THE UNIVERSITY of TENNESSEE

MUNICIPAL TECHNICAL ADVISORY SERVICE

LAKELAND, TENNESSEE

Fire Station Location Study

September 2011

Dennis Wolf, Fire Management Consultant
The University of Tennessee, Institute for Public Service
Municipal Technical Advisory Service

Table of Contents

List of Tables

List of Figures

Introduction and Scope of Work

This study was conducted at the request of Mr. Robert Wherry, City Manager for the City of Lakeland. The study's purpose is to answer two questions:

1. Where should Lakeland place its next fire station?
2. How many fire stations might Lakeland need in the long term?

A verbal request to MTAS from City Manager Robert Wherry authorized MTAS to conduct an official fire department study.

Background

The City of Lakeland is located in Shelby County in Southwest Tennessee adjacent to the cities of Memphis, Bartlett, and Arlington. Lakeland is governed by a City Manager-Commission form of government where the five-member Board of Commissioners sets policy and evaluates the management of the city and the City Manager, who is appointed by the Board of Commissioners, oversees all operational activities. Lakeland has no property tax and funds operations from the local sales tax, the state per capita rebate tax on gasoline, from a business tax on wholesale, retail, and home businesses, and from fees. Lakeland residents pay a monthly fee on their utility bills for fire services.

Fire protection and staffing is a local policy issue, and a community must balance local resources against acceptable risk. The City of Lakeland has chosen to contract for fire services with the Shelby County Fire Department. The Shelby County Fire Department is a career county fire department recognized by the State of Tennessee. The department is supported by the Shelby County Government and funded through fire service fees collected monthly on the utility bill. The fire department operates 9 engine companies from 8 fire stations, located throughout 300 mostly unincorporated square miles in Shelby County, Tennessee. All Shelby County Fire Department engines have a minimum staffing level of four personnel: a lieutenant, a driver, and two fire fighters. Since the Shelby County Fire Department provides fire services to Lakeland, the Insurance Services Office (ISO) classification of the Shelby County Fire Department applies to the City of Lakeland. That protection classification is ISO Class 5.

Shelby County Fire Department Stations		
District	**Equipment**	**Address**
61	Engine 61 / Brush Truck / Reserve Pumper / Rural-Metro Unit 41	11611 Macon Rd. Eads, TN
62	Ladder 62 (107' Quint) / Reserve Pumper / Batt 21 / Squad 2	4647 Forest Hill Irene Rd. Memphis, TN

63	Engine 63 (co-housed with Memphis Engine 55)	4602 Riverdale Rd. Memphis, TN
64	Ladder 64 (75' Quint) / Decon / Batt. 22 / Squad 1 / Rural/Metro Unit 46	5469 Raleigh Millington Rd. Millington, TN
65	Ladder 65 (75' Quint) / Rescue 66 / Hazmat / Brush Truck / Hydratrek / Rural/Metro Unit 35	9774 Beverle Rivera Rd. Lakeland, TN
67	Engine 67 / Rural/Metro Unit 37	895 North Circle Road Memphis, TN
68	Engine 68 / Reserve Pumper	2348 Garnett Rd. Millington, TN
69	Engine 69 / Rural/Metro Unit 49	7365 Brunswick Rd. Arlington, TN

Table 1 - Shelby County Fire Department Stations and Apparatus

One of the fire stations the Shelby County Fire Department staffs is located at 9774 Beverle Rivera Road in Lakeland and is known as Station 65. The City of Lakeland built and owns the station and the Shelby County Fire Department staffs the station through an interlocal agreement with Lakeland. Because of this contract arrangement for fire services, Lakeland residents and business owners enjoy an Insurance Services Office (ISO) Public Protection Classification of 5, which places Lakeland in the top 23% of communities nationwide (see Figure 1) in terms of fire protection and indicates that Lakeland has made good decisions in planning for community fire protection.

