THE UNIVERSITY of TENNESSEE

MUNICIPAL TECHNICAL ADVISORY SERVICE

FAIRVIEW, TENNESSEE

Fire Station Location Study

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Table of Contents

List of Tables

List of Figures

Introduction and Scope of Work

MTAS conducted this study at the request of Andrew Hyatt, City Manager for the City of Fairview. The study's purpose is to answer this question:

1. Where should Fairview place its fire stations to provide coverage for the City of Fairview and Fairview's response district based upon the maximum five-mile coverage area allowed by ISO?

A request to MTAS from Mr. Hyatt authorized MTAS to conduct an official fire department study.

Background

The City of Fairview is located in Williamson County in West Tennessee. Williamson County is the fastest growing county in Tennessee, experiencing a 47% increase in population between 2000 and 2010. According to the 2010 US census, the town has a population of 7,720. Fairview is growing, as the 2010 population shows a 33% increase over the 2000 census. Bowie Park, one of the largest city managed parks in the state, is located in Fairview. Fairview has two elementary schools, a middle school, and a high school with a combined enrollment of over 2,800 students. Fairview is a convenient 25 miles from downtown Nashville and offers a "small town flavor" for people who want to work in Nashville, Brentwood, or Franklin but live in an attractive, well-managed residential community with upscale personal, educational, cultural, leisure, and recreational amenities. Though most of the land use is residential, Fairview has sufficient commercial development to provide for the needs of its residents.

Fairview has a Manager-Commission form of government where the five-member elected board enacts legislation and sets policy and the city manager oversees all operational activities. The fire department is organized under Part 7 of the city charter. The city manager appoints the fire chief, who has full operational and administrative control of the fire department.

Recent ISO Evaluation

In March 2005, ISO reaffirmed Fairview's ISO Public Protection Classification of Class 6/9, which is commonly called the ISO rating. The Class 6 rating applies to properties within five-road miles of a fire station and within 1,000 feet of a fire hydrant. The Class 9 rating applies to properties within five-road miles of a fire station but more than 1,000 feet of a fire hydrant. The ISO rating is a representation of the community's fire protection capability and includes communications, the fire department, and the water supply.

While the ISO evaluation includes many items, this study will focus on the credit received for distribution, which reviews the number of fire stations in the community.

Distribution reviews the percent of the built upon area of the city with a first-due engine company within 1½ road miles of a fire station and a service or ladder company within 2½ miles of a fire station. Fairview received 1.73 points out of 4.00 possible points. ISO noted in the improvement statement that, "Additionally, to improve the Credit for Distribution of Companies, 2 additional engine company locations are needed for your district."

Community Fire Protection Decisions

Fire protection is a local policy issue, and a community must balance local resources against acceptable risk. Fairview has chosen to provide fire services as a city function through a municipal fire department established in Part 7 of the City Charter. The Fairview Fire Department is a paid fire department recognized by the State of Tennessee. The fire department operates two engine companies from two fire stations.

There are eight full-time employees consisting of six firefighters working rotating 24-hour shifts plus the fire chief and training officer, who work 8-hour days Monday through Friday. The department is authorized to have twenty-five part-time firefighters, and they currently have fourteen. The department participates in the Tennessee Commission on Fire Fighting certification program, and all firefighters eventually obtain Firefighter-II, Hazmat, and EMT certification.

The Insurance Services Office (ISO) Public Protection Classification for Fairview is ISO Class 6/9. The Class 6 rating applies to areas within five road miles of a fire station and within 1,000 feet of a fire hydrant. The Class 9 rating applies to areas within five road miles of a fire station but more than 1,000 feet from a fire hydrant. The Class 6 rating places Fairview in the top 50% of communities nationwide (see Figure 1) and in Tennessee (see Figure 2) in terms of fire protection.

First Out Apparatus					
Station	**Apparatus ID**	**Type**	**Pump Capacity**	**Maximum Daily Staffing**	**Minimum Daily Staffing**
31	Engine 31	Engine	1,250	2	2
31	Tanker 31	Tanker 2,000 gal	500	0	0
31	Squad 31	Service	N/A	0	0
32	Engine 34	Engine	1,250	0	0
Reserve Apparatus					
32	Engine 33	Engine	1,000	n/a	n/a
Notes:					
Reserve engine not owned by Fairview, on loan from the county.					

