Report to
Charleston, West Virginia

FIRE DEPARTMENT DEPLOYMENT & OPTIMIZATION STUDY

July 2011

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CHAPTER 1. INTRODUCTION

Charleston is the capital and largest city in the U.S. state of West Virginia. It is located at the confluence of the Elk and Kanawha Rivers in Kanawha County. Charleston is the county seat of Kanawha County. In the 2000 census, it had a population of 53,421, with its urban area having a population of 182,991, and its metropolitan area having a population of 309,635. According to the 2009 Census estimates, however, Charleston had a population of 50, 267, and a metro area population of 304,214. As shown from the numbers above the overall population in Charleston is decreasing.

Early industries important to Charleston included salt and natural gas wells. Later, coal became central to economic prosperity in the city and the surrounding area. Today, trade, utilities, government, medicine and education play the central role in the city's economy.

Charleston functions under the Mayor-Council form of city government. The Mayor is the designated Chief Executive Officer of the city with the duty to see that all of the laws and ordinances of the city are enforced. The Mayor gives general supervision over all executive departments, offices and agencies of the city government and is the presiding officer of the Council and a voting member thereof. The current mayor is a Republican, Danny Jones, who was elected in 2003, and re-elected in 2007. Charleston also has a City Manager who is appointed by the Mayor and approved by the Council. The City Manager has supervision and control of the executive work and management of the heads of all departments under his control as directed by the Mayor. He makes all contracts for labor and supplies, and generally has the responsibility for all of the business and administrative work of the city.

With 27 members, the Charleston City Council is somewhat larger than usual for a city with a population of 50,000. Twenty-one of the Council members are elected from a specific Ward within in the city, and an additional six members are elected by the city at large.

The age distribution is 20.7 percent under 18, 8.4 percent from 18 to 24, 27.9 percent from 25 to 44, 25.3 percent from 45 to 64, and 17.6 percent who were 65 or older. The median age is 41 years and for every 100 females there are 87.3 males. For every 100 females age 18 and over, there are 83.7 males. The median income for a household in the city was $34,009, and the median income for a family was $47,975. Males had a median income of $38,257 versus $26,671 for females. The per capita income for the city was $26,017. About 12.7 percent of families and 16.7 percent of the population were below the poverty line, including 24.5 percent of those under age 18 and 11.3 percent of those ages 65 or over.

Charleston Fire Department

The Charleston Fire Department has an ISO public protection rating of two and operates out of nine stations with 186 paid professionals. These stations house nine Engine Companies, two Ladder Companies, two Rescue Companies and four Advanced Life Support Ambulance Units. The Fire Department is also home to the West Virginia Regional Response Team Task Force One and maintains Building Collapse and Hazardous Materials Units. The members of the department are specially trained in firefighting, emergency medical services, vehicle rescue, technical rescue, hazardous materials, and water rescue.

Mission Statement – It is the stated mission of the Charleston Fire Department to provide maximum protection of life and property through the prevention and extinguishment of fires, provision of Emergency Medical Services, Hazardous Material response and Mitigation, Rescue, and performance of any other services to the citizens of Charleston that may be required to ensure a safe community.

The Fire Department attains this goal through preparation and training, dedication, public education, and a constant focus toward the end result—a safe City of Charleston.

Proposal – The City of Charleston requested an independent analysis of the operations, staffing levels, and asset deployment of the Charleston Fire Department. The assessment goal was to identify and present the best strategies to serve the citizens while addressing safety concerns of fire personnel and the need for adequate and affordable resources.

Scope of Work – The following topics were addressed in the Project Plan.

- Trends and characteristics of community population and demographics.
- Residential, industrial and municipal features of the community.
- Policies that determine staffing levels and types of staffing
- Shift schedule options in relation to overtime costs.
- Department dispatching options.
- Department response times in relationship to industry standards.
- Vehicles and staffing/run assignments in relationship to industry benchmarks.
- Review of station locations and asset deployment.
- Firefighter health and safety in relation to industry standards and laws.

Organization of the Report

The remainder of the report is organized as follows:

Chapter 2. Population Growth, Risk, and Demand Analyses – This chapter includes analysis of the risks and trends in demand currently experienced by the City of Charleston and what the city can expect in the future. TriData analyzed specific risks common to most suburban areas and those unique for Charleston. These risks include social, technological, economic, environmental, and political factors. EMS posed the highest workload and is affected by all of these factors. The physical risks were also reviewed (e.g., buildings occupied and unoccupied, industry, and degree of built-in structural fire protection). Establishing the required staffing level and possible alternatives requires understanding the fire and EMS call history of the town, where and when incidents occur most frequently, and where the most severe incidents are likely to occur.

Chapter 3. Station Location and Response Time Analyses – Based on the results of the risk, and demand analyses, we assessed the coverage provided by the current system of stations, considering both current workloads and projected demand. We determined the needed number of stations and their locations with consideration for short-term and long-term risks. We also considered several alternative solutions with minimum changes to lower cost—the modest improvement alternative. Our recommendations were data-driven and aimed at improving the efficiency and effectiveness of the fire/rescue system. We provided quantitative and qualitative reasoning supporting the recommendations and their implementations.

Chapter 4. Assess Fire and EMS Operation – This chapter assessed the appropriateness of the bulk of staffing—the positions in operations—and hence the majority of departmental costs. It evaluated the day-to-day operations of Charleston Fire Department with regard to emergency services staffing and service delivery. This chapter also included an evaluation of emergency staffing and response to calls for service. The report included measurements of current service level provision and recommended changes where needed. It provided an operational assessment of current fire department staffing, shift scheduling, and personnel deployment.

Chapter 5. Interjurisdictional Comparisons – In choosing cities for comparison, we considered population size, density, services offered (especially whether there is EMS and EMS transport), climate, socioeconomic factors (age, poverty levels, ethnic groups), number of operations staff on duty per 1000 population; average work week of firefighters. We also considered whether fire incidence and fire losses are comparable. We included area communities and communities elsewhere including other Appalachian cities. We showed how Charleston Fire Department ranks among the set of comparison cities and against the means. We also compared Charleston Fire Department to national standards and industry benchmarks.

Chapter 6. Service Delivery System and Future Options – In this chapter we evaluated the effectiveness and efficiency of the service delivery system and explored alternatives for enhancing the efficiency of the system. Furthermore, this chapter analyzed the mission, vision, strategic planning, goals, and objectives of the department. Recommendations were made to improve upon these areas, where necessary.

CHAPTER 2. POPULATION GROWTH, RISK, AND DEMAND ANALYSIS

This chapter includes analysis of the risks and trends in demand currently experienced by the City of Charleston and what the city can expect in the future. Specifically, we review the major factors that drive emergency service needs: population growth, risk and demand. The assessment of risk and demand is critical to not only the determination of the number and placement of resources, but also to the mitigation measures that may be available to the fire department.

Data Specification and Issues

This chapter and the following station location chapter are significantly based on data we collected from the fire department and dispatch center. It is generally known that information is only as good as the data used to compile that information. The quality of these two chapters is largely dependent on the jurisdiction's data quality. In this section we provide a brief overview of the data that was used for this study along with some data improvement recommendations.

TriData collected both Computer Aided Dispatch (CAD) data and National Fire Incident Reporting System (NFIRS) data for this study. Generally speaking CAD data records dispatch center actions (dispatched unit, unit timestamps, dispatch type, etc.) whereas NFIRS data provides a detailed after action data and report. The NFIRS database does overlap the CAD database because it requires most of the information that the CAD system collects (i.e. address, responding units, and unit response timestamps). Depending on how the NFIRS system is setup, firefighters have to manually look up timestamps and reenter them into the NFIRS system or the CAD system is setup to automatically populate these NFIRS fields (which is the best practice).

CAD Data Specifications – Computer Aided Dispatch (CAD) data provides a permanent record of communications between the dispatch center, the public, and fire department units in the field. Typically CAD data includes an incident dispatch type, incident address, incident coordinates, and response timestamps for all responding units. We requested CAD data for the calendar year 2010 and received the data in a format that could be reworked into our specified format.

We ran into issues with missing fields (that are currently not collected by the dispatch center). It is not uncommon for older CAD systems not to collect certain pieces of information, but that is an important reason to upgrade the system on a regular basis. For departments that do not perform (or base decisions) off of emergency services performance measurement, inadequate CAD systems are often left in place for years or decades as long as they are still able to functionally dispatch units. Why upgrade a system to collect incident coordinates or total response times when nobody is looking at (or placing great value on those results)? Charleston appears to have a very outdated CAD system that, although it can still dispatch units, fails significantly in two respects: it does not track incident coordinates and is unable to record a call received time from the phone system.

Incident Coordinates: Newer CAD systems are able to record a GPS location for each incident. Having this data fields allows a fire department analyst to associated incidents to geographic areas such as first-due areas or planning areas and conduct performance measurement at a much more detailed geographic level. Although it is possible to determine GPS coordinates based on an address (geocoding), this process is both time-consuming and inaccurate. Because coordinates where not available for this study, Metro 911 successfully geocoded 84 percent of the addresses. Although this was a huge help and allowed us to provide more detailed analysis in this study, having 16 percent of incidents simply not included when conducting fire department analysis is ultimately not acceptable in the long run.

Call Received Times: The dispatch center currently is not able to track call received times. Our understanding is that the first timestamp is recorded only once the call taker has received sufficient information and passes that information on to the dispatcher. Using the create time rather than the call received time could leave as much as 60 seconds off of the call processing and total response times. Although we understand that there are significant limitations in the ability of the current phone system to pass data to the CAD system, ultimately not recording the time at which calls received is unacceptable and the system should have been updated a long time ago.

Time Only Incident Stamps: The current CAD system only records the date at which the incident is first created in the CAD system. After that, all timestamps are simply recorded as times rather than as dates and times. For our analysis, we were able to use the CAD incident date for each of the incident timestamps, but this creates significant problems when attempting to calculate response time segments that span midnight (we did the best we could to deal with this subset of incidents).

We also found that the CAD data had a significant amount of clearly erroneous data. CAD records can be thought of more as permanent records of all dispatch center actions rather than a perfect reflection of actions in the field (meaning that if a dispatcher accidentally created two records for the same unit on the same incident, the CAD database would have a permanent record of the dispatcher’s mistake rather than reflecting the reality that each unit typically can only provide a single response per incident). CAD data quality issues are almost always present, and this study was no exception. Table 1 provides an overview of the problems found within the data.

Table 1: CAD Data Errors

	Responses	Percentage of Total
Missing incident number, incident date, or unit ID	0	0
Duplicate unit ID for single incident number	0	0
Responses with non-sequential timestamps	1,032	3
First-arriving unit with suspiciously long response time	5,747	17
Second-arriving unit with suspiciously long response time	2,048	6
Third-arriving unit with suspiciously long response time	437	1
Fourth-arriving unit with suspiciously long response time	189	1
Total responses	**34,740**	**100**

NFIRS Data Specifications – The National Fire Incident Reporting System (NFIRS) is a system established by the National Fire Data Center of the United States Fire Administration (USFA) to gather and analyze information on the magnitude of the Nation's fire problem, as well as its detailed characteristics and trends. The first version of NFIRS released in 1975 only collected fire incident data on a paper-based form. Over the last 35 years, the system has progressed to version 5.0 and now includes EMS, hazmat, and other data collection modules to reflect the all-hazard nature of current-day fire department work. Where CAD data provides only limited information about incident location and response times, NFIRS data paints a very in-depth picture of an incident. Everything from the type of building, to the number of smoke detectors present (and if they were working) to the type of medical care provided at an EMS incident is collected. The United States Fire Administration provides the detailed specifications for the database that collects this information, but leaves it up to third-party software vendors to design the software that allows users to enter incident information and translates that into the database. The software vendors are typically pretty good about forcing users to enter appropriate information. Furthermore, it is not uncommon for fire departments to add extra rules to further reduce erroneous data. Finally, unlike CAD data, which may not always be checked over, NFIRS data is typically entered in the first line staff and ultimately approved by command staff. With software companies designing good data entry software, building in accuracy checks, and having several sets of eyes look over the data that is ultimately entered in, NFIRS data is typically much more accurate than CAD data. We requested NFIRS as data for as far back as possible and received data from 2007-2010 in the USFA transaction file in which we requested it. We found that this data was generally in good shape, with one big exception. Unlike most departments, Charleston's NFIRS data does not contain records for all incidents. It only contains records for incidents attended by fire units (engine, rescue, truck, et cetera). Ambulances use an entirely different database, so there is not a single database that contains post-incident information about all incidents.

CAD to NFIRS Data Transfer – When conducting technical Fire Department analysis, it is preferable to use a single dataset rather than trying to match up data from two separate databases. It can be both time intensive, technically challenging, and error prone to match up separate databases. A best practice for fire Department data management is to have the CAD system automatically populate its data into the NFIRS software. This data link is important because it provides a more concrete link between CAD unit response times and after-action NFIRS data. It also potentially allows responding crews to review timestamps and note any inaccuracies (inaccuracies are often the result of radio signals not transmitting, dispatchers not hearing radio traffic, and human error). We found that the Charleston dispatch center does automatically transfer data and both line staff and commanding officers regularly review data.

Even though Charleston has implemented data passing capability, there are some problems with its implementation. Currently, the fire department is changing certain arrival times and not all CAD data values are being passed over into the NFIRS system. Although it may have been an issue with the export process, we also found that there was a lot of unit response data missing from the NFIRS data provided to us.

All fields Not Being Passed Over: Though the current NFIRS 5.0 data specifications are fairly comprehensive, they are not perfect. For some reason, the US Fire Administration left out unit enroute time from the database specification. They also included incident coordinates as an easy-to-miss optional location field rather than giving such an important piece of data its own field. We have found that most fire departments do not pass enroute and coordinate information into the NFIRS system despite its importance in conducting accurate fire Department analysis. In order to set up a single database from which the fire department can conduct in-house performance measurement and data analysis, we recommend revamping the system to pass these additional CAD data fields into the NFIRS system. [Note: Charleston could already set up the system to pass enroute times, but will have to wait for an updated CAD system to pass incident coordinates which are not currently being collected.]

Changing Unit Timestamps: We were told that, although the CAD system passes the correct timestamps for all units into the NFIRS software system, the line staff is instructed to change the unit arrival time for all units to the arrival time of the first arriving unit. Although there may be a good reason for doing this (probably to get the RMS system or Crystal Reports to work correctly), this is ultimately altering data and defeats one of the reasons for passing CAD data into the NFIRS system. Where we typically would use mostly NFIRS unit timestamps because of their increased accuracy, we were unable to do so for this study because of this timestamp altering practice.

Missing Unit Response Data: Although we were told that the fire department believes the unit response data within the NFIRS database to be complete, we found that the exported data provided included only a very small percentage of incident responses (approximately 10 percent). It very well may be that there is simply an issue with the export process, but this is something that Charleston Fire Department should work with their incident reporting software vendor to correct.

By addressing these couple issues, it will be possible for the fire department to conduct performance measurement and data analysis directly from the NFIRS database. They will avoid the potential data errors that often occur when cobbling together separate CAD and NFIRS datasets (see next section).

Datasets Used for our Analysis –We predominantly used two separate data sets for our analysis. For our long-term analysis (trend analysis, demand forecasting, and geospatial density mapping), we simply used the 2007-2010 NFIRS data as provided to us by the fire department. The only additions we made were adding our own incident type categorization and using yahoo geocoder to geocode all the addresses. We also had to categorize ambulance incidents not recorded in NFIRS using the CAD dispatch type.

For our short-term analysis (response times and workload) we used one year of CAD data cobbled together with some data from the NFIRS database and incident coordinates from the geocoded addresses provided by Metro 911. We used the NFIRS incident type classification to determine whether the incident warranted an emergency (lights and sirens) response (for removing "service calls" and other similar calls from the response time analysis). We also used the NFIRS data to classify whether each incident was within the jurisdiction boundary or a mutual aid response. Because we had to predominantly use raw CAD data for compiling this dataset, there are likely more errors than if we had used mostly NFIRS data. The NFIRS data typically has a higher level of accuracy checking, but because Charleston Fire Department changes unit arrival timestamps and there were significant numbers of missing responses, we were unable to use that data.

Within this chapter and the next, we always specify in the figure and table headings the analysis time period. Based on this specified time period, it is possible which of the two above datasets we used for our analysis. Upon request, our two datasets can be provided to Charleston for further review and analysis.

Planning Area Specification and Issues

A geographic information system (GIS), geographical information system, or geospatial information system is the system that captures, stores, analyzes, manages, and presents data with reference to geographic location data. In the simplest terms, GIS is the merging of cartography, statistical analysis, and database technology.[1] This and the following chapter include a significant amount of maps prepared using ESRI's ArcGIS software.

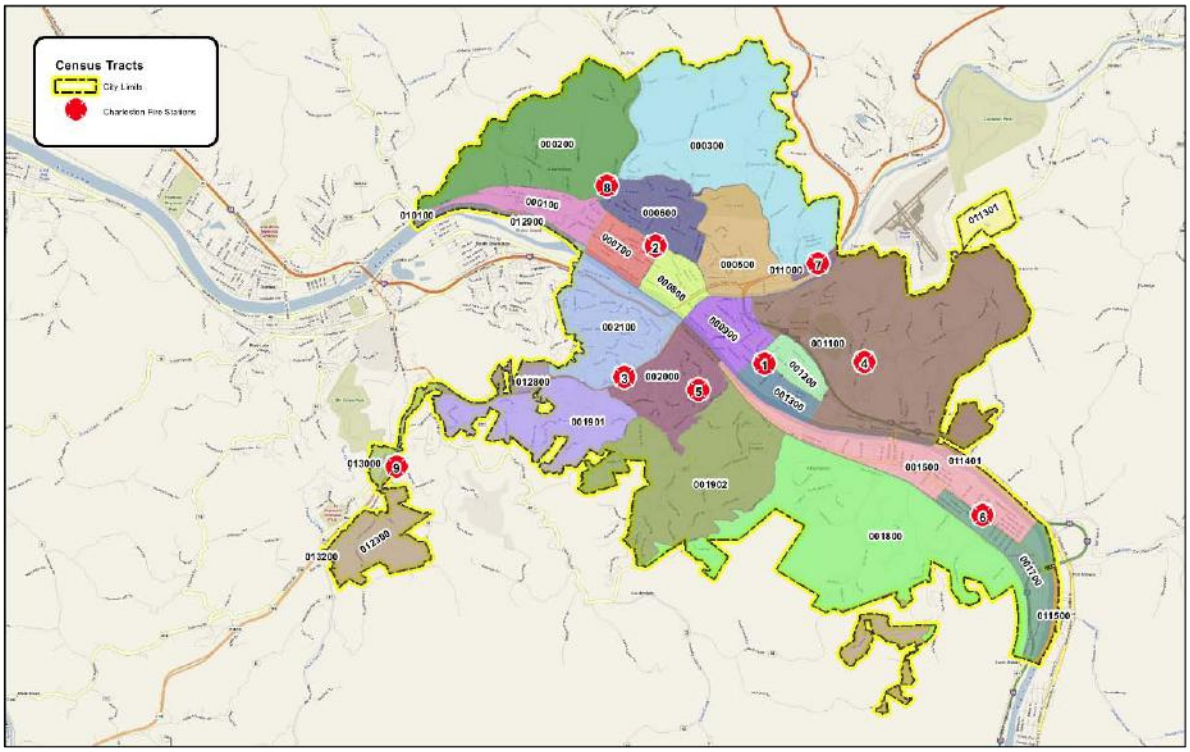
It is good practice for fire departments to consider risk and demand at a neighborhood level. In order to accomplish this, fire departments must have some predefined planning areas by

[1] Source: Wikipedia, "GIS"

which to summarize incident information. We requested a GIS file that provides planning areas by which to conduct our analysis, but found out that although there are city planning areas that could have been used; no GIS file currently exists for them. A big reason for this is that, to date, there has not been any sort of GIS department or GIS coordinator within the IT department.

Because planning area GIS files were not available, we chose to conduct our analysis using census tracts. Figure 1 shows the 28 census tracts (hereafter called "planning areas") used for our neighborhood-level risk and demand analysis throughout this chapter.

Figure 1: Planning Areas (Census Tracts)



Population Growth and Development

According to the Charleston Planning Department, the city is basically built out. While there was heavy development activity in the South Hills area over the last ten years, the city is now at a point where there is no more land and no annexation options of any significance. The hills in North Charleston have subdivision potential, but the market conditions are currently not very attractive. Some very small subdivisions may be created by entities like Habitat for Humanity, but market conditions are holding back any sort of significant new developments.

Charleston has had a declining population for the last 50 years. The planning department expects that Charleston's population will decrease just slightly over the next decade. Figure 2 shows us actual and projected population growth from 1850 to 2030. TriData has found that, in places such as Pittsburgh where populations have drastically declined, aging and often abandoned infrastructure adds significant fire risk (from both accidental and malicious causes). We understand that Charleston does have an active demolition program in place and this should be continued.