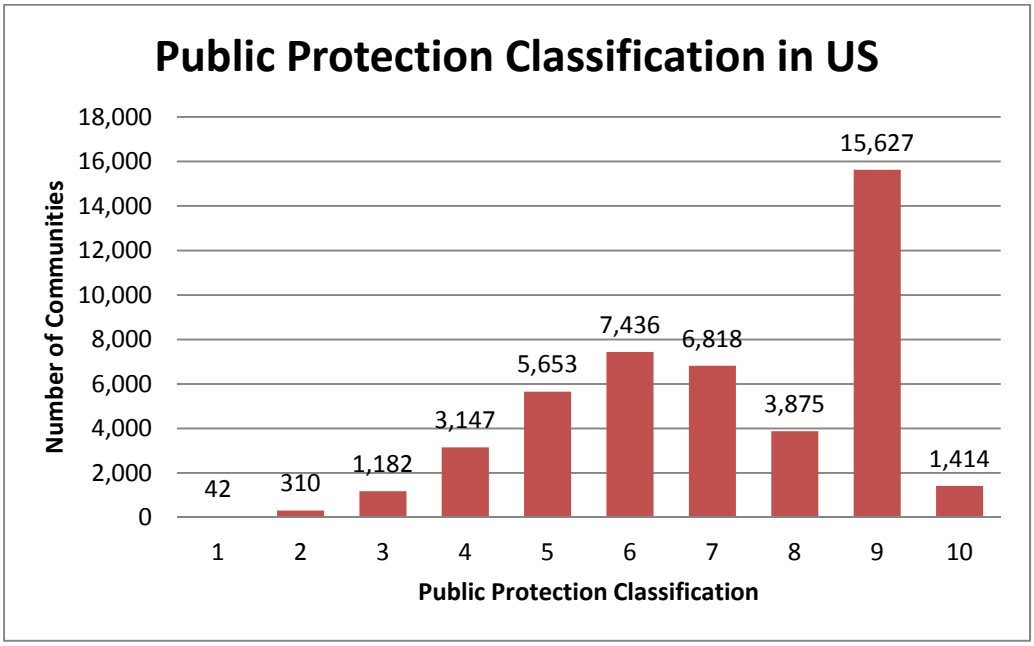

Figure 1 – Public Protection Classification (ISO Rating) in the US

The Shelby County Fire Department dispatch office receives calls for emergency fire and medical services for locations inside Lakeland's corporate limits and dispatches the appropriate emergency resources.

Water for public consumption and fire suppression is provided by Memphis Light, Gas and Water Division. The water pressure and the gallons-per-minute fire flows needed for fire suppression operations are adequate to protect the properties at risk.

Community Risk – General Overview

Lakeland covers 24 square miles and has a population of 12,500. The city's urban growth boundary is very small, so additional major growth is unlikely. Shelby County Engine 65 is stationed inside Lakeland's corporate limits and is the first due engine company for most of Lakeland. The Shelby County Fire Department provides additional engine companies for large fires and mutual aid agreements with Arlington, Bartlett, and other cities in Shelby County providing other resources commensurate to the emergency.

Approximately 16% of the land in Lakeland is zoned residential, with the majority remaining land area zoned as agricultural (see Table 2 and Figure 2). The zoning classification map is shown in Figure 5.

Zoning Classification	Count	Acres	Percent	Sq. Miles
AG: Agriculture	50	11,156.78	77.78%	17.43
C-1: Neighborhood Business	5	30.74	0.21%	0.05
C-2: General Business	19	566.19	3.95%	0.88
E-R: Estate Residential	9	379.80	2.65%	0.59
I-L: Light Industrial	2	297.13	2.07%	0.46
M-R: Multiple Family Dwelling	6	129.79	0.90%	0.20
R-1 (PRD): Planned Low Density Residential	11	336.91	2.35%	0.53
R-1: Low Density Residential	20	735.73	5.13%	1.15
R-2 (PRD): Planned Medium Density Residential	2	138.69	0.97%	0.22
R-2: Medium Density Residential	41	522.71	3.64%	0.82
R-2A: Alternate Medium Density Residential	6	49.78	0.35%	0.08
Totals	171	14,344.24	100.00%	22.41