Table 1 – Fairview Fire Department Stations and Apparatus

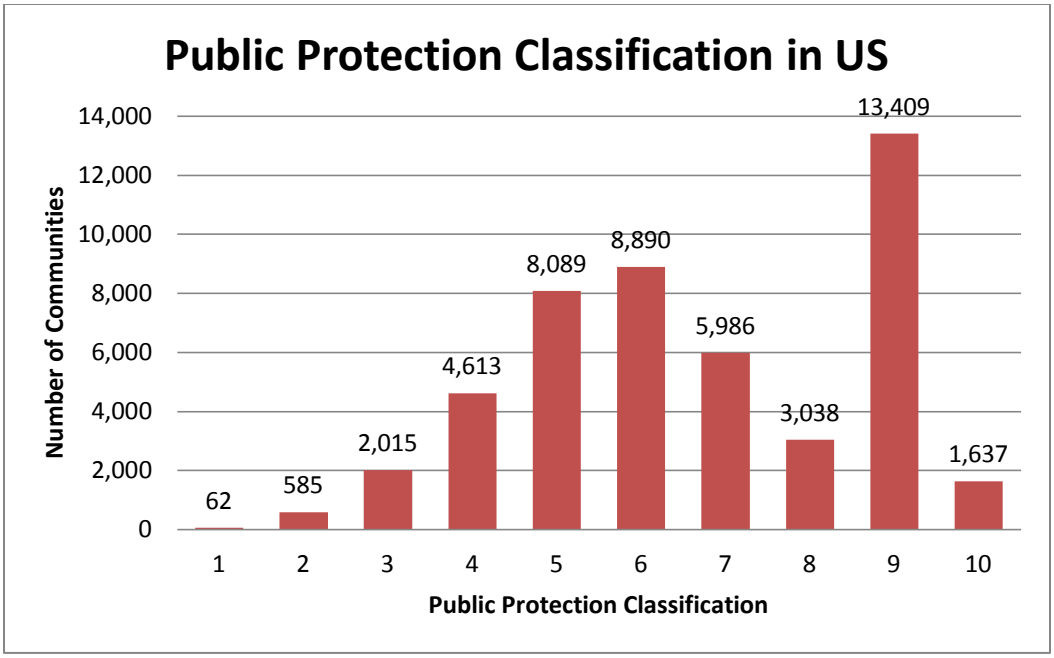

Figure 1 – Public Protection Classification (ISO Rating) in the US

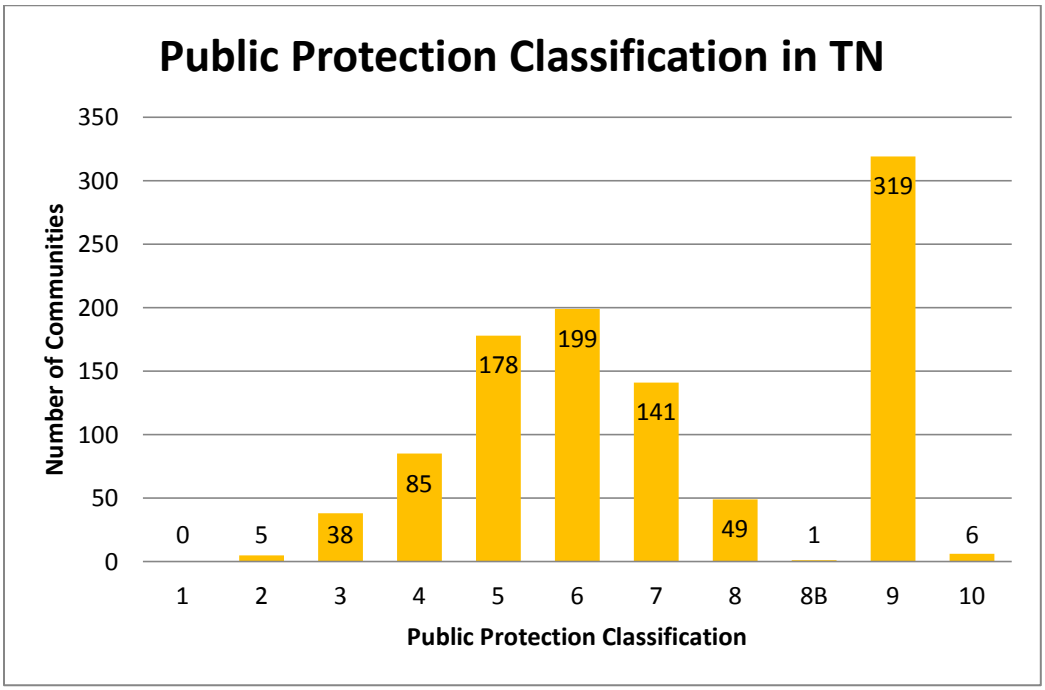

Figure 2 – Public Protection Classification (ISO Rating) in TN

The Fairview Police Department dispatch office receives calls for emergency fire and medical services for locations inside Fairview's corporate limits and dispatches the appropriate emergency resources.

The Water Authority of Dickson County and Harpeth Valley Utilities District provide water for public consumption and fire suppression. Fairview has minimal influence on the two utility systems when it comes to providing water for fire protection and in placing fire hydrants, but the water pressure and the gallons-per-minute fire flows needed for fire suppression operations are mostly adequate to protect the properties at risk within areas protected by adequately spaced fire hydrants.

Community Risk – General Overview

Fairview covers approximately 12.5 square miles and has a population of 7,720 people per the 2010 census estimate. The city's urban growth boundary is large, so additional major growth is likely. Williamson County provides annual funding to Fairview for the fire department to provide fire services to an additional 82 square miles in Williamson County that the fire department refers to as the district. Approximately 30% of the fire department's annual call volume occurs in the district.

Fairview does not have more than five buildings over 35-feet in height or with a needed fire flow greater than 3,500 gallons-per-minute (gpm), so Fairview does not need an aerial ladder truck, but it does need a service company.

Commercial occupancies include mostly retail and business uses distributed throughout the community and several industrial uses. The fifth highest individual property required fire flow determines the basic fire flow required in the community, and for Fairview that is 3,000 gallons-per-minute. ISO does not consider properties protected by automatic sprinkler systems when determining the basic fire flow for a given community. Requiring automatic sprinkler systems for all future commercial properties will improve (reduce) the overall fire risk to the community.

Highway 100 and Highway 96 are the major roads serving Fairview, and Fairview has easy access to Interstate 40 and Interstate 840. There are no major geographic barriers affecting the flow of traffic within the city, but the community does have many rural roads that slow the response speed of fire apparatus and increase response times.

The City of Fairview will continue to grow. Fairview offers an attractive, well-managed residential community with aesthetic design, has sufficient undeveloped land for planned residential and commercial growth, is conveniently located near Nashville, and has easy access to major transportation routes.

Future Needs

The Fairview Fire Department is a modern, well-trained, well-equipped fire department with full-time staffing and good fire dispatching resources. Figure 3 shows the location of current fire stations and their associated 1½ miles-as-measured-over-roads and five-miles coverage areas. In the event of a major fire or large incident, additional engine

companies and resources are available from neighboring fire departments through a mutual aid network.

