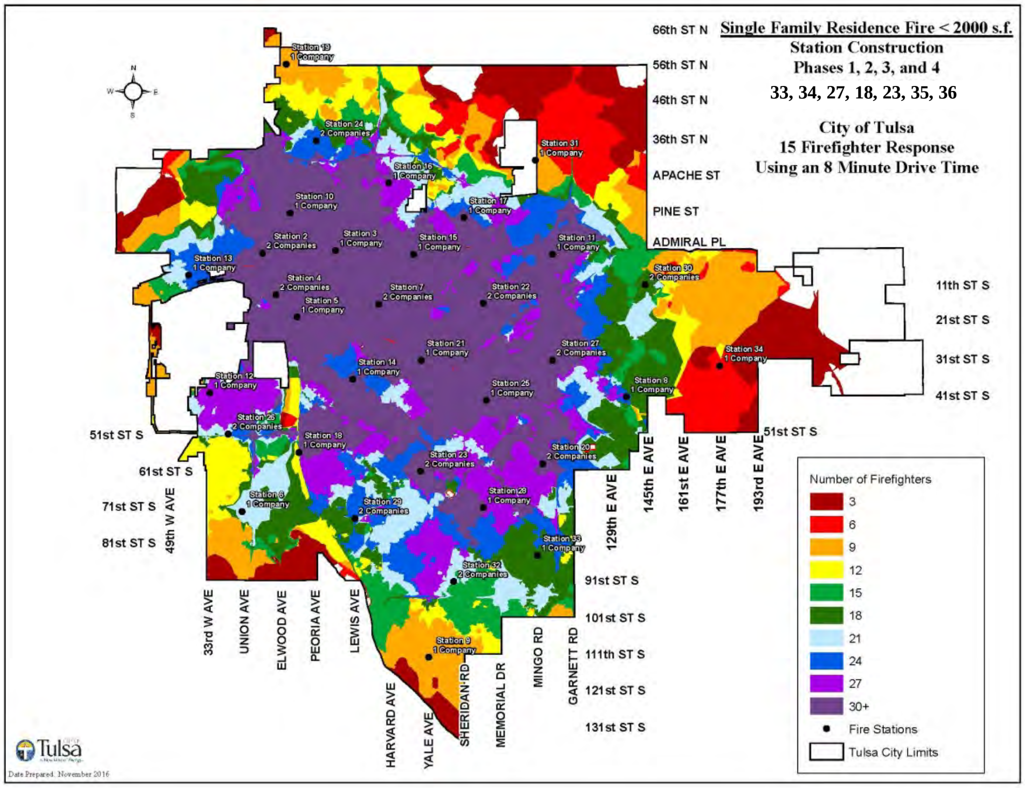
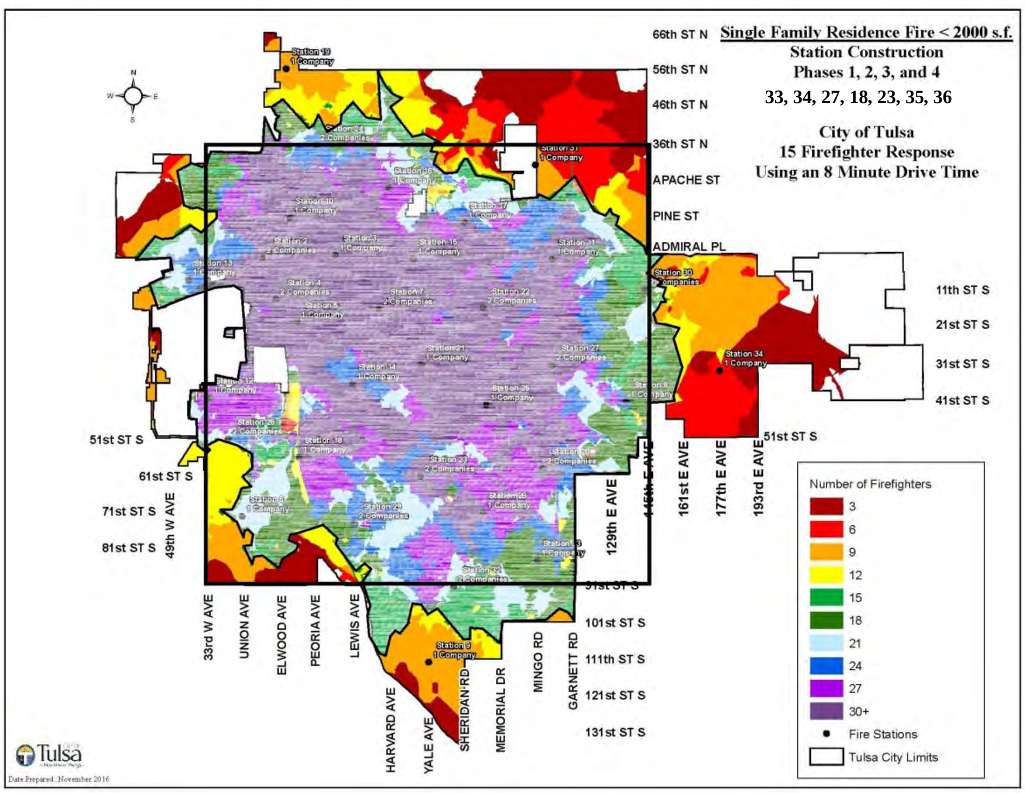


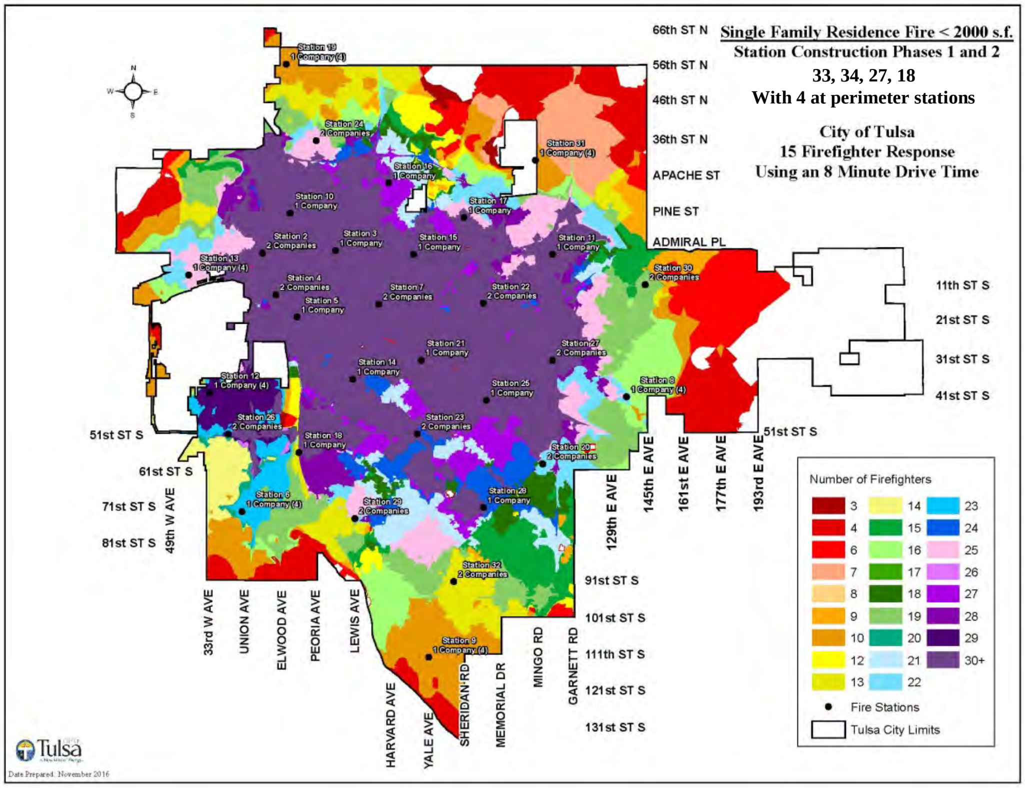
Effective Firefighting Force – Single Family Dwelling – Scenario 3



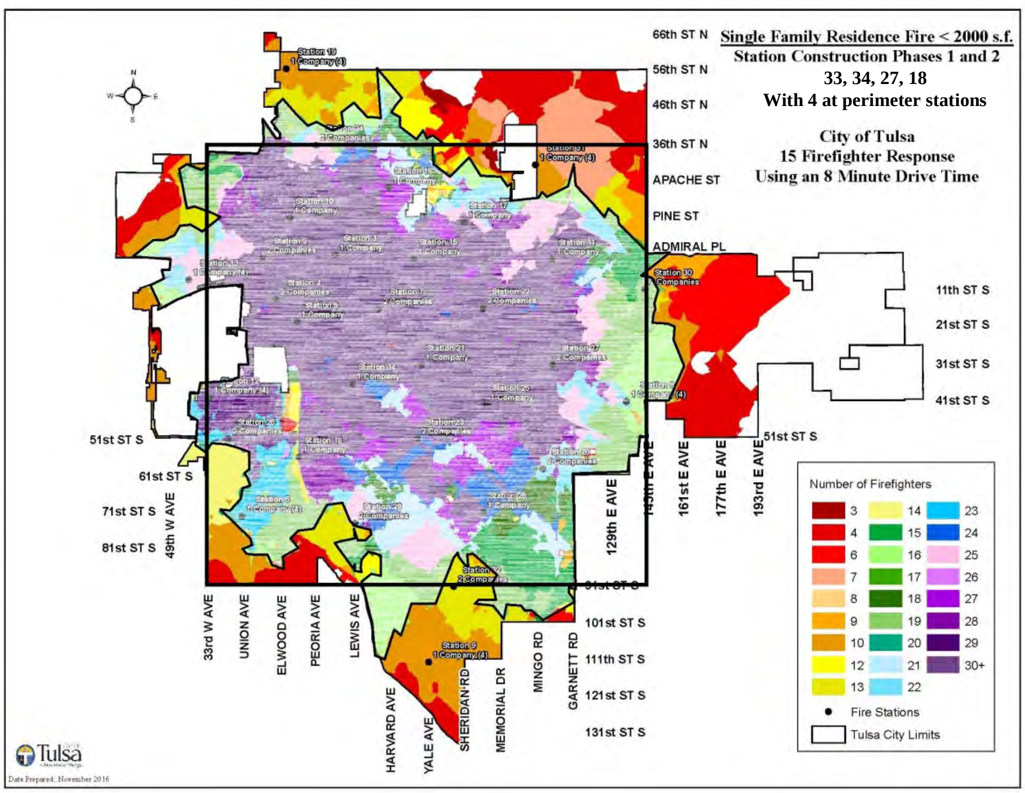
Effective Firefighting Force – Single Family Dwelling – Scenario 3 (Shaded)



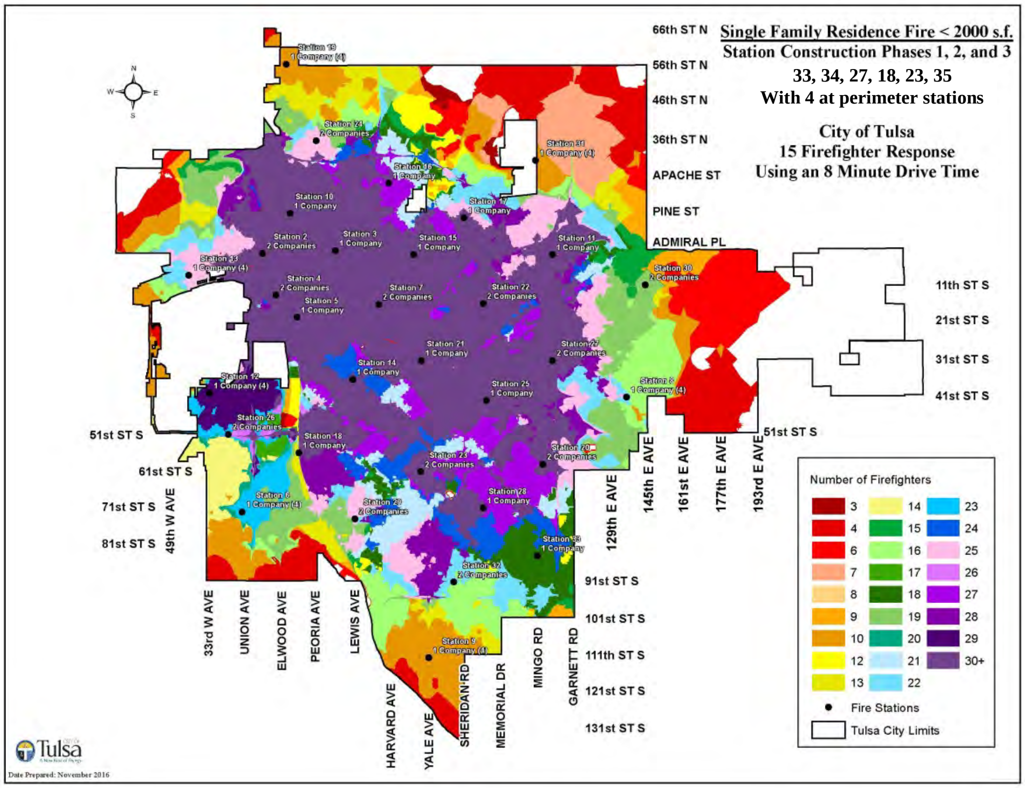
Effective Firefighting Force – Single Family Dwelling – Scenario 4