Table 2 – Zoning Classifications

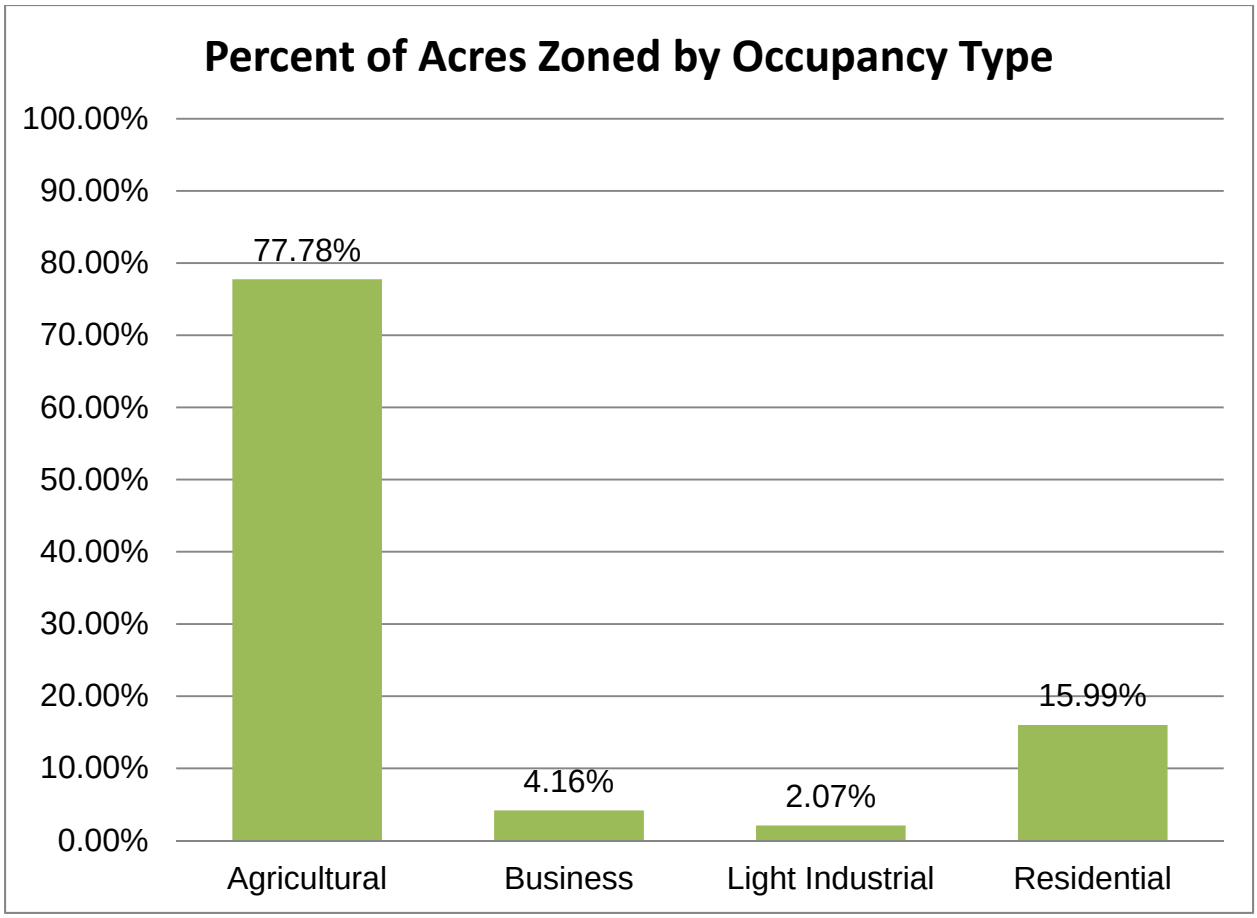

Figure 2 – Percent of Acres Zoned by Occupancy Type

There is no direct road access to the northern most portion of Lakeland, which is about 3.5 square miles. The Loosahatchie River and the CSX Railroad present physical challenges to providing major roadway access. One must use Paul Barrett Parkway to the east or Brunswick Road to the west to cross these barriers to reach the northern portion of the city.

Commercial occupancies include mostly retail and business uses that are distributed along US Highway 64 and concentrated near the intersection of Interstate 40 and Canada Road. At 55,000 square feet, the Kroger grocery store located at 9050 US Highway 64 is one of the largest commercial occupancies in Lakeland, and it has a needed fire flow of 3,500 gallons per minute. Another large commercial occupancy is the motel located at 9822 Huff 'n Puff Road with 28,950 square feet. A community's needed fire flow is determined by the fifth highest fire flow required in the community, and for Lakeland that is 2,000 gallons-per-minute (see Table 3). Properties protected by automatic sprinkler systems, such as the Belz Factory Outlet Mall, are not considered when determining the needed fire flow for a given community.

The City of Lakeland will continue to grow because of its close proximity to the City of Memphis. Lakeland offers an attractive residential community with aesthetic design, has sufficient undeveloped land (approximately 17 square miles) for planned residential

and commercial growth, and is located next to the major transportation routes of I-40, US Highway 70, and US Highway 64 making commuting convenient for those who want to work in Memphis but live in a small, well managed community.