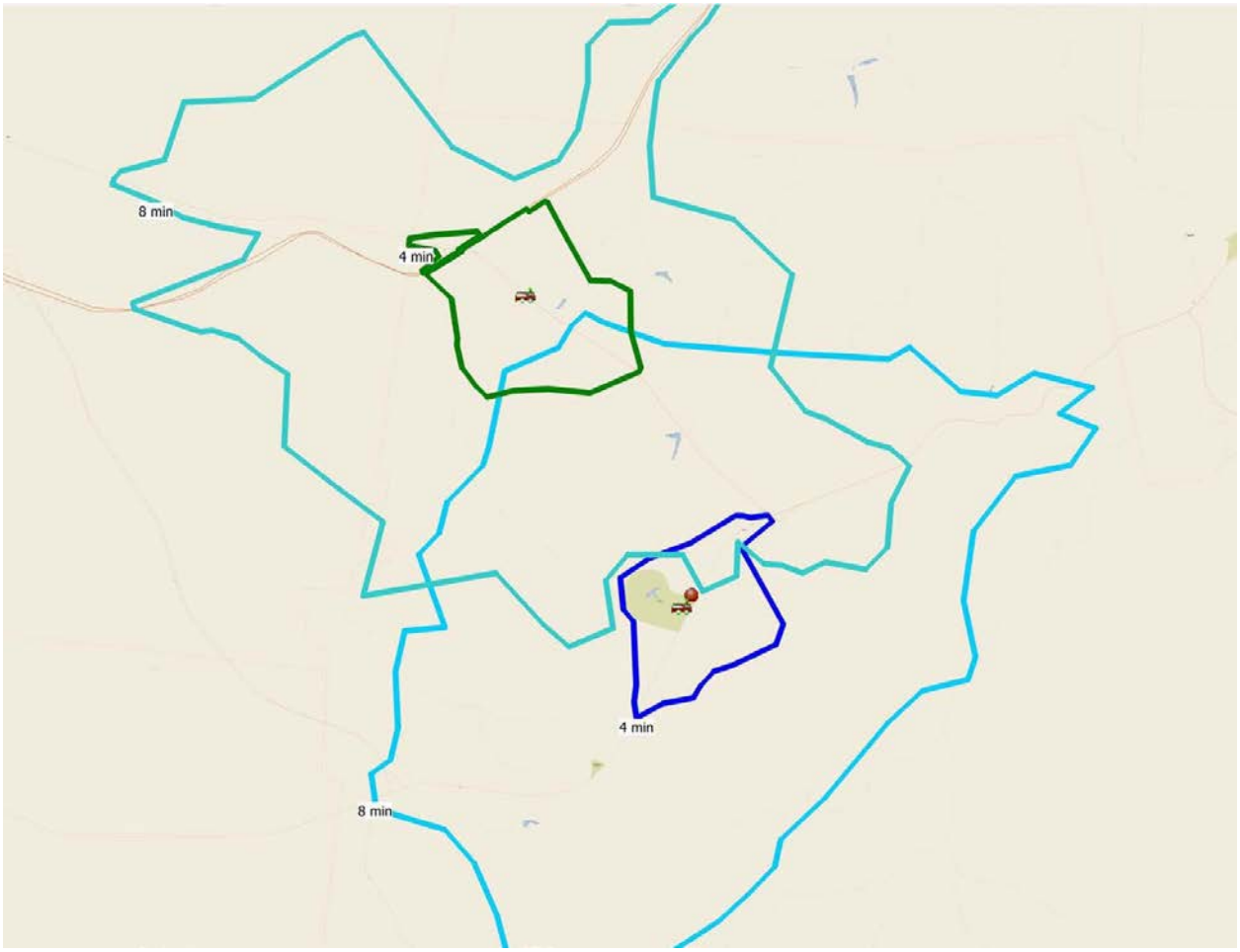

Figure 3 – Existing Fire Stations 1½ Miles and 5 Miles Response Areas

How Many Fire Stations Will Fairview Need?

To answer the long-term question of how many fire stations Fairview may need at build out, one can look at several sources for guidance. This report will make recommendations on the needs of the city and the needs of the district. The first source is the Insurance Services Office (ISO) Fire Suppression Rating Schedule. Section 560 of the schedule covers distribution of companies and states: "The built-upon area of the city should have a first-due engine company within 1½ miles and a ladder-service company within 2½ miles." The Prescriptive Model for Predicting Needed Engine Companies formula can be used to estimate the number of engine companies needed based upon square miles. One caveat: this formula assumes that all resources are evenly distributed throughout the area, which is not the case, and does not account for natural and manmade barriers, but the formula is useful as a reference. Based upon the current approximately 13 square miles corporate service area, a travel distance of 1½ miles (which is a travel time of approximately 3:12 with time expressed as minutes:

seconds), and assuming all engine companies are in their stations, Fairview currently needs 1.75 fire stations. The inference is that Fairview needs at least two stations for adequate coverage within the corporate limits. Based upon the 93 square miles response district, and a travel distance of 1½ miles, and assuming all engine companies are in their stations, Fairview will need 12.5 fire stations. The inference is that Fairview will need at least thirteen stations for adequate coverage throughout the response district.

The ISO standard for distribution is 1½ miles for an engine and 2½ miles for a truck or service company, but ISO will extend a community's fire protection rating as far as five miles from a fire station provided there is adequate water available for fire protection. There is a caveat for basing fire protection on this five-miles distance, and that is the risks associated with extended response times. Travel time, measured as the time from when the fire department resource starts to roll until it arrives on the scene, is just one component of response time. At 1½ miles, the travel time for a fire engine is approximately 3:12. At five miles, the travel time is approximately 9:09. The ***response*** time, which includes ring time, call answering, call processing, fire department turnout, and travel time, is much longer. Thus, a total response time of six or seven minutes for stations based on 1½ miles distribution increases to twelve or thirteen minutes (or longer if call processing and turnout times exceed NFPA recommendations) based on five-mile distribution. Using a station distribution distance of five miles, Fairview will need 4.5 fire stations. The inference is that Fairview will need at least five stations for adequate coverage based on five-miles distribution of stations throughout the response district.

The second resource is the National Fire Protection Association (NFPA). NFPA addresses the number of fire stations needed in an indirect way based on minimum travel times. NFPA Standard 1710 Section 5.2.4.1.1 allows a 240 second (4 minutes) travel time for the first arriving engine company. Using an empirical model called the piece-wise linear travel time function, based upon studies done by the Rand Institute estimating the average response speed of fire apparatus at 35 mph, one can determine that the distance a fire engine can travel in 4 minutes is approximately 1.97 miles. Based upon the current 13 square miles corporate service area, a travel distance of 1.97 miles, and assuming all engine companies are in their stations, Fairview needs 1.01 fire stations. The inference is that Fairview needs at least two stations for adequate coverage. For the 93 square miles district, based upon a travel distance of 1.97 miles and assuming all engine companies are in their stations, Fairview will need 7.25 fire stations. The inference is that Fairview will need at least eight stations for adequate coverage in the district. Again, this formula assumes even distribution and has no allowances for geographic barriers.

The previous two examples were based upon time and distance to be covered. A third resource is the ISO Fire Suppression Rating Schedule's determination of needed engine companies based upon the community's basic (needed) fire flow. Section 510 of the schedule requires one engine company for a basic fire flow of 500 to 1,000 gpm, two engine companies for a basic fire flow of 1,250 to 2,500 gpm, and three engine

companies for a basic fire flow of 3,000 to 3,500 gpm. Basic fire flow is calculated by determining the basic fire flow for all non-sprinklered properties in the community, and then the fifth highest is considered the basic fire flow for the community, however, the maximum fire flow for any community is 3,500 gpm.