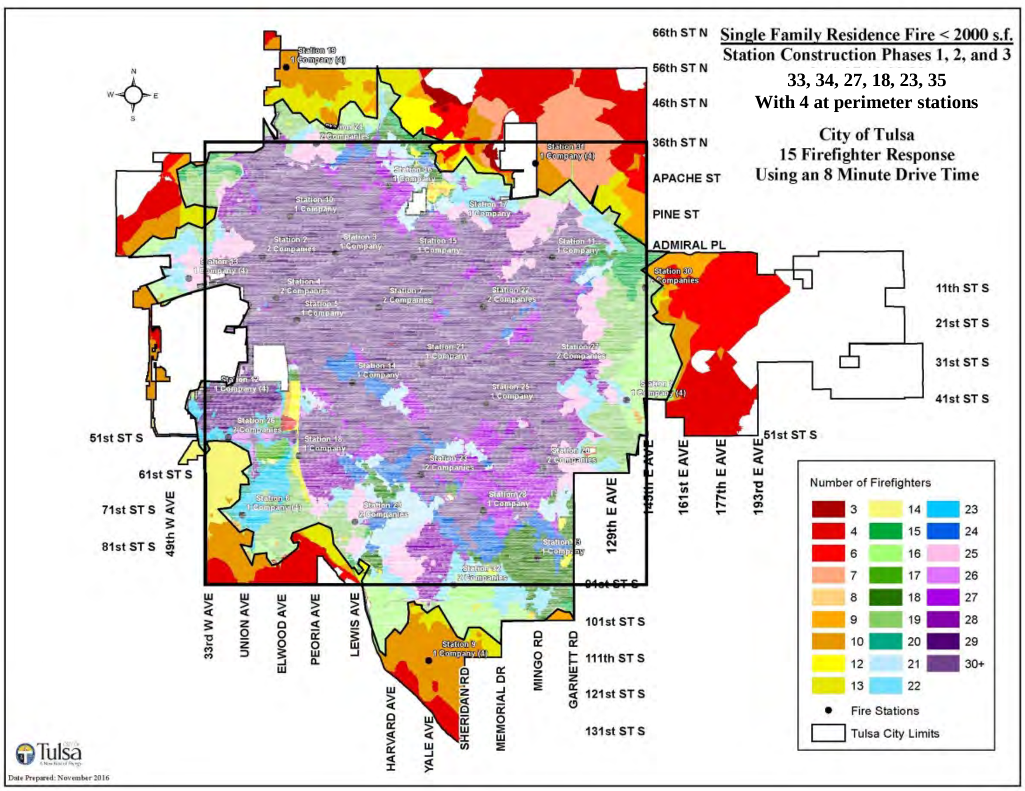
Effective Firefighting Force – Single Family Dwelling – Scenario 4 (Shaded)



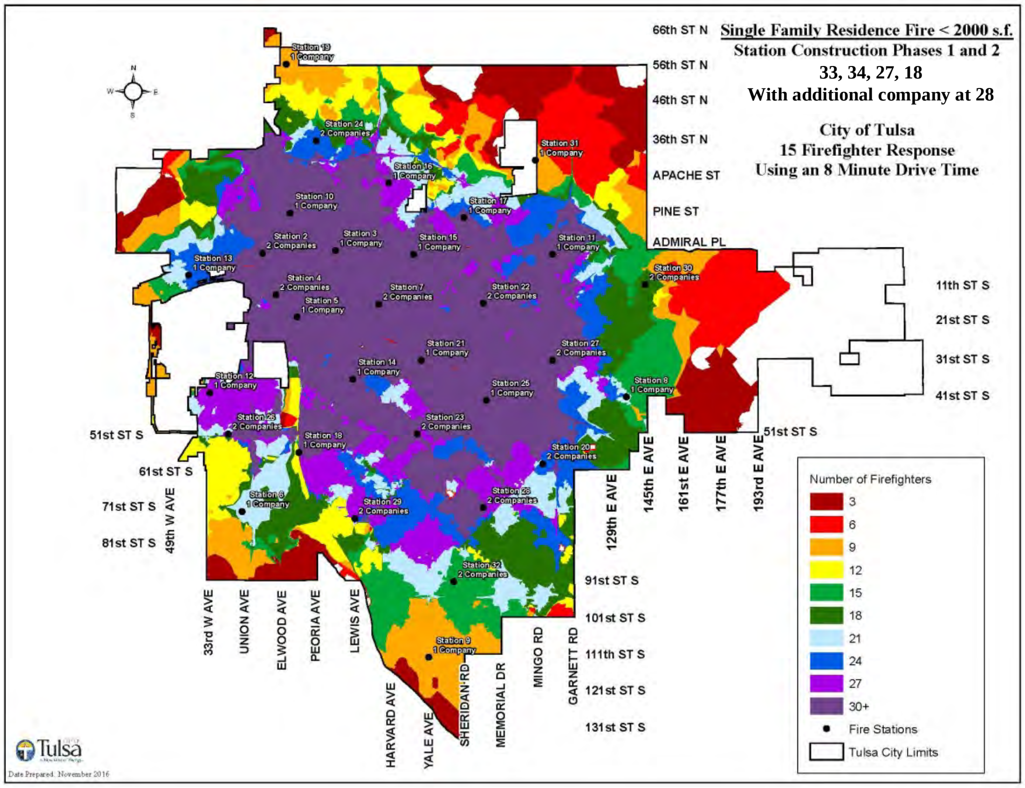
Effective Firefighting Force – Single Family Dwelling – Scenario 5



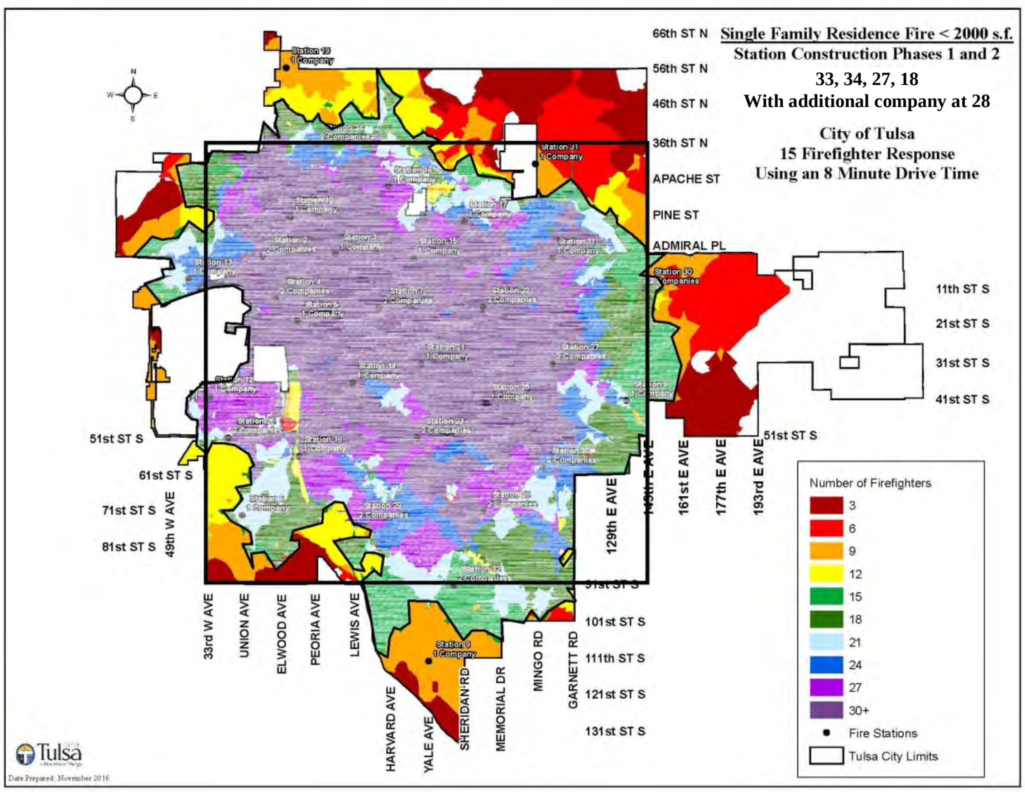
Effective Firefighting Force – Single Family Dwelling – Scenario 5 (Shaded)



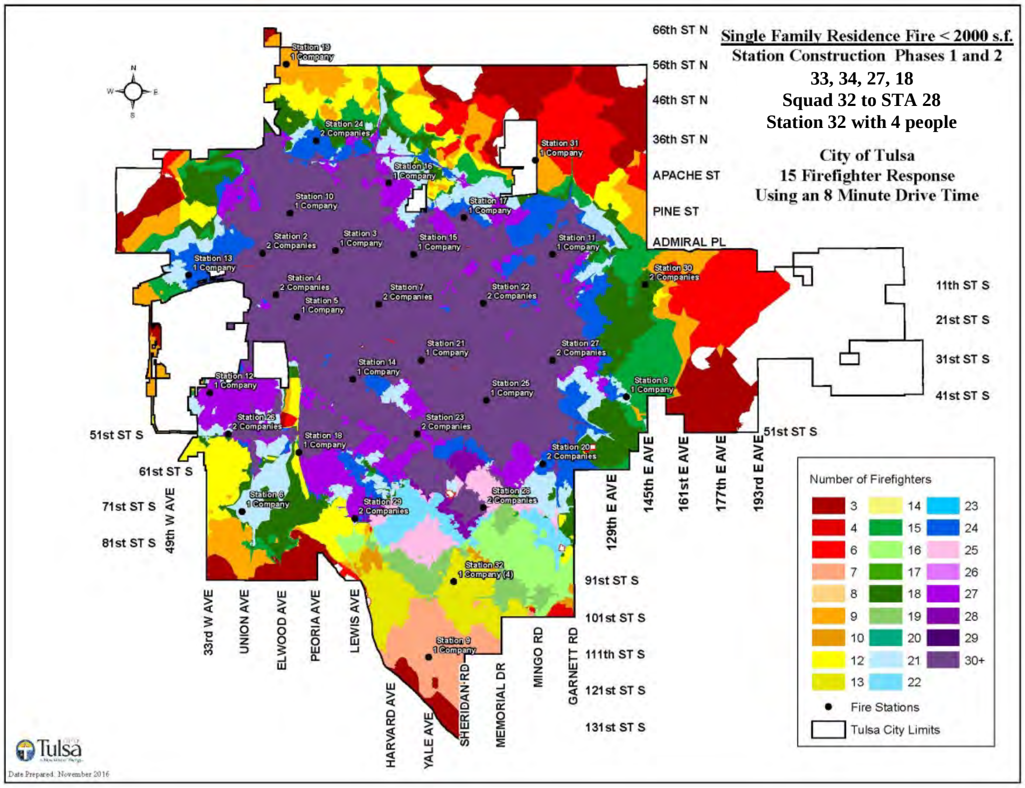
Effective Firefighting Force – Single Family Dwelling – Scenario 6



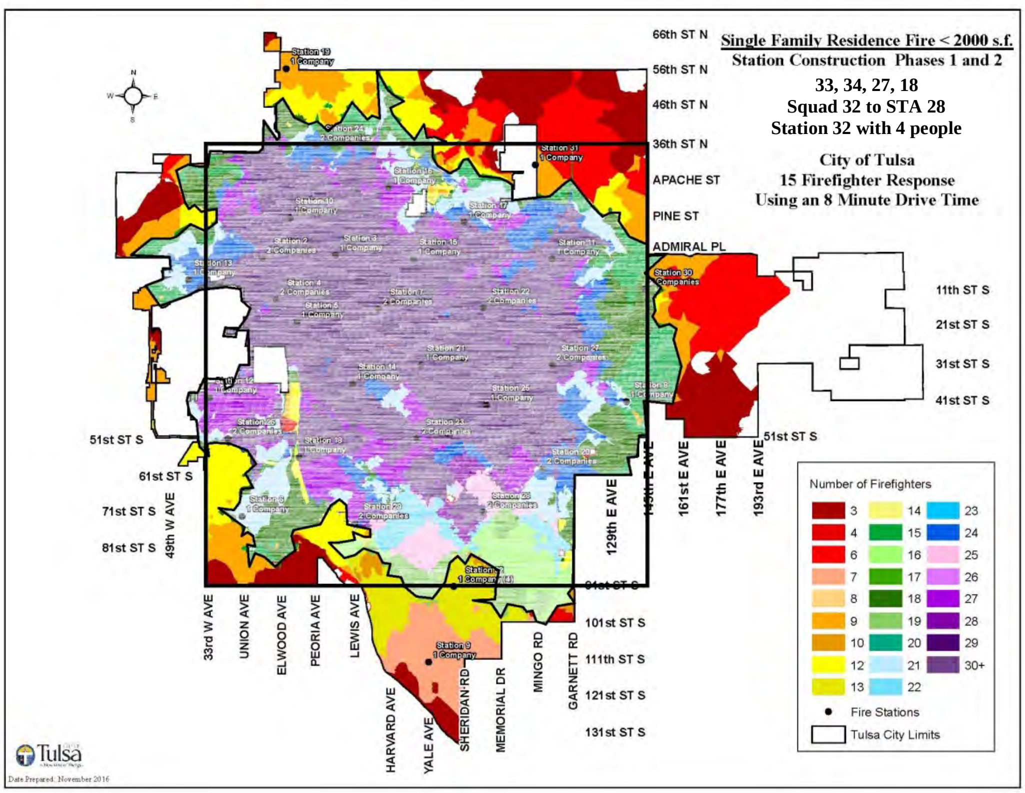
Effective Firefighting Force – Single Family Dwelling – Scenario 6 (Shaded)



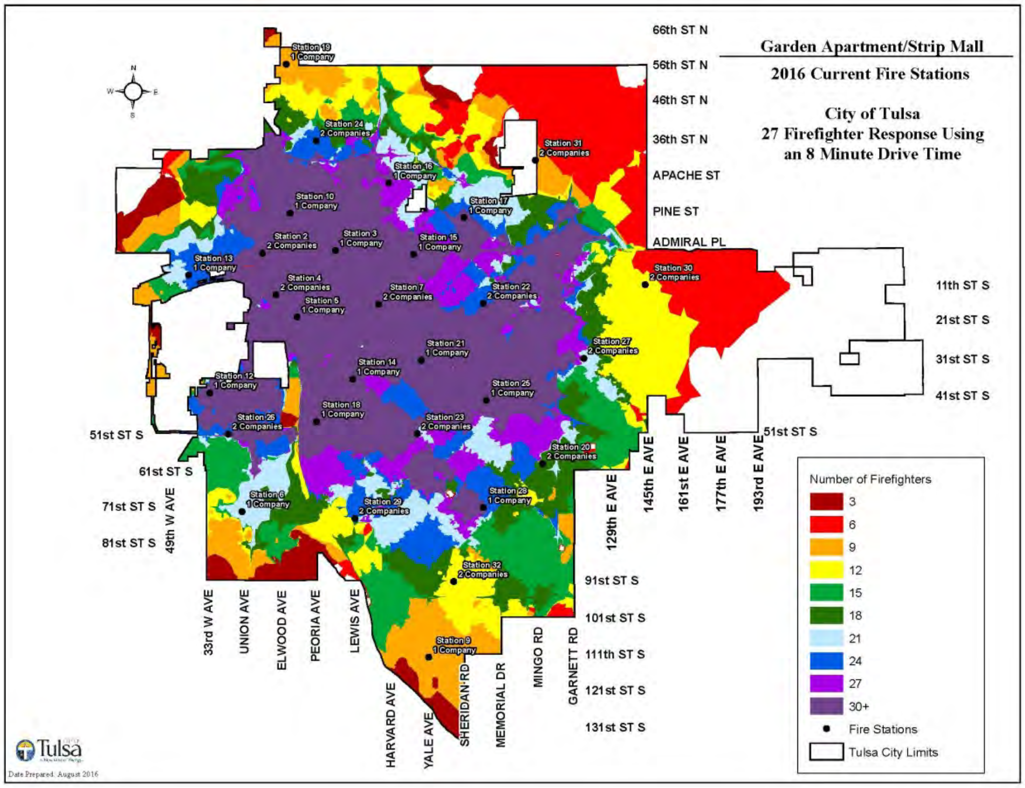
Effective Firefighting Force – Single Family Dwelling – Scenario 7