Future Needs

Lakeland is using the most cost effective method available to provide fire protection services. The community is protected by the Shelby County Fire Department, a modern, well trained, well equipped and staffed fire department with excellent fire dispatching resources. In the event of a major fire or large incident, additional engine companies and resources are available from the Shelby County Fire Department and from neighboring fire departments through mutual aid. This arrangement is beneficial to both Lakeland and Shelby County as Engine 65 serves areas in unincorporated Shelby County outside of Lakeland, and the fire department benefits from having a modern fire station to use with no capital investment. Barring any significant changes to the present circumstances, this arrangement should be beneficial for at least the next 5 years, and possibly longer.

Lakeland expects to see commercial development of available land along the major roads of US Highway 64, US Highway 70, and Paul Barrett Parkway (which will become part of the Interstate 269 corridor at some point in the future).

When completed, the Interstate 69 (I-69) corridor will provide a continuous highway link designed to Interstate highway standards from the Mexican border to the Canadian border, and I-269 will circle the outside portion of Shelby County. Approximately 1½ miles of the future I-269 exists now in Lakeland as Paul Barrett Parkway, and two exits serve Lakeland. The western exit is Brunswick Road, and the eastern exit is Stewart Road. There is a significant amount of undeveloped land along both sides of the 1½ mile stretch of the future I-269, and this presents an opportunity for commercial growth and development starting 5 to 10 years out. This area is the northern most portion of the city, which lacks direct road access from the south. Shelby County Fire Department Station 69 serves this area now, but to help attract commercial and corporate development, Lakeland will need to offer the service of good fire protection. For this reason, the city should begin planning for and build a fire station in this area before significant growth occurs. A station centrally located north of the CSX Railroad could serve the entire north portion of the city as a first due engine. One fire station would not provide 100% coverage of the area (as defined as being within 1½ miles of the fire station), but the response time for the entire area would be adequate and cost effective.

How Many Fire Stations Will Lakeland Need

To answer the long-term question of how many fire stations Lakeland may need at build out, one can look at several sources for guidance. The first 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. Two caveats: this formula assumes that all resources are evenly distributed throughout the area, which is generally not the case, and the formula does not allow for geographical barriers, such as the river and the railroad, but the formula is useful as a reference. Based upon a 24 square mile service area, a travel distance of 1½ miles, and assuming all engine companies are in their stations, Lakeland will need 3.23 fire stations. The inference is that Lakeland will need at least three stations for adequate coverage.

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 response 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 is 35 mph, one can determine that the distance a fire engine can travel in 4 minutes is approximately 1.97 miles. Based upon a 24 square mile service area, a travel distance of 1.97 miles, and assuming all engine companies are in their stations, Lakeland will need 1.87 fire stations. The inference is that Lakeland will need at least two stations for adequate coverage.

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 determined by determining the needed fire flow for all non-sprinklered properties in the community, and then the fifth highest is considered the basic fire flow for the community. Table 3 shows the five highest needed fire flows in Lakeland.

Occupancy	**Needed Fire Flow in gpm**
Kroger	3,500
Renaissance/Encino Companies	3,000
Club Windward	2,500
Cracker Barrel	2,500
Saint Paul United Methodist Church	2,000

Table 3 – Five Highest Needed Fire Flows

In Lakeland, the fifth highest fire flow is 2,000 gpm, so the number of needed engine companies based on Section 510 is two. Since Lakeland foresees significant future growth, and since the second highest needed fire flow is 3,000 gpm, it is probable that

significant future commercial and corporate development will result in buildings that require higher fire flows and that the needed fire flow for the community will increase accordingly, so Lakeland should plan long term growth with the need for at least three fire stations.

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 flames, and the temperature rises to a point where no person can survive, including fire fighters. 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." 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 3, flashover can occur within 9 to 11 minutes of the start of a fire, so locating fire stations to provide a total response time of 6 to 7 minutes is advantageous as fire fighters need time after arrival to setup, lay fire hose, and gain access to the seat of the fire before they can actually begin to extinguish the fire.