Fairview's basic fire flow is 3,000 gpm, so the number of needed engine companies based on Section 510 A (basic fire flow) is three. Since Fairview foresees significant future growth, and since Fairview is already at 3,000 gpm for its needed fire flow, it is probable that significant future commercial development will result in buildings that require higher fire flows. The Fairview Fire Department operates two fire engines with pumps rated to deliver 1,250 gpm, a tanker with a pump rated at 500 gpm, and a reserve pumper with a pump capacity of 1,000 gpm. ISO requires that a fire department be capable of placing the required basic fire flow pump capacity on the scene of every structure fire. The fire department can do this with existing resources. For example, Engine 31, Engine 34, and Tanker 31 respond to a structure fire. The total pump capacity equals 3,000 gpm (Engine 31 and Engine 34 have 1,250 gpm pumps, and Tanker 31 has a 500 gpm pump). This arrangement provides the required pump capacity for the basic fire flow of 3,000 gpm. However, if the tanker is used for water shuttle operations, the pump capacity is reduced by 500 gpm. Fairview should consider specifying 1,500 gpm pumps on future fire engines to allow for this.

It must be noted that the above calculations are based on ideal circumstances and assume that all engine companies are available and in quarters. The equation does not consider call volume, busy engine companies, geographic barriers, rural roads, and the community's desired response time, which means the results are conservative.

Finally, consideration must be given to the phenomenon known as flashover. As a fire grows in size, it gives off heat that heats other objects in the vicinity of the fire. At some point, all of the objects in the fire room reach their ignition temperature and ignite. The entire room bursts into flame, and the temperature rises to a point where no person can survive, including firefighters. This is called flashover. The NFPA Fire Protection Handbook states: "During flashover, however, the temperature rises very sharply to such a level that survival of persons still in the room at that stage becomes unlikely. Thus the time interval between the start of the fire and the occurrence of flashover is a major factor in the time that is available for safe evacuation of the fire area." Table 2 summarizes the significance of flashover. Flashover represents a significant threat to life and property, and it is the fire department's goal to arrive quickly and with sufficient resources for a safe, aggressive interior fire attack to prevent flashover from occurring.

Before Flashover	After Flashover
Fire size limited, probably to one room	Fire spreads beyond area/room of origin
Smaller attack lines are sufficient	Requires more and/or larger attack lines
Search and rescue is easier	Search and rescue difficult or impossible
Initial (first) alarm companies sufficient	Requires multiple alarms, more resources
Occupants can self-evacuate	Occupants have no chance to evacuate
Minor to moderate property loss	Major to total property loss

Table 2 – The Significance of Flashover

The development of fire conditions to reach the point of flashover is a function of temperature rise over time. Therefore, a sufficient number of fire stations strategically located to provide quick response times can reduce the incidence of flashover, thus saving lives and property. As shown in the graph in Figure 4, flashover can occur as early as 4 minutes of the start of a fire (the point of unrestricted fire growth), so locating fire stations to provide a total response time of 6 to 7 minutes is advantageous as firefighters need time after arrival to set up, lay fire hose, and gain access to the seat of the fire before they can actually begin to extinguish the fire.

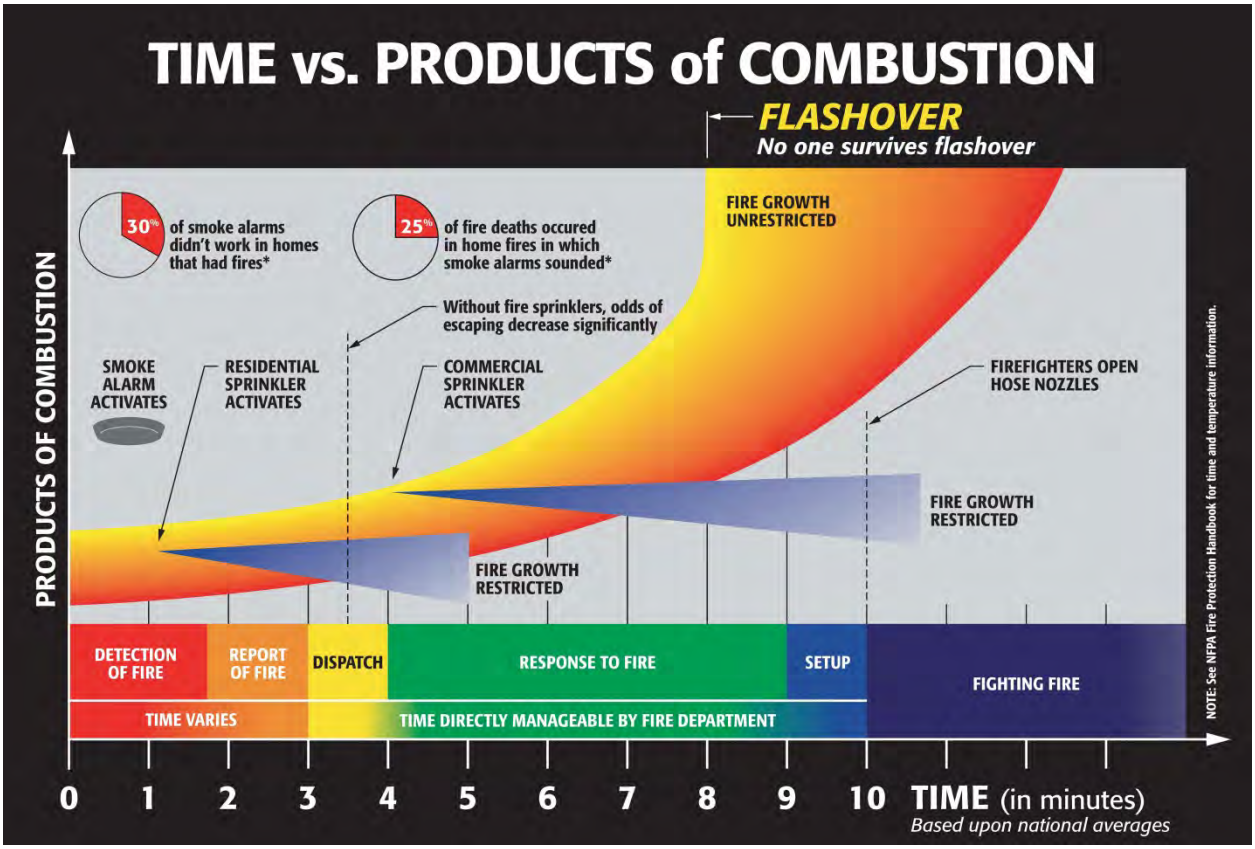

Figure 4 – Time versus Products of Combustion and Flashover

For optimal distribution, fire stations should be approximately three miles apart. Every community is different, and a high concentration of risks, such as a densely populated area, significant commercial development, mixed use development, a high call volume, the response time of backup and additional resources, the location and response times of part-time firefighters, etc., must be considered as well in determining the best location for fire stations.