Figure 2: Actual (solid) and Projected (dashed) Population, 1850-2030

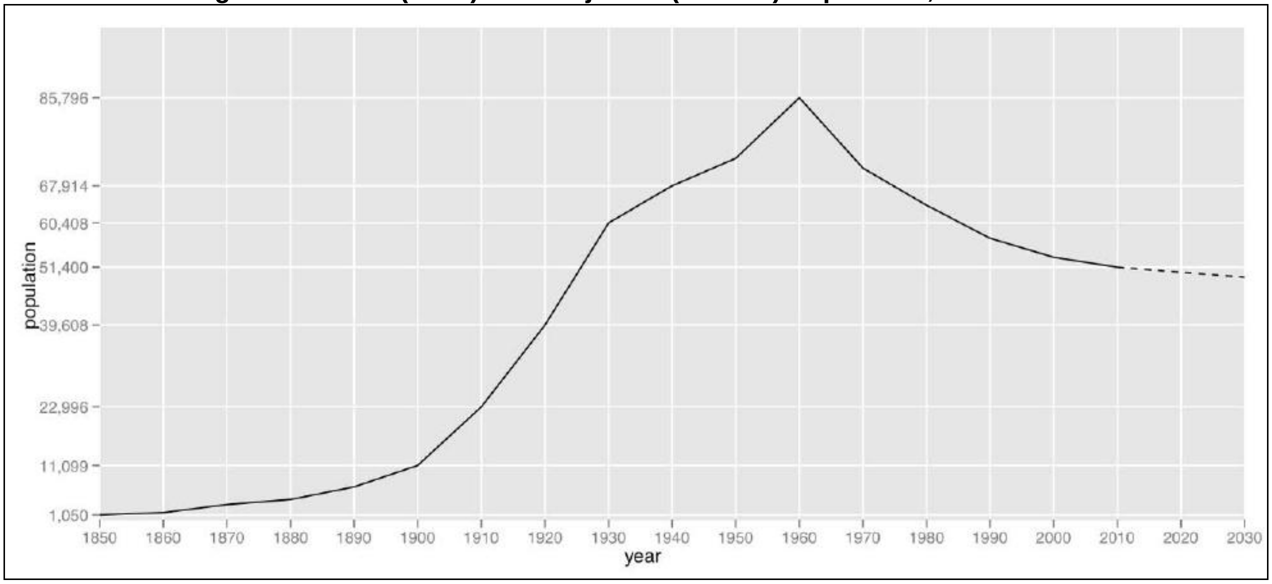
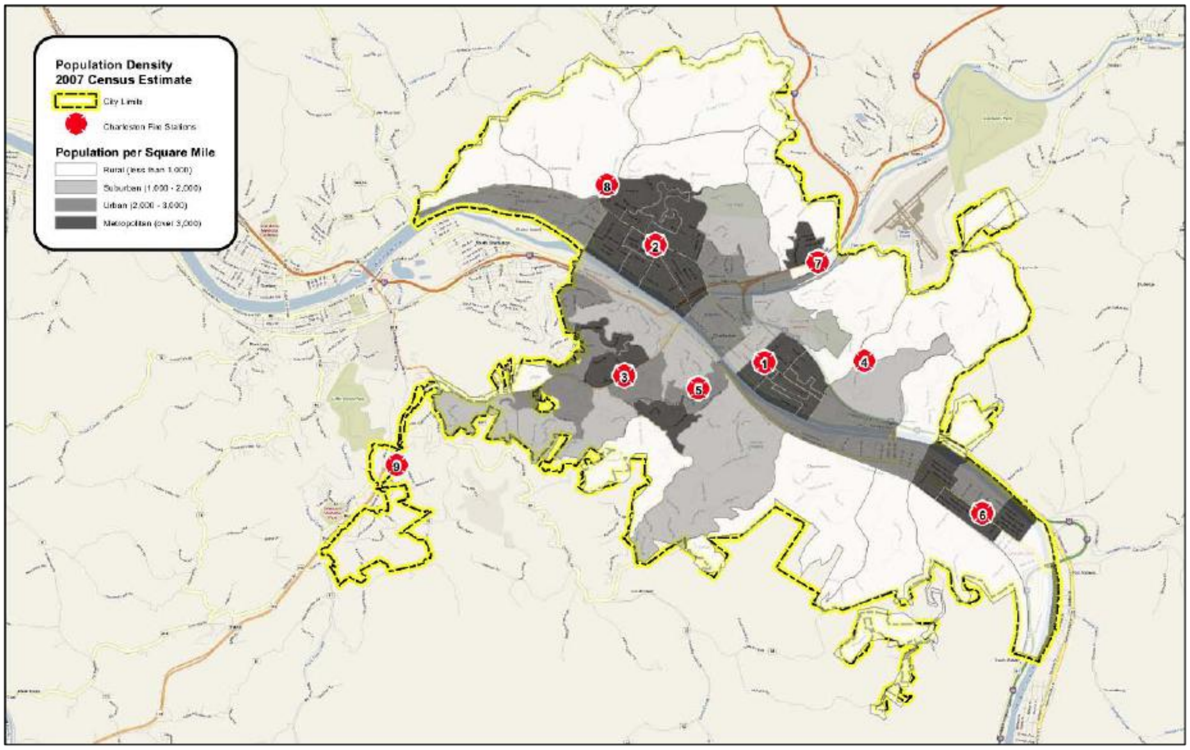


Figure 3 shows us the current population density (compiled using United States Census estimates). The map shows that Charleston, unlike most other cities (which usually have very homogeneous population densities), has a large spectrum of population densities ranging from rural to metropolitan. The key for providing good fire service is to make sure that apparatus deployment is tailored to these differences in population density. Generally, the outer perimeter of Charleston is rural with the areas of higher population density located more centrally within Charleston along the Kanawha River. This population distribution will be particularly important when looking at alternative station location configurations.

Figure 3: Population Density, 2007



Demand Analysis

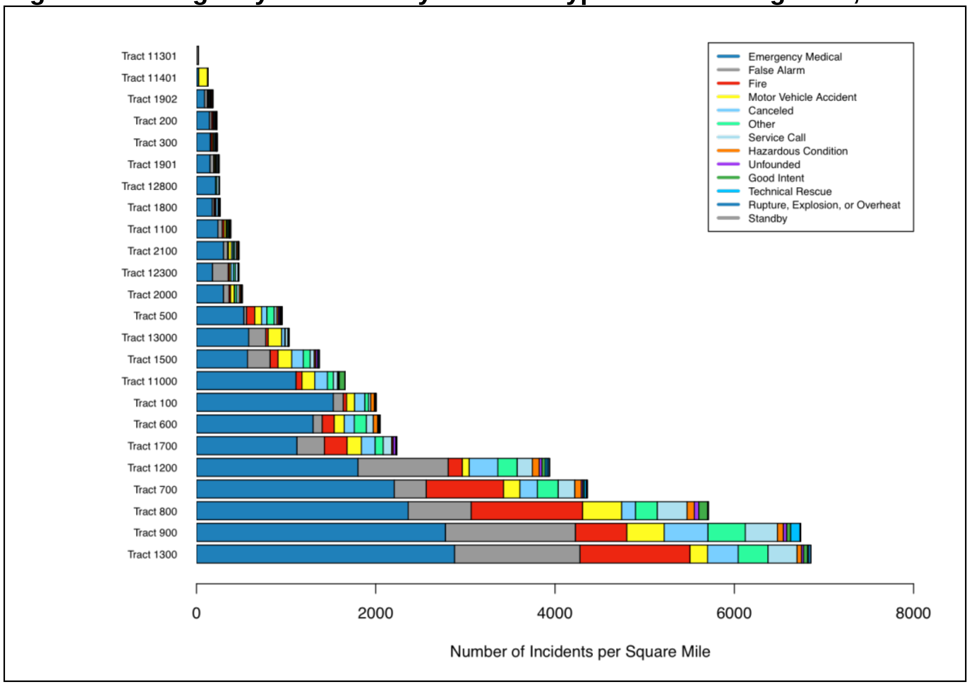
Demand is defined as the number of emergency incidents that required fire department intervention. In this section we review jurisdiction-wide incident type counts, make incident type forecasts, and review incident type breakdowns by planning areas. Understanding both current and predicted future demand will assist the city and fire department officials to make important decisions in the following areas:

- **Fire Unit Locations –** Planning areas with high levels of demand show where fire apparatus should be located. Further understanding of the types of incidents in each area helps to determine what types of response equipment are most appropriate.
- **Weight of Response –** The demand analysis shows the number of fires versus the number of fire alarms. A higher weight of response is prudent for planning areas with higher-risk properties, and where more structure fires actually occur.
- **Prevention –** Some areas have such a high demand for emergency service that prevention and education efforts must often be increased.

Demand Projection and Incident Type Trends – Because the NFIRS data does not include all emergency incidents (missing all ambulance-only incidents), it could not be used to accurately forecast total incidents and review incident type trends. TriData did request that a summary of incident totals by type be provided for this analysis, but because of the data residing in two separate databases (NFIRS and EMS Charts), it was not possible for CFD to provide this information prior to the publishing of this report.

Demand by Planning Area – The following figure shows emergency services demand by planning area (census tract). The length of each bar represents the total number of incidents that occurred in that planning area over the period of a year. Within that bar, the different incident types are represented by different colors depicted in the legend. Please note that these values are normalized by land area. Planning areas that have particularly large land areas may have higher total emergency services demand, yet have relatively low emergency services demand per capita or per square mile. To provide a fair comparison between planning areas, we simply divided the demand totals by the planning area's land area (in square miles).

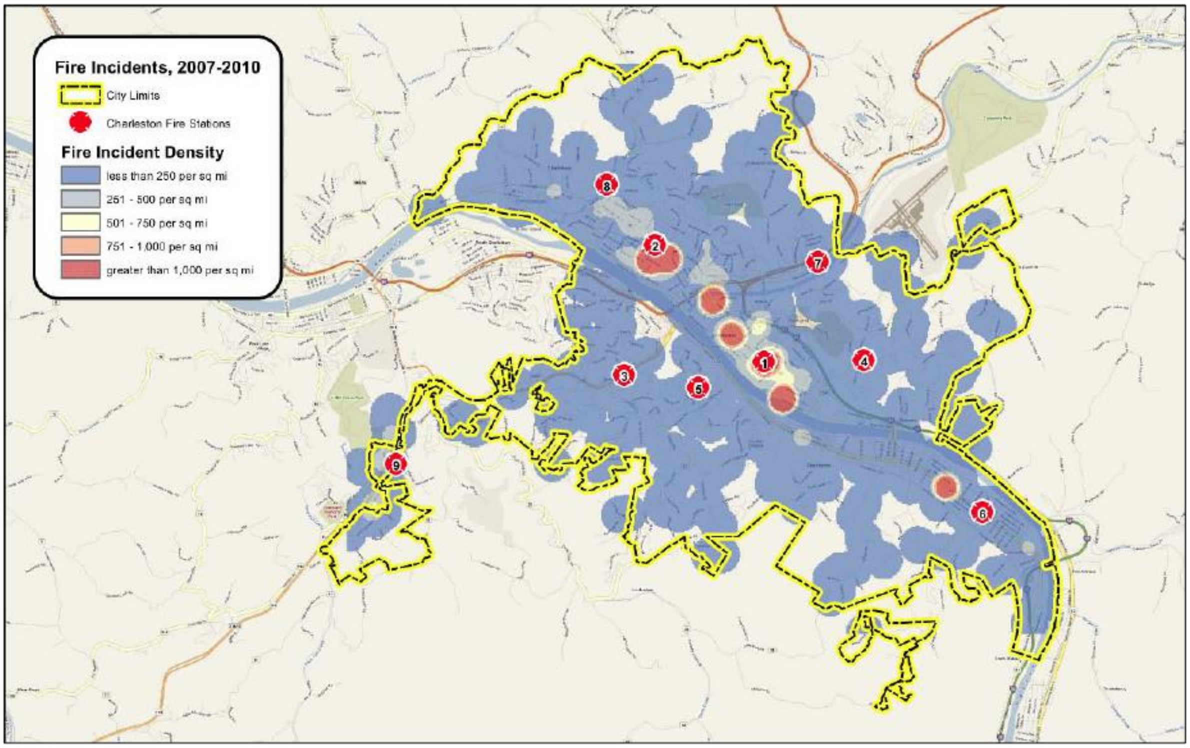
Figure 4: Emergency Incidents by Incident Type and Planning Area, CY2010



It is clear from this figure that there are significant differences in emergency services demand for different areas of the city. From this figure we can see that tracts 1200, 700, 800, 900, and 1300 have significantly higher demand per square mile than other census tracts. Referring back to the census tract map earlier in this chapter, it can be seen that the areas of highest emergency services demand run directly along the northeast side of the Kanawha River. [Note: This table illustrates why using neighborhoods rather than census tracts provides better information as census tract numbers provide little inherent meaning; most people have to look up census tracts on the map to associate them with a geographic area.]

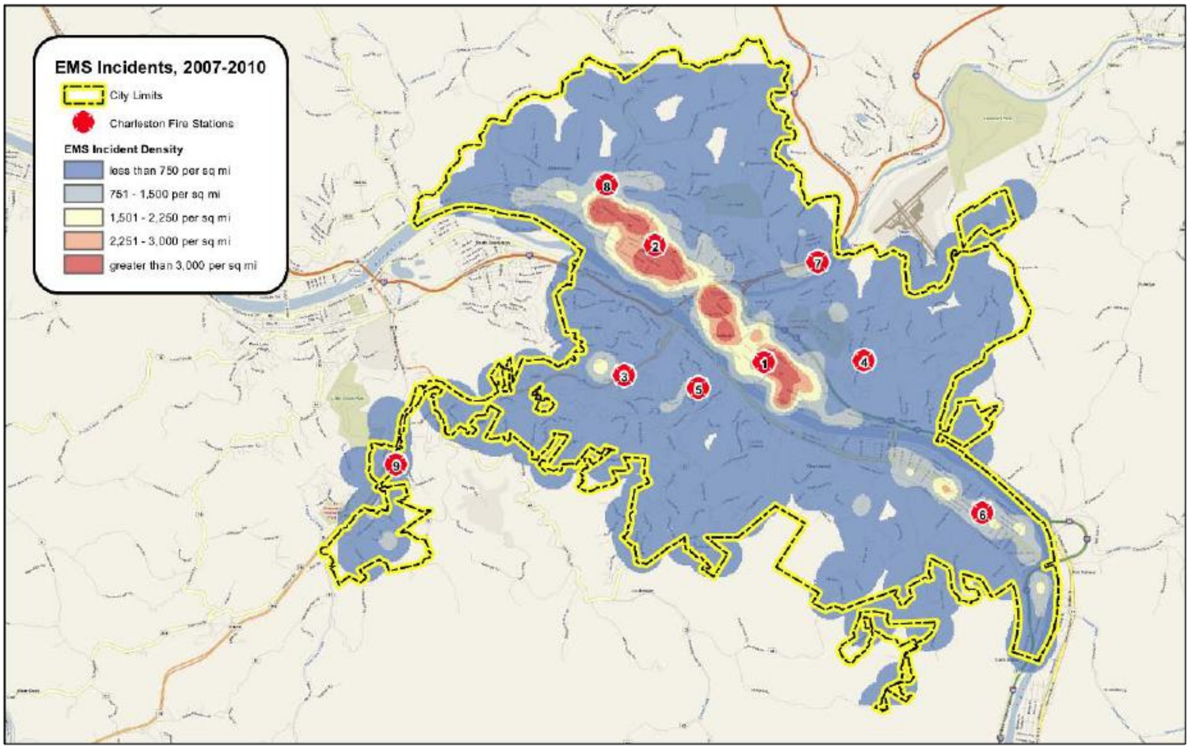
Geospatial Mapping of Fire and EMS Demand – An even better way of looking at demand than by planning area is to actually map out fire and EMS incident densities using GIS software. This allows us to even further pinpoint high-demand areas (or hotspots). Figure 5 and Figure 6 show fire and EMS incident densities.

Figure 5: Fire Incident Density



The fire incident density maps out all incidents classified as a fire within the NFIRS database (based on fire department reports of the incident). This includes structure fires, vehicle fires, and outside fires. Based on the fire density map it is pretty clear that the vast majority of fire demand is located between Fire Stations 1 and 2 along the northeastern side of the Kanawha River with a more isolated hotspot just northwest of Station 6.

Figure 6: EMS Incident Density



EMS incident density, as shown in Figure 6 is typically very closely related to population density.[2] The population density map shown in an earlier section showed the highest population density along the northeaster side of the Kanawha River. We would expect to, and do see the highest number of the EMS incidents in this area. The area of highest EMS demand roughly follows the same pattern as fire demand with a slightly longer footprint along the river (stretching between Station 1 and Station 8). Again we see a smaller hotspot just northwest of Station 6.

There are two additional EMS demand considerations that were not directly considered because of the limited scope of the EMS portion of this study. Senior homes are significant contributors of EMS demand and they often skew the typical relationship between population density and EMS incident density. Also, business hour commercial districts typically add peak-hour EMS demand to the equation. A more detailed EMS risk and unit location study would take also take a closer look at both of these factors with respect to the overall EMS picture.

Fire Risk Analysis

Fires are a small percent of total emergency services demand, but fire suppression activities require more personnel to mitigate than do most other emergencies. The fire risk assessment in this section evaluates the overall trend in fires, the probability of fires in different

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[2] CPSE, Developing Standards of Cover,

planning areas, and the consequence or likely severity of fires in different planning areas. All of these factors were considered for the overall protection requirements of each planning area.

Jurisdiction-Wide Fire Losses – One of the best indicators of fire risk is actual data collected from fires over multiple years. Table 2 shows the total number of fires, fire deaths, injuries, and property loss (defined as both the property and contents) over the last four years.

Table 2: Total Fire Loss, 2007-2010

Year	Total Fires	Dollar Loss	Injuries	Deaths
2007	632	$2,560,150	2	0
2008	765	$1,203,100	2	2
2009	629	$2,743,450	3	0
2010	689	$1,200,800	8	1
(average)	679	$1,926,875	4	1

The data reflects all fires, including vehicle fires and outside fires. It appears that, on average, there are slightly less than 700 fires per year. Several fire injuries occur per year, while the numbers of fire deaths are small. No fire deaths were recorded in 2007 or 2009. In 2008, however, a total of two fire deaths were recorded and in 2010 a total of one fire death was recorded.. Annual dollar loss due to fire ranged from $1,200,800 in 2008 to $2,743,450 in 2009. On average, there was about two million dollars worth of fire damage annually.

Table 3 compares Charleston fire loss data to regional and national averages. Fire loss data can be easily skewed. Any slight under-or over-reporting of deaths, injuries, or property loss could have a huge impact on the validity of the results. Also, different jurisdictions may collect data in slightly different ways making comparison imperfect. It is for these reasons that the results produced should be viewed with care. When data is recorded properly, however, these comparisons can provide a good indicator of fire department performance.

Table 3: Per Capita Fire Loss and Comparison Statistics, 2007-2010

	Total Fires (per 1K capita)	Dollar Loss (per capita)	Civilian Injuries (per 1M capita	Civilian Deaths (per 1M capita)
United States	4.4	$40.8	55.5	9.8
Region: South	4.7	$40.8	51.2	10.7
Population: 50,000 to 99,000	3.3	$36.4	62.4	6.7
Region and Population	4.3	$41.4	63.6	9.9
Charleston: 2007	12.3	$49.8	38.9	0.0
Charleston: 2008	14.9	$23.4	38.9	38.9
Charleston: 2009	12.2	$53.4	58.4	0.0
Charleston: 2010	13.4	$23.4	155.6	19.5
Charleston: (average)	13.2	$37.5	73.0	14.6

It appears that Charleston has a significant fire problem. On average, Charleston has four times more fires than national, regional and community size averages. Civilian injuries and deaths are also notably higher. Dollar loss values are slightly less than the comparison statistics (other than jurisdictions with similar population), but this may be partially the result of low median home prices (the median home price of $138,714[3] in Charleston is almost 40 percent lower than the US median home price of $216,700[4]). Undoubtedly the men and women of the Charleston Fire Department put forth their strongest effort to keep these statistics low, but we have seen in many rust belt cities that aging infrastructure and decreasing population can create significant fire problems. Strengthening prevention, public education, code enforcement, and abandoned building demolition programs will likely have the greatest impact on decreasing these fire loss statistics over time.

Geospatial Location and Severity of Fire Incidents – To help evaluate the appropriateness of fire unit locations, it helps to understand where the more serious structure fires (those that involve deaths or large fire losses) are occurring. Figure 7 shows the location and severity of structure fires shown by orange dots that are scaled based on the amount of fire loss. We also mapped out the location of all civilian fire deaths. [Please note that not all fires are mapped out because not all incidents were successfully geocoded. Investing in a CAD system that collects incident coordinates would allow for a more complete fire loss mapping.] The structure fire location figure shows that most fires are occurring in the high-population density area along the northeast side of the river, particularly around Station 2. We also noted that there is a slightly higher concentration of high dollar loss fires in the more rural area northeast of Station 8 and two particularly expensive fires right next to Station 5. Some unusual anomalies are expected, but overall there do not appear to be any significant geospatial structure fire trends that need to be addressed.

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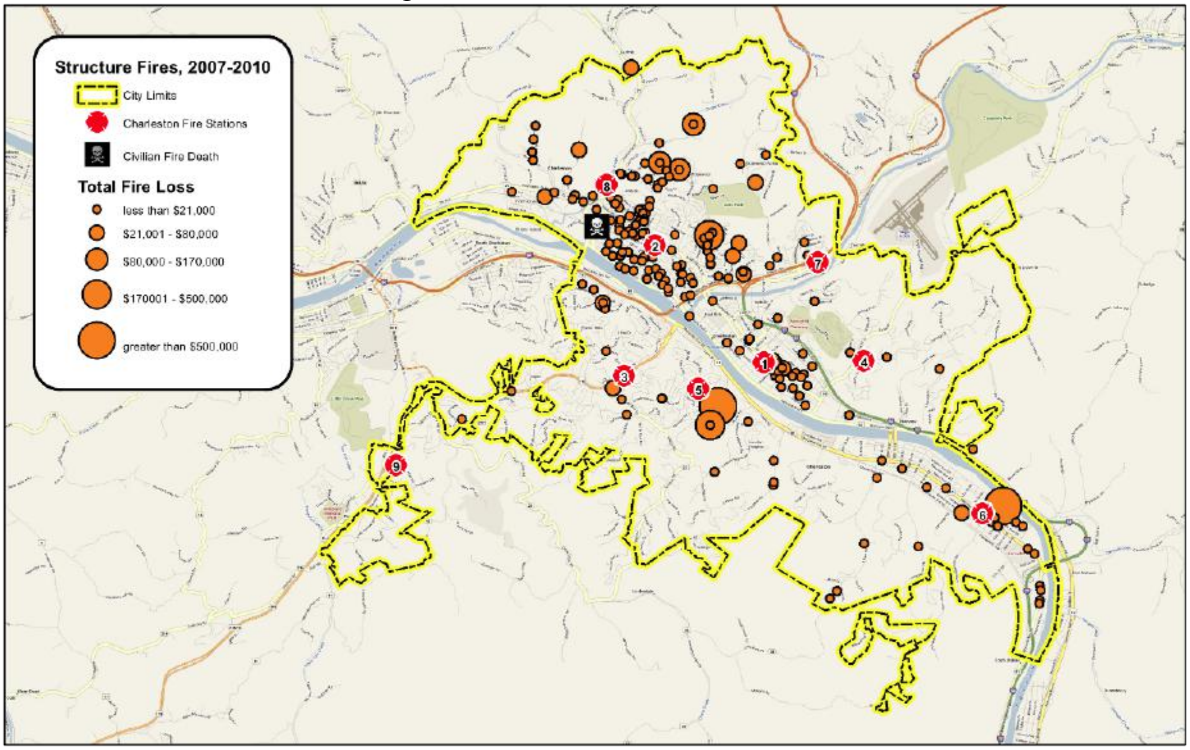
3 http://www.city-data.com/city/Charleston-West-Virginia.html
4 http://www.census.gov/const/uspriceann.pdf

Figure 7: Structure Fire Locations



Fire Risk by Planning Areas (Census Tracts) – Fire Risk is the product of fire probability and fire consequence. High risk, therefore, can result from either a large number of small fires, or a small number of large fires. Table 4 provides both probability and consequence statistics for each planning area. Probability is reflected in the total number of structure fires, defined as the number of fires that spread beyond their object of origin (meaning we excluded things such as trash can fires and cooking fires that did not extend beyond the pot). The table shows both the actual number of structure fires and the number normalized by land area (per square mile). Consequences are compared for each planning area using the following metrics:

- Property loss in dollars
- Contents loss in dollars
- Civilian fire deaths
- Civilian fire injuries
- Number of fires that spread beyond the room of origin (more serious structure fire)