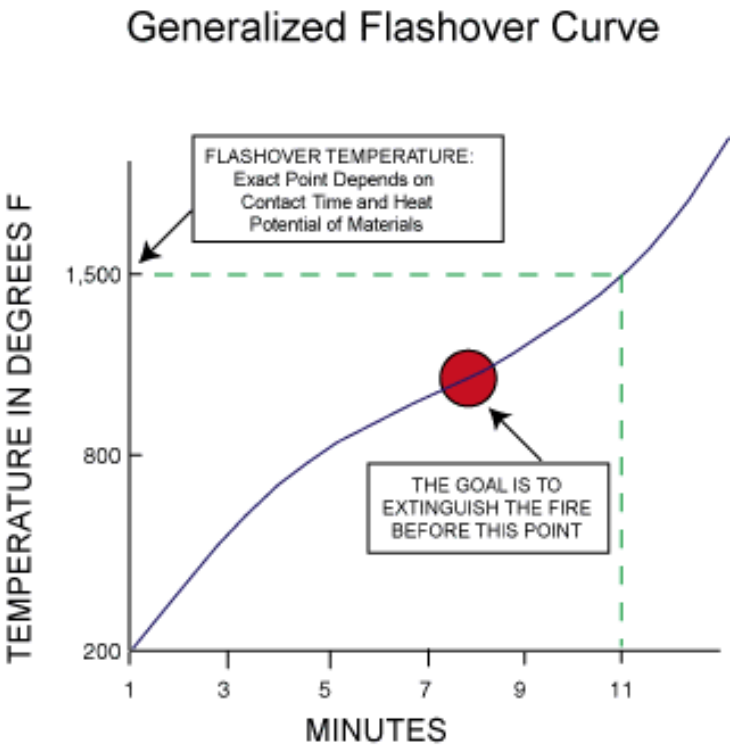

Figure 3 – Generalized Flashover Curve

Based upon the above models, and giving consideration to potential future growth and geographical boundaries, Lakeland should plan for a total of at least three fire stations at build out, and possibly a fourth fire station depending upon the type and amount of development that occurs along Highway 64 near Lakeland's eastern city limits. The existing station on Beverle Rivera is in a good location. The proposed site on Highway 70 is a good location (see Figure 5). A third station will be needed to serve the north portion of the city. This station should be centrally located north of the geographical boundaries of the Loosahatchie River and CSX Railroad. A fourth station may be needed to serve the southeast portion of Lakeland. It is 1.6 miles from the station on Beverle Rivera to Highway 64 and Canada Road, which is at the limit of an effective first due response. There is currently no direct way to access the area south of Monroe between Cobb Road and Chambers Chapel Road, but the area is not developed and is sparely populated. A fourth station may be needed to serve this area, but that will depend upon many factors including the development of the road network, the type of development (single family residential, multi-family residential, commercial, etc.), the density of development, the amount of built-in fire protection (i.e. sprinklers) provided, and the level of service desired by the area residents and business owners.

Figure 4 shows the current coverage area for Station 65 and the coverage area for the proposed second fire station, which should be located along Highway 70 near city hall. The shaded areas represent two travel time levels. The darker shaded area represents a travel time of 3 minutes, which is slightly less than what would be achieved by using the ISO recommendation of a travel distance of 1½ miles over roads. The formula $T = 1.7(D) + 0.65$ (where D equals travel distance) is used most often to estimate travel time for a specific distance. For this study, D = 1.5 miles, which is the maximum travel distance recommended by ISO for a first due engine company. Thus, $T = 1.7(1.5) + 0.65$, results in T = 3.2 minutes (192 seconds). The GIS tool used for this study would not accept decimals, so the whole number 3 was used (180 seconds) to draw the coverage maps. The actual coverage area will be slightly larger than what is shown on the map. The lighter shaded area represents a travel time of 4 minutes, which is what NFPA recommends as the maximum travel time for 90% of responses. For reference, the map also shows the 3 and 4 minute travel time coverage areas for Arlington Station 71, Bartlett Station 103, and Shelby County Fire Department Station 69. Arlington and Bartlett provide mutual aid response when needed. Figure 5 is a more detailed look at the 3 and 4 minute travel time coverage areas for the proposed location on Highway 70.