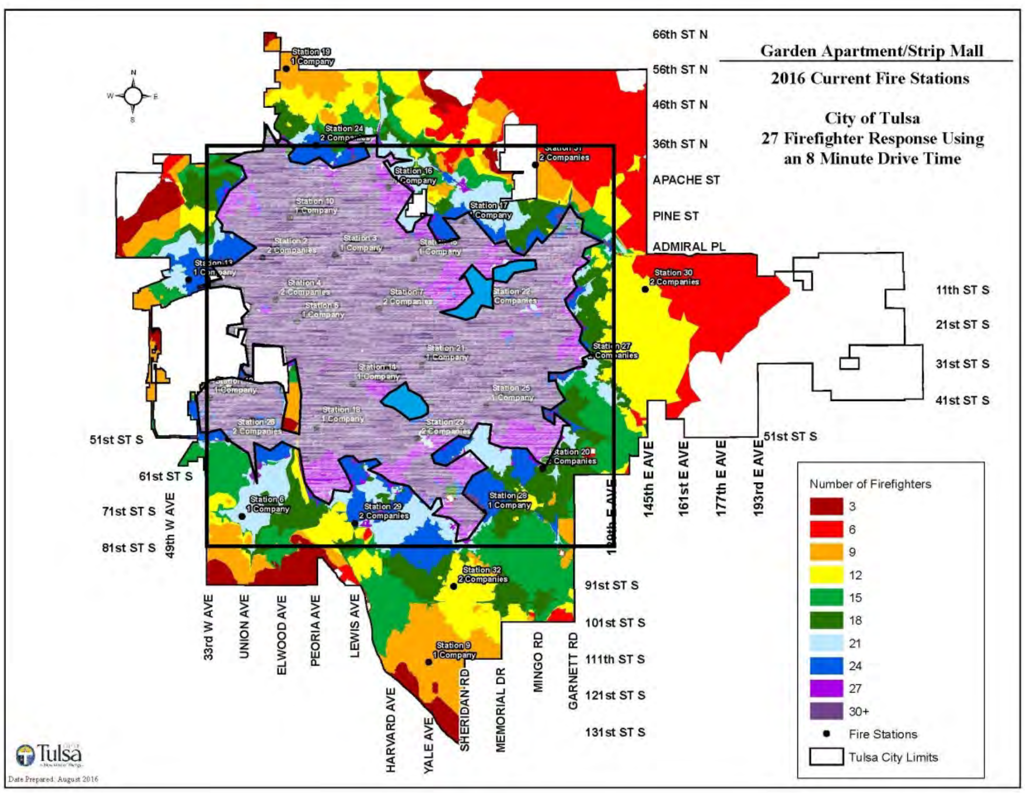
Effective Firefighting Force – Single Family Dwelling – Scenario 7 (Shaded)



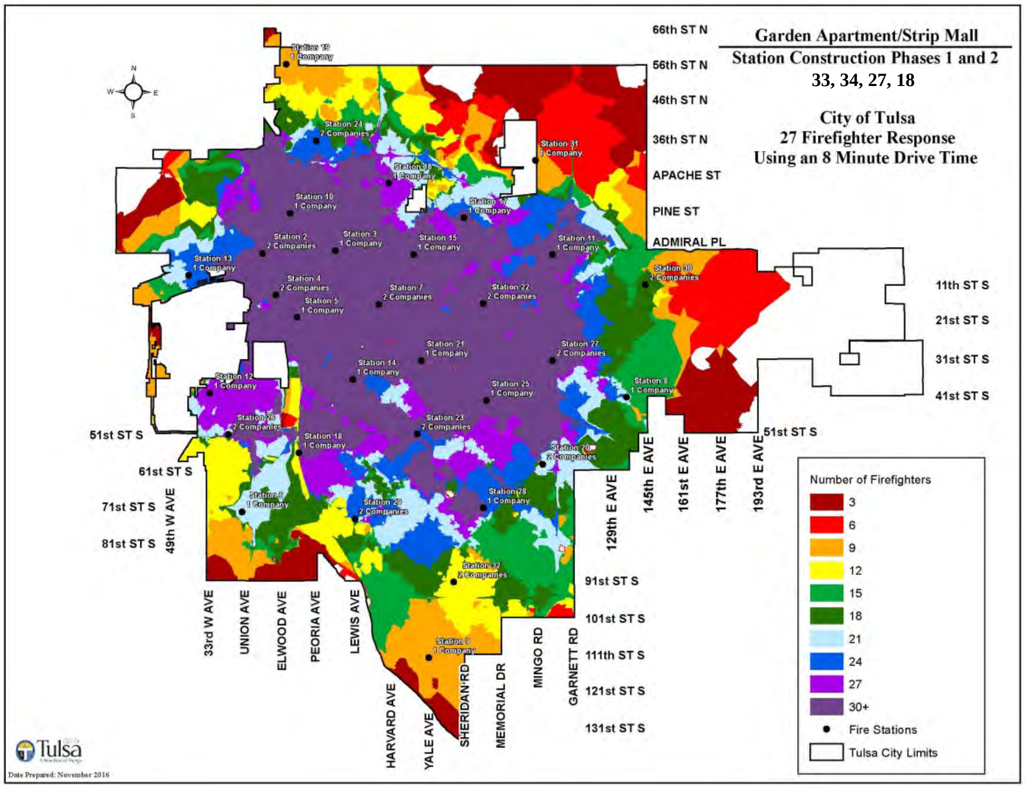
Effective Firefighting Force – Apartment/Strip Mall - TFD Current Stations



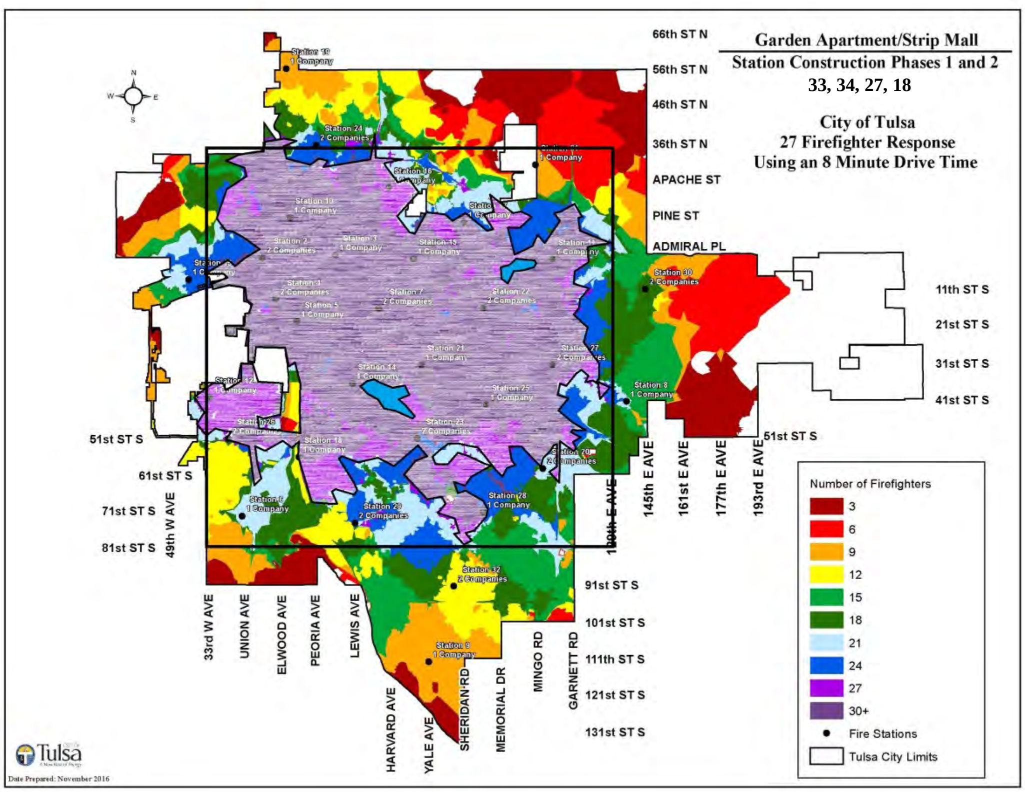
Effective Firefighting Force – Apartment/Strip Mall - TFD Current Stations (Shaded)



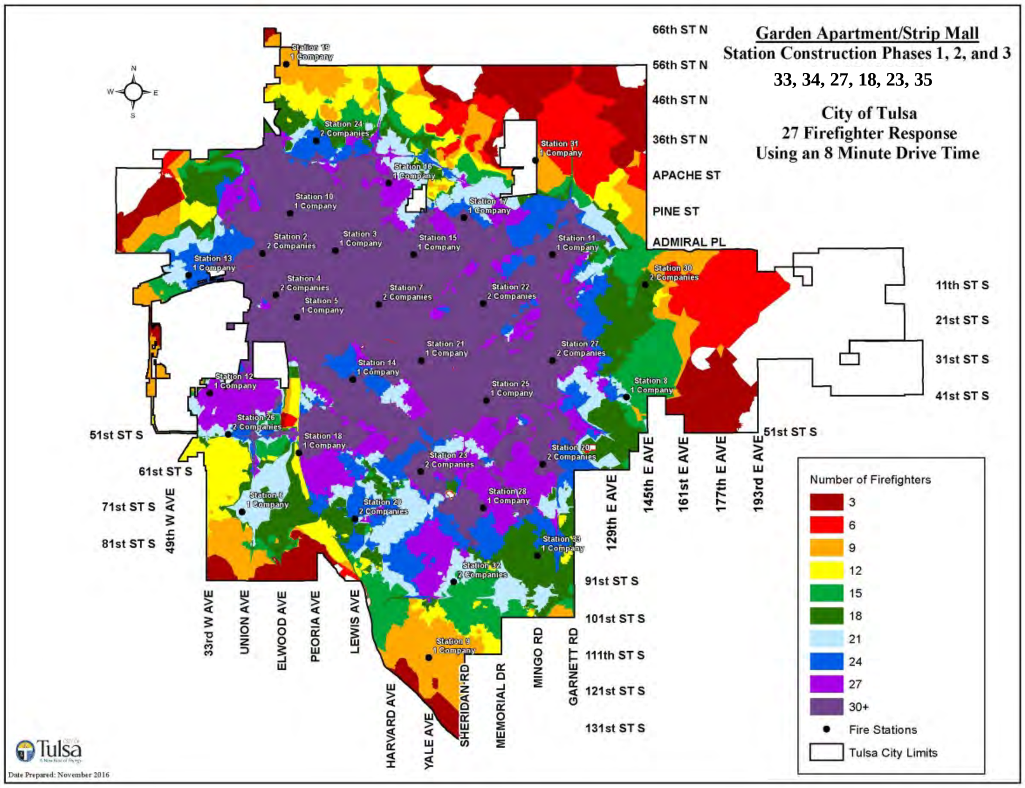
Effective Firefighting Force – Apartment/Strip Mall – Scenario 1



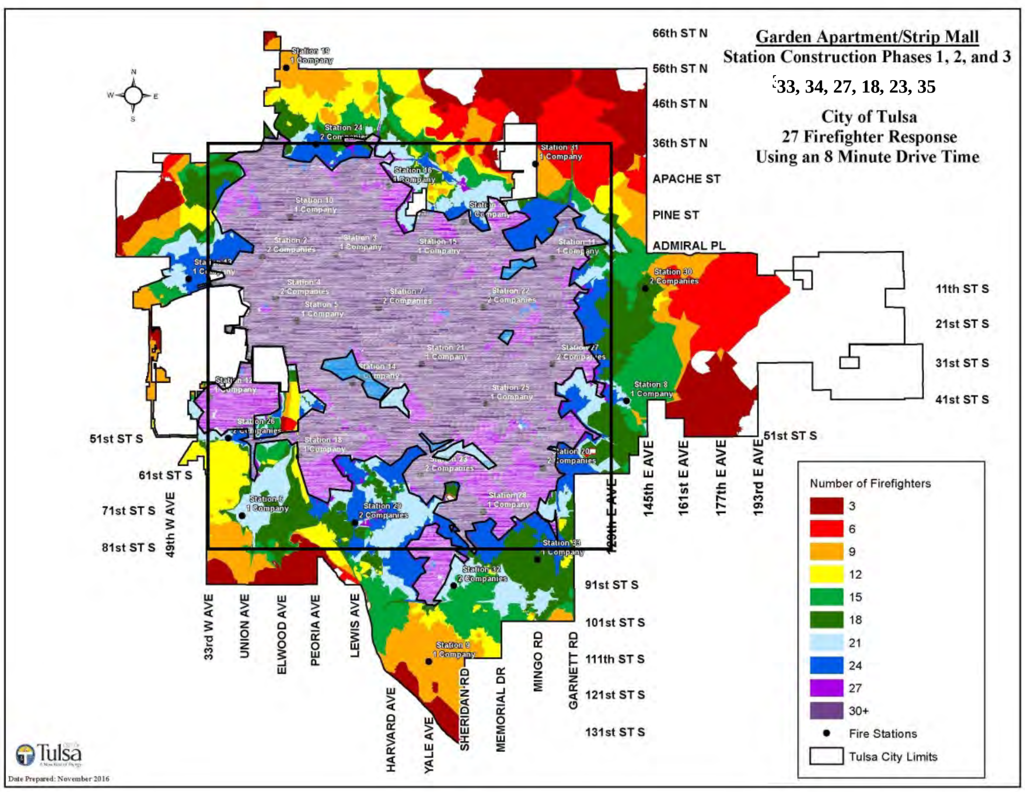
Effective Firefighting Force - Apartment/Strip Mall – Scenario 1 (Shaded)