Providing Coverage for Fairview and the Response District

The purpose of this report is to provide a recommendation for providing fire services for both the City of Fairview and the response district based upon the maximum five-miles coverage area allowed by ISO. From this perspective, Fairview's main fire station at 7131 Bowie Lake Road is not located to provide optimal response. The station is located in Bowie Park, which covers approximately one square mile, so any response to the north and northwest is blocked by the park, which increases response times. As noted above, based on a five-miles distribution of stations, Fairview will need 4.5 stations to provide adequate coverage. Since the response district is sparsely populated, and since some areas are more populated than other areas, four strategically located stations can provide adequate coverage provided both existing fire stations are relocated.

It is important to locate stations to maintain the five-miles distribution to avoid excessive travel distance. ISO looks at an engine company as being needed because the protection class or split protection class that is developed for the graded area will be applicable to all areas within five road miles of all engine company fire stations.

The following maps show the area that is covered by the proposed locations of the new fire stations. Each individual station map will show both the 1½ and five-miles response areas. One map will show the 1½ miles response area for all four proposed fire stations, and the sixth map will show the five-miles response area for all four proposed stations. The software program used to create these maps was not capable of providing street details at this scale, but Bowie Park and the intersection of Highway 96 and Highway 100 are visible and serve as landmarks for orientation.