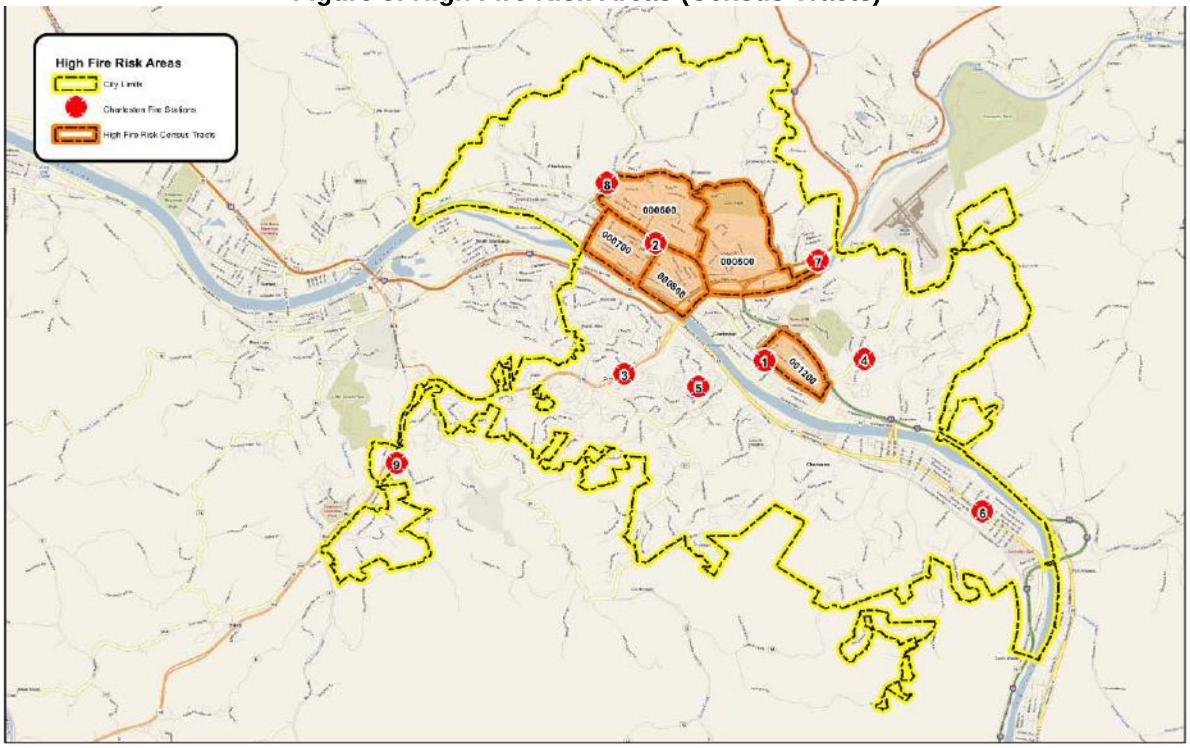
Table 4: Fire Risk Classification by Planning Areas, 2007-2010

	Fires	(per sq mi)	Beyond Room	(% of fires)	Property Loss	(per sq mi)	Contents Loss	(per sq mi)	Deaths	(per sq mi)	Injuries	(per sq mi)
Tract 100	7	10.8	5	71	$160,000	$245,891	$20,000	$30,736	0	0	0	0
Tract 10100	0	0	0	–	$0	$0	$0	$0	0	0	0	0
Tract 1100	7	1.3	4	57	$30,800	$5,913	$5,000	$960	0	0	0	0
Tract 11000	2	19	0	0	$0	$0	$0	$0	0	0	0	0
Tract 11301	0	0	0	–	$0	$0	$0	$0	0	0	0	0
Tract 11401	0	0	0	–	$0	$0	$0	$0	0	0	0	0
Tract 11500	0	0	0	–	$0	$0	$0	$0	0	0	0	0
Tract 1200	12	35.6	6	50	$217,000	$644,290	$10,500	$31,175	0	0	4	11.9
Tract 12300	0	0	0	–	$0	$0	$0	$0	0	0	0	0
Tract 12800	1	4.5	0	0	$0	$0	$0	$0	0	0	0	0
Tract 12900	0	0	0	–	$0	$0	$0	$0	0	0	0	0
Tract 1300	9	23.5	2	22	$218,000	$569,122	$2,000	$5,221	0	0	1	2.6
Tract 13000	0	0	0	–	$0	$0	$0	$0	0	0	0	0
Tract 13200	0	0	0	–	$0	$0	$0	$0	0	0	0	0
Tract 1500	7	4.6	4	57	$783,500	$516,961	$100,500	$66,311	0	0	1	0.7
Tract 1700	12	15	5	42	$218,000	$273,098	$30,000	$37,582	0	0	0	0
Tract 1800	7	1.6	6	86	$145,000	$33,677	$0	$0	0	0	0	0
Tract 1901	2	1.3	2	100	$35,000	$23,338	$0	$0	0	0	0	0
Tract 1902	6	2.1	6	100	$1,082,000	$385,516	$696,350	$248,109	0	0	0	0
Tract 200	11	4.2	9	82	$238,500	$91,607	$16,000	$6,146	0	0	2	0.8
Tract 2000	4	3.5	3	75	$75,000	$65,446	$11,000	$9,599	0	0	0	0
Tract 2100	6	3.8	1	17	$138,000	$87,167	$10,000	$6,316	0	0	0	0
Tract 300	19	5	15	79	$529,000	$140,214	$121,000	$32,072	0	0	0	0
Tract 500	20	16.6	15	75	$344,000	$284,978	$105,000	$86,985	0	0	1	0.8
Tract 600	32	36.3	23	72	$346,800	$393,367	$15,000	$17,014	0	0	1	1.1
Tract 700	32	66.6	21	66	$342,600	$713,061	$2,500	$5,203	1	2.1	0	0
Tract 800	18	38.8	11	61	$166,500	$358,713	$2,100	$4,524	0	0	0	0
Tract 900	8	12.6	1	12	$67,600	$106,652	$2,500	$3,944	0	0	0	0

We also normalized the consequence statistics by land area to make them more comparable between planning areas. Finally we color-coded each of the statistics using the normalized value. If the normalized value fell in the better 25 percent of values, it was color-coded green. If the normalized value fell into the worse 25 percent of values, it was color-coded red. The remaining values were left uncolored. Using this technique it is fairly easy to determine which planning areas have higher fire risks (higher probability and/or consequence of fire) and which planning areas have lower fire risks (lower probability and/or consequence of fire).

The results of this planning area fire risk analysis where fairly straightforward. The highest risk census tracts are 500, 600, 700, 800, and 1200 because they all had a “high” number of fires of which at least 50 percent spread beyond the room of origin. All of these areas also had significant dollar loss per square mile. Census Tract 1300 was left off the high-risk list because even though it had a high number of fires per square mile, only 22 percent spread beyond the room of origin and the dollar loss was effectively only categorized as “high” because of the large number of census tracts that had zero dollar loss. It should be noted that this finding is very much related to population density. Although we normalized the probability and consequence stats by land area, we did not take into account planning area population. The reason for this was simple. When considering where to appropriately locate fire stations (this chapter and the risk and demand chapter are somewhat a setup to the following station location chapter), it is important to consider the risk per unit of land rather than per capita because ultimately fire stations cover land and area. An area that has more people brings more fire risks and, ultimately, requires more fire department attention. The high fire risk tracts are mapped out in Figure 8.

Figure 8: High Fire Risk Areas (Census Tracts)



Risk and Demand Conclusion

The results of the analysis conducted in this chapter have essentially pointed to the same conclusion, that the areas along the northeast side of the Kanawha River have the highest emergency services demand and the highest fire risk. More specifically, we know that the area of highest risk and demand is located right around Station 2. Going forward it is unlikely that the areas of highest risk and demand will change much because population is expected to decline slightly and no major development areas have been identified within the city.

CHAPTER 3. STATION LOCATION AND RESPONSE TIME ANALYSES

Our response time analysis found times to be slightly higher than national standards, but still good. There are areas for response time improvement identified in this chapter, in particular turnout times. The station location portion of this chapter determined that the city's nine fire stations provide good coverage in their current arrangement but that improvements in performance and/or efficiency may be possible.

The major steps for a deployment analysis include a risk assessment (discussed in the previous chapter), working with the public and local government officials to determine response time goals for the community as a whole or by individual planning areas, and measuring current and potential performance against selected goals. The Center for Public Safety Excellence (CPSE) publishes an excellent reference that can be used by communities to understand the process and determine the choices available to them. Generally referred to as a "standard of cover" analysis, we used the CPSE methodology in the analysis of response time.

Deployment decisions concerning fire station and apparatus locations should be an iterative process largely based on continual or periodic performance measurement. Because the needs of Charleston do change, the recommendations made by this analysis should be considered as a step in a continuing process. Going forward, the fire department needs to be regularly conducting neighborhood-level performance measurement for the process to be effective.

Performance Measurement

As part of the planning process, CFD should work with city officials to decide the performance goals it considers right for the city overall and for each planning area. It will also need to find a reasonable response time and a reliability goal for each planning area (and each incident type).

Setting performance goals by planning area is one way to do this because risk factors can be matched with travel time and reliability goals. Then, if analysis shows a problem with response times (or reliability), further analysis can be done to determine the contributing factors. Ultimately, fire leaders need to understand why the desired goals are not being achieved in a particular area and the response situation for each fire station protecting that area before it makes changes to the system.

As stated earlier, the NFPA 1710 response time standard is based on typical fire growth rates and patient outcomes, primarily those involving cardiac arrest. The recommended time for the first unit to arrive under the standard for both fire and EMS incidents is six minutes (four minute travel time plus two minutes for call processing and turnout time). The time is based on research showing that a structure fire begins to grow exponentially after six minutes and individuals in cardiac arrest need defibrillation within six-minutes.

The problem with using standards "carte-blanche" is that they are sometimes overkill for the particular situation. For example, an area with a very young population might be okay with an eight-minute medical response time since the more serious and time-sensitive EMS calls occur less frequently. Likewise, an area with a large percentage of sprinklered buildings might not require as fast of a response as those in unprotected buildings. Planning areas where a majority of structures are equipped with sprinklers can have a lower performance goal (80 percent or even 75) applied as the acceptable goal.

Appropriate performance levels are very much based on the characteristics of individual planning areas. Fire department personnel are very good at determining appropriate response time and reliability goals. For its part, CFD should have its strategic planning team, and others within the fire department familiar with the various planning areas, recommend the response time goals for each of the city's planning areas.

Assessing Deployment Performance – Assessing fire department deployment is a difficult task because of the many factors that affect performance. A simplistic way of determining fire station locations would be to use a GIS program to map out four-minute coverage areas to make sure there are no coverage gaps. This method focuses entirely on the location of the fire station and would work well if the fire department only answered one call at a time. The problem of this approach for a city like Charleston is that some stations are busier than others and concurrent calls are common, especially during weekdays.

We recommend that Charleston use the Center for Public Safety Excellence (CPSE) Standard of Cover process to evaluate the overall performance in Charleston. The premise of this assessment method is that for each analysis area, there is a trade-off between unit availability and performance. Generally speaking, as the correct unit for a particular area becomes less available (due to other calls, training, etc.), performance for that area should decrease because outside responding units from other stations have further distances to travel. For this analysis two metrics are used:

- Unit Availability – The percentage of incidents where a unit from the correct station was available to handle the call and did so.
- Performance Level – The percentage of incidents where the travel time was at or below (faster) than the recommended goal.

Although performing this type of analysis was out of the scope of this study, we recommend that CFD familiarize them with this performance measurement methodology and use it to gauge station and unit location performance.

Reporting Deployment Performance – After taking the time to establish deployment goals for each neighborhood or demand zone, and learning some of the more advanced CPSE analysis methodologies, the last step is to establish regular reporting mechanisms. We recommend that Charleston Fire Department consider producing the following two types of reports:

- **Monthly Deployment Performance Report –** This report should be distributed department-wide each month. Such a report serves several very important functions. First, it provides information and data feedback to those entering in incident data; getting a detailed report that shows workload by units and response time performance can provide firefighters the ability to gauge and challenge themselves to better performance (e.g. one engine crew has had the slowest turnout time in the past few month and makes it their goal to be in the top three engine companies for turnout time). Also, putting out a monthly report provides an excellent error checking mechanism, as firefighters will be the first to notice and announce any problematic performance stats. Finally, having somebody try and pull together some stats with Excel for an annual report is asking for problems. The reason for this being that you cannot truly be familiar with data only looked at once a year. Putting together monthly reports ensures that the fire department is on top of its data collection and performance measurements.
- **Annual Deployment Performance Report –** Where the monthly report can be fairly short and limited to some simple workload and response time results, we recommend a more in-depth annual report. The report should be setup so that department leaders can review deployment performance for the entire system and each individual planning area. The report should be setup to note performance changes/trends in specific planning areas so that fire department officials are in good position to recommend near and long-term deployment modifications. We strongly recommend that this annual performance measurement report reflect most of the analysis types found in the CPSE Standards of Cover Manual.

Charleston Response Times

Response time is the most common performance measure used by the fire service because it is understood by citizens, easy to compute, and useful in the evaluation of end results. Rapid response is also an aspect of the quality of service that most citizens care about. NFPA 1710 provides generally accepted response time standards for career fire departments, though there is no single set of nationally accepted response time standards. Many communities choose to develop their own response time goals in light of what is currently achieved and what it would take to improve them. There have been a few attempts to measure the incremental value of a minute faster response time for fires and EMS calls, but there is no definitive study of the incremental benefit. Faster is better, but it is unclear how much better in terms of dollars or lives saved. In place of true measures of fire rescue service outcome, response time is often used as a proxy measure.

Most fire departments use the NFPA 1710 standard as a goal, not as a prescriptive requirement. Few departments are currently meeting or exceeding NFPA 1710, especially with respect to travel time (which is the hardest to improve). In this response time analysis, we show average times, 80^{th} percentile times and 90^{th} percentile times to show how different calculation methods provide drastically different measures of performance. Average response times have been increasingly less used by the emergency service industry because small numbers of very short or long response times (or data errors) can distort the results. **Although we show average response times because people typically understand them better than fractile times, fire departments should never gauge performance strictly on average response times.** The public is interested in how fast a system responds to most calls, which is better reflected in fractiles rather than averages. More and more departments are adopting the 90th percentile for reporting response times (mostly due to NFPA 1710's use of this measure). However, meeting the 90^{th} percentile goal is not always the most efficient means for delivering emergency services. A 90^{th} percentile response time of *x* minutes means that, at least 90 percent of the time, emergency crews arrive in less than *x* minutes. A system designed for 90 percent compliance allows only 10 percent of calls to have response times that exceed the target goal time. Although it is certainly possible to design a system with 90 percent compliance for all areas of a jurisdiction, it is usually not a cost-effective strategy. Urban areas close to several fire stations should have high compliance, but it does not always make sense to dictate such high compliance for suburban and rural areas (NFPA 1710 even acknowledges that it would not make sense to apply 1710 goal times to more rural areas).

Although NFPA 1710 recommends a 90 percent compliance with their goal times, we typically judge department response times at an 80^{th} percentile level instead. There are several reasons for this. First, we subdivide our analysis into incident types and geographic areas (which most departments do not do). Ninety percent compliance in each of these subdivided areas would result in much higher than 90 percent compliance citywide. Second, departments that do not have rigorous data quality controls will typically have more calls with incorrectly long response times than incorrectly short response times. Because 90 percent compliance is very difficult to achieve, we use 80 percent compliance to account for some erroneous data. Finally, almost no departments achieve 90 percent compliance as recommended in NFPA 1710. Achieving NFPA 1710 at 90 percent compliance is a great goal but, in our professional judgment, using 80 percent compliance is a more appropriate measure of current performance [The CPSE Standards of Cover Manual also uses 80^{th} percentile times for assessing station location performance]. Ultimately the best way of determining appropriate performance measurement metrics is for the city and fire department officials to set those metrics for each individual planning area.

The analysis of response times for Charleston included only incidents dispatched as an emergency (we eliminated service calls from the response time analysis). Our analysis included only frontline pumping and aerial apparatus for fire incidents and only first-response capable units for EMS calls. These criteria were applied to keep the analysis in line with the NFPA 1710 standards specifications

For all time segments, we analyzed one year's worth of data as specified earlier in this chapter. We eliminated those time segments that were more than three standard deviations from the median (outliers). Three times the standard deviation was used because if travel times had a normal probability distribution, 99.7 percent of incidents are expected to fall within three standard deviations. Anything more than three standard deviations is likely to be an error in the data or a highly unusual situation. Each response time segment is analyzed both by hour of the day and incident type.

Call Processing or Alarm Handling Time – According to NFPA 1710, the Alarm Handling Time is the "time interval from the receipt of the alarm at the primary public safety answering point (PSAP) until the beginning of the transmittal of the response information via voice or electronic means to emergency response facilities (ERFs) or the emergency response units (ERUs) in the field." Metro 911 is currently unable to accurately record this full time segment because the phone system is unable to pass call-received times to the CAD system. This is not an uncommon problem for dispatch centers, but one that ultimately has to be fixed. **This report's call-processing time only accounts for the time it took for the dispatcher to dispatch a call and does not include the time it took for call takers to take down information and pass it to the dispatchers.**

NFPA 1710 (4.1.2.3.3) specifies that "the fire department shall establish a performance objective of having an alarm processing time of not more than 60 seconds for at least 90 percent of the alarms and not more than 90 seconds for at least 99 percent of the alarms, as specified by NFPA 1221." Figure 9 and Table 5 shows the call processing times by time of day and incident type and they do not come close to meeting this standard. The 90^{th} percentile call processing time for all fire and EMS calls is currently 4:26. The analyzed time is over four times the 60-second standard and does not even include the call-taking time. When trying to reduce total response times, it is much cheaper to address the call processing component than the travel time component (which generally requires building additional stations and staffing additional units). It appears that very significant response time improvements may be realized from revamping the dispatch center.

Figure 9: Call Processing Time by Hour of the Day, CY2010

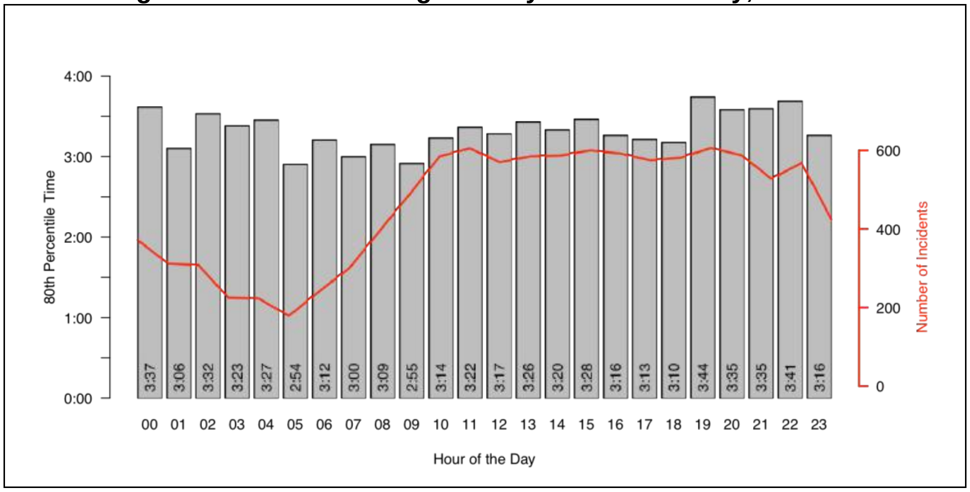


Table 5: Call Processing Time by Incident Type, CY2010

Incident Type	Average	80th Percentile	90th Percentile
Emergency medical service	2:26	3:22	4:28
Fire & special operations	2:02	2:58	3:56
(all)	2:24	3:20	4:26

Turnout (or Reaction) Time – NFPA 1710 defines turnout time as "the time interval that begins when the emergency response facilities (ERFs) and emergency response units (ERUs) notification process begins by either an audible alarm or visual annunciation or both and ends at the beginning point of travel time." The standard specifies a "90 second turnout time for fire and special operations response and [a] 60 second turnout time for EMS response."

Figure 10 and Table 6 show the turnout times by time of day and incident type. It appears that current turnout times are not meeting the stated standards. For fire and special operation responses, the 80th percentile turnout time of 2:44 is almost twice the 90-second standard. For EMS responses, the 80th percentile turnout time of 2:00 is twice the 60-second standard. Turnout times need to be drastically improved.

Figure 10: Turnout Time by Hour of the Day, CY2010

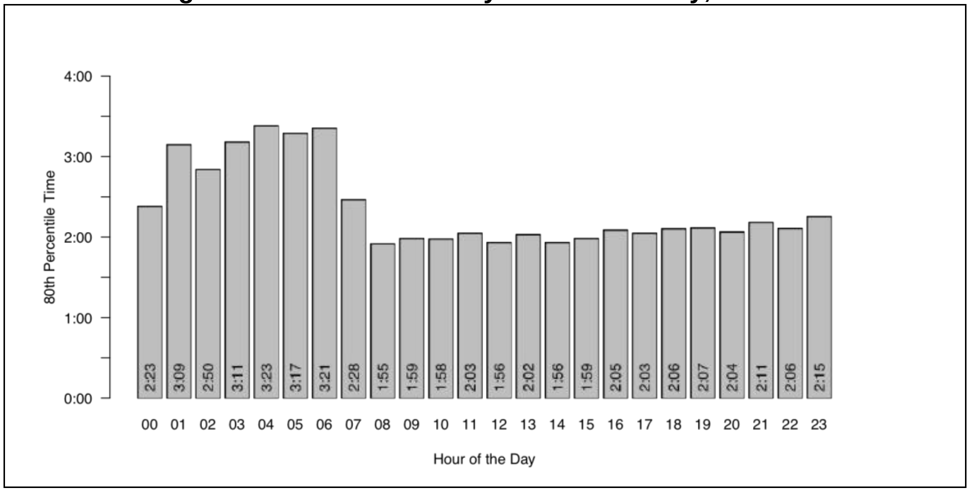


Table 6: Turnout Time by Incident Type, CY2010

Incident Type	Average	80th Percentile	90th Percentile
Emergency medical service	1:20	2:00	2:41
Fire & special operations	1:51	2:44	3:15
(all)	1:26	2:12	2:52

Travel Time by Hour of the Day and Incident Type – Travel time is the time interval that begins when a unit is en route to the emergency incident and ends when the unit arrives at the scene. Travel times are a function of geography, road conditions, traffic/congestion, and the number of and location of fire stations with respect to the location of actual calls. NFPA 1710 recommends "240 seconds or less travel time for the arrival of the first arriving engine company at a fire suppression incident" and "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."

At the 80th percentile level, travel time for all emergency incidents was 8:48, about four minutes above the NFPA travel time recommendations. The travel times were much faster (5:41) for fire and special response incidents and significantly slower for EMS incidents (9:03). Although overall citywide travel times are significantly slower than the NFPA standard, this is mostly the result of slow EMS responses. Because Charleston runs a significant number of single-ambulance responses and the ambulances are commonly busy and out of place, this is not surprising. We later recommend that additional ambulances be added to alleviate ambulance workload and attempt to bring down this travel time hike that comes from commonly having units out of place. In terms of evaluating station locations, the time of 5:41 for fire and special operations responses is a much better indicator (because fire units are less likely to be out of place due to high workload). 5:41 is still higher than the NFPA recommended time of four minutes, but is in line with what many other fire departments are achieving. The NFPA standard is an excellent goal time; however, few fire departments actually meet the standard.