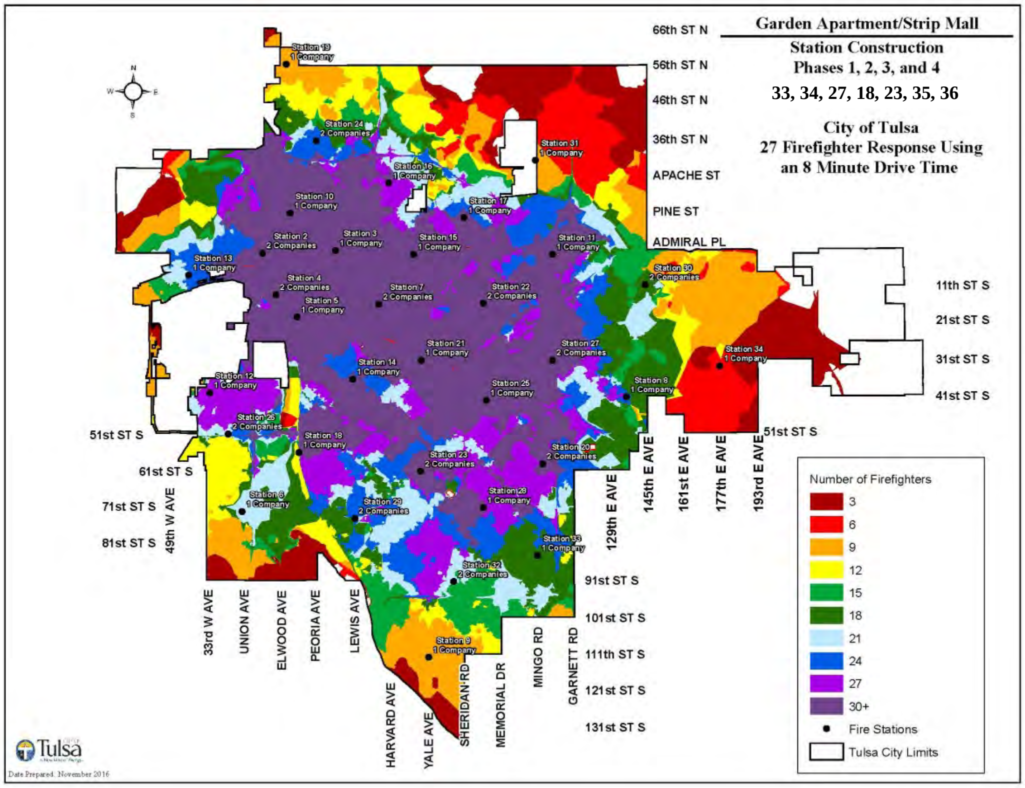
Effective Firefighting Force – Apartment/Strip Mall – Scenario 2



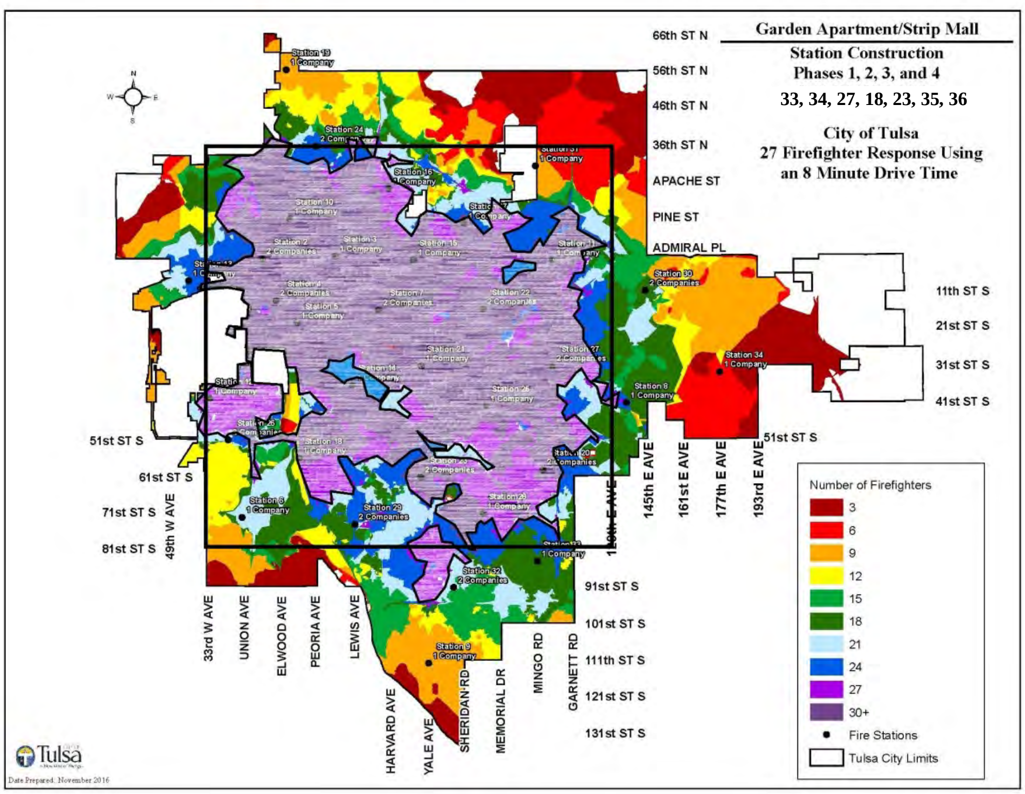
Effective Firefighting Force – Apartment/Strip Mall – Scenario 2 (Shaded)



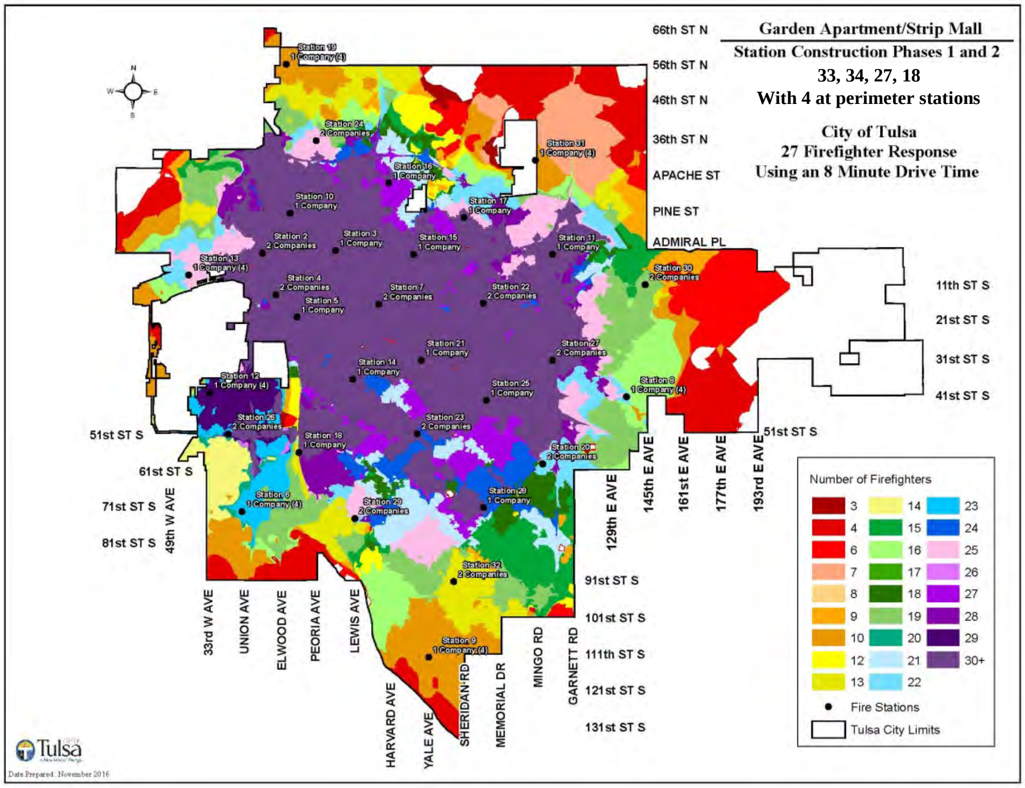
Effective Firefighting Force – Apartment/Strip Mall – Scenario 3



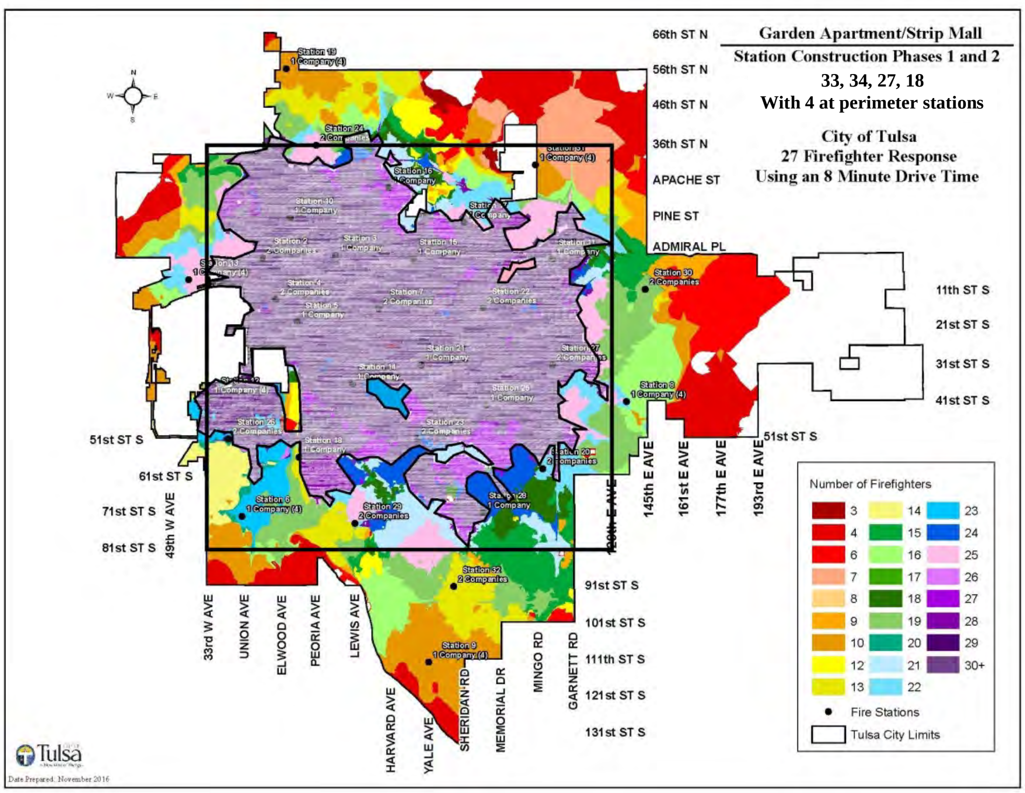
Effective Firefighting Force – Apartment/Strip Mall – Scenario 3 (Shaded)



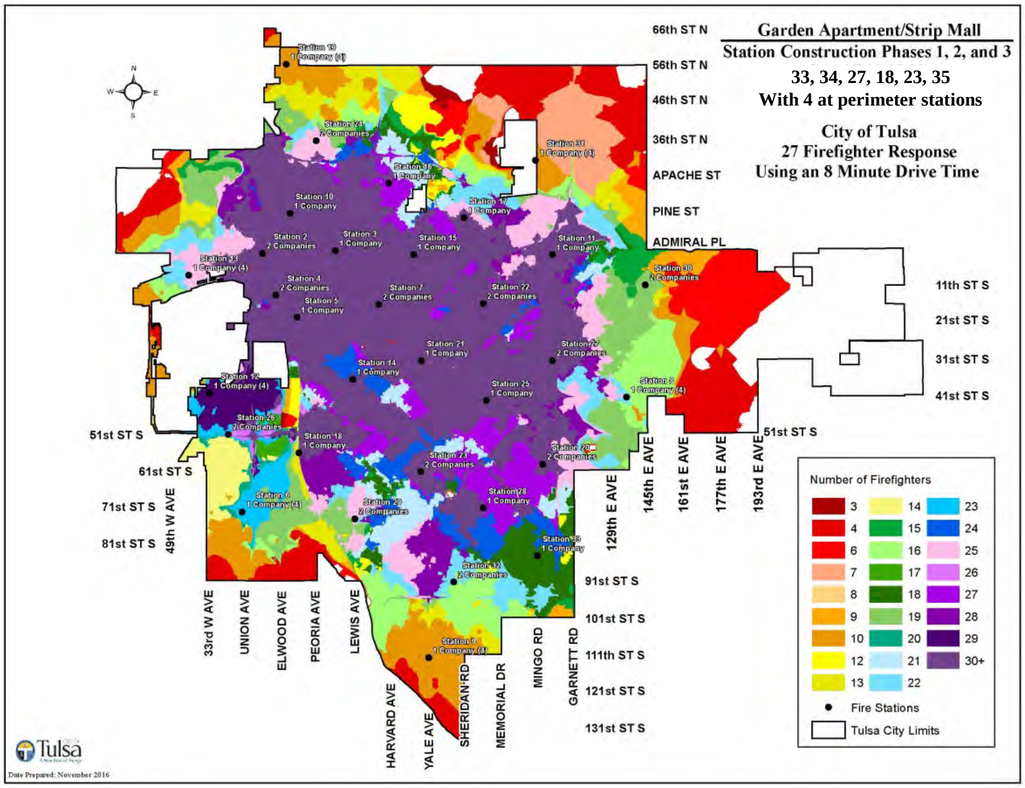
Effective Firefighting Force – Apartment/Strip Mall – Scenario 4