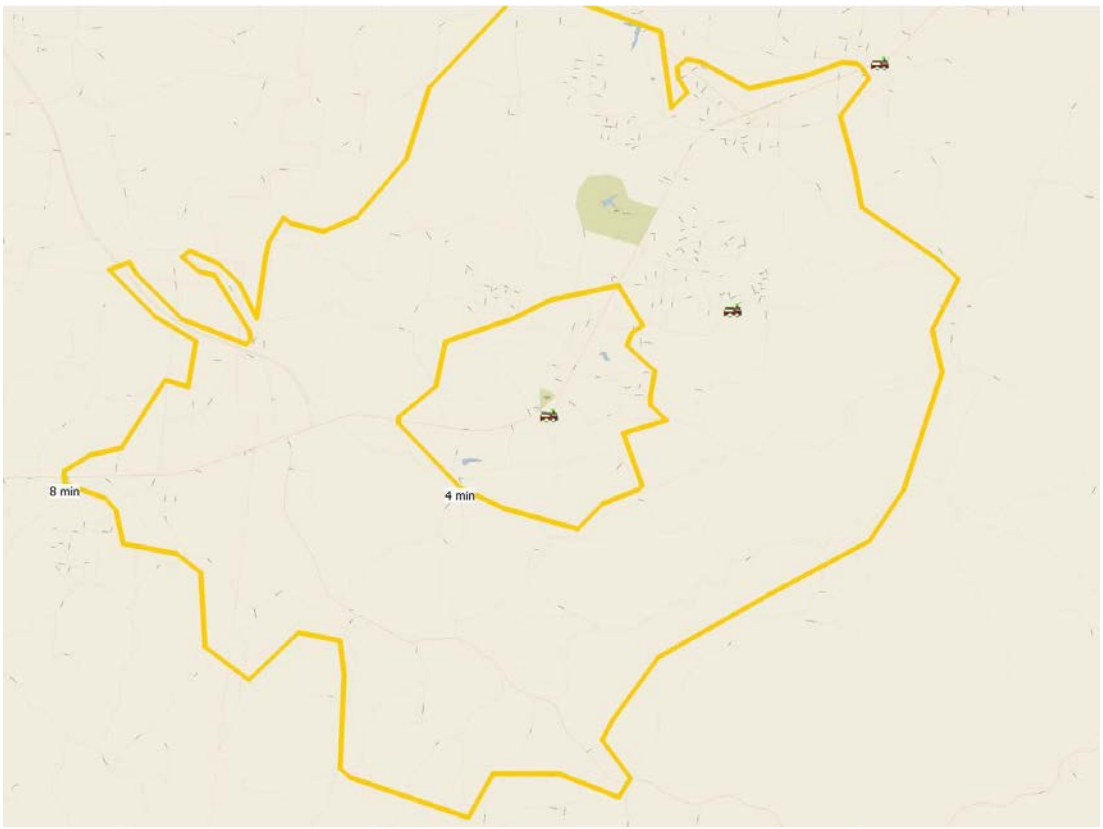

Figure 5 – 1½ Miles & 5 Miles Response Zone for Proposed Station 1

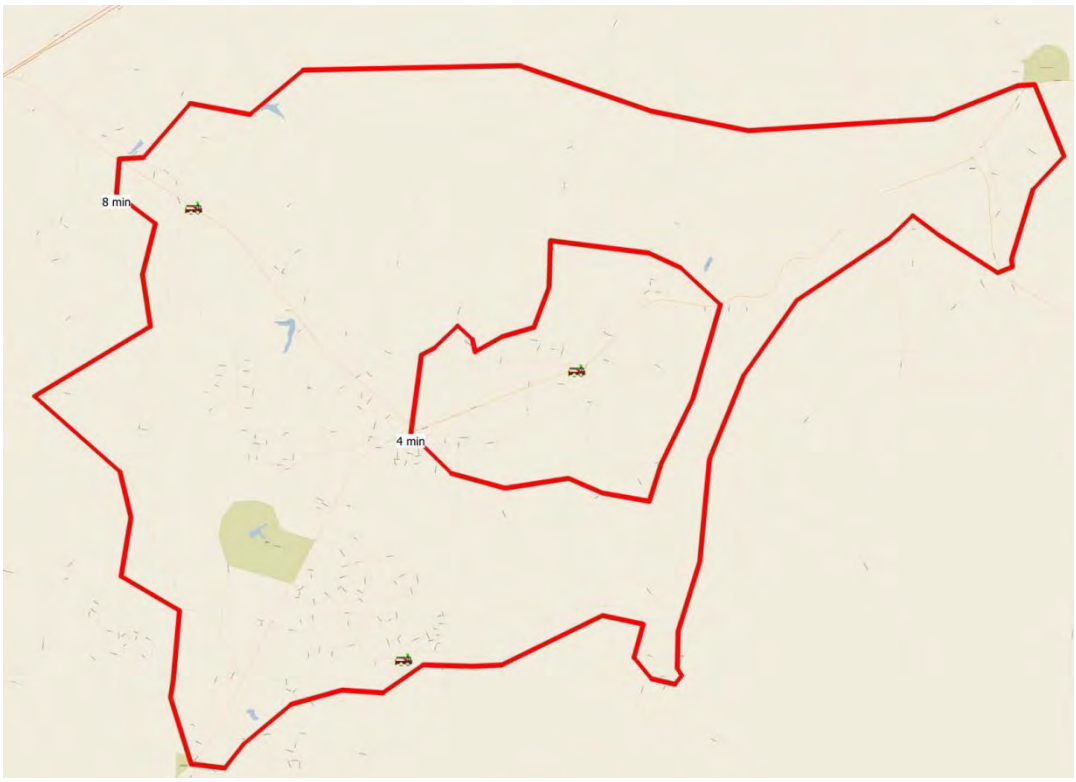

Figure 6 – 1½ Miles & 5 Miles Response Zone for Proposed Station 2

Figure 7 – 1½ Miles & 5 Miles Response Zone for Proposed Station 3

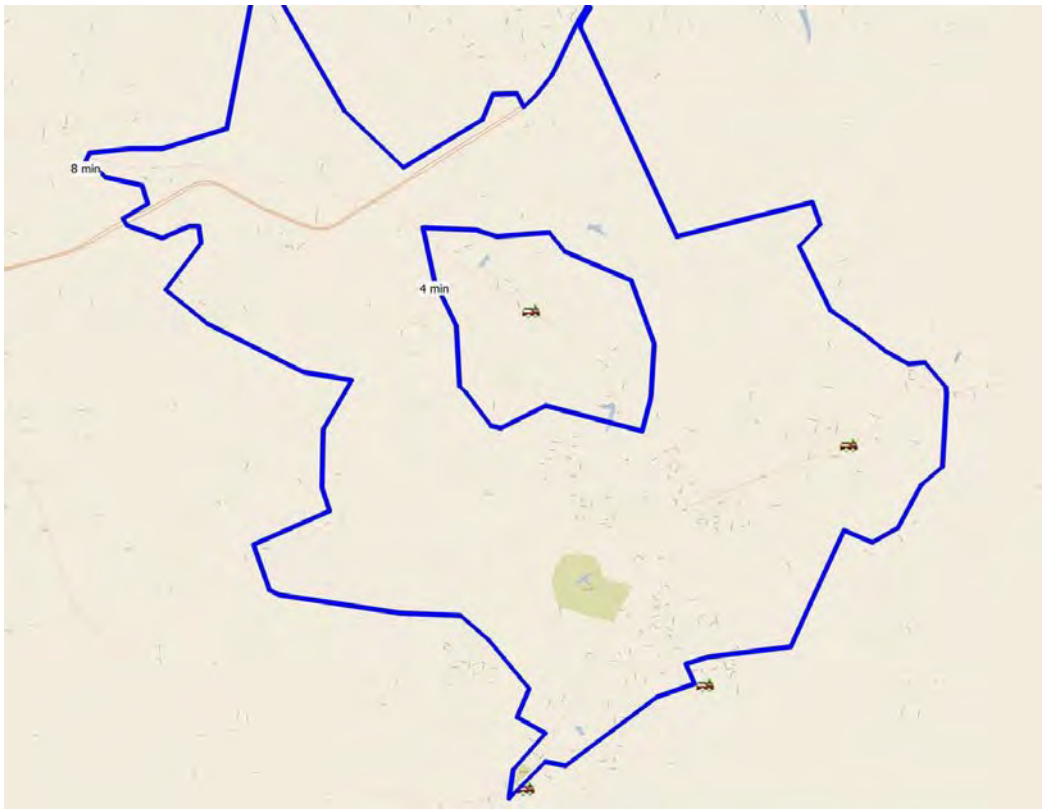

Figure 8 – 1½ Miles & 5 Miles Response Zone for Proposed Station 4

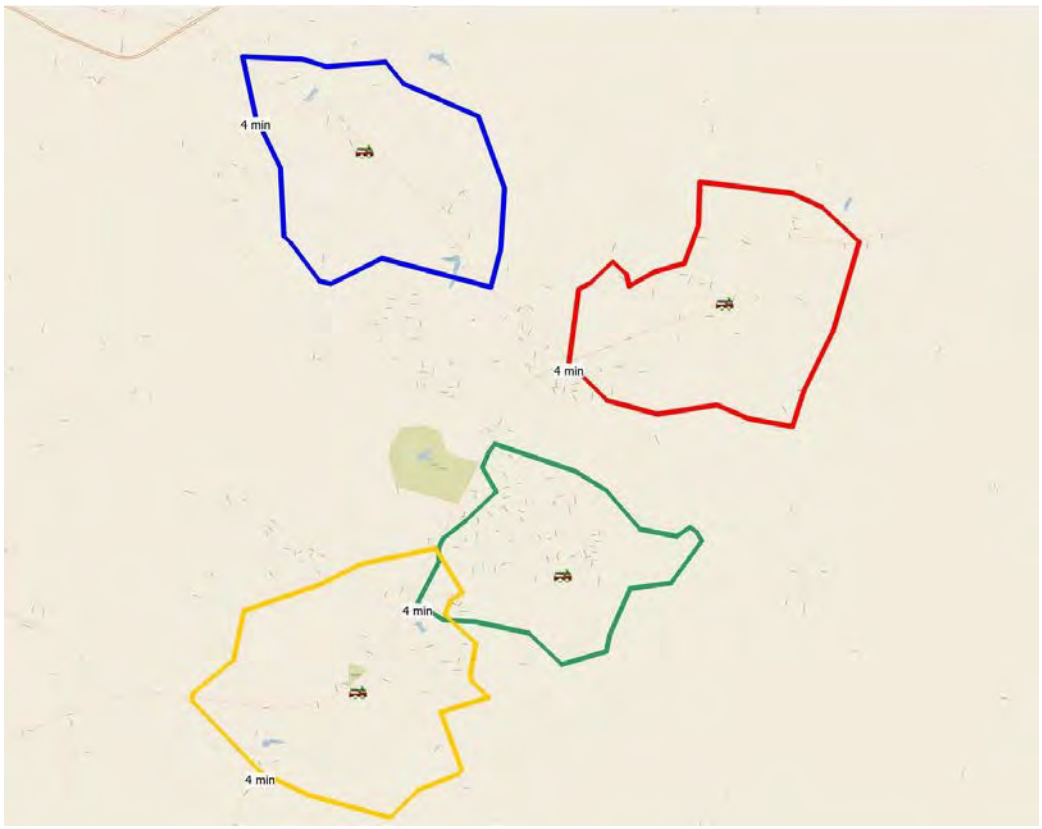

Figure 9 – 1½ Miles Response Zones for All Four Proposed Stations

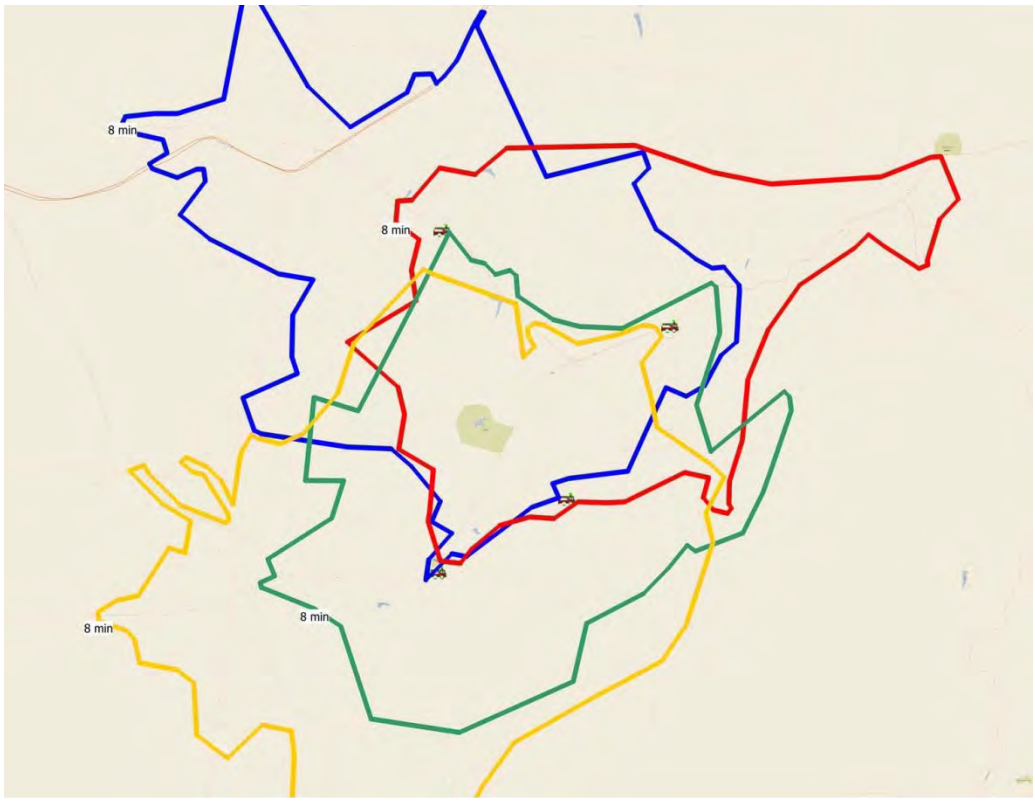

Figure 10 – 5 Miles Response Zone for All Four Proposed Stations

Though the map in Figure 10 lacks road details, it is still obvious that four stations strategically located based upon the maximum five-miles coverage area allowed by ISO will provide adequate coverage within the City of Fairview and the response district.

However, this configuration is not ideal. As Fairview grows and the economy improves, the city may wish to improve its ISO rating. As evident in Figure 9, the gap in coverage in the center of Fairview will prevent the city from improving its ISO rating. At some point in the future, the city may consider placing an engine company back in service at the existing Bowie Road fire station to close that gap, to build an additional fire station to serve the gap area, or some other option to provide the distribution required by ISO. Long travel times increase the morbidity and mortality risk for medical emergencies and for serious injury, increase property loss, and increase the risk of injury or death from fire, so fire stations should be located to provide a network of stations from which the fire department delivers emergency services with minimum travel time.

Plan Implementation