Figure 11: Travel Time (First Arriving Unit) by Hour of the Day, CY2010

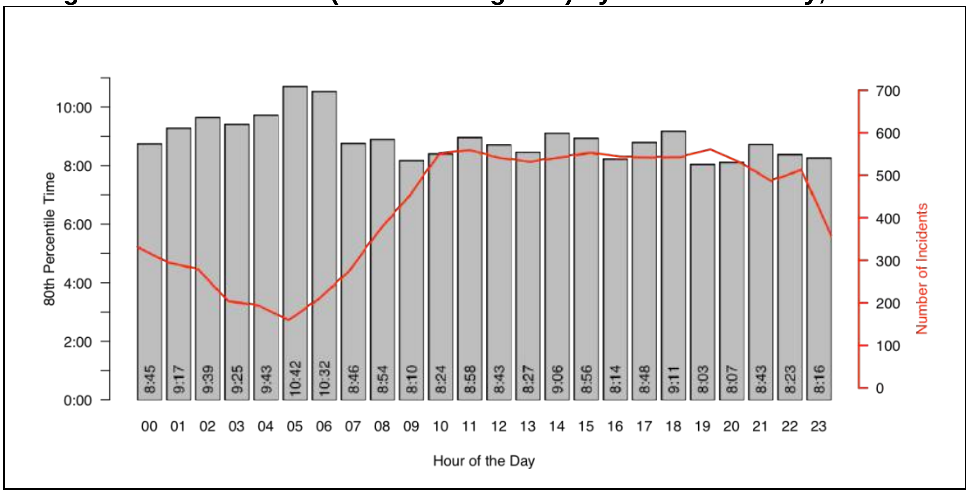


Table 7: Travel Time (First Arriving Unit) by Incident Type, CY2010

Incident Type	Average	80th Percentile	90th Percentile
Emergency medical service	6:22	9:03	11:11
Fire & special operations	3:58	5:41	7:38
(all)	6:09	8:48	10:59

Total Response Time – Total response or reflex time is the most important time segment because it combines all the previously analyzed time segments and is the measure by which the public evaluates the effectiveness of fire and EMS service. The NFPA defines total response time to include three phases: "(1) Phase One – Alarm Handling Time, (2) Phase Two – Turnout Time and Travel Time, and (3) Phase Three – Initiating Action/Intervention Time." Because "phase three" is not currently being recorded by CFPD, we defined total response time for this analysis as the time interval from the receipt of the alarm at the primary PSAP to when the first emergency response unit arrives at the scene. The total response time should be less than 6:00 for EMS calls (60 second alarm handling + 60 second turnout + 240 second travel) and 6:30 for other calls (60 second alarm handling + 90 second turnout + 240 second travel).

Figure 12 shows the total response time for the first unit to arrive at an emergency by incident type. At the 80th percent level, the total response times are 7:21 over the standard for EMS incidents and 3:37 over for fire and special operation incidents. Overall, these response times are very slow and need to be addressed. For Charleston, it appears that improving call-processing times and turnout times would be the easiest and cost-effective method by which to improve total response times.

Figure 12: Total Reflex Time (First Arriving Unit) by Hour of the Day, CY2010

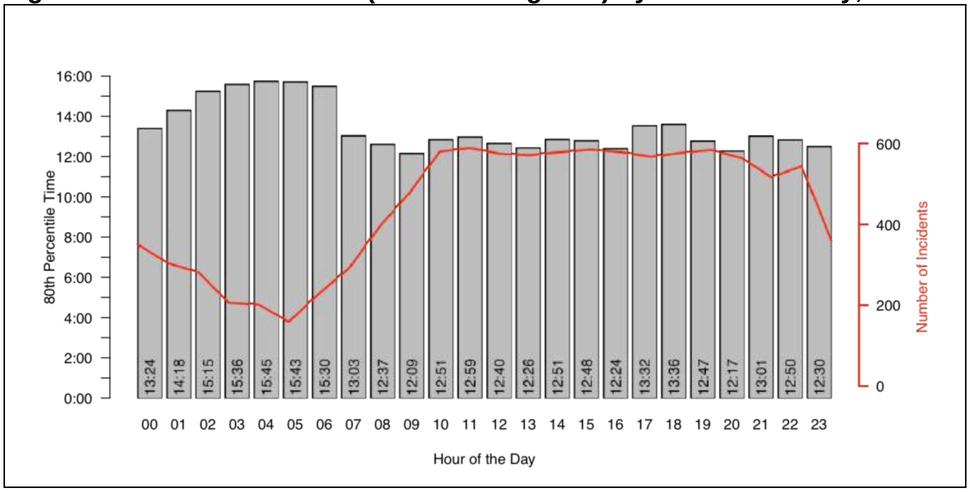


Table 8: Total Reflex Time (First Arriving Unit) by Incident Type, CY2010

Incident Type	Average	80th Percentile	90th Percentile
Emergency medical service	10:18	13:21	16:05
Fire & special operations	7:38	10:07	12:55
(all)	10:04	13:10	15:52

Workload Analysis

In this section we look at the call volume and workload for each fire station and unit. As explained in previous section, these factors affect performance and reliability. For example, a fire station first-due area with a high workload, such as fire stations 1 or 2, might continue to meet response time goals even if the primary unit is often unavailable. The reason being other nearby stations can also cover the area adequately. However, other first-due areas (Fire Station 9) may be more susceptible to workload increases because a larger distance between stations means that other stations cannot adequately cover their calls if the primary unit is unavailable. Table 9 shows the run totals by station and unit type for the previous year.

Table 9: Responses by Station and Unit, CY2010

Station and Unit	Ambulance	EMS Supervisor	Engine	Rescue	Truck
ST1	4206	–	2265	1668	1262
ST2	–	1337	2235	1316	925
ST3	–	–	1158	–	–
ST4	–	–	1441	–	–
ST5	–	–	1033	–	–
ST6	2931	–	1453	–	–
ST7	4208	–	1224	–	–
ST8	3892	–	1521	–	–
ST9	–	–	561	–	–

We can see from this table that stations 1 and 2 were the busiest with around 2,000 annual runs (excluding the ambulance, rescue, and truck from these stations because they have larger and not station-specific first-due areas). With the exception of Station 9 (which had only 561 responses), the rest of the stations all had about ½ to ¾ the call volume of the busiest stations. Figure 13 and Table 10 show the workload and call types for each of the individual units. Table 11 provides additional workload statistics for each unit. Please note that all of these workload tables show slightly fewer responses than were shown in the responses by station and unit matrix above. This discrepancy is the result of eliminating a certain number of responses for either a negative utilization time (clear time earlier than dispatch time) or a utilization time greater than three standard deviations from the mean (likely an error).

Figure 13: Workload (Unit Hours) by Unit and Incident Type, CY2010

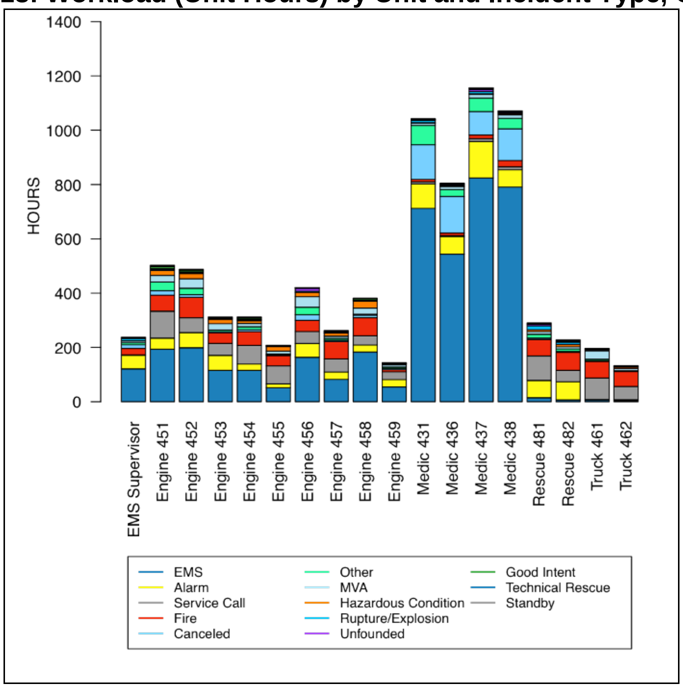


Table 10: Unit Workload (Unit Hours), CY2010

	EMS	False Alarm	Service	Fire	Canceled	Other	MVA	HazCond	Rupt/Explosion	Unfounded	Good Intent	TechRescue	Standby	(all)
EMS Supervisor	121.1	50.0	1.9	23.8	12.8	7.6	6.3	1.2	8.2	2.5	1.3	0.3	1.0	237.9
Engine 451	193.7	40.7	99.0	59.4	16.6	31.4	24.5	18.3	4.3	2.9	7.4	3.6	0.4	502.3
Engine 452	198.8	56.0	54.6	75.2	9.8	23.6	34.8	18.6	3.7	3.6	5.8	2.8	0.1	487.5
Engine 453	115.8	54.9	44.3	39.2	4.4	5.4	23.4	16.0	1.7	1.7	3.4	1.1	0.5	311.8
Engine 454	115.8	23.1	68.4	51.0	7.0	10.7	12.1	10.1	3.5	2.0	4.4	2.7	1.2	312.1
Engine 455	51.4	14.4	66.3	38.1	2.6	3.2	10.3	16.4	1.5	1.0	1.4	0.9	0.6	208.2
Engine 456	163.7	50.9	44.1	41.5	20.3	27.6	39.0	15.8	4.3	11.0	1.9	0.6	0.0	420.6
Engine 457	82.3	27.3	48.0	63.9	5.2	6.7	8.1	12.1	0.0	3.4	2.4	2.4	0.3	261.9
Engine 458	183.3	25.7	34.0	66.8	9.4	3.4	22.3	25.8	3.0	1.0	4.8	1.5	0.2	381.2
Engine 459	54.6	27.1	28.6	7.8	4.3	5.3	8.3	3.3	0.6	1.3	1.8	0.3	0.5	143.9
Medic 431	712.2	90.0	8.0	8.6	127.8	70.8	8.4	1.9	8.0	2.3	1.8	1.1	1.8	1042.8
Medic 436	543.9	64.8	3.7	9.6	134.5	25.4	10.9	1.3	3.6	3.8	2.7	0.2	0.0	804.4
Medic 437	824.4	134.3	10.4	13.7	85.9	49.7	13.9	1.8	8.3	7.7	4.3	0.4	0.9	1155.7
Medic 438	790.7	63.5	10.9	23.4	116.5	39.0	12.5	4.4	2.4	4.2	1.7	0.8	0.8	1071.0
Rescue 481	14.7	63.6	90.5	60.5	4.9	14.3	9.9	6.9	14.2	5.2	2.0	2.8	0.5	290.0
Rescue 482	6.8	67.0	42.0	66.2	3.2	9.4	7.7	8.9	8.4	2.8	1.8	2.0	1.4	227.6
Truck 461	6.2	1.8	79.5	61.4	2.0	5.4	31.0	2.0	2.8	0.4	0.7	3.0	0.4	196.7
Truck 462	3.4	3.8	49.1	55.3	0.8	1.8	7.9	5.9	1.1	1.1	0.9	1.7	0.0	132.9
(all)	4182.7	859.0	783.3	765.3	568.2	340.8	291.2	170.8	79.9	58.1	50.5	28.2	10.6	8188.6

Table 11: Workload Statistics by Unit, CY2010

	Total Runs	Runs per Day	Total Unit Hours	Unit Hours per Day	Unit Hours per Run
EMS Supervisor	845	2.3	372	1.0	0.44
Engine 451	2169	5.9	529	1.4	0.24
Engine 452	2167	5.9	520	1.4	0.24
Engine 453	1090	3.0	328	0.9	0.30
Engine 454	1381	3.8	339	0.9	0.25
Engine 455	994	2.7	239	0.7	0.24
Engine 456	1384	3.8	459	1.3	0.33
Engine 457	1157	3.2	284	0.8	0.25
Engine 458	1456	4.0	404	1.1	0.28
Engine 459	530	1.5	162	0.4	0.31
Medic 431	3800	10.4	3138	8.6	0.83
Medic 436	2704	7.4	2558	7.0	0.95
Medic 437	3784	10.4	2908	8.0	0.77
Medic 438	3548	9.7	2932	8.0	0.83
Rescue 481	1539	4.2	327	0.9	0.21
Rescue 482	1229	3.4	247	0.7	0.20
Truck 461	1141	3.1	211	0.6	0.18
Truck 462	827	2.3	144	0.4	0.17
All Units	31745	87.0	16101	44.1	0.51

The engines at Stations 1, 2, 6, 8 are the busiest but, still only average between 1 and 1.5 unit hours of emergency work daily. We would consider these engines to have low to moderate workloads. The remaining engines have low workloads.

The trucks and rescues all average less than a unit hour of emergency work daily and would be consider to have low workloads. Finally, the ambulances have the highest workload by far, averaging between seven and nine hours of emergency work daily, which is high.

The takeaway from this section is that, besides the ambulances, none of the units are particularly busy. While city officials often want to assume this means units can be simply eliminated and workload consolidated, it does not quite work that way. Often units are required, despite low workloads, to maintain response time goals. In the following section we will pull together our understanding of risk, demand, response times, and workload to decide if any station/unit consolidations are possible.

Assessment of Fire Station Locations

In this section we present an analysis of fire station locations using Geographic Information System (GIS) software (ArcGIS 10). GIS data for our analysis came from both the Metro 911 and ESRI. TriData also visited each fire station to get a feel for its location and overall condition. This allowed us to understand the location of the fire stations relative to the area protected, not just from a GIS map. Figure 14 shows the current location of the nine Charleston fire stations.

Figure 14: Current Fire Station Locations

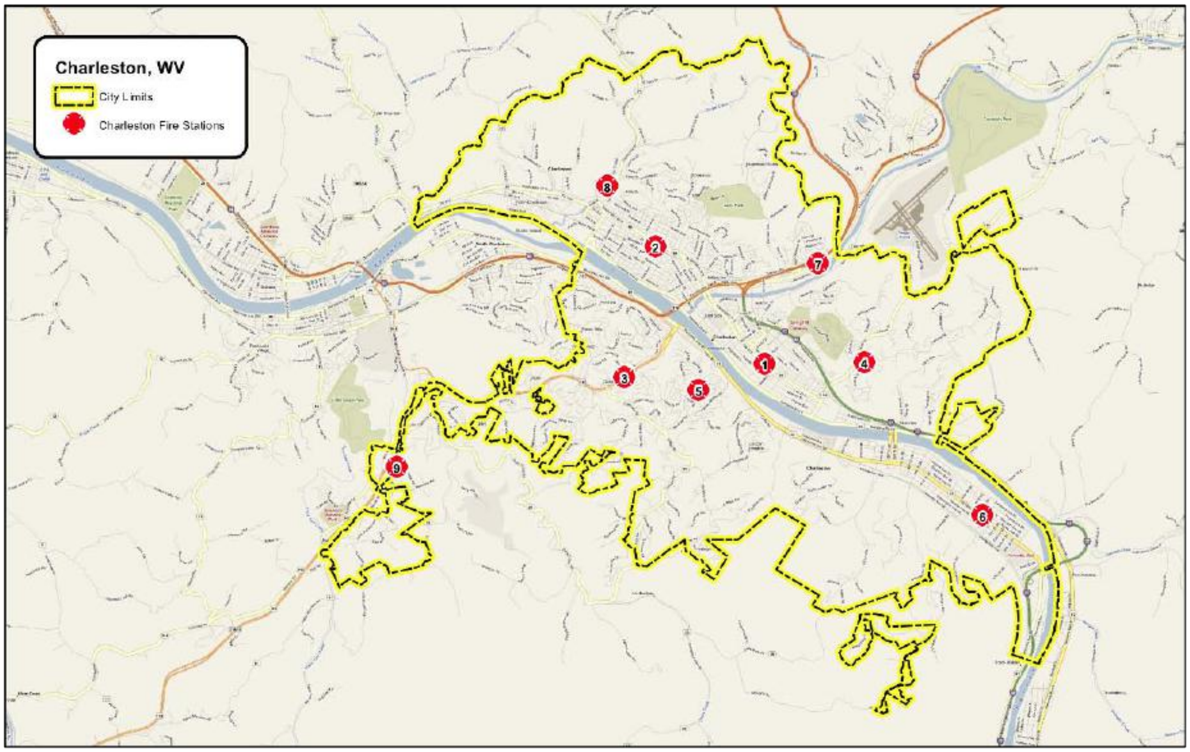
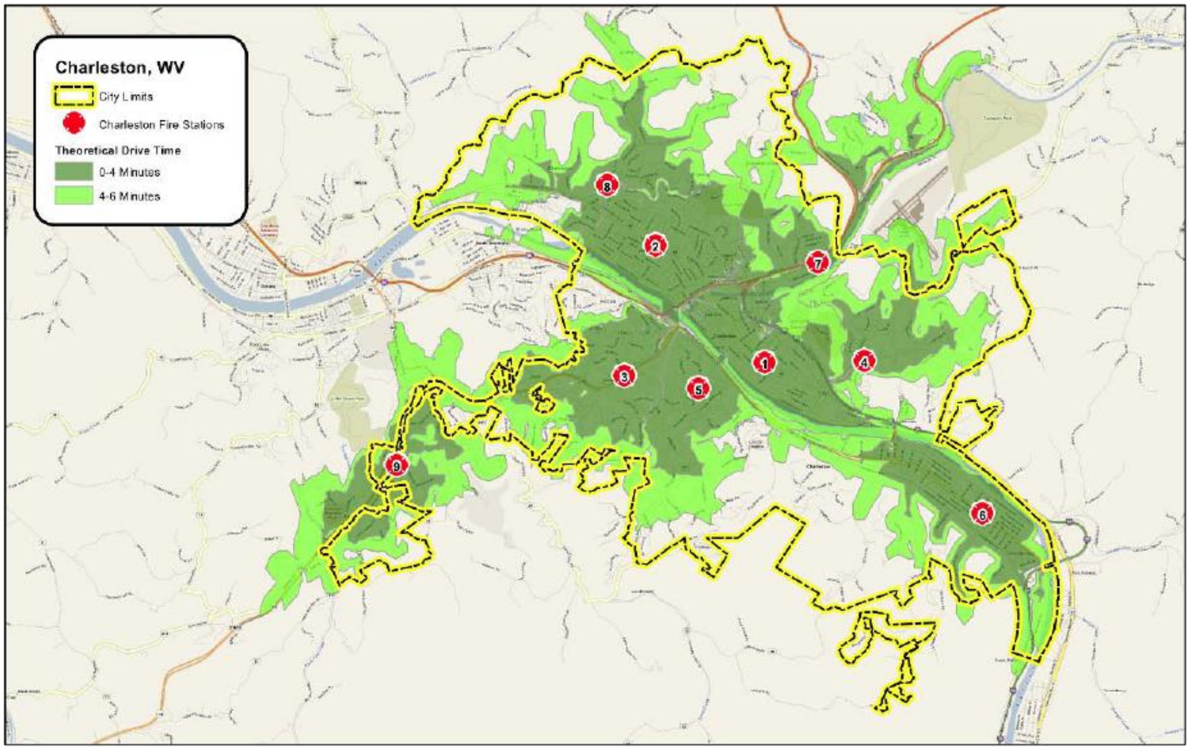


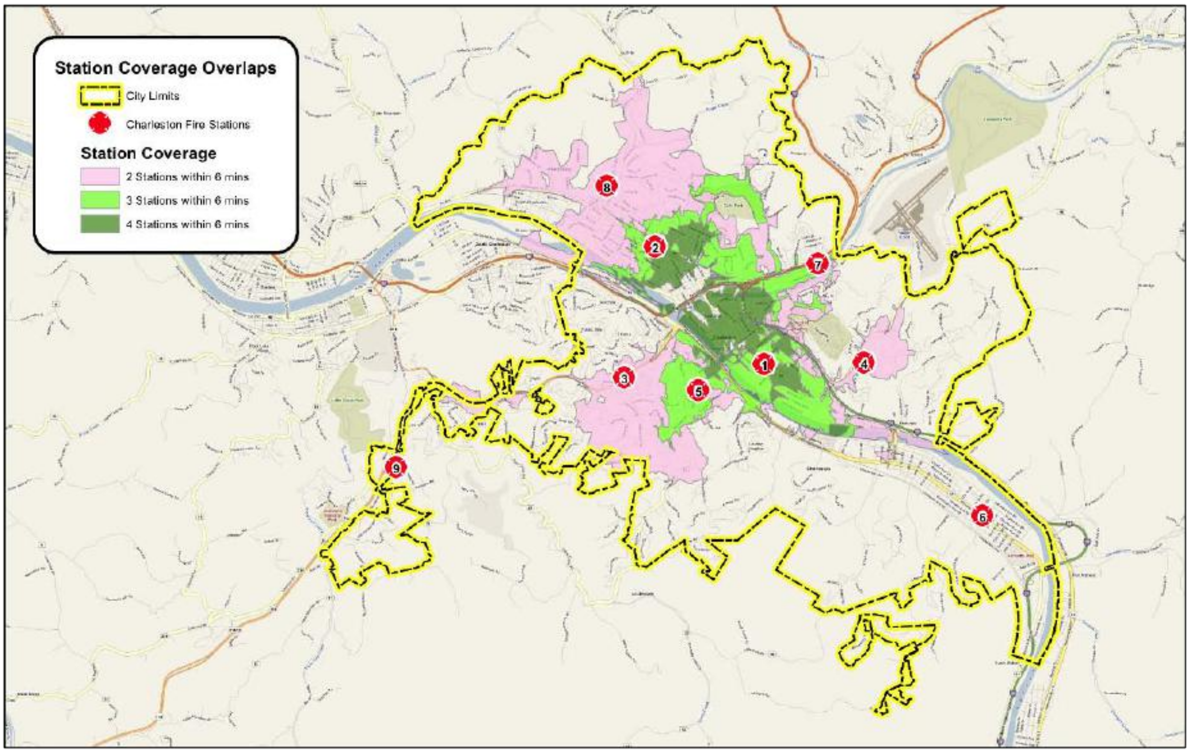
Figure 15 shows the theoretical travel time from each of the nine city fire stations. Areas in dark green can theoretically be reached in four minutes and areas in light green can be reached in six minutes. As stated at the outset of this chapter, the current configuration of fire stations provides good coverage, but stations are not necessarily optimally placed. Because several stations are located rather close to the jurisdiction boundary, it is likely that the same level of coverage can be achieved with fewer stations. Typically we discuss any coverage gaps that are found in the theoretical drive time analysis, but Charleston does not appear to have any major coverage gaps. There is a coverage gap in the southeast corner of the city. Because that area is relatively rural, it is not a huge concern (but something we will address later in the chapter nonetheless). All other parts of the city have a fire station with six minutes drive time and most of the city is within four minutes of a fire station. There are other coverage gaps seen along some of the outer perimeters of the city, but these are the result of areas that do not have roads.

Figure 15: Four- and Six-Minute Travel Time Analysis



Simply showing that there is adequate coverage from all the fire stations does not take into account that more than one incident often occurs at the same time in a first due area. Some coverage overlap is good in the areas of highest demand. Figure 16 shows that many stations can reach each part of the city within six minutes. Thinking back to the plots of fire and EMS incident density in the previous section, we remember that the vast majority of emergency services demand occurs along the southeast side of the Kanawha River. It is this area that we would want to have coverage from multiple stations, and it appears that is the case. Three to four different stations can reach the high-demand area between Station 1 and Station 2 within six-minute travel time. There does not appear to be much redundant station coverage overlap where the risk and demand level does not justify it.

Figure 16: Current Station Overlap



For this study we considered whether new stations were needed, whether existing stations should be moved, and whether station merger opportunities exist. The travel time map showed good theoretical response time coverage and the coverage overlap map showed good 6-minute response time overlaps in the highest demand areas. As stated earlier, we found that despite good coverage, there are some stations that are not optimally located for providing efficient emergency response coverage. In particular, stations 6, 7, and 8 seemed to be located to close to the jurisdiction boundary. It is a good practice to locate stations approximately four-minute travel time from boundaries to optimize their four-minute travel area (e.g. a station located directly on a boundary with no mutual aid first-due responsibilities, covers exactly half the area of a centrally located station that can travel in all directions). The goal of this station location analysis was to see if we could achieve the same theoretical travel time and station overlap coverage using fewer, but more centrally located stations.