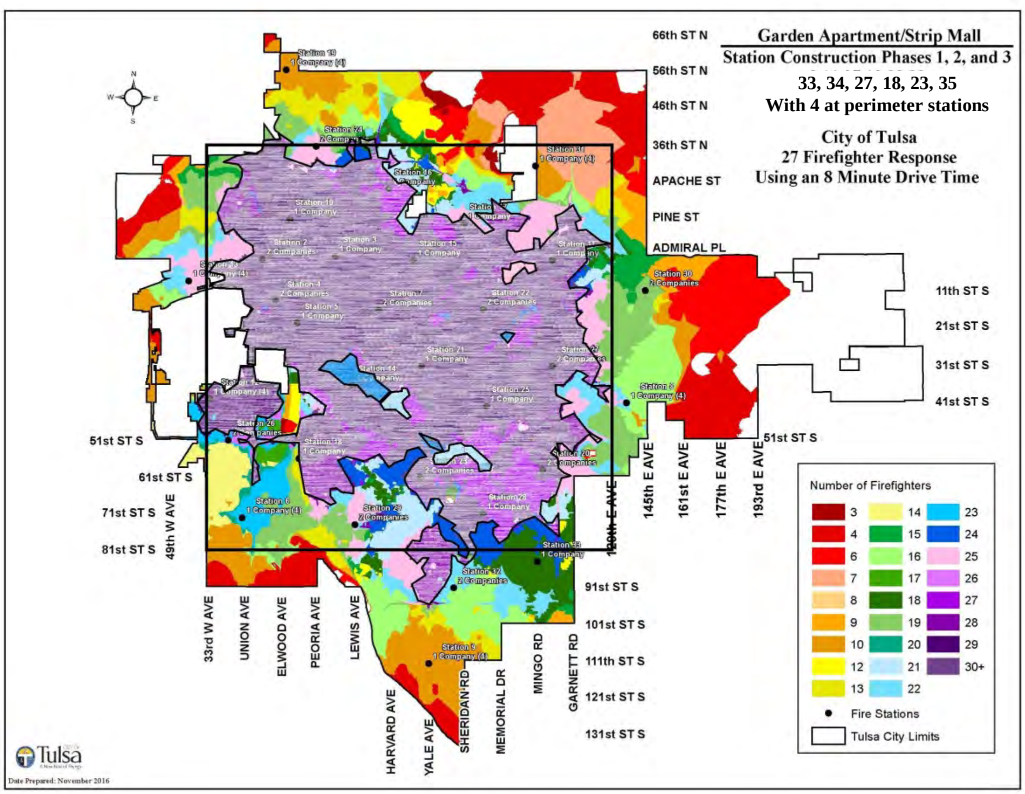
Effective Firefighting Force – Apartment/Strip Mall – Scenario 4 (Shaded)



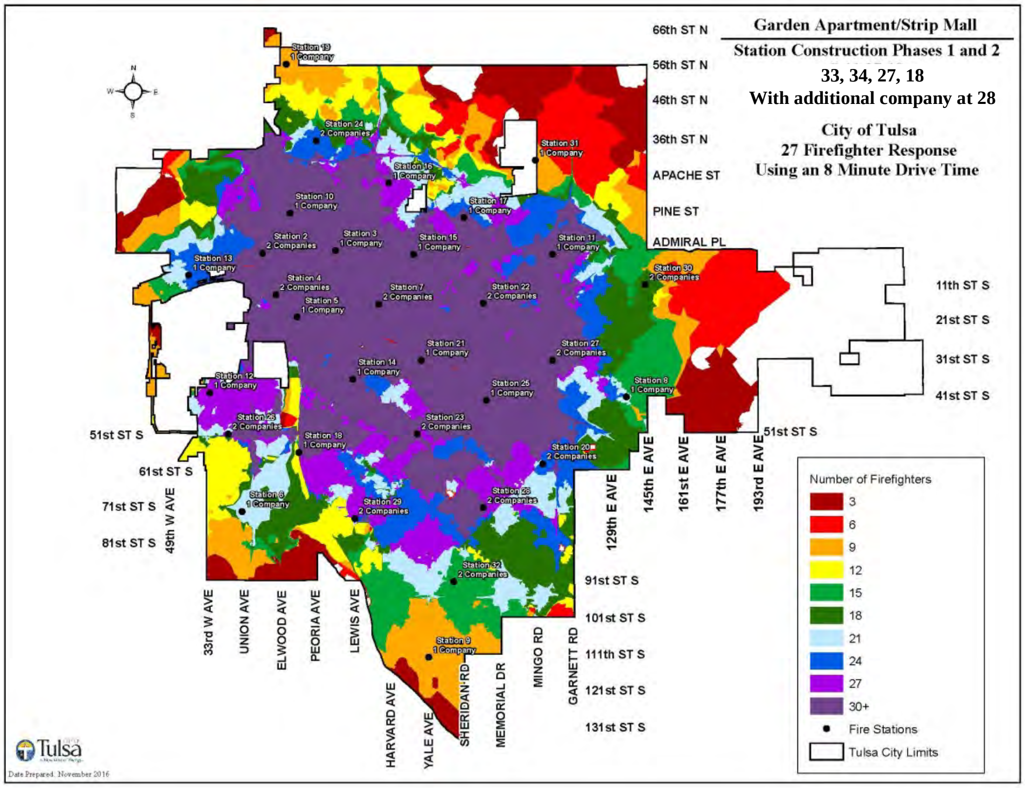
Effective Firefighting Force – Apartment/Strip Mall – Scenario 5



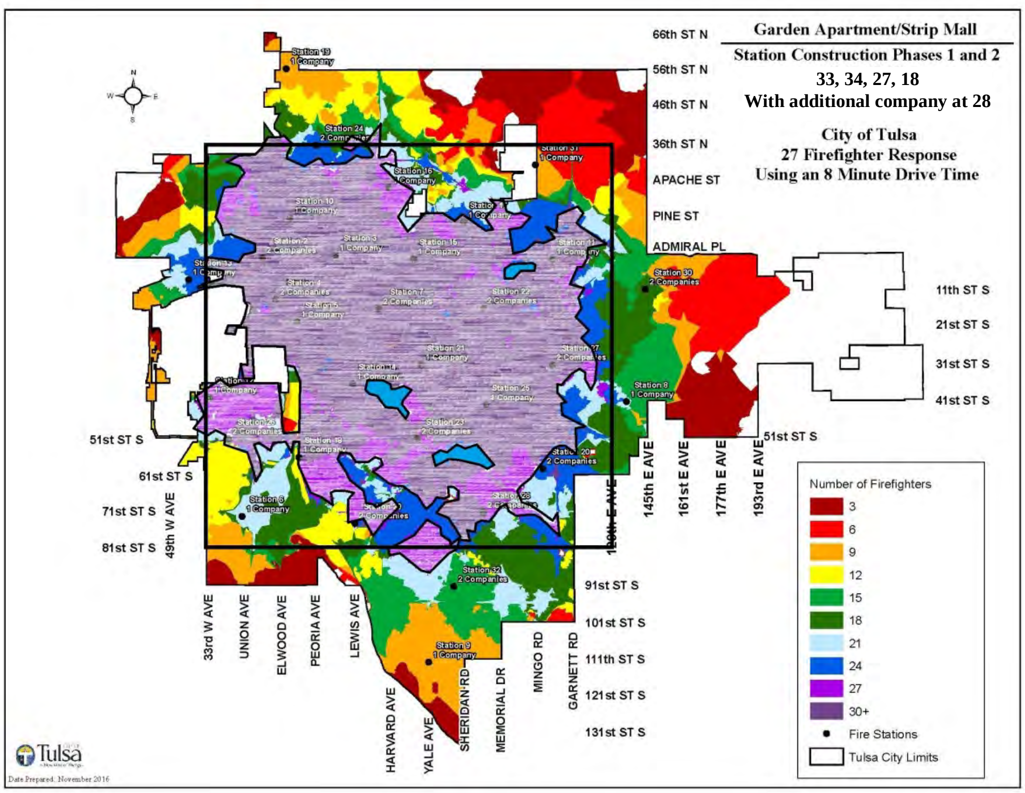
Effective Firefighting Force – Apartment/Strip Mall – Scenario 5 (Shaded)



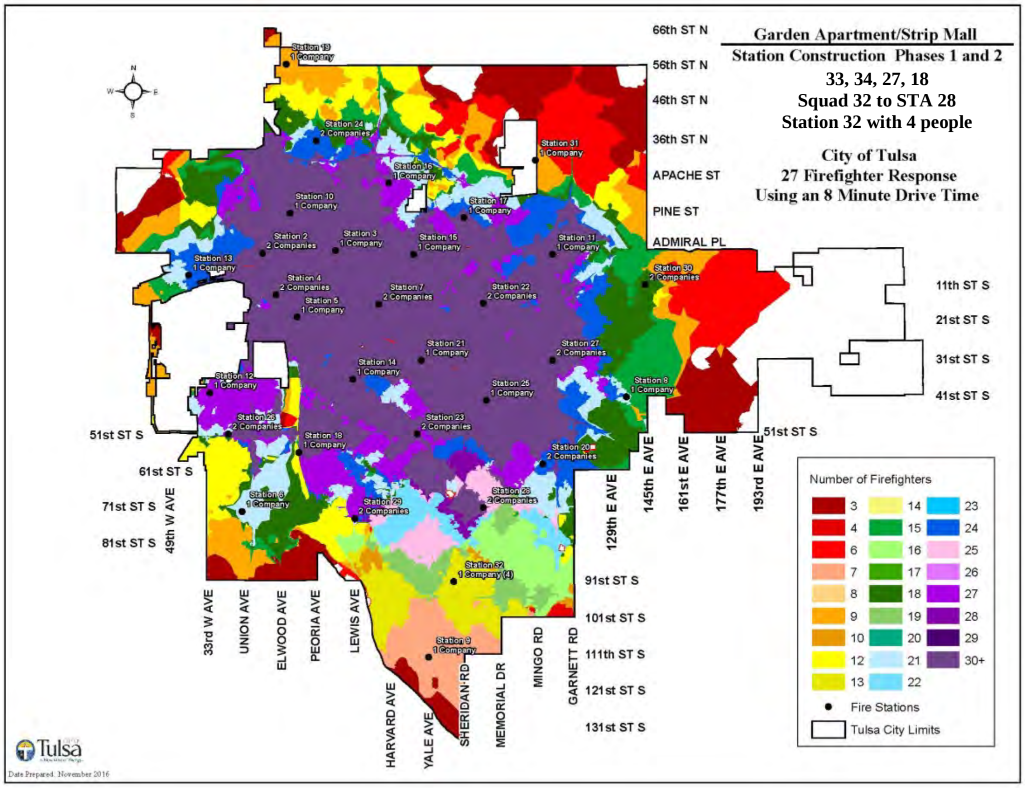
Effective Firefighting Force – Apartment/Strip Mall – Scenario 6



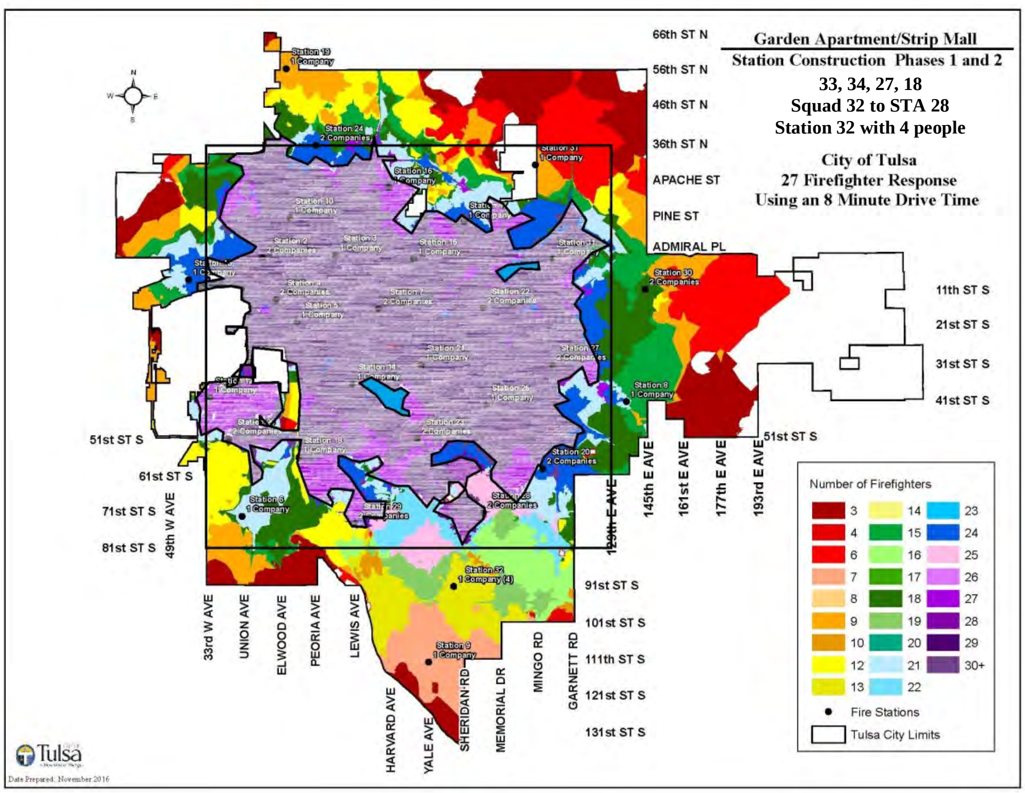
Effective Firefighting Force – Apartment/Strip Mall – Scenario 6 (Shaded)



Effective Firefighting Force – Apartment/Strip Mall – Scenario 7



Effective Firefighting Force – Apartment/Strip Mall – Scenario 7 (Shaded)



Appendix E: Case Studies

1. **Single Family Residence Fire – S. 33rd W. Ave**
2. **U-Haul Building Fire – Downtown**
3. **North Tulsa Tornado (EF-2)**

TULSA FIRE DEPARTMENT

CASE STUDY

Incident #5178

Date February 2,2015

Courtesy of channel 6 News

2

PURPOSE

This Case Study will serve as documentation of Tulsa Fire Department's performance and accomplishments, a comprehensive analysis of current procedures and practices and identify areas of improvement to include a corrective action plan.

EXECUTIVE SUMMARY

- Overview
- Major Strengths demonstrated during incident
- Areas that may require improvement

TIMELINE

- Dispatch February 2, 2015 1143hrs

INCIDENT OPERATIONS

INITIAL ASSIGNMENTS

Arrival times	114543	E-12,	(3 personnel) Size up and Pass command Fire Attack
""	114700	L-26,	(3 personnel) assigned two to Fire Attack
""	114930	E-6,	(3 personnel) water supply, assigned to fire attack
""	115544	E-5,	(3 personnel) assigned to medical group
""	114917	L-4,	(3 personnel) search and rescue, utility control
""	112657	Sq-26,	(2 personnel) set up command, medical group
""	12035	Dist.3,	(2 personnel) Incident command and safety

Conditions on Arrival E-12 on scene, fire showing in window on the A C sides of a single story wood frame residence (approx.1000 ft.)