Two stations currently serve Fairview and the district. These stations must remain in service while construction of the proposed stations is underway, and then closed as part of the plan. The main fire station is located on Bowie Lake Road because it was the only land available when the city sold the old fire station site to Publix. Moving the Highway 96 station further south will improve coverage and response times.

Fairview should build the first new station near Deer Ridge Road and Highway 100. This station will provide coverage to the commercial properties, schools, and residential areas on the east side. The location has good access to Highway 100 for quick response to the east. Constructing this station begins the process to allow the Bowie Lake Road station to be closed (see Figure 5 for the coverage map).

The second station should be built near Taylor Road and Highway 100. This station will provide coverage to the west portion of Fairview and have good access to Highway 100 for quick response to the east. Constructing this station completes the process to allow the Bowie Lake station to be closed (see Figure 6 for the coverage map), as the proposed Stations 1 and 2 can cover the center of Fairview under a five-miles response district for each station. As shown in Figure 11, the center point between these two stations, represented by an “X” on the map, is 2.5 miles from each proposed fire station, which equals an estimated travel time of 4:54. When these two stations are operational, Fairview could choose to close the Bowie Lake Road station.

Cumberland Drive near Chester Road is the best location for the third station. This location provides coverage to the south and helps “close the gap” created by closing the Bowie Lake Road station. Travel times to Highway 100 via Chester Road (travel time of 3:22) and Cumberland Drive (travel time of 3:12) provide quick access to the east and west respectively to back up Stations 1 and 2.