Alternative Station Layout Scenarios

This has been long assessment process with lots of potential station location options evaluated and lots of feedback from stakeholders. The final part of this section provides our recommended conclusions/steps, but ultimately it is up to Charleston to figure out what they want to do. The following are different scenarios that were considered as part of the station location evaluation process:

What would be the optimal station layout if all stations could be moved? – We found that by moving stations 3, 6, 7, and 8 closer to the center of Charleston, it is possible to achieve nearly the same coverage as the current station layout with two fewer stations. Figure 17 shows the theoretical drive time map, which is essentially unchanged from the current configuration despite two fewer stations. We also wanted to make sure that this alternative configuration would not affect station overlaps (redundancy) for the high-risk and high-demand area on the northeast side of the river. Figure 18 shows that our alternative station layout would still have three stations within six-minute drive time of the high-demand area. We also considered the possible effect of workload redistribution on performance (a big concern when adding workload to already busy units). Because none of the Charleston fire units currently have high workload and coverage redundancy remains in the high-demand areas that are most likely to have concurrent calls, it is unlikely that workload redistribution would affect performance.

Figure 17: Alternative Station Layout with Theoretical Drive Times

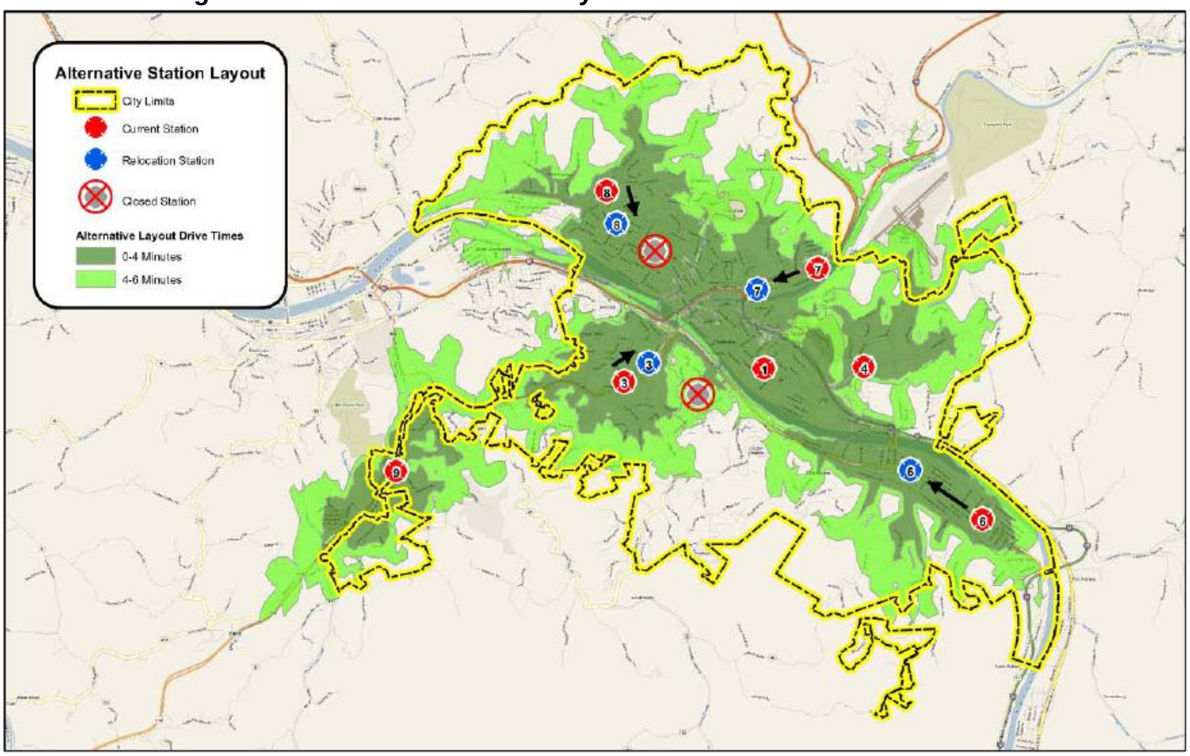
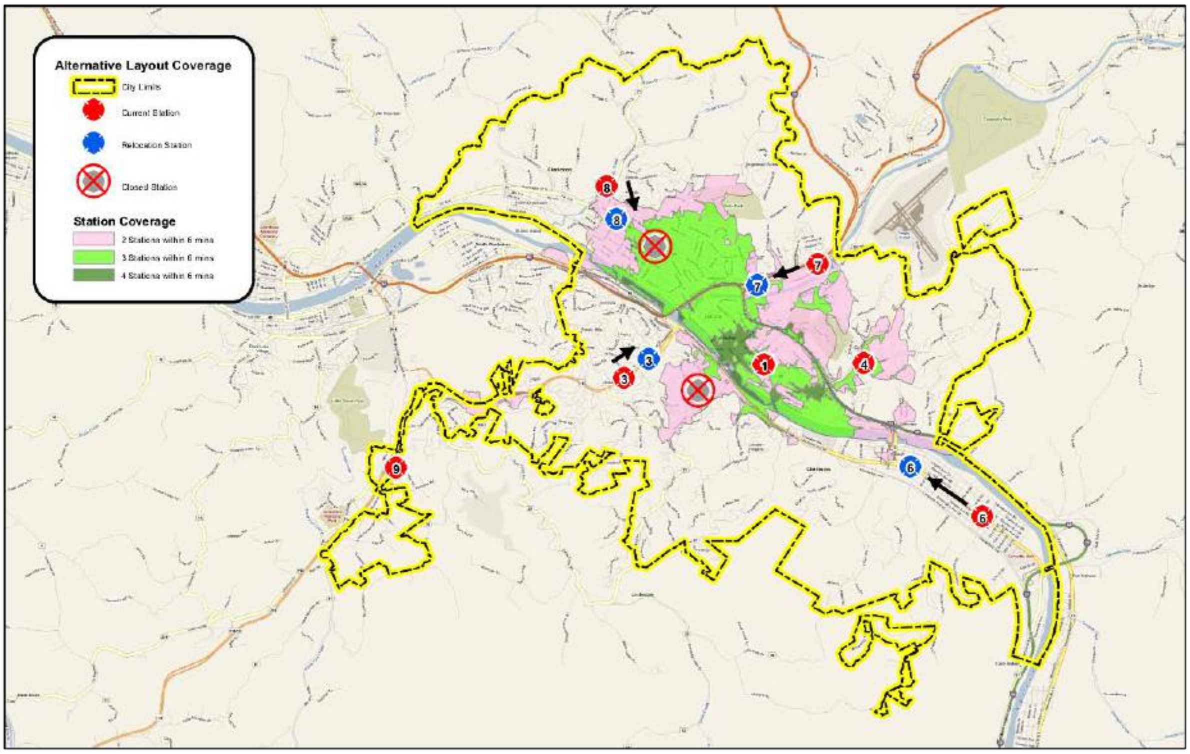


Figure 18: Alternative Station Layout with Station Coverage Overlaps



What are the most efficient station locations if Station 8 and Station 2 are left in their current positions? – If Stations 8 and 2 are left in their current positions, there is little room for efficiency on the north side of the river. There is, however, still an opportunity to increase performance by moving Station 7.

The difficulty with setting up a good station location layout on the north side of Charleston is that there are several outlying areas that are not very well connected. This requires that several stations be placed in otherwise less than optimal locations to provide adequate coverage to these disconnected far reaches of the city. To setup a good station location layout in Charleston, it is necessary to work from the outside in. The idea is to have all the stations as centrally located as possible while still maintaining good coverage to the outlying areas.

Station 4 is a good example of a station that is fairly well placed. To reach areas such as Hunting Hills Drive or Woodbridge Drive in a reasonable amount of time, Station 4 had to be placed north of the Greenbrier St and Interstate 64 intersection. Because Station 4 was placed just slightly north of this intersection, it can also quickly respond downtown. If Station 4 had theoretically been built on Woodbridge Drive, it would have still provided good first-due coverage for its area, but would not have functioned as a good backup for the higher-demand Station 1 area. The goal for an efficient and high-performance station layout is centrally locating all the stations to provide good citywide coverage and redundant coverage overlaps to the higher-risk and higher-demand downtown area.

Station 7 is poorly placed in its current position because it is located almost on the city limits. While it can provide good coverage for its first-due area, it does not serve as a redundant station for the downtown areas that are most likely to have concurrent calls. TriData felt that a much better (more central location) would be at 115 Lee Street West.

Relocating Station 7 to a more central location essentially creates a fourth downtown station. With an additional downtown station we looked at possible station mergers. We tried several different scenarios by slightly moving around Stations 1, 2, 7, and 8. The only scenario that did not create coverage gaps was to move Station 7 to the eastern side of the current Station 2 first-due area and move Station 8 in closer on the western side of Station 2. These two moves were the only rearrangement of downtown stations that would maintain good coverage throughout the north side of Charleston. However, because Station 8 was so recently built (and is actually in a pretty good position for its first-due area), it appears that there really are no good efficiency opportunities on the north side of the river. Charleston should continue to look at opportunities for station mergers, but it appears that opportunities are somewhat constrained by geography and road layout in the outlying portions of north Charleston.

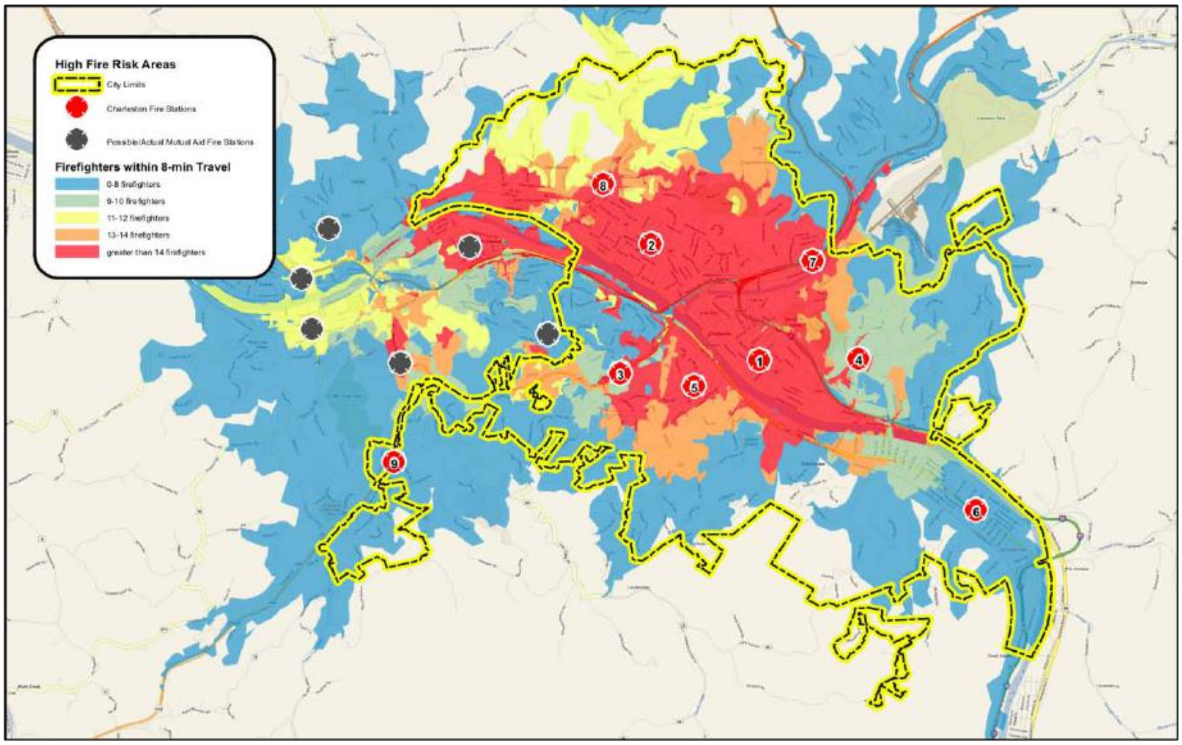
Should Station 9 be operated by South Charleston Fire Department? Would this require moving Station 3 more south towards Oakwood Road (around 7-11 area) instead of the Park-n-Ride area? – Station 9 serves an area that does not have a lot of fire stations nearby. If an incident were to occur right around Station 9, the following stations could respond in the listed time:

- South Charleston FD Station 4 – 4.73 minutes
- Charleston FD Station 3 – 9.19 minutes
- South Charleston FD 2 – 9.67 minutes
- South Charleston FD 1 – 11.35 minutes
- Dunbar FD 1 – 12.27 minutes
- Charleston FD Station 5 – 13.06 minutes
- South Charleston FD 3 – 13.06 minutes

Although this is the order of closest stations, it does not mean that all these stations would respond because automatic aid agreements are not in place for all these stations. It is important to know that the majority of the closest stations belong to South Charleston.

Our understanding is that currently there are areas in Charleston that South Charleston Station 4 provides automatic aid for and areas in South Charleston that Charleston Station 9 provides automatic aid. There are discussions about South Charleston taking over Station 9 and closing their Station 4. If this occurs, it means that there is now only one unit (assuming they do not run two units out Station 9) that is covering this joint Charleston / South Charleston that was previously covered by two units. For fires this is problematic as it appears that Charleston's Station 3 would be the next closest unit, but with an over nine minute travel time (11 minutes when adding in call-processing and turnout time). You can see in Figure 19, that this area has less than 8 firefighters within 8-minute travel time. If South Charleston Station 4 is closed, this would hurt complement staffing even more, and would likely mean that either Station 3 would need to be moved closer to this area or South Charleston would need to move one of their stations closer to this area.

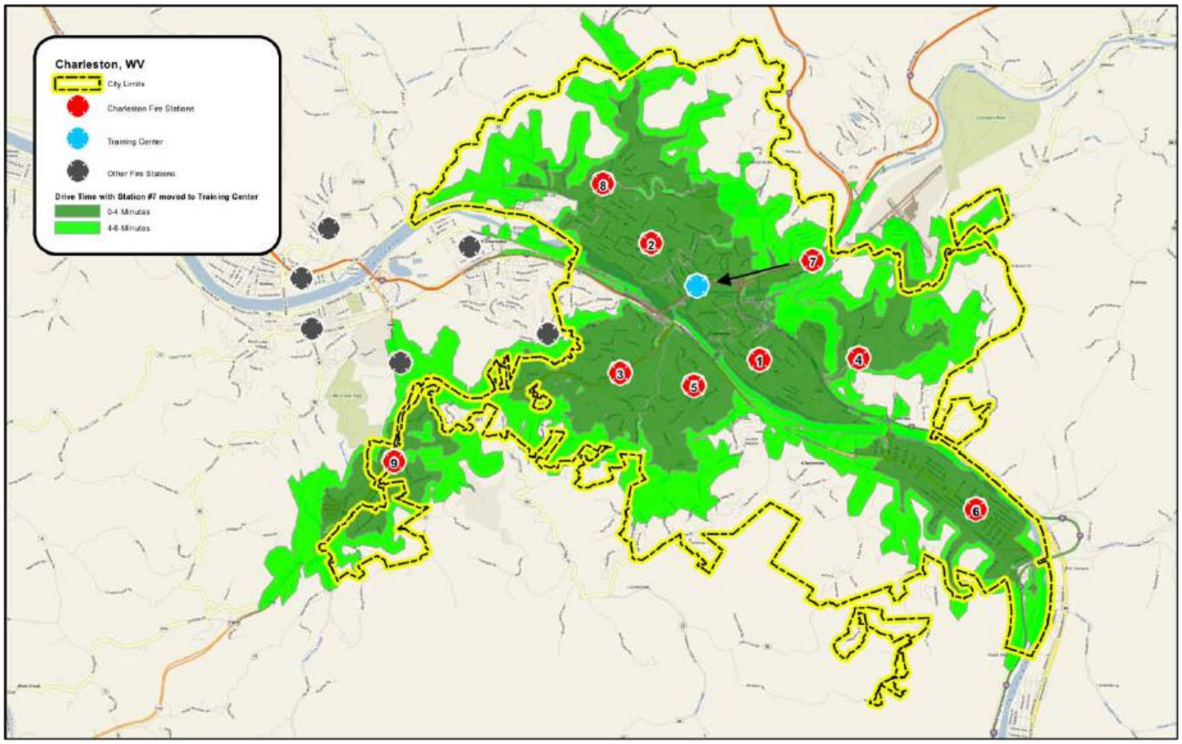
Figure 19: Current 8-min Travel Complement Staffing



From a management perspective it makes more sense for South Charleston to operate this station since most of the closest units are South Charleston units and from a command perspective it would likely make more sense to be under South Charleston command.

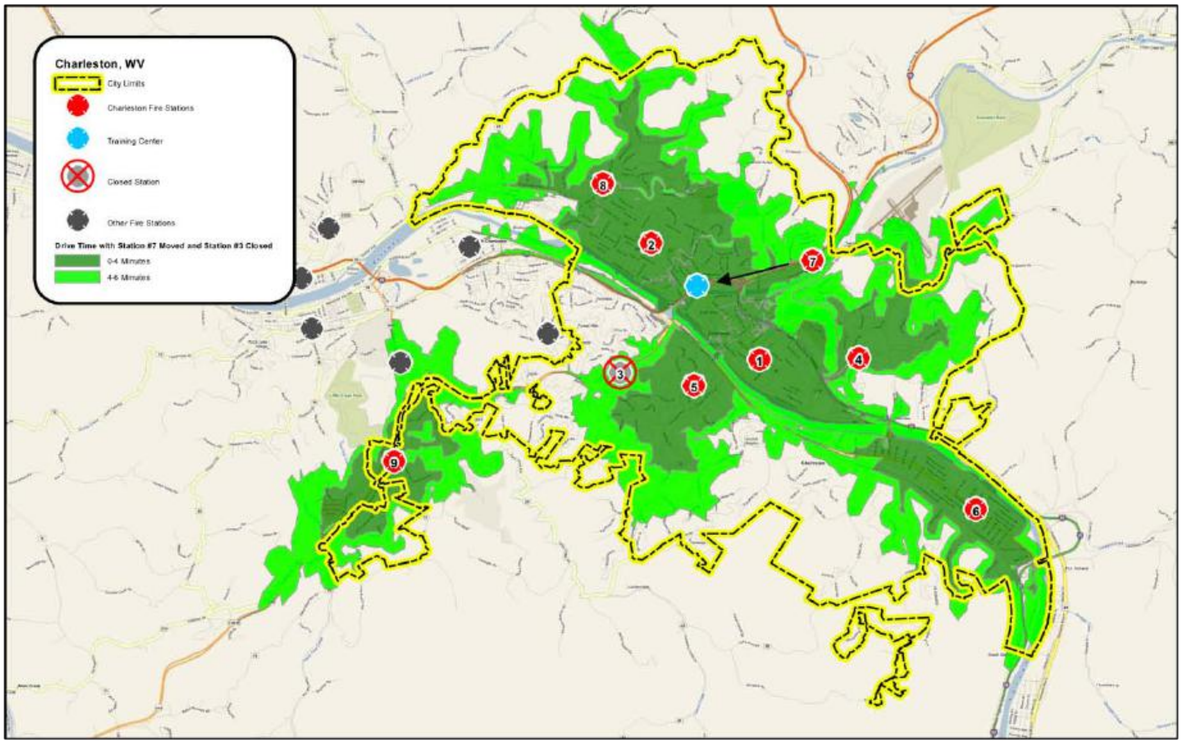
Could the Training Center be moved to Chandler Elementary and the Station 7 units relocated to the Training Center, which is already capable of housing an engine company? – This looks like a fairly good move, CFD should make sure that a unit could reach the north city boundary (near the current Station 7 location) in about 4-5 minutes travel time. Our theoretical GIS drive times show it to possible, but this should be verified. It may be that this location is almost too centrally located. If it is possible to provide good coverage to the northern city boundary, this is an excellent new location because it provides additional overlapping station coverage for the high-risk, high-demand downtown area and is better placed for crossing the river to the Southside of Charleston. This move does still beg the question if you really need Stations 8, 2, 7, and 1 all in such relative proximity.

Figure 20: Moving Station 7 to Current Training Center



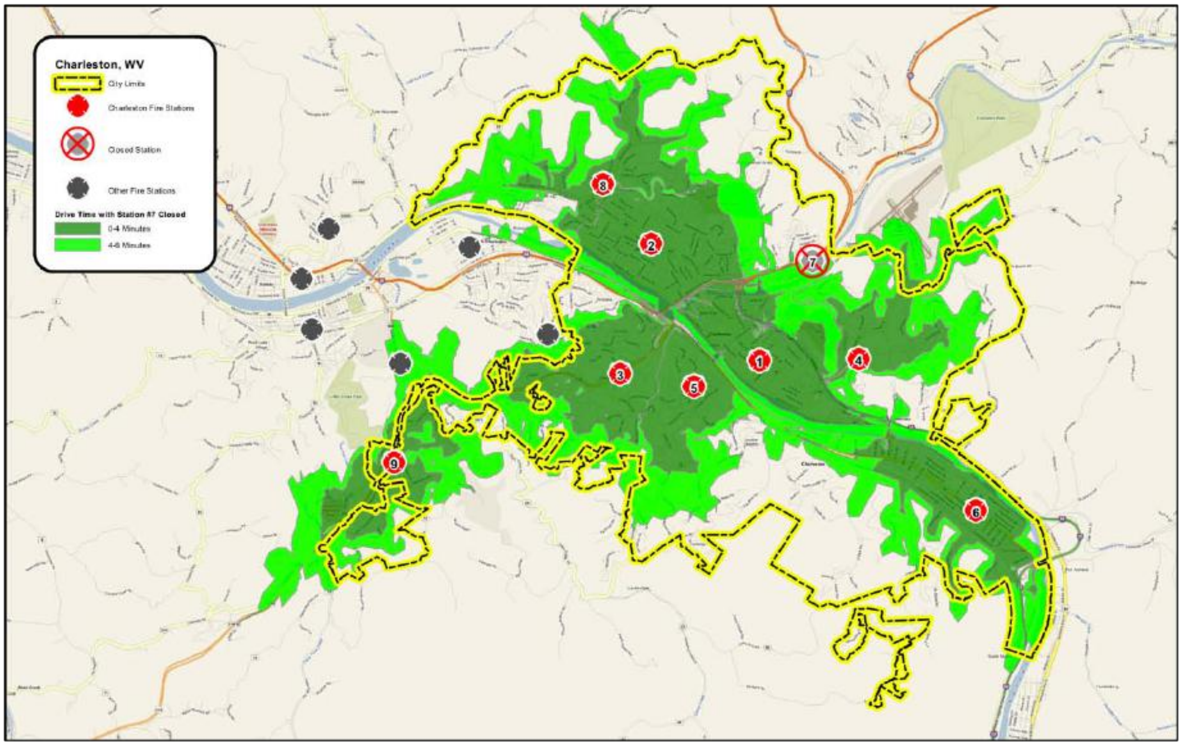
If Station 7 is relocated to the training center, could it cover the current Station 3 area if that station was eliminated (and Station 5 remained in place)? – This does not appear to work. Eliminating Station 3, even with a newly located Station 7 opens up a significant coverage gap as seen in Figure 21.