3

INCIDENT SUPPORT

Air and Light 4 (1 person) air and oxygen bottle replenishment

E-29, (3 personnel) Paramedic assigned to medical group, Utility control

E-18, (3 personnel) assist with search and rescue

L-29, (3 personnel) assist with ventilation

Hazmat 1 and 2 (4 personnel) 2 to medical group, 2 to secondary search and rescue

C-810 (2 personnel) assisted with patient care

C-832 and C-834 (1person each) Brought additional Cyanokits and additional medical equipment for resupply

C-835 (1 person) Medical group leader

C-641 (2 personnel) additional district chief and Cyanokit

C-892 (1 person) Public Information Officer

C-895 (1person) assisted with patient care

C-896 and C-897 (1person each) Documentation Unit

C-763 and C-765 (1person each) Fire Investigators

EMSA Units 4 (2 personnel each) Medical transport

EMSA Supervisor 2 (1 person each) Supervise transport and patient care

TPD 4 (1 person each) Traffic control

ISSUES AND RECOMMENDATIONS

Issue: Initial assignment was sufficient for a structure fire of this size. Once patients were found the on scene staffing was unable to meet the OMD requirements of 6 medical personnel per patient.

Cause: Staffing levels below recommended 4 per apparatus

Recommended Solution: Maintain a constant manning of 4 personnel per fire apparatus per recommendation of NFPA standards (1710)

4

NFPA 1710 outlines the following minimum requirements for staffing fire suppression *The activities involved in controlling and extinguishing fires.* services (based upon operations for a 2000 square-foot, two-story, single-family occupancy with no basement, exposures or unusual hazards):

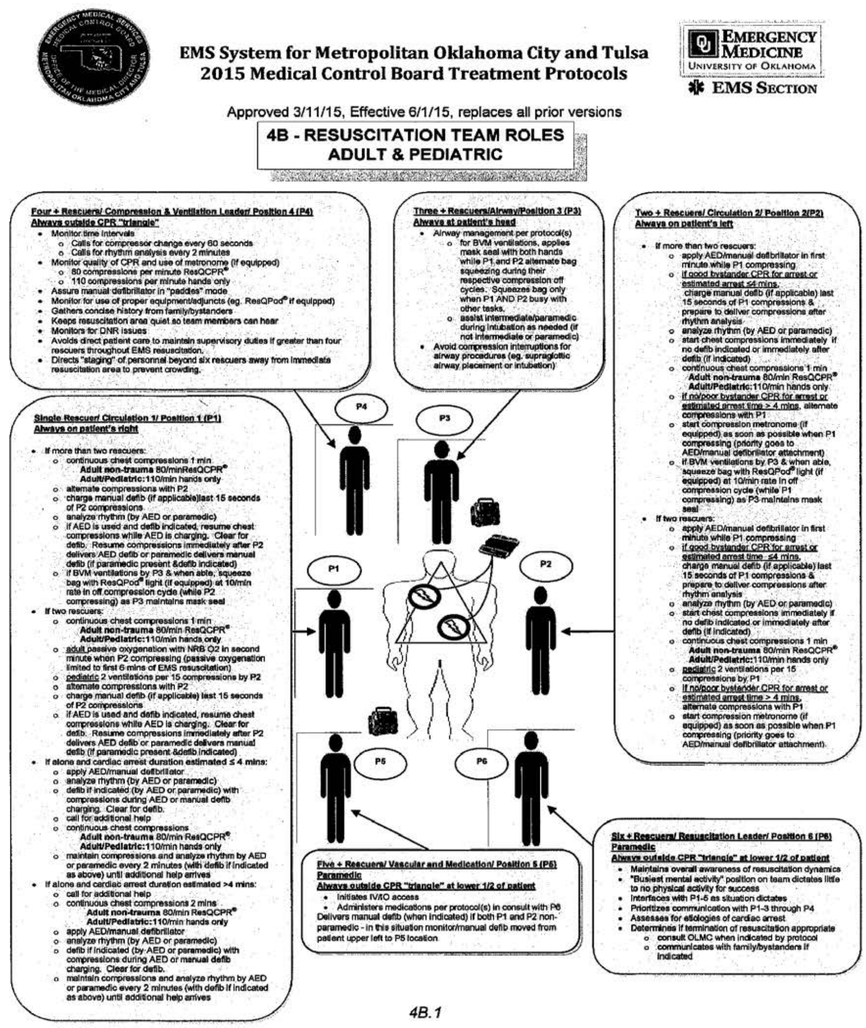
- A minimum of four fire fighters per engine company *Fire companies whose primary functions are to pump and deliver water and perform basic fire fighting at fires, including search and rescue.* or truck company *Fire companies whose primary functions are to perform the variety of services associated with truck work, such as forcible entry, ventilation, search and rescue, aerial operations for water delivery and rescue, utility control, illumination, overhaul, and salvage work.* (§ 5.2.2.1.1).
- Quint apparatus *A fire department emergency vehicle with a permanently mounted fire pump, a water tank, a hose storage area, an aerial device with a permanently mounted waterway, and a complement of ground ladders.* staffed as an engine or truck company (four fire fighters) or be staffed with additional personnel to perform multiple engine/truck company tasks (§ 5.2.2.4).
- Supervisory Chief Officers *A member whose responsibility is to assume command through a formalized transfer of command process and to allow company officers to directly supervise personnel assigned to them.* are required to respond as part of all full alarm incidents (§ 5.2.1.2.3).

The Standard sets requirements for the number of personnel required per company *A group of members: (1) Under the direct supervision of an officer; (2) Trained and equipped to perform assigned tasks; (3) Usually organized and identified as engine companies, ladder companies, rescue companies, squad companies, or multi-functional companies; (4) Operating with one piece of fire apparatus (engine, ladder truck, elevating platform, quint, rescue, squad, ambulance) except where multiple apparatus are assigned that are dispatched and arrive together, continuously operate together, and are managed by a single company officer; (5) arriving at the incident scene on fire apparatus.*, not per apparatus *A motor-driven vehicle or group of vehicles designed and constructed for the purpose of fighting fires.*. Therefore, if a company is composed of two or more engines, it can staff each engine with two personnel, as long as the company contains a minimum of four personnel continually operating together (§ A.3.3.8). Since most jurisdictions *The department's territorial range of authority as provided by the local government.* deploy one engine or truck per company, most jurisdictions must staff each engine or truck with a minimum of four personnel.

Note that the above criteria applies to low hazard situations in single-family occupancies as described above. In jurisdictions with tactical hazards, high hazard occupancies, high incident frequencies, or geographical restrictions, companies must be staffed with a minimum of five or six on-duty members (§ 5.2.2.1.2). The number of additional fire fighters above four is predicated on the specific duties to be accomplished at these high hazard locations as well as the time requirements associated with initiating these tasks.

5

Recourses required by OMD per patient



EMS System for Metropolitan Oklahoma City and Tulsa
2015 Medical Control Board Treatment Protocols

EMERGENCY MEDICINE
UNIVERSITY OF OKLAHOMA
EMS SECTION

Approved 3/11/15, Effective 6/1/15, replaces all prior versions

4B - RESUSCITATION TEAM ROLES
ADULT & PEDIATRIC

Four + Rescuers/ Compression & Ventilation Leader/ Position 4 (P4)
Always outside CPR "triangle"

- Monitor time intervals
  - Calls for compressor change every 60 seconds
  - Calls for rhythm analysis every 2 minutes
- Monitor quality of CPR and use of metronome (if equipped)
  - 80 compressions per minute ResQCPR®
  - 110 compressions per minute hands only
- Assure manual defibrillator in "paddles" mode
- Monitor for use of proper equipment/adjuncts (eg. ResQPod® if equipped)
- Gathers concise history from family/bystanders
- Keeps resuscitation area quiet so team members can hear
- Monitors for DNR issues
- Avoids direct patient care to maintain supervisory duties if greater than four rescuers throughout EMS resuscitation.
- Directs "staging" of personnel beyond six rescuers away from immediate resuscitation area to prevent crowding.

Three + Rescuers/Airway/Position 3 (P3)
Always at patient's head

- Airway management per protocol(s)
  - for BVM ventilations, applies mask seal with both hands while P1 and P2 alternate bag squeezing during their respective compression off cycles. Squeezes bag only when P1 AND P2 busy with other tasks.
  - assist intermediate/paramedic during intubation as needed (if not intermediate or paramedic)
- Avoid compression interruptions for airway procedures (eg. supraglottic airway placement or intubation)

Two + Rescuers/ Circulation 2/ Position 2(P2)
Always on patient's left

- If more than two rescuers:
  - apply AED/manual defibrillator in first minute while P1 compressing
  - if good bystander CPR for arrest or estimated arrest ≤4 mins, charge manual defib (if applicable) last 15 seconds of P1 compressions & prepare to deliver compressions after rhythm analysis
  - analyze rhythm (by AED or paramedic)
  - start chest compressions immediately if no defib indicated or immediately after defib (if indicated)
  - continuous chest compressions 1 min
    Adult non-trauma 80/min ResQCPR®
    Adult/Pediatric:110/min hands only
  - if no/poor bystander CPR for arrest or estimated arrest time > 4 mins, alternate compressions with P1
  - start compression metronome (if equipped) as soon as possible when P1 compressing (priority goes to AED/manual defibrillator attachment)
  - if BVM ventilations by P3 & when able, squeeze bag with ResQPod® light (if equipped) at 10/min rate in off compression cycle (while P1 compressing) as P3 maintains mask seal
- If two rescuers:
  - apply AED/manual defibrillator in first minute while P1 compressing
  - if good bystander CPR for arrest or estimated arrest time ≤4 mins, charge manual defib (if applicable) last 15 seconds of P1 compressions & prepare to deliver compressions after rhythm analysis
  - analyze rhythm (by AED or paramedic)
  - start chest compressions immediately if no defib indicated or immediately after defib (if indicated)
  - continuous chest compressions 1 min
    Adult non-trauma 80/min ResQCPR®
    Adult/Pediatric:110/min hands only
  - pediatric 2 ventilations per 15 compressions by P1
  - if no/poor bystander CPR for arrest or estimated arrest time > 4 mins, alternate compressions with P1
  - start compression metronome (if equipped) as soon as possible when P1 compressing (priority goes to AED/manual defibrillator attachment).

Single Rescuer/ Circulation 1/ Position 1 (P1)
Always on patient's right

- If more than two rescuers:
  - continuous chest compressions 1 min
    Adult non-trauma 80/minResQCPR®
    Adult/Pediatric:110/min hands only
  - alternate compressions with P2
  - charge manual defib (if applicable)last 15 seconds of P2 compressions
  - analyze rhythm (by AED or paramedic)
  - if AED is used and defib indicated, resume chest compressions while AED is charging. Clear for defib. Resume compressions immediately after P2 delivers AED defib or paramedic delivers manual defib (if paramedic present &defib indicated)
  - if BVM ventilations by P3 & when able, squeeze bag with ResQPod® light (if equipped) at 10/min rate in off compression cycle (while P2 compressing) as P3 maintains mask seal
- If two rescuers:
  - continuous chest compressions 1 min
    Adult non-trauma 80/min ResQCPR®
    Adult/Pediatric:110/min hands only
  - adult passive oxygenation with NRB O2 in second minute when P2 compressing (passive oxygenation limited to first 6 mins of EMS resuscitation)
  - pediatric 2 ventilations per 15 compressions by P2
  - alternate compressions with P2
  - charge manual defib (if applicable) last 15 seconds of P2 compressions
  - if AED is used and defib indicated, resume chest compressions while AED is charging. Clear for defib. Resume compressions immediately after P2 delivers AED defib or paramedic delivers manual defib (if paramedic present &defib indicated)
- If alone and cardiac arrest duration estimated ≤ 4 mins:
  - apply AED/manual defibrillator
  - analyze rhythm (by AED or paramedic)
  - defib if indicated (by AED or paramedic) with compressions during AED or manual defib charging. Clear for defib.
  - call for additional help
  - continuous chest compressions
    Adult non-trauma 80/min ResQCPR®
    Adult/Pediatric:110/min hands only
  - maintain compressions and analyze rhythm by AED or paramedic every 2 minutes (with defib if indicated as above) until additional help arrives
- If alone and cardiac arrest duration estimated >4 mins:
  - call for additional help
  - continuous chest compressions 2 mins
    Adult non-trauma 80/min ResQCPR®
    Adult/Pediatric:110/min hands only
  - apply AED/manual defibrillator
  - analyze rhythm (by AED or paramedic)
  - defib if indicated (by AED or paramedic) with compressions during AED or manual defib charging. Clear for defib.
  - maintain compressions and analyze rhythm by AED or paramedic every 2 minutes (with defib if indicated as above) until additional help arrives

Five + Rescuers/ Vascular and Medication/ Position 5 (P5)
Paramedic
Always outside CPR "triangle" at lower 1/2 of patient

- Initiates IV/IO access
- Administers medications per protocol(s) in consult with P6

Delivers manual defib (when indicated) if both P1 and P2 non-paramedic - in this situation monitor/manual defib moved from patient upper left to P5 location

Six + Rescuers/ Resuscitation Leader/ Position 6 (P6)
Paramedic
Always outside CPR "triangle" at lower 1/2 of patient

- Maintains overall awareness of resuscitation dynamics
- "Busiest mental activity" position on team dictates little to no physical activity for success
- Interfaces with P1-5 as situation dictates
- Prioritizes communication with P1-3 through P4
- Assesses for etiologies of cardiac arrest
- Determines if termination of resuscitation appropriate
  - consult OLMC when indicated by protocol
  - communicates with family/bystanders if indicated

4B.1

6

Issue: Cyanokits availability

Recommended Solution: Have Cyanokits available on all ALS apparatus as well as EMSA units

Issue: Communication between Fire companies and transport units

Recommended solution: All units responding agencies could be automatically regrouped to the same Chanel and sub fleet. It would allow direct communication with command requirements which would be expedited without miscommunication.