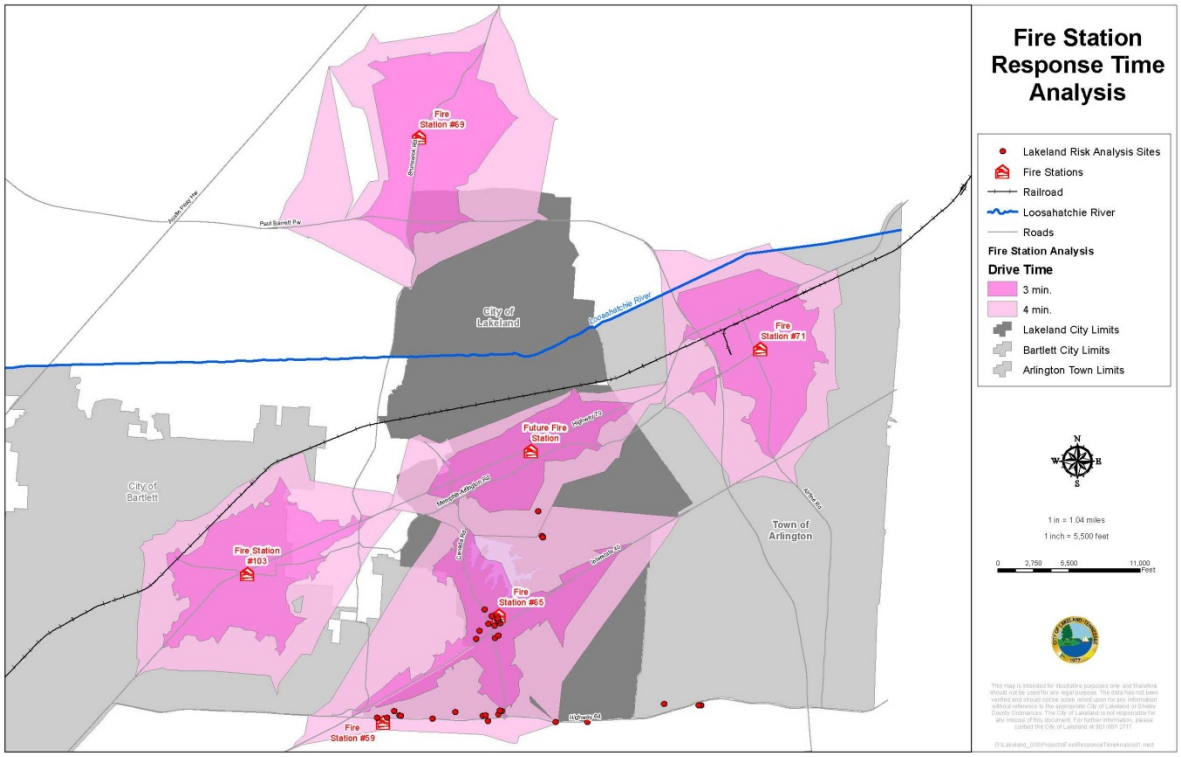

Figure 4 – Fire Station Travel Time Analysis – 3 and 4 Minutes

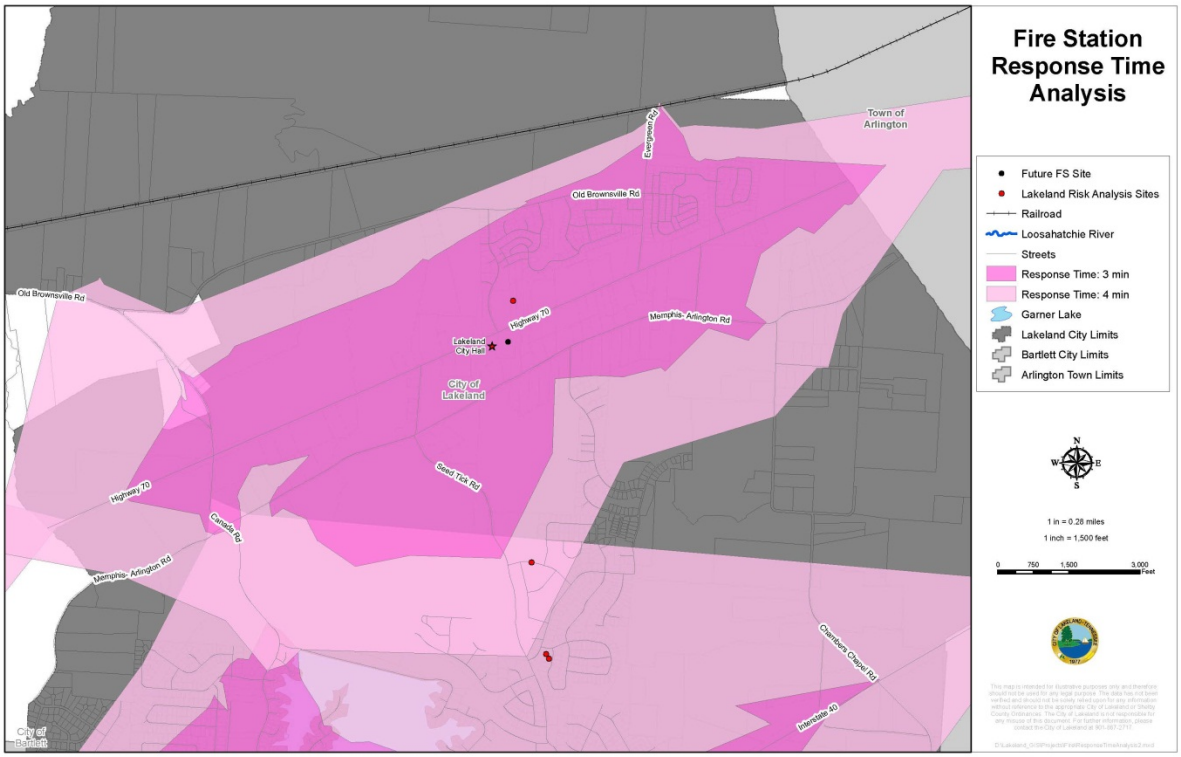

Figure 5 – Response Time Analysis for Highway 70 Fire Station Location

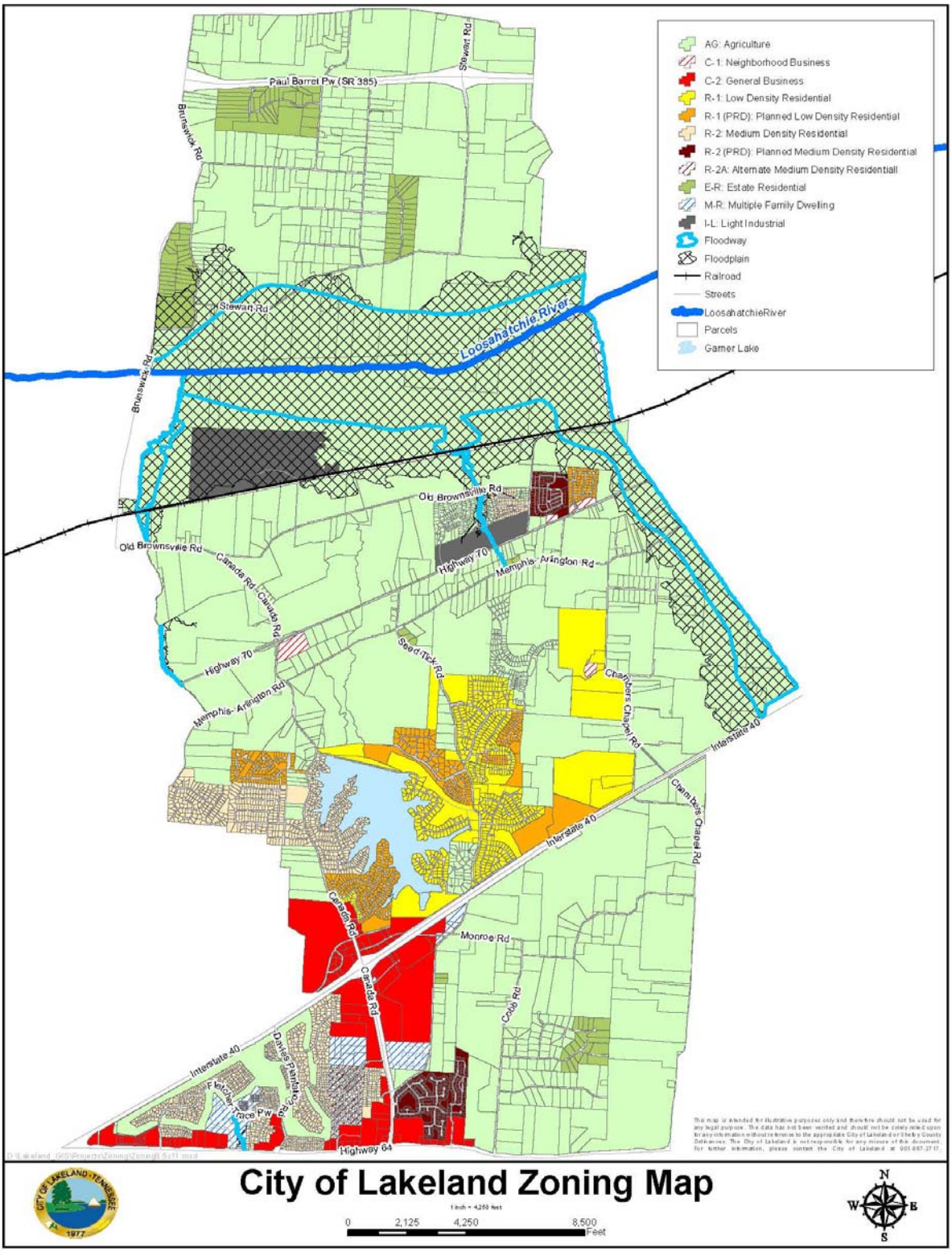

Figure 6 – City of Lakeland Zoning Map

Recommendations

The most efficient and cost effective way for the City of Lakeland to provide an all-hazards service delivery program that addresses community risks and needs is in the following recommendations, which also answers the two questions.