Figure 21: Move Station 7 to Current Training Center and Close Station 3



How would simply closing Station 7 affect coverage? – It is not a horrible scenario. In fact this may be a very serious possibility. It does leave the area right next to the current Station 7 location not quite covered within six-minutes as shown in Figure 22, but if the City of Charleston finds this to be an acceptable risk (and you really can never get 100 percent coverage), this may be an option.

Figure 22: Closed Station 7



Station Layout Conclusion and Recommended Steps

After looking at the many different station relocation scenarios, TriData felt that the following list of steps (in sequence) would make the most sense. We have attempted to work with the City of Charleston to look at and consider as many different scenarios as possible. We have provided in-depth explanation of both the pros and cons of each of these moves in the previous scenarios section. While these are the TriData recommendations, ultimately the City of Charleston has to decide how to best locate their stations for good coverage and good performance.

1. Transfer control of Station 9 to SCFD
2. Move Station 3 closer to Station 9 (assuming SCFD closes their Station 4)
3. Move Station 7 to the training center located at 115 Lee Street West or close it and staff all suppression apparatus with 4 personnel
4. Move Station 6 to a more central location near the hospital or the college
5. Staff a 5th ambulance and move to the new Station 3 when built. Until then, use situational location based upon call needs.
6. Evaluate closure of station 5 after relocation of station 3 and relocation of station 6. The critical need here is for complete call response time data, as generated by a new CAD system, to be sure coverage will be adequate for this downsizing.

CHAPTER 4. ASSESS FIRE AND EMS OPERATION

This chapter assessed the appropriateness of the bulk of staffing—the positions in operations—and hence the bulk of departmental costs. It evaluated the day-to-day operations of Charleston Fire Department with regard to emergency services staffing and service delivery. The chapter also included an evaluation of emergency staffing and response to calls for service. The report included measurements of current service level provision and recommends changes where needed. It provides an operational assessment of current fire department staffing, shift scheduling, and personnel deployment.

Overview

Charleston Fire Department is charged with emergency response to fire and medical emergencies, hazardous material mitigation and response and special rescue operations. This is the perceived primary role of the organization. Though the Charleston Fire Department functions well, there is room for improvement.

Charleston Fire Department Mission Statement

It is the mission of the Charleston Fire Department to provide maximum protection of life and property through the prevention and extinguishment of fires, provision of Emergency Medical Services, Hazardous Material response and Mitigation, Rescue, and performance of any other services to the citizens of Charleston that may be required to ensure a safe community.

The Fire Department works to attain this goal through preparation and training, dedication, public education, and a constant focus toward the end result -- a safe City of Charleston.

The Charleston Fire Department protects 50,267 people who live in an area of 33 square miles among the hills and valleys surrounding the Kanawha and Elk Rivers. Charleston is the Capital of West Virginia and is the state's largest, most populous city. Three interstates converge in Charleston, Interstates 64, 77, and 79 linking the Midwest cities to those in the North, East, and South. The metropolitan area surrounding Charleston is much larger, with more than 200,000 people converging into the city for work and recreation.

The Charleston Fire Department has an ISO public protection rating of class two and operated out of nine stations with 196 career personnel at the time of the TriData on site visit. These nine stations house eight Engine Companies, one quint, two Ladder Companies, two Rescue Companies and four Advanced Life Support Ambulance Units. The Fire Department is also home to the West Virginia Regional Response Team Task Force One and houses Building Collapse and Hazardous Materials Units. The department provides services in fire fighting, emergency medical services, vehicle rescue, technical rescue, hazardous materials, and water rescue. CFD is considered a full service fire department providing an all hazards approach to emergency incident management.

Station by Station Inventories

CFD station by station inventories of equipment and the resultant personnel assigned to these apparatus were at the time of the onsite visit:

Station 1 - 300 Morris Street

- Engine 451-2010 Pierce Pumper, mileage 2744, 3 personnel –Capt., Lt., FF
- Ladder 461-1999 Smeal Ariel straight ladder, mileage 48,224, 2 personnel-Capt., Lt.
- Rescue 481-2007 Spartan, mileage 77,110—2 personnel -Lt, FF
- Ambulance 431-2009 GMC 4500, mileage 28,289, 2 personnel-Paramedic, EMT
- Water Rescue 414-1995 GMC (old ambulance), mileage 93,433, not staffed unless needed

Station 2 - 808 Virginia Street West

- Engine 452-1998 Smeal/HME Pumper, estimated mileage 70,000, 3 personnel-Capt., Lt., FF
- Truck 462-2010 Smeal Aerial Platform, mileage 4519, 2 personnel-Capt., Lt.
- Rescue 482-2000 Ford F578, mileage?, 2 personnel- Lt., FF
- Shift Commander 450-2007 Dodge Durango, mileage 26626, 1 Asst. Chief
- Medic Supervisor 408-2009 Dodge Durango, mileage 33,306, 1 Capt.
- Fire Chief- 2006 Jeep Cherokee
- Administrative Assistant Chief- 2007 Dodge Durango, mileage 37,855
- Captain Fire Prevention-2004 Dodge Durango, mileage 79,707
- Lt. Public information-2002 Dodge Intrepid, 60,562
- FF Fire Prevention-1999 Crown Vic,
- 2003 Dodge Durango-used for fire investigator call out
- Pick- up truck-2001Dodge,
- 2005 Ford E350 Van,
- Mechanic’s garage is located here,
- housing spare ladder truck- 1990 Simon LTI platform,

- spare ambulance,
- shop truck- 2001 Dodge 3500
- Fire Safety trailer
- Command Trailer
- Unit 413- Mini Snout-inflatable rescue boat & trailer

Station 3 - 822 Oakwood Road

- Engine 453-2005 Smeal/HME Pumper, mileage 42,692, 3 personnel-Capt., Lt., FF
- Decon Trailer
- Responsible for Unit 411-fire boat on Kanawha River

Station 4 - 1810 Oakridge Road

- Engine 454-2004 Smeal/HME Pumper mileage 51,136, 3 personnel-Capt., Lt., FF
- Spare 1996 Smeal/HME Pumper,

Station 5 - 918 Bridge Road

- Engine 455-2009 Smeal/HME Pumper, mileage 11,247, 3 personnel-Capt., Lt., FF
- Utility/spare rescue Ford F550, mileage 7192, not staffed
- One of the Radio repeaters located here

Station 6 - 5008 MacCorkle Avenue, S.E.

- Engine 456-2001 Smeal/HME Quint, mileage 63,648, 3 personnel-Capt., Lt., FF
- Ambulance 436-2008 GMC, mileage 44,401, 2 personnel-Paramedic, EMT

Station 7 - 128 Cora Street

- Engine 457-2002 Smeal/HME Pumper, mileage 51,591, 3 personnel-Capt., Lt., FF
- Ambulance 437- 2007 Ford, mileage 92,343, 2 personnel-Paramedic, EMT

Station 8 - 208 Copenhaver

- Engine 458-2004 Smeal/HME Pumper, mileage 51,591, 4 personnel-Capt., Lt., FF, FF
- Ambulance 438-2006 GMC, mileage 100,849, 2 personnel-Paramedic, EMT
- Unit 418—USAR 2004 Freightliner ,mileage 3522, not staffed unless needed (State Owned)

- 3 Spare ambulances in basement

Station 9 - Camp Way, Southridge

- Engine 459-2000 Smeal/HME Pumper, mileage 62,839, 3 personnel-Capt., Lt., FF
- Unit 417- Hazmat- 2004 Freightliner, mileage 6012, not staffed unless needed (State Owned)
- Spare engine-1988 Ford 8000 Pumper,

Training Center - 115 Lee Street W

- Assistant Chief of Operations- Unit 403, 2006 Jeep Cherokee, mileage 69,522
- Unit 420-Safety officer-2004 Dodge Durango, mileage 57,939, 1 Capt
- Unit 419-2004 Freightliner, Light and Air truck (State Owned) not staffed unless needed
- Training Staff vehicles, 2002 Dodge Durango, 200 Chevy Impala
- Kawasaki Mule, off road/utility vehicle
- Hazmat trailer
- Mass Casualty trailer
- Foam storage

Wellness Center - 26th Street

- Gym and exercise equipment

Totals:

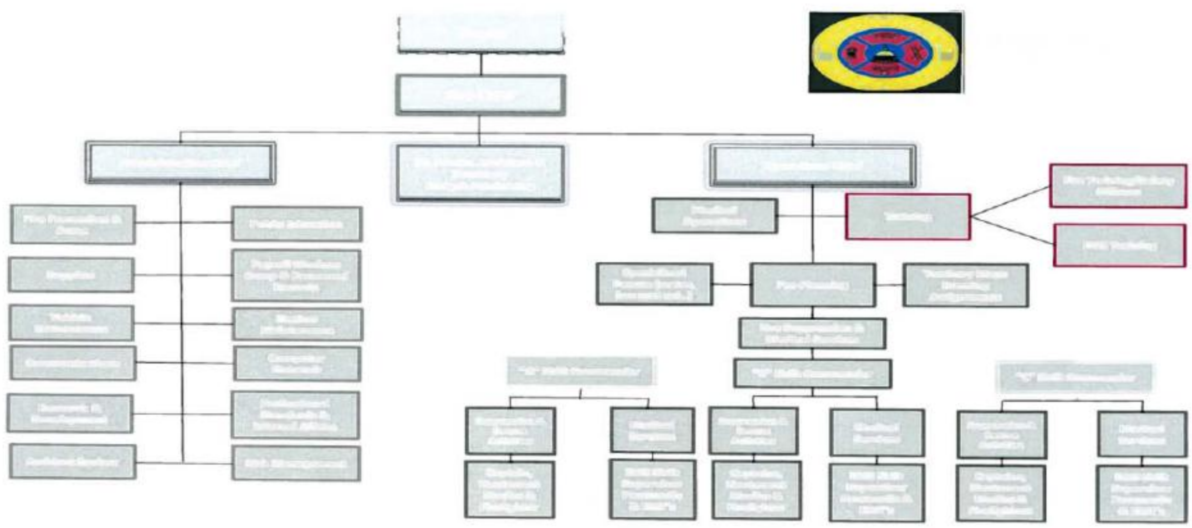
- 8 front line engines, 1 quint, + 2 reserve engines
- 4 ambulances + 4 reserve ambulances + 1 water rescue (ambulance)
- 2 aerial ladders + 1 reserve ladder + 1 Quint
- 2 Rescues + 1 reserve rescue
- 1 light & air unit
- 4 trailers (command, mass casualty, decon, Haz Mat)
- 1 boat
- 1 USAR response unit
- 1 Haz Mat truck

- 1 off road vehicle
- 12 staff vehicles

48 units TOTAL in CFD fleet inventory

Organizational Structure

Charleston Fire Department is under the direction of the mayor and administered by the Fire Chief. The Chief is supported by two Assistant Chiefs (administration and operations) as well as an administrative assistant and secretary. The Administrative Assistant Chief is responsible for all support functions of the department while the Operations Assistant Chief supervises fire, EMS, and training activities of CFD. The organizational structure is displayed in the organizational chart below. CFD organization structure is classic for a full service fire organization. The department has two main trees at the Assistant Chief level and the functional structures at the lower levels.



Organizational Communications

The foundation of all effective and efficient organizations is excellent organizational communications. Organizational communications can be separated into internal and external communications and organizational culture. Though separate, each of the three types of organizational communications directly affects the other mechanisms of communications.

Internal Communications – This is how well the organization can communicate within itself and how information moves through the structure of the organization. This includes formal and informal communications. The flow of information within the CFD is mostly well structured and formalized. There is a defined mechanism to give and get information, however, the current departmental orders (SOG'S) are dated and in need of review and updating. Additionally, there is no mechanism in place for a routine sharing of information from administration to all levels of the department such as a weekly letter from the Chief to all personnel to disseminate pertinent information concerning the good of the order. Developing such a regular communications instrument would benefit the department.

External Communications – This describes how well the organization communicates with other entities. CFD has some routine communications with other departments in the City as well as outside agencies. Key among the outside agencies is the 911 PSAP and the County EMS department. The local hospitals are also a key stakeholder for CFD. These external communications networks are weak and lack a formalized system of input and feedback essential to maintaining optimum efficiency. A scheduled system of external stakeholder input and feedback should be developed to keep everyone on the same page and working at optimum efficiency.

Organizational Culture – Culture refers to the values, beliefs, and traditions shared by all members of the organization. Culture has a profound impact on organizational performance as it guides everyday practices and behaviors, which may or may not be in harmony with the stated vision and core values of an organization. The single most prevalent issue is the lack of understanding by CFD administration and staff that EMS is a part of the organizational and an essential service provided by the department for citizens of Charleston. There is also the cultural belief that public interaction is only initiated by prevention and public education functions of CFD. Finally the department's title of Charleston Fire Department is not reflective of the 21st century all hazards operation of the organization which includes EMS, prevention, and special operations functions.

Overview of Operations

This section discusses an overview of the operations component of CFD. Areas reviewed include fire service practices, EMS practices, support services, staffing levels, and overtime. An analysis of demand and workloads for the different stations and units was presented in Chapters 2 and 3. Finally comparisons with similar jurisdictions will be presented in Chapter 5.

In order to provide effective service, fire departments should maintain operational objectives that are consistent with the demands that exist within the community. Sometimes the decision about levels of service is not consistent with the level of risk and service demands. In many communities we have observed, decisions regarding service levels have not been made through a tactical risk analysis process; rather, it is often the result of incremental policymaking or based on "best case" alternatives developed in the wake of budget reductions.

Fire – CFD operates 8 engine companies, 2 ladder companies, 1 quint, 2 rescue companies, 4 transport ALS ambulances, a duty chief, an EMS supervisor, and a safety officer on each shift for a total of 47 positions staffed 24/7/365. All Engines are staffed with 3 personnel (firefighter, Lt, Capt) except Engine 8 which has 4 personnel with an additional firefighter. Trucks and rescues are all staffed by a Lt and Capt and all ambulances are staffed by a paramedic and an EMT. CFD responds to emergency calls per departmental SOG's listed below:

High Hazard (High Rise, Schools, Hospitals)		Total: 15 Firefighters
3 Engine Companies	9 Firefighters*	
2 Truck Companies	4 Firefighters	
1 Rescue Company	2 Firefighters	
Structure Fire on "the Flats"		Total: 13 Firefighters
3 Engine Companies	9 Firefighters*	
1 Truck Company	2 Firefighters	
1 Rescue Company	2 Firefighters	
Structure Fire on "the Hills"		Total: 11 Firefighters
3 Engine Companies	9 Firefighters*	
1 Rescue Company	2 Firefighters	

Upon confirmation of working incident:
1 Battalion Chief
1 Safety Officer – If staffed
1 ALS Unit
1 EMS Supervisor

*Engine 8 has 4 personnel. Add 1 additional to total for incidents within their response district.

For Auto Accidents/Rescues:

Standard:		Total: 5 Fire, 2 EMS
1 Engine Company	3 Firefighters*	
1 Rescue Company	2 Firefighters	
1 ALS Unit	1 Paramedic/FF, 1 EMT/FF	
With Entrapment:		Total: 7 Fire, 2 EMS
1 Engine Company	3 Firefighters*	
2 Rescue Companies	4 Firefighters	

NFPA Fire Protection Handbook 18th Edition Table 2 has the following guidelines as industry benchmarks for structural calls based upon structure risk:

NFPA Handbook - Response Level By Risk

Low Hazard	Medium Hazard	High Hazard
Comprised of 1, 2, or 3 family dwellings and scattered small businesses. Response – 2 engines, 1 ladder, 1 command = 13 personnel	Comprised of apartments, offices, mercantile, and light industrial Response - 3 engines, 1 ladder, and 1 command = 17 personnel	Comprised of schools, hospitals, nursing homes, heavy industrial, and high rises Response – 4 engines, 2 ladders, 2 command = 25 personnel

Source: NFPA Handbook 18th edition, Table 10-2A

CFD clearly has sufficient personnel resources on duty to handle all hazard responses as classified by NFPA. They also have sufficient personnel reserves to handle all multiple alarm resource needs, except 2 simultaneous high hazard calls, which would demand mutual aid assistance for additional ladder trucks and some personnel. This level of staffing is excellent but rarely seen due to the financial demands of providing such resources 24/7.

EMS – CFD provides ALS transport EMS service as has been the case since June 26, 1996. Currently this service delivery is based upon staffing 4 ambulances 24/7 which responded to 15,237 calls in CY 2010. The current 4 ALS ambulances are responding to about 3800 calls per year per unit. This annual calls per unit benchmark indicates an ambulance is on calls over 50 percent of the time based upon average call duration of 90 minutes. This time on a call is actually sometimes doubled for CFD ALS ambulances due to the extended amount of time EMS crews are tied up at the hospital which can be as long as 90 minutes on some occasions. TriData analysis of emergency room turnaround times showed that 71 percent of the time EMS crews are tied up at the hospital for over 30 minutes and 20 percent of the time this time at the ER exceeds 60 minutes. The actual total time an EMS call takes can exceed 2+ hours for CFD. In addition to the call volume and very long duration calls there are three other issues which are creating problems for CFD EMS services:

1. The current 12 hour shifting for ambulance crews is a source of scheduling and potentially overtime problems. Since each ambulance must be scheduled with two crews of a paramedic and an EMT daily.
2. Since fire personnel work a 24 hour shift but EMS is 12 hours there is a separation between the two key functions of CFD and has created a, we vs. they, informal structure within the department.

3. The call volume and long duration of many of these calls is causing routine mutual aid from County EMS which results in longer response to calls and loss of revenues for the City of Charleston.

These EMS service delivery problems indicate that CFD should consider staffing a fifth ALS ambulance 24/7 and changing the EMS shift to a single 24 hour assignment to match suppression schedule. This change in service delivery could be most easily achieved by closing down 1 Rescue Company and using this additional staff to man the 5th ALS ambulance. Additionally the two truck companies could be outfitted to respond to light rescue incidents with heavy rescue handled by the one remaining rescue company since call volumes indicate these companies are capable of the increased workload without significant adverse risk to citizens or firefighters if staffing on units are aligned with TriData proposed levels in Chapter 6.

Support Services

Training –Training is a key function in all fire departments nationwide. This is especially true with the number of actual working fires is declining nationally. With this loss of real time experience it is even more important now than it was in the past to have a comprehensive training program which covers all facets of the department's service delivery spectrum. This spectrum includes firefighting, EMS, special operations, and basic public safety education.

CFD has a training division which provides firefighting training to staff as well as some special operations training to maintain necessary certifications for staff. The training division is staffed by a Captain and EMS supervisor as well as 2 staff positions. Each shift trains daily as well as specialized training for certain teams and some whole shift training for scenario work.

The training division operates from a facility located at 115 Lee Street West which includes classrooms, a tower, and numerous props. The division also has a trailer to bring the needed resources to outside locations and is assigned 2 vehicles.

This key area of CFD could be expended as outlined later in this study to support area departments and as a revenue generating operation.

Fire Prevention – The city's prevention program is average among American cities, which tend to invest less of the fire department budget in prevention than European nations. This is unfortunate, because fire prevention is important, for three major reasons:

- It directly affects the frequency of emergency incidents—the numbers of fires, EMS calls, and other calls.
- It affects the severity of incidents that occur (e.g., there is less damage and life lost from early detection of fires if smoke detectors are present and working).

- Less obviously, it can reduce the cost of fire protection, because good prevention can slow if not stop or even roll back the increase in demand (calls per 1,000 population), which in turn affects the number of fire units and personnel needed. High workloads in a fire station's first-due area will require extra units to service the calls within adequate response times.

CFD staffs the Prevention Bureau with a Captain, a Lieutenant, and a firefighter. The FPB provides code enforcement, public education, and investigation services for the department. The City operates under the West Virginia State Fire Code as a mini/maxi code system. There is currently no company level inspection program of commercial occupancies provided by CFD. The FPB inspects new construction and monitors businesses with a certificate of occupancy program. Occupancies with an automatic extinguishment system are inspected twice per year and inspections from complaints as well as random inspections are done on an as needed basis.

Public Education programs in CFD are the centerpiece of the Bureau. The "Safety City" developed for Charleston third graders is a testament to the City's desire to protect the youth of the city. There is also a smoke trailer and onsite programs for most age groups. A senior safety program is available in a partnered effort with Charleston Housing. The life safe program established over 25 years ago in coordination with the chamber of commerce is utilized to reach out to the business community of Charleston.

This CFD operational area could also be expanded to serve not only the City of Charleston but other area jurisdictions and could also become a revenue generating part of the department. The details of this expansion are discussed later in this report.

Special Operations

CFD is the "go to" department in West Virginia for special operations needs. Services include Haz Mat; confined space, high angle, and trench rescue; swift water rescue; and dive rescue/recovery operations. These low frequency/ high impact services require a significant commitment to training and equipment as well the possibility of extended deployment outside the City. It is a testament to CFD and the City of Charleston that accepting this responsibility is part of the mission of the department.

Support Services

Vehicle Maintenance – This program was part of CFD operations until it was recently repositioned into DPW's Fleet Management division. The Fleet Management division provides 2 mechanics to work on CFD apparatus and equipment including repair as well as preventive maintenance functions for the departmental apparatus. All vehicle records are automated including a new fueling system. Fleet Management currently has a replacement program for staff vehicles but lacks an apparatus replacement program such as those developed by NFPA or

APWA guidelines. Interviewees noted excellent coordination between CFD and DPW staff and related no substantial problems.

Staffing and Overtime

Based upon the current 9 station operation, a minimum of 47 shift positions per day, with 59 personnel per shift is utilized. This provides a backfill pool of 12 firefighters to maintain the daily minimum. Annual leaves are; an average of 7 vacation shifts, 15 Kelley shifts, 5 holiday shifts, average 5 sick days (shifts), and 3.5 shifts of other time off for a total of 35.5 shifts of leave per employee. This leave when deducted from the scheduled 122 shifts per year per firefighter means the average CFD shift firefighter works 86.5 shifts per year (2076 hours) or 71 percent of the scheduled annual shifts for each platoon per year. The staffing factor or number of firefighters needed to staff a budgeted position (122 shifts) is 1.42 personnel.

Current shift staffing needs per year are 47 firefighters per shift x 122 days scheduled per year = 5,734 shifts to staff x 3 shifts = 17,202 shifts to staff per year for CFD

Currently 59 shift personnel per shift x 86.5 shifts worked per year = 5103.5 shifts staffed x 3 shifts = 15,310.5 shifts per year which are covered by staff

Shifts to be filled are 17,202 shifts needed – 15,310.5 shifts filled by duty staff = 1891.5 shifts per year filled by overtime or 45,396 hours annually. This is an average of 5.17 shifts or 124.4 hours of overtime per day. This hypothesis assumes that all previously stated leaves are consistently occurring, which is not likely the case. This information, however, cannot be factored into this analysis, so the overtime calculation is actually lower than reality This analysis does likely mean 6 or more shifts of overtime staffing are occurring daily to maintain a minimum of 47 personnel on duty 24/7/365.

CHAPTER 5. INTERJURISDICTIONAL COMPARISONS

In choosing cities for comparison, we considered population size, density, services offered (especially whether there is EMS and EMS transport), climate, socioeconomic factors (age, poverty levels, ethnic groups), number of operations staff on duty per 1000 population; and the average work week of firefighters. We also considered whether fire incidence and fire losses were comparable. We included West Virginia area communities and communities elsewhere including other Appalachian cities. We show how Charleston Fire Department ranks among the set of comparison cities and against the means.