Comments: This scene was handled with the professionalism and service that is the Hallmark of the Tulsa Fire Department. This was an extremely dynamic scene; expert care was delivered to the victims of this unfortunate circumstance, in spite of the minimal staffing with supporting agencies.

LESSONS LEARNED

1. **Move up resources sooner if patient(s) are suspected**
2. **Cyanokits more readily available**
3 **Coordination of commutation between Fire and transport units needs to be real time.**

Tulsa Fire Department

CASE STUDY

Incident #: 55879

Date: November 1st, 2015

PURPOSE:

This Case Study will serve as documentation of the Tulsa Fire Department's response; actions taken and results for a building fire located 504 E. Archer Street. This Case Study will also take a comprehensive analysis of current procedures and practices and identify areas of improvement to include a corrective action plan.

EXECUTIVE SUMMARY:

- Overview
- Strengths demonstrated during the incident
- Areas that may require improvement

TIMELINE:

- 911 call pickup: 16:54:59
- Initial dispatch: 16:55:32
- First unit arrival: 16:59:33
- Last unit leaving: 01:04:30
- Incident duration: 08:09:31

INCIDENT OPERATIONS:

Initial Assignments: (1st Alarm)

Unit:	Assigned:	Enroute:	Arrival:	Completion of assignment:
E-3	16:56:22	16:57:21	17:00:16	22:18:06
E-2	16:56:22	16:57:12	17:00:44	22:17:31
E-4	16:56:22	16:57:32	17:01:09	21:27:58
L-4	16:56:22	16:57:35	17:01:26	01:03:25
E-10	16:56:22	16:57:14	16:59:33	22:40:07
E-5	16:56:22	16:57:24	17:01:06	22:08:05
L-7	16:56:22	16:57:38	17:03:35	19:53:30
L-24	16:56:22	16:57:52	17:04:15	23:21:01
SQ-2	16:56:22	16:56:57	17:04:15	01:03:31
C-641	16:56:22	16:57:16	17:03:15	01:02:27

Additional Assignments:

Unit:	Assigned:	Enroute:	Arrival:	Completion of assignment:
Air 4	17:00:22	17:00:22	17:05:51	00:32:32
L-26	17:10:31	17:11:59	17:22:04	23:21:22
E-13	17:10:31	17:11:44	17:17:56	23:37:44
E-7	17:12:07	17:12:07	17:16:17	19:17:52
E-15	17:13:07	17:13:07	17:17:56	20:43:06
SQ-26	17:14:01	17:14:02	17:23:15	23:06:18
C-835	17:37:30	17:37:31	17:37:31	01:04:22
Air 27	18:18:46	18:21:00	19:03:59	19:43:26
C-766	18:53:56	18:53:56	18:53:56	01:04:26
L-20	19:16:23	19:17:43	19:25:17	22:45:40
E-24	19:16:23	19:18:47	19:26:53	00:21:38
L-30	19:17:36	19:17:36		19:26:54
C-522	20:10:09	20:10:09	20:10:12	01:04:28
E-14	23:10:20	23:10:20	23:21:58	01:04:30
L-29	23:13:51	23:13:51	23:33:55	01:03:36

Conditions on Arrival:

E-2: Smoke showing from 3rd floor, passing command, fire attack

Initial ICS:

- C-641 – IC
- C-641 Intern – Safety
- E-2, E-3, Sq-2, E-10, E-5 – Fire Attack / Water Supply
- L-26 – Search & Rescue
- E-4 – RIC
- Sq-26 – EMS
- L-4 – Ventilation / Ladder Pipe

Issues & Solutions:

1) Issue: Initial assignment was not sufficient for a building of this size.

   Cause: The initial assignment was a Class A assignment. (5 Engines & 2 Ladders)

   Solution: This building was only 3 stories tall, our policy states that a 3rd Alarm will be called when there is a confirmed fire in high rise building (which is 5 stories or more). Size of the building, construction type and fire load should also be used when determining the need for calling for a 3rd Alarm. (EOG Section: 300.2.3.4.2)

2) Issue: Difficulty ventilating the fire.

   Cause: Layout of the fire floor due to extensive remodeling.

   Solution: Continuation of the monthly walk through program already implemented and the sharing of information among platoons, districts and stations. (AOP Section: 502)
   It would be advantageous if there was software kept on the TFD tough books that could house the layout of commercial buildings that could easily be extrapolated.

Comments:

The biggest issue that the Tulsa Fire Department incurred during this structure fire was the inability to properly ventilate.

The fire was located on the 3rd (top) floor of the U-Haul building. This floor has been remodeled into rows and rows of walk in storage rooms both in the middle of the room, as well as along the outside walls. Not only are these storage rooms, but we also found out that homeless people rent these lockers and then use them as a make shift home for themselves during normal business hours. This creates an abnormally high fire load than what would normally be expected in a storage building.

The lay out of the storage rooms created a shell within a shell within a shell; making horizontal ventilation incredibly difficult. As well, the roof was a poured concrete flat roof that made vertical ventilation nearly impossible. This created an environment of a moderate sized fire that was creating a large amount of smoke that could not be dissipated. The only direct windows into the main room of the 3rd floor are located on the South wall. However, that night, the wind was coming from the North. We put two large fans in the doorways of the 3rd floor on the North/East corner as well as the East side of the building. However, because this floor was so cut up with the storage rooms, the fans had little to no effect on the smoke. The only ventilation option that we didn't try was to put Ladder 4's bucket with a smoke ejector in the windows on the South side and try to extract the smoke that way. In the event of another fire on that floor, this might be the best option. Although because of the layout of the floor, it still might not be effective.

Tulsa Fire Department Case Study: North Tulsa Tornado

4600 N. Hartford Ave.

Wednesday, March 30, 2016 – 1920 Hours

(PRE-DISPATCH PHOTO BY G. HURT)

(PHOTOS COURTESY OF TULSA WORLD)

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Purpose:

- This study will serve as analysis and documentation of TFD's performance, and also of current policies and procedures regarding storm disaster response. This study will also identify areas of improvement and lessons learned to include a suggested corrective action plan.

Key Points/Summary:

- Overview
- Incident Strengths
- Areas of Improvement/Lessons Learned

Initial Dispatch Information:

- Incident #14056 (NFIRS #14148)
- Wednesday, March 30, 2016, 1920 Hours (approximately)
- News reports of a tornado and/or funnel in the area of 56th St. North and Highway 169
- Engine 19 dispatched to and reports lines down and widespread damage in the area of 46th St. North and Hartford/Iroquois Ave.
- Rescue Task Force (with District 1) dispatched with District 4 companies

Initial Assignments:

- E19
- E24
- L24
- Rescue Task Force – E4, R4, E5, C641
- E2
- E3
- E10
- Air/Guard Team

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Secondary Assignments/Support:

- HM1
- HM2
- L20
- L32
- C831, C832, C833
- L20
- L32
- C522 and USAR Teams
- C843
- EMSA
- TPD
- Street Department
- American Red Cross

Recommended Policy/Guidelines:

- EOG Section 300.9 – Storm Disaster Response – Post Storm Procedures

Response and Actions:

- Upon dispatch and enroute, C641 discussed implementing storm disaster response procedures and utilizing divisions.
- C641 arrived on scene in the area of 46th St. North and Iroquois to widespread damage, multiple power poles and lines down, and multiple life safety, crowd, and traffic control issues.
- 46th St. North Area Command was established with the command post located at 46th St. North and Iroquois.
- 46th Street North Area Command communicated to responding companies that the incident would be operating in "storm disaster response mode" with emphasis on windshield surveys and establishing perimeters. Crews were instructed to only stop and render aid to critical patients.

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- 3 Divisions were established with crews on scene and enroute for perimeter establishment. 2 units from Air/Guard responded and were utilized within divisions. C641 Intern quickly utilized map pages to track perimeter as crews communicated areas of damage. C641 Intern also assisted with communicating by phone to EOC and others and assisting with the overwhelming amount of information coming in.
- TPD was initially delayed. Other companies/personnel on scene were utilized for crowd and traffic control and deterring citizens from walking into the hot zone. The Street Department was eventually dispatched by the EOC and assisted with blocking streets.
- EMSA was on scene quickly and was intially assigned to take care of all medical needs. C835 was requested, but C831, C832, and C833 self dispatched and were given the function of EMS Group/Branch upon arrival.
- EMS Branch(C831) suggested initiating EMS staging at Tisdale Clinic located at located at 3600 N. Hartford Ave. This parking lot became the formal staging area for other responding agencies/apparatus (C832 was staging area manager)
- Air/Light 4 was initially utilized for scene lighting and crowd control/victim staging located at a church just east of the command post. A/L4 was eventually redirected to staging for standby.
- Responding HAZMAT units were initially utilized for gas leaks, but quickly became absorbed for other functions including working within divisions and cordoning off hazardous conditions and downed lines/poles.
- TPD, PSO, ONG, and C843 were all called for assistance. C522 was requested to assist with media. RedCross also self dispatched for victim and canteen needs.
- L20 and L32 were utilized for functions within divisions as needed. Eventually they were returned to service to fill for District 4 companies.
- As windshield surveys were starting to wrap up and perimeters had been defined, USAR deployed 4 teams, each equipped with a search dog. Divisions were then reestablished with a USAR team for house to house canvassing.
- As systematic canvassing got underway, division leaders would report needs to the IC. Specific needs would be dispatched by the IC to appropriate entities: TPD, ONG, PSO, EMSA, etc..
- As the incident began to deescalate, resources were sent to rehab and staging, and eventually returned to service. A short briefing was held at staging and the incident was terminated just before midnight.

Positive Outcome/Additional Incident Information:

- Storm response guidelines were implemented and the incident was managed successfully
- EMSA only transported a total of 7 victims to area hospitals
- There were no reported civilian fatalities and no known firefighter injuries
- TPD was left on scene to patrol the area and keep streets and power lines blocked
- American Red Cross assisted at least 1 displaced family

Issues and Recommendations:

- Command Post located in "HOT" zone; Quickly became part of the incident and in danger zone; Overwhelmed by incident radio traffic while trying to manage crowd and traffic control and victims walking up to the command post for help:
  - ➢ Note first signs of damage upon approach and set up command in a good location or fixed position (eg. Fire station) in the warm zone well away from danger, citizens, bystanders, wounded victims, etc.
  - ➢ Announce to crews that the incident is operating in storm disaster reponse mode and what the initial goal is. With multiple hazards and low light, make sure crews are conscientious of situational awareness.
  - ➢ Call for additional DC (and additional alarms if needed) if not already dispatched to assist with radio traffic and documentation and/or command functions
  - ➢ Have a next in responding resource/company identify and set up staging well away fro the incident and early on, for the potentially large number of self dispatching and other needed resources

- Delay on initial requests for needed resources (eg. Delay of TPD to assist with traffic/streets); Confusion on who to request resources from; Too hectic for IC and Intern to utilize radio and cell phone at the same time:
  - ➢ Have EOC personnel take over radio communication/dispatch needs (instead of main) for the incident with all resource requests going through them
  - ➢ Train dispatchers and DC's on disaster response communications

- No dedicated TFD EMS presence on initial assignment:
  - ➢ C835 should be included in initial assignment and dedicated to establishing EMS Group/Branch, responsible for requesting additional EMS resources as needed and coordination of Triage, Treatment, and Transportation with EMSA

- Command post problems; no room to work, juggling paperwork and map pages on the dash; no lighting; keeping track of multiple reassignments of companies while managing lengthy radio messages and cell phone calls; lacking needed office supplies:
  - ➢ Establishing command from a fixed location with an extra DC and intern on the assignment would solve most problems
  - ➢ Stock chief's cars with tape, a dry erase board, markers and an eraser.
  - ➢ Keep radio traffic to a minimum and train companies to only transmit short critical messages, utilized separate radio channels if needed
  - ➢ Train interns on functions of assisting with perimeter tracking/division coordination, radio traffic, and documentation at complex incidents

- Time Consuming initial perimeter establishment and difficulty coordinating with multiple crews; Some crews on standby for extended periods; forgot to check on large residential facilities (eg. nursing homes, etc.)until late in the incident; didn't work on clearing major streets for potential victim/EMS transport:
  - ➢ Implement complex incident/ large storm disaster responses into company drills
  - ➢ Intern/DC must work closely together and be ready to go!
  - ➢ Have crews think of the windshield surveys/damage assessment as a primary search and/or triage – As quickly and SAFELY as possible, determine areas of damage and identify immediate life threats and only stop for life threatening emergencies.
  - ➢ As crews complete perimeter assignments and are awaiting new assignments they could be utilized to check on/identify occupancies such as hospitals, nursing homes, etc. in the area of damage.
  - ➢ Utilize EOC early on for PSO, grass rigs, street dept., etc for clearing debris in major thoroughfares for EMS transport needs

- Initial problems keeping track of and managing hazardous conditions such as downed power lines/poles and natural gas leaks:
  - Have companies Triage downed lines/poles, and natural gas leaks
  - Have dispatch assist with keeping a list of the hazards and utilize EOC for PSO and ONG to response for the high priority hazards

(PHOTO COURTESY OF TULSA WORLD)