1. Continue to contract with Shelby County Government for fire protection services. This arrangement is adequate and cost-effective and provides good service.
2. Continue to maintain good working relationships with Arlington and Bartlett as these communities can provide mutual aid response should Lakeland create its own fire department at some point in the future. Arlington Station 71 is well located to provide mutual aid response from the east, and Bartlett's Station 103 is well located to provide mutual aid response from the west.
3. Adopt a response time standard for the community. Lakeland is a perpetual organization that will outlast current leaders, and this study looks towards build out, which is 20-plus 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, fire fighter turnout time – 80 seconds, travel time – 240 seconds. Using this standard, planners would look for fire station locations to maintain a 4 minute travel time to as much of the area to be protected as possible.
4. Adopt a sprinkler ordinance for all new commercial construction. ISO does not consider properties protected by a code complaint automatic sprinkler system when determining the needed fire flow for a community. In buildings protected by sprinklers, the sprinkler system either extinguishes the fire before the fire department arrives, or holds the fire in check until the fire department arrives to complete extinguishment. 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 for a non-sprinklered building.
5. 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.
6. Begin planning and budgeting for construction of the second Lakeland fire station on Highway 70 near city hall. This location is good because it provides coverage for the existing residential development (Saffron Springs area, Mary Glade Drive

area, Spruce View Way area) north of Highway 70, for future commercial development along Highway 70, is 1.3 miles from Lakeland Elementary School located at 10050 Oak Seed Lane, and is centered between the east and west city limits which provides good response times in either direction (see Figure 5).

7. Using the community's response time standard, proactively evaluate potential sites for fire stations and begin land acquisition. The majority of Lakeland's land (77.78%/17.43 square miles) is zoned agricultural (see Figure 6), which means these areas lack major roads and infrastructure and are therefore open to planning opportunities. The city should evaluate the major road plan and future proposed development and select sites to evaluate for future fire stations, and examine alternative sites using what-if scenarios. Factors affecting site selection include but are not limited to desired response time, access to major roads (current or planned), traffic patterns, traffic congestion, enough street frontage for a minimum 60-foot wide curb cut for the driveway, sight lines approaching and departing from the site, availability of utilities, environmental considerations, need for site improvements, drainage, soil type, size of the station in terms of square feet and number of apparatus bays, sustainable design, and community concerns (some residents may not want a fire station in their neighborhood). A fire station is an essential facility and should be designed to be self-sufficient for major emergencies (power outages, etc.) and immediately occupiable following an earthquake of a magnitude possible for the community, which in Shelby County is an M7.7. It is beyond the scope of this study to provide program planning for a fire station. These comments are made to illustrate the complexity of a fire station project and the need to use professional architects, engineers, and builders who are familiar with the special needs for fire stations.
8. Should Lakeland decide at some future point to create a municipal fire department, contact MTAS or another company that provides fire consulting services and request a study on creating and organizing a municipal fire department.

References

Compton, Dennis and John Granito, eds. (2002). *Managing Fire and Rescue Services (2nd ed)*. Washington, DC: The International City/County Management Association (ICMA).

Cote, Arthur, Grant, Casey, Hall, John, Solomon, Robert (Eds.). (2008). *Fire Protection Handbook, 20th Edition*. Quincy, MA: National Fire Protection Association (NFPA).

Folz, David H., Shults, Chris, Meyers, Mike, Adams-O'Brien, Frances, Festa, Leah, West, Gary L. (2011). *An Analysis of Civilian Residential Fire Deaths in Tennessee, 2002 - 2010*. Knoxville, TN: The University of Tennessee.

Insurance Services Office. (2003). *Fire Protection Rating Schedule (edition 02-03)*. Jersey City, NJ: Insurance Services Office (ISO).

National Fire Protection Association. (2010). *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*. Boston, MA: National Fire Protection Association.