Interjurisdictional Comparisons

To put a department's performance in perspective, it can be helpful to compare the department with other organizations that share similar characteristics. In doing so, department leaders can identify benchmarks that can be used to assess their own performance. When these comparisons are drastically different, further evaluation is required.

Jurisdictional comparisons can be difficult to interpret as there are many variables. No two jurisdictions are exactly alike in terms of geographic size and features, population dynamics, governmental organization and services provided. Many jurisdictions, however, do share some similar qualities that are useful for comparison. While these comparisons are not direct indicators of departmental performance, they do provide a valuable function in assessing a department in relation to the performance of its peers. This direct comparison identifies organizational strengths and suggests areas for improvement.

All the jurisdictions chosen for comparison possess characteristics similar to Charleston. The data used was obtained from websites, through direct contact with the departments and from surveys, U.S. Census 2009 estimates, and other TriData research. We compared several different attributes on a per capita basis including: stations and equipment, cost, demand for service, and staffing. Averages shown in the comparison tables were calculated without Charleston included.

Population

A unique feature of Charleston is the significant influx of people to the city during the workday. As is shown in Table 12, the daytime population of Charleston is more than 75 percent greater than the nominal population, which is considerably higher than in comparable jurisdictions. The result is that the taxpayers of Charleston must fund a fire department capable of providing services to a much larger daytime population. It is important to note that even though the area of Charleston is larger than the average jurisdictions, the density (population per square mile) is significantly less.

Table 12: Comparison of Populations Served by Various Jurisdictions, 2009

Jurisdiction	Population (July 2009)	Area (Square Miles)	Density (Population/ Square Mile)	Daytime Population Change	% Daytime Population Change
Roanoke, VA *	94,482	43	2,202	25,853	27.36%
Jackson, TN	63,732	50	1,288	22,922	35.97%
Owensboro, KY	55,745	17	3,204	9,204	16.51%
Elyria, OH	54,969	20	2,762	3,326	6.05%
Hattiesburg, MS	53,533	49	1,086	17,845	33.33%
Kettering, OH	53,460	19	2,859	(1,504)	-2.81%
Elkhart, IN *	53,060	21	2,479	18,955	35.72%
Valdosta, GA	52,087	30	1,742	12,264	23.55%
Mentor, OH *	51,894	27	1,936	6,215	11.98%
Battle Creek, MI	51,843	43	1,211	15,429	29.76%
Middletown, OH	51,601	26	2,008	2,100	4.07%
Burlington, NC	51,577	21	2,421	11,522	22.34%
Cuyahoga Falls, OH	51,095	26	2,004	(5,510)	-10.78%
Mansfield, OH *	49,406	30	1,652	11,865	24.02%
Huntington, WV	49,129	16	3,090	18,429	37.51%
Wilson, NC	48,721	23	2,091	8,527	17.50%
Hendersonville, TN	48,332	27	1,770	(9,159)	-18.95%
Newark, OH *	47,413	20	2,419	2,087	4.40%
Biloxi, MS	45,768	38	1,204	17,005	37.15%
Kokomo, IN	45,396	16	2,802	19,897	43.83%
Southaven, MS	45,395	34	1,343	(4,525)	-9.97%
Kingsport, TN	44,758	44	1,015	23,859	53.31%
Kannapolis, NC	43,404	30	1,452	(3,080)	-7.10%
Warren, OH	43,402	16	2,696	7,984	18.40%
Covington, KY	43,082	13	3,289	4,534	10.52%
Hagerstown, MD	39,996	11	3,738	7,643	19.11%
Average	**51,280**	**27**	**2,145**	**9,373**	**17.80%**
Median	**50,251**	**26**	**2,049**	**8,866**	**18.75%**
Charleston, WV	***50,267***	***32***	***1,591***	***38,087***	***75.77%***

* Jurisdictions with ALS transport units.

Charleston has a total of 9 stations that each covers 3.5 square miles. Comparable jurisdictions average 4.9 square miles per station as shown in Table 13. Charleston station serve an area larger than comparable jurisdictions, however, the population being served per station is only 60% of the comparable jurisdictions average.

Table 13: Comparison of Population Served per Stations, 2009

Jurisdiction	Population (July 2009)	Area Served (Square Miles)	Number of Stations	Population/ Station	Square Miles/ Station
Roanoke, VA*	94,482	43	11	8,589	3.9
Jackson, TN	63,732	50	6	10,622	8.3
Owensboro, KY	55,745	17	5	11,149	3.5
Elyria, OH	54,969	20	3	18,323	6.6
Hattiesburg, MS	53,533	49	8	6,692	6.2
Kettering, OH	53,460	19	7	7,637	2.7
Elkhart, IN*	53,060	21	7	7,580	3.1
Valdosta, GA	52,087	30	7	7,441	4.3
Mentor, OH*	51,894	27	5	10,379	5.4
Battle Creek, MI	51,843	43	5	10,369	8.6
Middletown, OH	51,601	26	5	10,320	5.1
Burlington, NC	51,577	21	5	10,315	4.3
Cuyahoga Falls, OH	51,095	26	5	10,219	5.1
Mansfield, OH*	49,406	30	5	9,881	6.0
Huntington, WV	49,129	16	6	8,188	2.7
Wilson, NC	48,721	23	5	9,744	4.7
Hendersonville, TN	48,332	27	6	8,055	4.6
Newark, OH*	47,413	20	4	11,853	4.9
Biloxi, MS	45,768	38	9	5,085	4.2
Kokomo, IN	45,396	16	6	7,566	2.7
Southaven, MS	45,395	34	4	11,349	8.5
Kingsport, TN	44,758	44	7	6,394	6.3
Kannapolis, NC	43,404	30	5	8,681	6.0
Warren, OH	43,402	16	3	14,467	5.4
Covington, KY	43,082	13	5	8,616	2.6
Hagerstown, MD	39,996	11	6	6,666	1.8
Average	**51,280**	**27**	**6**	**9,469**	**4.9**
Median	**50,251**	**26**	**5**	**9,213**	**4.8**
Charleston, WV	***50,267***	***32***	***9***	***5,585***	***3.5***

* Jurisdictions with ALS transport units.

Stations and Equipment

Each jurisdiction was also asked about the amount of apparatus staffed each day. Table 14 shows the number of engines, trucks, heavy rescues or squads, and quints for each jurisdiction.

Table 14: Comparison of Fire Apparatus's, 2009

Jurisdiction	Population (July 2009)	Engine Companies	Truck Companies	Rescue Companies	Quints
Roanoke, VA*	94,482	10	3	1	1
Jackson, TN	63,732	11	3	0	2
Owensboro, KY	55,745	5	2	1	1
Elyria, OH	54,969	3	1	1	0
Hattiesburg, MS	53,533	8	0	0	2
Elkhart, IN*	53,060	6	1	0	1
Valdosta, GA	52,087	7	3	1	0
Mentor, OH*	51,894	5	1	0	0
Burlington, NC	51,577	5	1	2	0
Mansfield, OH*	49,406	4	1	0	1
Wilson, NC	48,721	3	1	1	2
Newark, OH*	47,413	3	1	1	1
Kingsport, TN	44,758	8	1	0	0
Kannapolis, NC	43,404	5	0	0	1
Warren, OH	43,402	3	1	1	1
Hagerstown, MD	39,996	5	2	0	0
Average	**53,011**	**6**	**1**	**1**	**1**
Median	**51,736**	**5**	**1**	**1**	**1**
Charleston, WV	***50,267***	***8***	***2***	***2***	***1***

* Jurisdictions with ALS transport units.

Table 15 takes the comparison another step by considering equipment per capita and the ratios among different types of apparatus's. Key comparisons include the number of engines as a function of population, and the ratios of engines to trucks and other special service units. Special service units, mainly ladder trucks, are usually called to perform search and rescue of occupants as well as vital support functions to engine companies necessary for fire suppression, including forcible entry, ventilation, and electrical and natural gas utility control. A smaller engine to special service ratio value indicates a department with greater special service companies available to perform these duties.

Table 15: Suppression Equipment Ratios, 2009

Jurisdiction	Engine : Truck Ratio	Engine : Special Service Ratio	Engines/ 10,000 Population
Roanoke, VA*	3.3	2.0	1.06
Jackson, TN	3.7	2.2	1.73
Owensboro, KY	2.5	1.3	0.90
Elyria, OH	3.0	1.5	0.55
Hattiesburg, MS	N/A	4.0	1.49
Elkhart, IN*	6.0	3.0	1.13
Valdosta, GA	2.3	1.8	1.34
Mentor, OH*	5.0	5.0	0.96
Burlington, NC	5.0	1.7	0.97
Mansfield, OH*	4.0	2.0	0.81
Wilson, NC	3.0	0.8	0.62
Newark, OH*	3.0	1.0	0.63
Kingsport, TN	8.0	8.0	1.79
Kannapolis, NC	N/A	5.0	1.15
Warren, OH	3.0	1.0	0.69
Hagerstown, MD	2.5	2.5	1.25
Average	**3.9**	**2.7**	**1.1**
Median	**3.2**	**2.0**	**1.0**
Charleston, WV	***4.0***	***1.6***	***1.6***

* Jurisdictions with ALS transport units.

This is the case in Charleston, which has a smaller engine to special services ratio than similar jurisdictions. When comparing Charleston to the average, Charleston has a slightly greater engine to truck ratio and engines per 10,000 residents than comparable jurisdictions. This is due to the fact that Charleston has a far greater number of engine companies, 8 in total, than the average of 6.

Emergency Medical Services

Table 16 depicts data regarding EMS transport units. The selection of jurisdictions is smaller for these figures because only around a quarter of the comparable jurisdictions operate EMS transport units. Charleston exhibits an average number of EMS transport units per capita. While this may appear to be acceptable, Table 20 will show that Charleston responds to far more calls per 1,000 residents as do their peers. It is important to note, however, that when looking at the call volume per day time population, Charleston responds to a similar number of calls as comparable jurisdictions. Above-average call volume with an average fleet size results in severely overworked EMS transport units that are not always available to respond to calls for service.

Table 16: EMS Transport Units, 2009

Jurisdiction	Population (July 2009)	EMS Transport Units	EMS Units/10,000 Population
Roanoke, VA	94,482	8.5	0.9
Elkhart, IN	53,060	4	0.8
Mentor, OH	51,894	5	1.0
Mansfield, OH	49,406	3	0.6
Newark, OH	47,413	3	0.6
Average	**59,251**	**5**	**0.8**
Median	**51,894**	**4**	**0.8**
Charleston, WV	**50,267**	**4**	**0.8**

Cost Per Capita

Cost per capita for fire protection gives a rough indication of efficiency; it does not consider quality of service. Never the less, while many factors play into this ratio, it can be useful to compare peer jurisdictions. Table 17 shows comparative costs per capita and indicates that Charleston, with an operating cost per capita of $313, is well above the average of $152. When considering the operating cost per capita of $178 for the daytime population, Charleston is still above the average.

Table 17: Cost Per Capita, 2009

Jurisdiction	Population (July 2009)	Annual Budget	Budget per Capita	Budget per Daytime Population
Roanoke, VA*	94,482	$19,000,000	$201	$158
Jackson, TN	63,732	$11,491,558	$180	$133
Owensboro, KY	55,745	$8,100,000	$145	$125
Elyria, OH*	54,969	$6,186,108	$113	$106
Hattiesburg, MS	53,533	$7,021,608	$131	$98
Elkhart, IN*	53,060	$7,900,000	$149	$110
Valdosta, GA	52,087	$6,700,000	$129	$104
Mentor, OH*	51,894	$9,538,361	$184	$164
Burlington, NC	51,577	$5,907,553	$115	$94
Mansfield, OH*	49,406	$7,019,205	$142	$115
Wilson, NC	48,721	$8,029,544	$165	$140
Newark, OH*	47,413	$9,376,476	$198	$189
Kingsport, TN	44,758	$7,743,800	$173	$113
Kannapolis, NC	43,404	$5,310,438	$122	$132

Jurisdiction	Population (July 2009)	Annual Budget	Budget per Capita	Budget per Daytime Population
Warren, OH	43,402	$5,700,000	$131	$111
Hagerstown, MD	39,996	$6,281,465	$157	$132
Average	**53,011**	**$8,206,632**	**$152**	**$126**
Median	**51,736**	**$7,382,704**	**$147**	**$120**
Charleston, WV	**50,267**	**$15,723,846**	**$313**	**$178**

* Jurisdictions with ALS transport units.

There are several possible explanations for the higher cost per capita. While most fire departments provide hazmat and technical rescue services for their citizens, only five departments included in this assessment provide ALS transport. The average cost per capita for these jurisdictions is $175, which reflects the additional cost of personnel, apparatus, equipment, training, and all of the other components necessary to provide this service. These figures are shown in Table 18. Another factor that should be considered when viewing Charleston's cost per capita is the above average number of EMS responses per 10,000 residents. This data is described in the next section.

Table 18: Cost Per Capita When ALS Transport Is Provided, 2009

Jurisdiction	Population (July 2009)	Annual Budget	Budget per Capita
Roanoke, VA	94,482	$19,000,000	$201
Elkhart, IN	53,060	$7,900,000	$149
Mentor, OH	51,894	$9,538,361	$184
Mansfield, OH	49,406	$7,019,205	$142
Newark, OH	47,413	$9,376,476	$198
Average	**59,251**	**$10,566,808**	**$175**
Median	**51,894**	**$9,376,476**	**$184**
Charleston, WV	***50,267***	***$15,723,846***	***$313***

Charleston far exceeds the average for the amount of money spent on overtime. When comparing the overall percentage of the annual budget used to fund overtime Charleston uses a much higher percentage, of their annual budget, funding overtime than the average (Table 19).

Table 19: Percentage of Annual Budget Spent On Overtime, 2009

Jurisdiction	Annual Budget	2010 Overtime	Overtime Percentage of Budget
Roanoke, VA*	$19,000,000	$77,000	0.4%
Jackson, TN	$11,491,558	$198,511	1.7%
Owensboro, KY	$8,100,000	$150,000	1.9%
Elyria, OH	$6,186,108	$224,398	3.6%
Hattiesburg, MS	$7,021,608	$260,449	3.7%

Jurisdiction	Annual Budget	2010 Overtime	Overtime Percentage of Budget
Elkhart, IN*	$7,900,000	$385,000	4.9%
Valdosta, GA	$6,700,000	$175,000	2.6%
Mentor, OH*	$9,538,361	$312,400	3.3%
Burlington, NC	$5,907,553	$172,277	2.9%
Mansfield, OH*	$7,019,205	$521,732	7.4%
Wilson, NC	$8,029,544	$101,792	1.3%
Newark, OH*	$9,376,476	$193,599	2.1%
Kingsport, TN	$7,743,800	$150,000	1.9%
Kannapolis, NC	$5,310,438	$365,000	6.9%
Warren, OH	$5,700,000	$68,000	1.2%
Hagerstown, MD	$6,281,465	$126,864	2.0%
Average	**$8,206,632**	**$217,626**	**3.0%**
Median	**$7,382,704**	**$184,300**	**2.3%**
Charleston, WV	***$15,723,846***	***$1.160.267***	***7.4%***

* Jurisdictions with ALS transport units.

Demand for Service

Demand for fire department services is effectively assessed in terms of calls per 1,000 residents. Table 20 shows that the Charleston Fire Department responded to 332 calls per 1,000 residents in 2009 nearly triple the average of 117. When looking at the daytime population, however, Charleston Fire Department responded to 189 calls per 1,000 residents in 2009, which is almost double the average of 99. Charleston is below the average demand per capita for fire, but above average for other calls and far above the average for EMS. Such a high volume of EMS calls might be explained by the fact Charleston is a jurisdiction where the daytime population increases by 76 percent.

Another possible explanation for the high demand is that Charleston is compared with jurisdictions that do not provide EMS transport. However, when compared only to jurisdictions with transport units, Charleston still has a far greater EMS response per 1,000 residents than its peers.

Table 20: Calls For Service Per 1,000 Residents, 2009

Jurisdiction	Total Calls per 1,000 Population	Total Calls per 1,000 DAYTIME Population	Fire Calls per 1,000 Population	EMS Calls per 1,000 Population	Other Calls per 1,000 Population
Roanoke, VA*	258.1	202.6	55.6	202.5	
Jackson, TN	38.4	28.2	2.6	7.9	27.9
Owensboro, KY	76.9	66.0	8.0	53.0	15.8
Elyria, OH	50.1	47.3	4.5	26.8	18.8
Hattiesburg, MS	48.8	36.6	5.0	31.5	12.3
Elkhart, IN*	135.3	99.7	12.8	121.7	0.8
Valdosta, GA	50.9	41.2	7.8	12.1	31.0
Mentor, OH*	126.8	113.2	3.1	26.9	96.8
Burlington, NC	140.9	115.2	45.8	95.1	
Mansfield, OH*	168.5	135.9	31.3	137.2	
Wilson, NC	82.9	70.6	5.6	48.7	28.7
Newark, OH*	308.0	295.0	135.0	166.0	7.0
Kingsport, TN	156.6	102.1	4.2	108.9	43.4
Kannapolis, NC	135.8	146.1	4.5	92.9	38.3
Warren, OH	29.8	25.1	5.6	1.2	23.0
Hagerstown, MD	60.0	50.4	7.9	15.6	36.5
Average	**116.7**	**98.5**	**21.2**	**71.8**	**29.3**
Median	**104.9**	**85.1**	**6.7**	**50.9**	**27.9**
Charleston, WV	***332.1***	***188.9***	***12.5***	***249.4***	***70.1***

Note: 1) The fire calls per 1,000 population is slightly higher than the number of fires per 1,000 population listed in Chapter 2. The reason for this is fire calls can include such things as cancelled in route, etc., whereas the fires per 1,000 population only account for actual fires. 2) The numbers for total calls, fire calls and other calls come from the Charleston Fire Department, Incident Type Report (Summary), Alarm Date Between {01/01/2009} And {12/31/2009}. 3) The numbers for the EMS calls comes from Charleston Fire Department Annual Report 2009. 4) The asterisks denote those jurisdictions with ALS transport units.

Table 21: EMS Calls By Jurisdictions With Transport Units, 2009

Jurisdiction	Population (July 2009)	EMS Calls	EMS Calls per 1,000 Population
Roanoke, VA	94,482	19,129	202
Elkhart, IN	53,060	6,460	121.7
Mentor, OH	51,894	1,395	26.9
Mansfield, OH	49,406	6,777	137.2
Newark, OH	47,413	7,871	166.0
Average	**59,251**	**8,326**	**131**
Median	**51,894**	**6,777**	**137**
Charleston, WV	***50,267***	***12,538***	***249.4***

Note: The number of EMS calls comes from the Charleston Fire Department, Annual Report 2009.

Staffing

There are several viewpoints from which staffing should be assessed. Total staffing, uniformed staffing, the ratio of uniformed to total staffing, and minimum on-duty staffing per 10,000 residents is depicted in Table 22. Total staffing includes both operational personnel and the support personnel who keep departments running as smoothly as possible, while uniformed staffing is those people whose primary job is staffing fire and EMS apparatus. Table 22 shows that Charleston Fire Department, with 99 percent of its employees in uniform, has more uniformed personnel than nearly any of the other jurisdictions. Charleston also has more than double the average for the minimum on-duty staffing.

Another number to note in this table is the minimum operations staffing maintained by the department at any given time per 10,000 residents. With 11.5 personnel per 10,000 residents, Charleston is well above the average value of 4.7. This is likely partially due to the large number of calls per 1,000 residents that the department responds to as well as the current 49 hour work week; which requires 1.42 personnel for each position in the operations division as compared to other jurisdictions with 56 hour work weeks.

Table 22: Staffing Comparison, 2009

Jurisdiction	Total Staffing	Uniformed FF (Career)	Uniformed FF/10,000 Population	Minimum On-Duty Staffing	Minimum On-Duty Staffing/ 10,000 Pop	% of Total Staffing in Uniform
Roanoke, VA*	247	237	25.1	61	6.5	96%
Jackson, TN	164	153	24.0	38	6.0	93%
Owensboro, KY	95	94	16.9	25	4.5	99%
Elyria, OH	76	70	12.7	N/A		92%
Hattiesburg, MS	126	118	22.0	29	5.4	94%
Elkhart, IN*	128	112	21.1	31	5.8	88%
Valdosta, GA	106	102	19.6	28	5.4	96%
Mentor, OH*	135	127	24.5	21	4.0	94%
Burlington, NC	92	81	15.7	22	4.3	88%
Mansfield, OH*	86	79	16.0	21	4.3	92%
Wilson, NC	94	81	16.6	22	4.5	86%
Newark, OH*	85	77	16.2	19	4.0	91%
Kingsport, TN	106	N/A		26	5.8	
Kannapolis, NC	81	74	17.0	18	4.1	91%
Warren, OH	63	N/A		11	2.5	
Hagerstown, MD	83	78	19.5	15	3.8	94%
Average	**110**	**106**	**19.1**	**26**	**4.7**	**92%**
Charleston, WV	**186**	**184**	**36.8**	**47**	**9.4**	**99%**

* Jurisdictions with ALS transport units.

Conclusions

CFD when compared to similar jurisdictions, 26 overall and 16 in detail, including 5 with transport ALS service, has many areas which are outside the averages and in some cases at the extreme ends of the comparable cities analyzed. Charleston is near the average population and is slightly larger in geographic size than the comparable jurisdictions. It has 50 percent more stations and each station covers 30 percent less territory than the sampling average. The number of suppression apparatus is also above the sampling average with the exception of Quints. ALS ambulances are below comparable averages. Overall calls for service per thousand population are at the high side of the comparables and EMS calls per thousand population in jurisdictions with EMS transport are the highest of all comparables. CFD staffing is 69 percent above the average and daily duty crew size is double the comparable average. Also of note is the fact that CFD overtime is 7.4 percent of the total budget compared to an average of 3 percent for the comparable jurisdictions.

CHAPTER 6. SERVICE DELIVERY SYSTEM AND FUTURE OPTIONS

In this chapter we evaluate effectiveness and efficiency of the CFD service delivery system and explore alternatives for enhancing the system. Alternative solutions are presented to improve upon these areas, where necessary.

Key Options to Improve Service Delivery

1. Overtime **–** This is the number one issue for CFD to improve efficiency by reducing the staffing factor (number of personnel needed to fill a position) of 1.42 which means in essence it takes nearly 3 people to fill 2 positions.

The largest single item which raises the staffing factor is the CFD 49 hour workweek using a 3 shift structure. This work week will generate a 7 hour gap weekly for each employee since the 3 shift system workweek used by CFD actually means each position is scheduled to work 56 hours. Filling this gap currently uses a backfill pool and unscheduled overtime.

The first alternative to improve the staffing factor is to eliminate the Kelley Day system which will generate 360 hours (15 days) of additional work hours per employee per year and lower the staffing factor to 1.2 employees needed for each position. Since the minimum staffing is already set, the total number of employees and thus man hours daily is fixed. The only additional cost therefore is the ½ time cost for overtime.

The second alternative is to pay an annual stipend for working City observed holidays. This stipend would be the value of 1/3 of the City observed holidays since the CFD operates on a 3 shift system. This alternative would again lower the staffing factor to 1.12 employees needed to each position.