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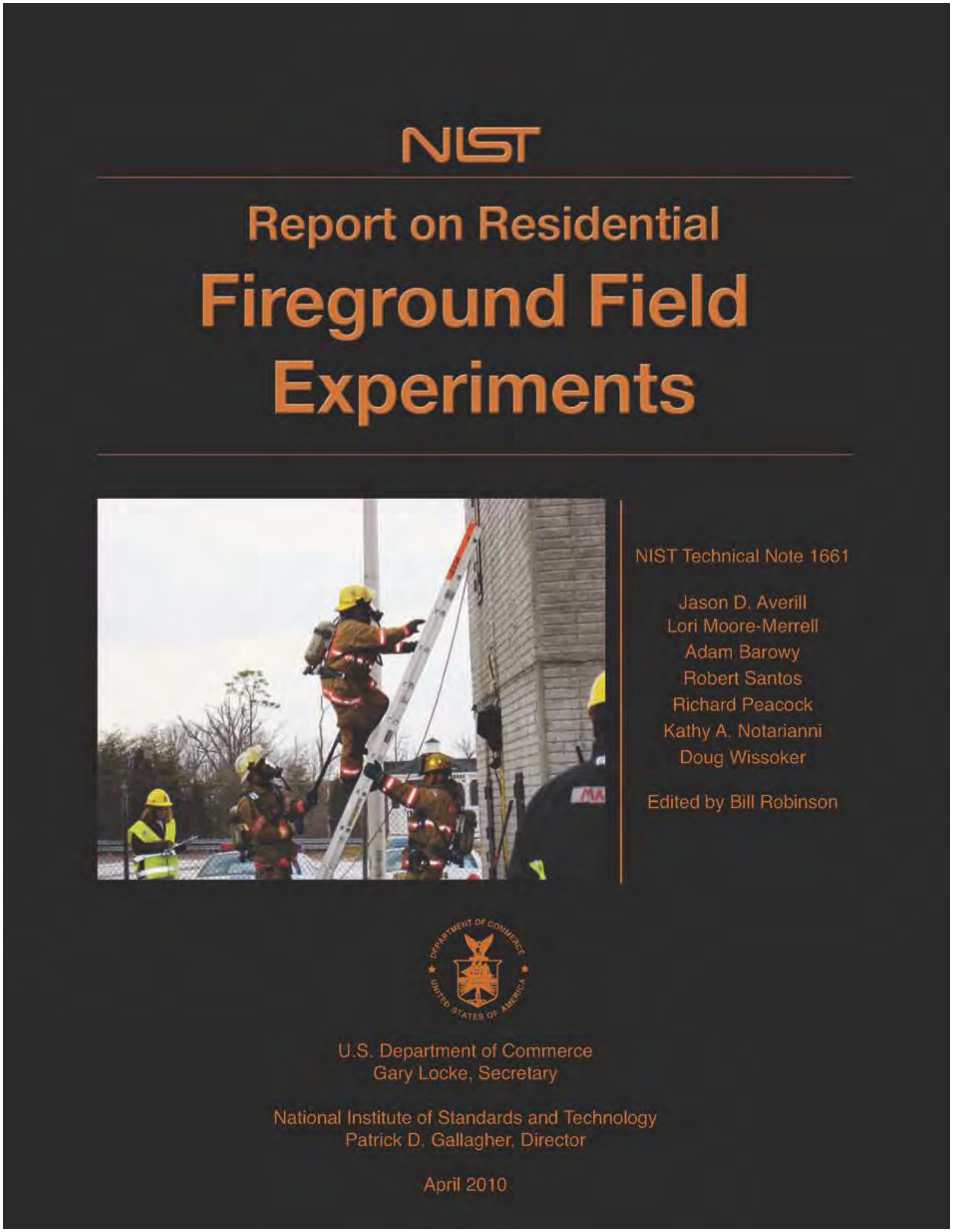
Appendix F: NIST *Report on Residential Fireground Field Experiments* – Executive Summary (Robinson 2010)


NIST

Report on Residential

Fireground Field Experiments

NIST Technical Note 1661

Jason D. Averill
Lori Moore-Merrell
Adam Barowy
Robert Santos
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Edited by Bill Robinson

U.S. Department of Commerce
Gary Locke, Secretary

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Abstract

Service expectations placed on the fire service, including Emergency Medical Services (EMS), response to natural disasters, hazardous materials incidents, and acts of terrorism, have steadily increased. However, local decision-makers are challenged to balance these community service expectations with finite resources without a solid technical foundation for evaluating the impact of staffing and deployment decisions on the safety of the public and firefighters.

For the first time, this study investigates the effect of varying crew size, first apparatus arrival time, and response time on firefighter safety, overall task completion, and interior residential tenability using realistic residential fires. This study is also unique because of the array of stakeholders and the caliber of technical experts involved. Additionally, the structure used in the field experiments included customized instrumentation; all related industry standards were followed; and robust research methods were used. The results and conclusions will directly inform the NPFA 1710 Technical Committee, who is responsible for developing consensus industry deployment standards.

This report presents the results of more than 60 laboratory and residential fireground experiments designed to quantify the effects of various fire department deployment configurations on the most common type of fire — a low hazard residential structure fire. For the fireground experiments, a 2,000 sq ft (186 m^2), two-story residential structure was designed and built at the Montgomery County Public Safety Training Academy in Rockville, MD. Fire crews from Montgomery County, MD and Fairfax County, VA were deployed in response to live fires within this facility. In addition to systematically controlling for the arrival times of the first and subsequent fire apparatus, crew size was varied to consider two-, three-, four-, and five-person staffing. Each deployment performed a series of 22 tasks that were timed, while the thermal and toxic environment inside the structure was measured. Additional experiments with larger fuel loads as well as fire modeling produced additional insight. Report results quantify the effectiveness of crew size, first-due engine arrival time, and apparatus arrival stagger on the duration and time to completion of the key 22 fireground tasks and the effect on occupant and firefighter safety.

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Executive Summary

Both the increasing demands on the fire service - such as the growing number of Emergency Medical Services (EMS) responses, challenges from natural disasters, hazardous materials incidents, and acts of terrorism — and previous research point to the need for scientifically based studies of the effect of different crew sizes and firefighter arrival times on the effectiveness of the fire service to protect lives and property. To meet this need, a research partnership of the Commission on Fire Accreditation International (CFAI), International Association of Fire Chiefs (IAFC), International Association of Firefighters (IAFF), National Institute of Standards and Technology (NIST), and Worcester Polytechnic Institute (WPI) was formed to conduct a multiphase study of the deployment of resources as it affects firefighter and occupant safety. Starting in FY 2005, funding was provided through the Department of Homeland Security (DHS) / Federal Emergency Management Agency (FEMA) Grant Program Directorate for Assistance to Firefighters Grant Program — Fire Prevention and Safety Grants. In addition to the low-hazard residential fireground experiments described in this report, the multiple phases of the overall research effort include development of a conceptual model for community risk assessment and deployment of resources, implementation of a generalizable department incident survey, and delivery of a software tool to quantify the effects of deployment decisions on resultant firefighter and civilian injuries and on property losses.

The first phase of the project was an extensive survey of more than 400 career and combination (both career and volunteer) fire departments in the United States with the objective of optimizing a fire service leader's capability to deploy resources to prevent or mitigate adverse events that occur in risk- and hazard-filled environments. The results of this survey are not documented in this report, which is limited to the experimental phase of the project. The survey results will constitute significant input into the development of a future software tool to quantify the effects of community risks and associated deployment decisions on resultant firefighter and civilian injuries and property losses.

The following research questions guided the experimental design of the low-hazard residential fireground experiments documented in this report:

1. How do crew size and stagger affect overall start-to-completion response timing?

2. How do crew size and stagger affect the timings of task initiation, task duration, and task completion for each of the 22 critical fireground tasks?

3. How does crew size affect elapsed times to achieve three critical events that are known to change fire behavior or tenability within the structure:
   a. Entry into structure?
   b. Water on fire?
   c. Ventilation through windows (three upstairs and one back downstairs window and the burn room window).

4. How does the elapsed time to achieve the national standard of assembling 15 firefighters at the scene vary between crew sizes of four and five?

In order to address the primary research questions, the research was divided into four distinct, yet interconnected parts:

- Part 1 — Laboratory experiments to design appropriate fuel load
- Part 2 — Experiments to measure the time for various crew sizes and apparatus stagger (interval between arrival of various apparatus) to accomplish key tasks in rescuing occupants, extinguishing a fire, and protecting property
- Part 3 — Additional experiments with enhanced fuel load that prohibited firefighter entry into the burn prop – a building constructed for the fire experiments
- Part 4 — Fire modeling to correlate time-to-task completion by crew size and stagger to the increase in toxicity of the atmosphere in the burn prop for a range of fire growth rates.

The experiments were conducted in a burn prop designed to simulate a low-hazard[1] fire in a residential structure described as typical in NFPA 1710® *Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*. NFPA 1710 is the consensus standard for career firefighter deployment, including requirements for fire department arrival time, staffing levels, and fireground responsibilities.

Limitations of the study include firefighters' advance knowledge of the burn prop, invariable number of apparatus, and lack of experiments in elevated outdoor temperatures or at night. Further, the applicability of the conclusions from this report to commercial structure fires, high-rise fires, outside fires, terrorism/natural disaster response, HAZMAT or other technical responses has not been assessed and should not be extrapolated from this report.

Primary Findings

Of the 22 fireground tasks measured during the experiments, results indicated that the following factors had the most significant impact on the success of fire fighting operations. All differential outcomes described below are statistically significant at the 95 % confidence level or better.

Overall Scene Time:

The four-person crews operating on a low-hazard structure fire completed all the tasks on the fireground (on average) seven minutes faster — nearly 30 % — than the two-person crews. The four-person crews completed the same number of fireground tasks (on average) 5.1 minutes faster — nearly 25 % — than the three-person crews. On the low-hazard residential structure fire, adding a fifth person to the crews did not decrease overall fireground task times. However, it should be noted that the

1 A low-hazard occupancy is defined in the NFPA Handbook as a one-, two-, or three-family dwelling and some small businesses. Medium hazards occupancies include apartments, offices, mercantile and industrial occupancies not normally requiring extensive rescue or firefighting forces. High-hazard occupancies include schools, hospitals, nursing homes, explosive plants, refineries, high-rise buildings, and other highlife hazard or large fire potential occupancies.

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benefit of five-person crews has been documented in other evaluations to be significant for medium- and high-hazard structures, particularly in urban settings, and is recognized in industry standards.[2]

Time to Water on Fire:

There was a 10% difference in the "water on fire" time between the two- and three-person crews. There was an additional 6% difference in the "water on fire" time between the three- and four-person crews. (i.e., four-person crews put water on the fire 16% faster than two person crews). There was an additional 6% difference in the "water on fire" time between the four- and five-person crews (i.e. five-person crews put water on the fire 22% faster than two-person crews).

Ground Ladders and Ventilation:

The four-person crews operating on a low-hazard structure fire completed laddering and ventilation (for life safety and rescue) 30 % faster than the two-person crews and 25 % faster than the three-person crews.

Primary Search:

The three-person crews started and completed a primary search and rescue 25 % faster than the two-person crews. The four- and five-person crews started and completed a primary search 6 % faster than the three-person crews and 30 % faster than the two-person crew. A 10 % difference was equivalent to just over one minute.

Hose Stretch Time:

In comparing four-and five-person crews to two-and three-person crews collectively, the time difference to stretch a line was 76 seconds. In conducting more specific analysis comparing all crew sizes to the two-person crews the differences are more distinct. Two-person crews took 57 seconds longer than three-person crews to stretch a line. Two-person crews took 87 seconds longer than four-person crews to complete the same tasks. Finally, the most notable comparison was between two-person crews and five-person crews — more than 2 minutes (122 seconds) difference in task completion time.

Industry Standard Achieved:

As defined by NFPA 1710, the "industry standard achieved" time started from the first engine arrival at the hydrant and ended when 15 firefighters were assembled on scene.[3] An effective response force was assembled by the five-person crews three minutes faster than the four-person crews. Based on the study protocols, modeled after a typical fire department apparatus deployment strategy, the total number of firefighters on scene in the two- and three-person crew scenarios never equaled 15 and therefore the two- and three-person crews were unable to assemble enough personnel to meet this standard.

Occupant Rescue:

Three different "standard" fires were simulated using the Fire Dynamics Simulator (FDS) model. Characterized in the *Handbook of the Society of Fire Protection Engineers* as slow-, medium-, and fast-growth rate[4], the fires grew exponentially with time. The rescue scenario was based on a non-ambulatory occupant in an upstairs bedroom with the bedroom door open.

Independent of fire size, there was a significant difference between the toxicity, expressed as fractional effective dose (FED), for occupants at the time of rescue depending on arrival times for all crew sizes. Occupants rescued by early-arriving crews had less exposure to combustion products than occupants rescued by late-arriving crews. The fire modeling showed clearly that two-person crews cannot complete essential fireground tasks in time to rescue occupants without subjecting them to an increasingly toxic atmosphere. For a slow-growth rate fire with two-person crews, the FED was approaching the level at which sensitive populations, such as children and the elderly are threatened. For a medium-growth rate fire with two-person crews, the FED was far above that threshold and approached the level affecting the general population. For a fast-growth rate fire with two-person crews, the FED was well above the median level at which 50 % of the general population would be incapacitated. Larger crews responding to slow-growth rate fires can rescue most occupants prior to incapacitation along with early-arriving larger crews responding to medium-growth rate fires. The result for late-arriving (two minutes later than early-arriving) larger crews may result in a threat to sensitive populations for medium-growth rate fires. Statistical averages should not, however, mask the fact that there is no FED level so low that every occupant in every situation is safe.

Conclusion:

More than 60 full-scale fire experiments were conducted to determine the impact of crew size, first-due engine arrival time, and subsequent apparatus arrival times on firefighter safety and effectiveness at a low-hazard residential structure fire. This report quantifies the effects of changes to staffing and arrival times for residential firefighting operations. While resource deployment is addressed in the context of a single structure type and risk level, it is recognized that public policy decisions regarding the cost-benefit of specific deployment decisions are a function of many other factors including geography, local risks and hazards, available resources, as well as community expectations. This report does not specifically address these other factors.

The results of these field experiments contribute significant knowledge to the fire service industry. First, the results provide a quantitative basis for the effectiveness of four-person crews for low-hazard response in *NFPA 1710*. The results also provide valid measures of total effective response force assembly on scene for fireground operations, as well as the expected performance time-to-critical-task measures for low-hazard structure fires. Additionally, the results provide tenability measures associated with a range of modeled fires.

Future research should extend the findings of this report in order to quantify the effects of crew size and apparatus arrival times for moderate- and high-hazard events, such as fires in high-rise buildings, commercial properties, certain factories, or warehouse facilities, responses to large-scale non-fire incidents, or technical rescue operations.

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2 NFPA Standard 1710 - A.5.2.4.2.1 ...Other occupancies and structures in the community that present greater hazards should be addressed by additional fire fighter functions and additional responding personnel on the initial full alarm assignment.

3 NFPA 1710 Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments. Section 5.2.1 – Fire Suppression Capability and Section 5.2.2 Staffing.

4 As defined in the handbook, a fast fire grows exponentially to 1.0 MW in 150 seconds. A medium fire grows exponentially to 1 MW in 300 seconds. A slow fire grows exponentially to 1 MW in 600 seconds. A 1 MW fire can be thought-of as a typical upholstered chair burning at its peak. A large sofa might be 2 to 3 MWs.