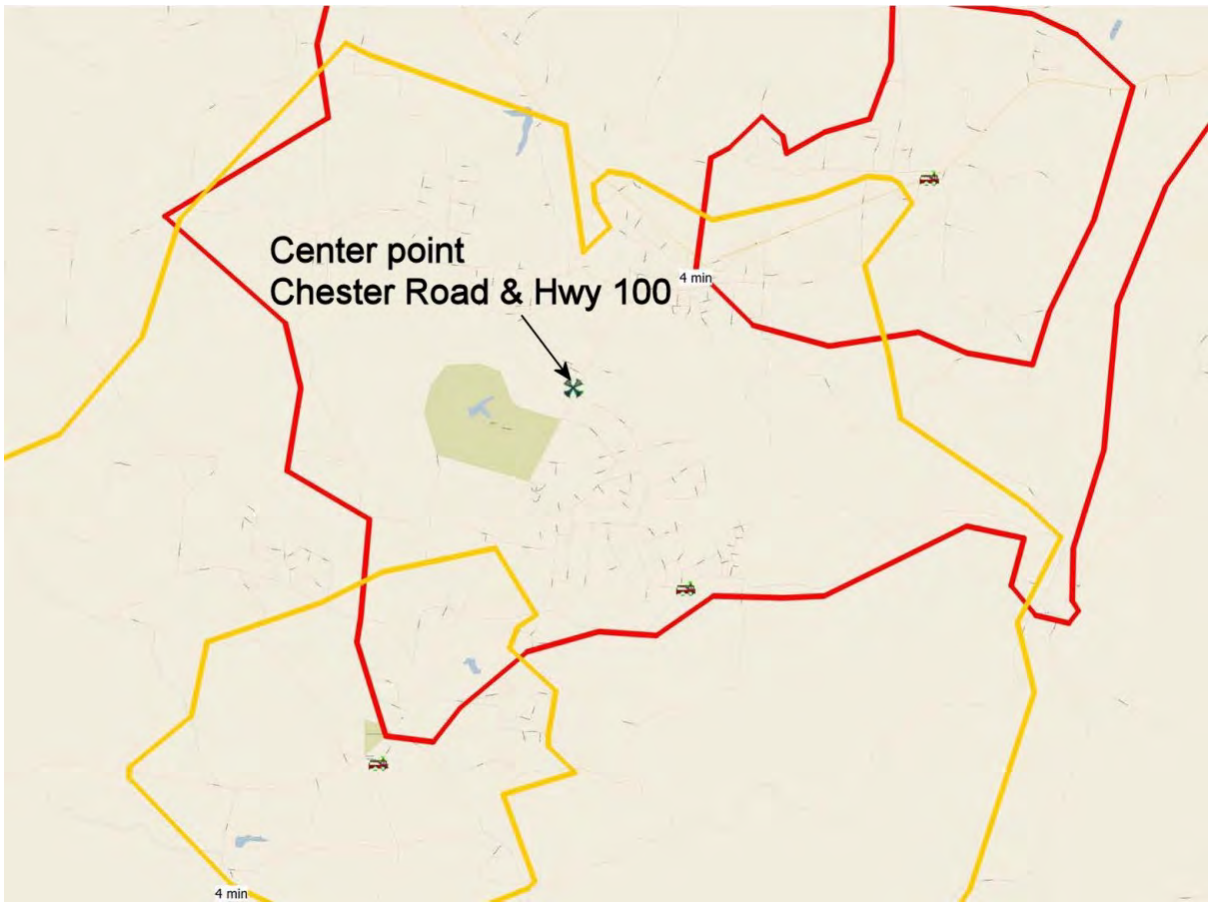

Figure 11 – 5 Miles Response Zone for Proposed Stations 1 and 2

Relocating the Highway 96 station approximately one mile to the south will improve coverage in Fairview and improve response times to the south. A location on Highway 96 between Northwest Highway and the southern terminus of New Hope Road will provide good access to Highway 96 and to the west and southwest. Since Station 32 provides coverage for this area and will remain operational during the implementation of the plan, this should be the last new station constructed.

As Fairview is at risk for tornados (the largest tornado in the Fairview Area was an F5 in 1998 that caused 36 injuries and 3 deaths), consider including a safe room in all of the new fire stations.

Recommendations

The most efficient and cost effective way for the Town of Fairview to locate fire stations to provide an all-hazards service delivery program that addresses community risks and needs is in the following recommendations.

1. Budget for and adopt the plan to relocate Stations 31 and 32 and to construct two additional fire stations based upon five-mile response districts. A fire station is an essential facility and should be designed to be self-sufficient for major emergencies (power outages, ice storms, etc.) and immediately occupiable following an earthquake of a magnitude possible for the community, which is an M5.5 for Williamson County. As Fairview is at risk for tornados (the largest tornado in the Fairview Area was an F5 in 1998 that caused 36 injuries and 3 deaths), consider including a safe room in all of the new fire stations. A fire station is a complex building, and Fairview should use professional architects, engineers, and builders who are familiar with the special needs for fire stations.
2. Adopt a response time standard for the community. Fairview is a perpetual organization that will outlast current leaders, and this study looks towards build out, which is many years in the future. Once adopted, the response time standard will serve as a planning guide for future leaders. This study recommends a response time standard of 6:35 (six minutes, 35 seconds) for 90% of all responses, which is based upon recommendations found in NFPA Standard 1710, Standard for the Organization and Deployment of Fire Suppression Operations. The 6:35 breaks down as follows: ring time – 15 seconds, call processing time – 60 seconds, firefighter turnout time – 80 seconds, travel time – 240 seconds. Using this standard, planners should look for fire station locations to maintain a 4 minute travel time to at least 85% or more of the area to be protected.
3. Fairview has a commercial sprinkler ordinance requiring sprinklers in buildings over 5,000 square feet. Fairview should continue to require sprinklers for all new commercial construction. When determining the basic fire flow for a community, ISO does not consider properties protected by a code complaint automatic sprinkler system. In a sprinklered building, the amount of time between the occurrence of a fire and reopening for business can be as little as a few hours versus months, years or even never rebuilding for a non-sprinklered building.
4. Research and consider adopting a residential sprinkler ordinance to require residential sprinklers in all new residential construction. Tennessee's fire mortality rate for civilians has been among the highest in the nation. During 2002-2010, the time period for the Tennessee Fire Mortality Study, the national fire mortality rate declined, but the rate in Tennessee increased. Residential structure fires account for about three-fourths of all civilian fire deaths in the state. Residential sprinklers save money and lives and are a good investment in a home, but they are controversial in many communities which is why this study recommends research on residential sprinklers before considering adopting an ordinance. Adopting an ordinance would be proactive for community safety.

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