Finally, the backfill pool concept could be eliminated and all apparatus assigned a maximum and minimum staffing level per apparatus. This staffing alternative would include elimination of Kelley Days, and Holiday days as discussed above and allow for close supervision of sick leave usage. This staffing modification should cut paid time off from an average of 35.5 shifts per year to less than 15 shifts per year per employee. In addition this staffing option should reduce unscheduled overtime dramatically and would staff apparatus's in alignment with NFPA 1710 standards (as assigned). This will help place sufficient firefighting personnel on first due units to initiate suppression operations immediately upon arrival as per OSHA regulations. Currently the first arriving CFD apparatus must wait for the second arriving, which can be upwards of 5 minutes in some areas of the City, to begin suppression operations. Currently there are at a maximum only 3 personnel on any unit in CFD. This current operational delay results in increased property losses as noted in the annual fire loss data for CFD and has potential for conflagrations in fast moving fires. The proposed staffing model would be:

Table 23: Staffing By Apparatus

Apparatus	Staffing
Engines, Trucks, Rescues	4 personnel maximum/3 personnel minimum
Ambulances	2 personnel (1PM and 1 EMT) 5 ambulances using a 24 hour shift
Staff Vehicles	1 personnel

8 station CFD complement based upon proposed model (Station #9 to SCFD):

Table 24: 8 Station Staffing

Assigned	Minimum
8 E @ 4 = 32 firefighters	8 E @ 3 = 24 firefighters
2 L @ 4 = 8 firefighters	2 L @ 3 = 6 firefighters
1 R @ 4 = 4 firefighters	1 R @ 3 = 3 firefighters
5 A @ 2 = 10 firefighters	5 A @ 2 = 10 firefighters
Staff 3 = 3 firefighters	Staff 3 = 3 firefighters
Total = 57 firefighters per shift x 3 shifts = 171	**Total = 46 firefighters per shift x 3 shifts = 138**
Administration = 12 positions	**Administration = 12 positions**
CFD departmental staff = 183 firefighters	**Minimum complement = 150 firefighters**

7 station CFD complement based upon proposed model (closure of Station #5 or #7):

Table 25: 7 Station Staffing

Assigned	Minimum
7 E @ 4 = 28 firefighters	7 E @ 3 = 21 firefighters
2 L @ 4 = 8 firefighters	2 L @ 3 = 6 firefighters
1 R @ 4 = 4 firefighters	1 R @ 3 = 3 firefighters
5 A @ 2 = 10 firefighters	5 A @ 2 = 10 firefighters
Staff 3 = 3 firefighters	Staff 3 = 3 firefighters
Total = 53 firefighters per shift x 3 shifts = 159	**Total = 43 firefighters per shift x 3 shifts = 129**
Administration = 12 positions	**Administration = 12 positions**
CFD departmental staff = 171firefighters	**Minimum complement = 141 firefighters**

6 station CFD complement based upon proposed model (closure of Stations #5 and #7):

Table 26: 6 Station Staffing

Assigned	Minimum
6 E @ 4 = 24 firefighters	6 E @ 3 = 18 firefighters
2 L @ 4 = 8 firefighters	2 L @ 3 = 6 firefighters
1 R @ 4 = 4 firefighters	1 R @ 3 = 3 firefighters
5 A @ 2 = 10 firefighters	5 A @ 2 = 10 firefighters
Staff 3 = 3 firefighters	Staff 3 = 3 firefighters
Total = 49 firefighters per shift x 3 shifts = 147	**Total = 40 firefighters per shift x 3 shifts = 120**
Administration = 12 positions	**Administration = 12 positions**
CFD departmental staff = 159 firefighters	**Minimum complement = 132 firefighters**

2. Number of Stations **–** At the time of the onsite visit CFD was operating from 9 stations to deliver fire/rescue service to the community. Since that time based upon discussions with TriData, City administration has been actively negotiating an arrangement with the City of South Charleston to have SCFD staff Station 9, thus bringing the total number of CFD stations down to 8.

Chapter 3, of this study, also evaluated the service delivery efficiency of relocating Station 3, since the current Station 3 is structurally unsound and must be replaced. In conjunction with this relocation, the relocations of Stations 6 and possibly Station 7 were also evaluated to determine where additional efficiencies could be achieved. Finally, the closures of Station 5 and/or Station 7 were evaluated.

The consolidation of Stations 2 and 8 were also evaluated in Chapter 3. This option however would be unlikely since Station 8 is quite new and is located in an area where future demand due to area demographics will require its continued presence.

The staffing of Station 9 by SCFD, relocation of stations 3, and 6, and the closure or relocation of Station 7 would increase the efficiency of CFD. These changes would allow CFD to respond to the areas of highest risk and demand with larger crews and thus quicker extinguishment operations. After this multi station adjustment has been done, service delivery from Station 5 should be analyzed to see if a consolidation of 5 with the new station 3 would be practical. This analysis means call data for CFD must be in a single computer program with capability to query the information, which is not the case in current programs.

3. EMS **–** The CFD is an all hazards service which provides ALS transport EMS as a key part of its operations. In2010 there were over 15K calls responded to by the four CFD ALS ambulances. This equates to about 3800 calls for each of the ambulances. Call durations are frequently very long and CFD EMS staff is spending up to 2+ hours per call in specific instances. Much of this call duration is attributable to the crew being tied up in the hospitals and unable to get back into service quickly. It is also a source of lost revenue since mutual aid outside agencies are responding to calls in the City and receiving the fees collect for those calls.

The number and duration of EMS calls, an average of over 10 per day is keeping CFD medics tied up over 50 percent of the time. This does not include the additional time spent documenting calls, completing required training, and other necessary tasks. EMS personnel are now using a 12 hour shift within their 24 hour duty shift to alleviate the stress of this high volume operation. Though this split shift is helping allow crews to get time to complete their non response tasks, it is creating staffing issues for administration daily. Administration personnel have to shuffle every shift or overtime called in to keep the 12 hour split working. An additional problem is the two culture environment this staffing process develops within CFD (medic vs. firefighter or 12 hr vs. 24 hr shifts).

CFD needs to initiate an additional ALS ambulance to be used 24/7. This will allow for a total of 5 units in service and a 24 hour shift system for all operations including EMS. This additional ambulance will decrease the number of calls per day per ambulance by 25 percent. Doing away with the split shift (12 hour tour) which takes twice the personnel of a 24 hour shift would take 38 percent less personnel daily than current split EMS shifts (16 vs. 10).

Also needed is a user fee which would be assessed to the receiving hospital when CFD staff is detained at the hospital for over 30 minutes from their arrival at the ER. This cost should be in the area of $250 for each 30 minutes or portion thereof when a crew is detained more than 30 minutes at any hospital.

Logistically, the staff for the 5th ALS ambulance could come from closing down one of the current two CFD Rescues; including light rescue operations and equipment as part of the routine functions of the current two truck companies. This option would then mean no additional positions would need to be created but, rather a realignment of current personnel would occur. Medics are already available if all EMS staffing assignments become 24 hour shifts for ambulance personnel when the 5th unit is activated. This additional unit will decrease all workloads by 25 percent and will decrease the number of calls per unit annually to about 3000.

The City of Charleston should review and adjust the fees for ambulance services on an annual basis to stay abreast of any fee changes from Medicare and Medicaid, as well as private insurance companies. Also, when the fifth ambulance is put into service the City should evaluate expanding this service to include nonemergency transports and transfers of patients within the city. This is a potentially significant revenue source and these revenues could be used to fund some of the EMS operations.

Finally the City and Kanawha County EMS may want to evaluate the overall efficiency of all EMS transport services becoming a function of County operations. Many changes have occurred since EMS was initiated by CFD in the 1990's and the possibility of a countywide single system may be an area to explore. A cautionary issue in this evaluation is that if CFD still provides first responder services call volumes for engines, ladders, and recue will be the same but the revenue source from EMS will be gone.

4. Departmental Title – Charleston Fire Department has been a key function of the City of Charleston since 1845. This is a very long and proud tradition which has evolved from a fire suppression department of the 19th century to an all hazards, full services agency of the 21st century. With these changes many tasks have been added including: fire prevention, special operations, and Emergency Medical Services (EMS) to name a few.

To address these expansions of operations the department and the city should consider an expansion of the departmental title or name to "**Charleston Fire/Rescue Department".** This new name would be a more accurate reflection of the scope of services delivered by the department and on line with the changes occurring nationally in departmental titles.

Finally the CFD entry and promotional processes should also be evaluated. Entry qualifications could include applicants to hold a current NFPA firefighter 2 certification and a paramedic license (West Virginia or National Registry). This would cut costs for the recruit academy and bring personnel to CFD who already have backgrounds in fire/rescue either through experience, education or a combination of both. Additionally the advertisement for these potential positions should be initiated nationally using trade media as well as internet sources. Departments currently using this national marketing approach are getting 200 to 300 applicants for each opening and can select the best of the best for their vacancies.

Promotions should be based upon assessment of a set of skills needed to be successful in the promotional position. This would include prerequisite officer classes as well as general administrative education classes. In addition to seniority, testing should include a written examination as well as assessed situational evaluations for operational and administrative skills.

5. Enhancing Service Delivery – The City of Charleston and CFD have opportunities to enhance two service delivery functions and develop a strategy for generating revenues. The functions are fire prevention and training.

1. The CFD Fire Prevention Bureau is a full service division with code enforcement, public education, and fire cause determination capabilities. This level of expertise could serve outside jurisdictions which have a limited capability for fire prevention or none at all. This interjurisdictional agreement would be for a specific number of hours per week or for services as needed at a specific hourly rate.
2. Training is another area of operations where the fulltime resources of CFD could be utilized to assist outside agencies with their unfulfilled needs. Training for smaller agencies and even private brigades could be a part of CFD Training Division scope and could be used to generate revenue.

6. Data Collection – A key to assessing and ultimately measuring any organization or any service it provides is the collection and storage of complete and accurate information. CFD has issues with many parts of its data collection and storage. The department should work with city administration to determine what information should be collected and stored as well as how to best classify this data to be usable in the future. City IT should also be a partner in this endeavor so that the information is compatible with other city information formats and available to all identified departments whenever needed.

Separate from this issue but directly related is the current 911 CAD information system. The software used by Metro 911 is almost 15 years old and on life support at this time. TriData and Metro personnel spent many hours massaging the raw data to make it into a usable document for this analysis. 911Center software has a working lifespan of about 5 years based upon the national average for software age in centers nationwide. The software products at Metro 911 are the oldest system observed nationally by TriData analysts which are still being used on a daily basis as the operational system. This situation was not only difficult for this analysis but is an endangerment for citizens of Kanawha County should there be a system failure. Since there are no vendor available repair parts or programs for the current software, a system replacement is the only viable option.

Finally there is a need for Automatic Vehicle Location (AVL) hardware in all CFD apparatus, because of the high call volumes it is essential that 911Dispatch knows where the closest available unit is located. This unit information could mean the difference between life and death for citizens as well as CFD personnel involved in an emergency incident. AVL would provide real-time tracking of all CFD apparatus.

7. Longer term issues - In addition to the six key areas listed above there are ten long term issues which will be topical areas for longer term strategic planning for the City of Charleston and CFD.

1. **Potential future station consolidations –** This includes potential merging of Stations 3 and 5 which is logical based upon current run volumes and multi station second and third due response times. However the merger of Stations 3 and 5 should be evaluated after Stations 6 and 7 are relocated to more central sites or Station 7 is closed to improve service delivery efficiency. The consolidation of 2 and 8 was also evaluated and is not recommended due to likely future changes in demographics and increased service demand in the Station 8 first-due area, but again this issue should be revisited in the future to see if demands have changed.
2. **Increased staffing for training and prevention programs –** CFD is now the go to department in West Virginia for many technical operations. They could generate revenue from their expertise by helping other departments enhance their service deliveries.
3. **Apparatus replacement scheduling –** Since public works has taken over maintenance of CFD apparatus and equipment the results have been very positive. This program should be further expanded by developing and utilizing an apparatus replacement schedule system such as the one NFPA or APWA provides.
4. **Pay incentives for professional development –** To develop a succession plan for CFD it is a good idea to begin by promoting professional development in the ranks. This usually includes such things as paying for educational hours or tuition, an annual stipend for personnel with advanced degrees or specialized skills, and bonus points on promotional scoring criteria.
5. **Incorporating PD and FD into a teamed public safety program –** Public safety education program delivery could be expanded and the content enhanced by utilizing

a cross trained team of educators from PD and FD to deliver the all hazards messages to citizens of Charleston.

6. **Improve interaction of FD and Inspection Services –** These service delivery functions are natural areas of interagency cooperation and interaction for the two departments. With some additional training inspectors can become eyes and ears for fire safety in Charleston. Inspectors are already trained to see details of construction and this is a further expansion of this power of observation.
7. **Begin a company level commercial inspection program –** Charleston has a high instance of structure fires as compared to national and regional statistics. One way to improve this negative community fire risk is to begin a company level commercial inspection program and meet with businesses annually to inspect their occupancies and provide ways for the business to become safer.
8. **Assisting PD with ICS training –** Incident Command System training and utilizing the National Incident Management System are now the benchmarks for emergency services operations in the United States. CFD could help CPD to develop their capabilities and train jointly to maintain key skills.
9. **Assess doing transfer ambulance service in City –** With the expansion of EMS in CFD to include a fifth ambulance, the City should also look at providing transfer ambulance service within Charleston. This is a very profitable expansion of the current operations and would help fund additional portions of EMS operations costs for the City.
10. **Developing CFD administration understanding of overall city government operations –** CFD has been outside the realm of central city operations due to its unique way of doing business. This has lent a perception of isolation, aloofness, and self-protection to the department which is largely incorrect. This perception has been promoted by a lack of actually knowing all the pieces which are the City of Charleston government and how they operation and interact.

Master Plan

There is a need to develop a long range plan for all fire/rescue services in the City of Charleston. This is clearly a priority. Using CFD Fire administration, other key stakeholders, and the City administrator or designee as the working committee, this key team should set a plan for the next 2, 5, and 10 years. The resultant long range plan must have sufficient detail to build the structure, operations, and financial foundations for CFD services and to set a clear course for the foreseeable future.

A strategic process should be used to develop the long range plan for emergency services in the community. All potential stakeholders must be identified and included in this process and all input should be well structured to avoid allegations of favoritism or exclusion.

Master Plan Process

Step 1: Identify the future mission and vision for CFD services. This is the who, what, when, where, why, and how of the process. It is imperative that this process be consensual between the participating stakeholders.

Step 2: Prioritize the six major and ten future issues that are identified in this chapter of this study to develop direction for the plan.

Step 4: Establish broad brush goals to achieve your desired outcomes. These goals will be general statements of the outcomes needed to achieve and maintain the mission and vision of the Master Plan.

Step 5: Set objectives and activities under each goal area to achieve the desired results. This should include specific steps and timelines for these steps, as well as overall timelines for the objectives.

Step 6: Feedback and re-evaluation of the plan is essential to the overall success of the process. This must be done routinely during the entire implementation cycle of the plan and at least annually thereafter.

Prioritizing Key Issues

There are 6 key and 10 longer term issues identified above in this chapter of the report but, not all are of equal importance to the City of Charleston. To assist the City with the assessment process, we have developed a method to evaluate each of the 16 issues using similar criteria. The criteria are:

1. What is the overall value of the key issue to the city? Does it improve the level of fire or emergency medical service provided?
2. What is the overall value of the recommendation to the City of Charleston as an organization? Does it contribute to firefighter safety employee welfare?
3. What is the overall level of difficulty to implement the recommendation? Can it be implemented quickly or does it require a long or difficult planning process?
4. What is the overall cost to implement? Is the cost a one-time expenditure or does it require repeated funding?

Criteria Defined – A general definition for each criterion follows:

1. Value of Recommendation to the City: Recommendations with very high value to the community would be those with the potential to significantly improve service delivery such as adding a new service or improving an existing one. An example may be a recommendation that has the potential to significantly reduce loss or response time. A value judgment score of five means the recommendation has very high potential to improve community safety and emergency service delivery. Conversely, a judgment value of 0 means the recommendation will have no impact on community safety.
2. Value of Recommendation to the emergency services: Recommendations with a very high value to the emergency services are those that improve daily operations, improve efficiency and effectiveness, or change the organizational culture and management in a positive way. These can also be recommendations that are perceived by firefighters as improving their quality of work life or that improve their safety and health. A value judgment score of five means the recommendation has the highest potential to improve the organization; a score of zero means the recommendation will have no impact on the Department.
3. Level of Difficulty to Implement: Recommendations with a high level of difficulty to implement are those that have long planning cycles, require significant changes to infrastructure, changes to codes or labor agreements, or require major policy changes. Recommendations with a judgment value score of zero means the recommendation

has an extreme level of difficulty to implement; a score of five means there is no difficulty.

4. Cost of Implementation: Recommendations with high implementation costs are those requiring significant capital outlays like new fire stations, land purchases, or large recurring costs such as additional personnel. A recommendation that requires only a minor change in policy, for example, would likely have a low cost of implementation. Recommendations with a judgment value score of five means that it has no implementation cost; a score of zero means that it has an extremely high cost to implement.

Scoring – For each recommendation a value judgment was made using the four evaluation criteria above and a numerical score was assigned. The score ranges are shown below.

Criteria Scoring Range

Criteria	Low Score (Poorest)	High Score (Best)
Value to the Community	No Value = 0	Extreme Value = 5
Value to the Organization	No Value = 0	Extreme Value = 5
Level of Difficulty to Implement	Extreme Difficulty = 0	No Difficulty = 5
Cost of Implementation	Extreme Cost = 0	No Cost = 5

For example, a recommendation with the highest possible value to emergency services and to the community would have a combined score of 10 for benchmarks 1 and 2. If the same recommendation had the lowest "level of difficulty to implement", and it also had little (or no) cost to implement, its total score would be 20 points. Such a recommendation would be considered to be a high priority because it could be implemented easily and economically; it would also be of significant value to the community and to the emergency services. The composite score values can be interpreted as follows:

Composite Values

Lowest Priority.......................0 to 4

Low Priority ....5 to 8

Moderate Priority...................9 to 12

High Priority ....13 to 16

Highest Priority......................17 to 20

This study has provided many recommendations, detailed analyzes, and comparisons of CFD to comparable cities and national benchmarks. The study is in essence a cookbook of emergency service recipes. The recipes you choose to use and the exact ingredients you add are in fact up to the City of Charleston. Whether you choose to make dessert before the main course is a decision for your leadership, hopefully with stakeholder input.

Whichever option is chosen, one thing is certain: the process will have its share of supporters and non-supporters who will have a great effect on the outcome of the decisions. The leaders must always keep the mission of all emergency services at the sharp point of this endeavor. That mission is simply to save lives and protect property, and to do what is right for Mrs. Smith.

APPENDIX: TABLES AND FIGURES

Table 1: CAD Data Errors

	Responses	Percentage of Total
Missing incident number, incident date, or unit ID	0	0
Duplicate unit ID for single incident number	0	0
Responses with non-sequential timestamps	1032	3
First-arriving unit with suspiciously long response time	5747	17
Second-arriving unit with suspiciously long response time	2048	6
Third-arriving unit with suspiciously long response time	437	1
Fourth-arriving unit with suspiciously long response time	189	1
Total responses	**34740**	**100**

Table 2: Total Fire Loss, 2007-2010

Year	Total Fires	Dollar Loss	Injuries	Deaths
2007	632	$2,560,150	2	0
2008	765	$1,203,100	2	2
2009	629	$2,743,450	3	0
2010	689	$1,200,800	8	1
(average)	679	$1,926,875	4	1

Table 3: Per Capita Fire Loss and Comparison Statistics, 2007-2010

	Total Fires (per 1K capita)	Dollar Loss (per capita)	Civilian Injuries (per 1M capita	Civilian Deaths (per 1M capita)
United States	4.4	$40.8	55.5	9.8
Region: South	4.7	$40.8	51.2	10.7
Population: 50,000 to 99,000	3.3	$36.4	62.4	6.7
Region and Population	4.3	$41.4	63.6	9.9
Charleston: 2007	12.3	$49.8	38.9	0.0
Charleston: 2008	14.9	$23.4	38.9	38.9
Charleston: 2009	12.2	$53.4	58.4	0.0
Charleston: 2010	13.4	$23.4	155.6	19.5
Charleston: (average)	13.2	$37.5	73.0	14.6

Table 4: Fire Risk Classification by Planning Areas, 2007-2010

	Fires	(per sq mi)	Beyond Room	(% of fires)	Property Loss	(per sq mi)	Contents Loss	(per sq mi)	Deaths	(per sq mi)	Injuries	(per sq mi)
Tract 100	7	10.8	5	71	$160,000	$245,891	$20,000	$30,736	0	0	0	0
Tract 10100	0	0	0	–	$0	$0	$0	$0	0	0	0	0
Tract 1100	7	1.3	4	57	$30,800	$5,913	$5,000	$960	0	0	0	0
Tract 11000	2	19	0	0	$0	$0	$0	$0	0	0	0	0
Tract 11301	0	0	0	–	$0	$0	$0	$0	0	0	0	0
Tract 11401	0	0	0	–	$0	$0	$0	$0	0	0	0	0
Tract 11500	0	0	0	–	$0	$0	$0	$0	0	0	0	0
Tract 1200	12	35.6	6	50	$217,000	$644,290	$10,500	$31,175	0	0	4	11.9
Tract 12300	0	0	0	–	$0	$0	$0	$0	0	0	0	0
Tract 12800	1	4.5	0	0	$0	$0	$0	$0	0	0	0	0
Tract 12900	0	0	0	–	$0	$0	$0	$0	0	0	0	0
Tract 1300	9	23.5	2	22	$218,000	$569,122	$2,000	$5,221	0	0	1	2.6
Tract 13000	0	0	0	–	$0	$0	$0	$0	0	0	0	0
Tract 13200	0	0	0	–	$0	$0	$0	$0	0	0	0	0
Tract 1500	7	4.6	4	57	$783,500	$516,961	$100,500	$66,311	0	0	1	0.7
Tract 1700	12	15	5	42	$218,000	$273,098	$30,000	$37,582	0	0	0	0
Tract 1800	7	1.6	6	86	$145,000	$33,677	$0	$0	0	0	0	0
Tract 1901	2	1.3	2	100	$35,000	$23,338	$0	$0	0	0	0	0
Tract 1902	6	2.1	6	100	$1,082,000	$385,516	$696,350	$248,109	0	0	0	0
Tract 200	11	4.2	9	82	$238,500	$91,607	$16,000	$6,146	0	0	2	0.8
Tract 2000	4	3.5	3	75	$75,000	$65,446	$11,000	$9,599	0	0	0	0
Tract 2100	6	3.8	1	17	$138,000	$87,167	$10,000	$6,316	0	0	0	0
Tract 300	19	5	15	79	$529,000	$140,214	$121,000	$32,072	0	0	0	0
Tract 500	20	16.6	15	75	$344,000	$284,978	$105,000	$86,985	0	0	1	0.8
Tract 600	32	36.3	23	72	$346,800	$393,367	$15,000	$17,014	0	0	1	1.1
Tract 700	32	66.6	21	66	$342,600	$713,061	$2,500	$5,203	1	2.1	0	0
Tract 800	18	38.8	11	61	$166,500	$358,713	$2,100	$4,524	0	0	0	0
Tract 900	8	12.6	1	12	$67,600	$106,652	$2,500	$3,944	0	0	0	0

Table 5: Call Processing Time by Incident Type, CY2010

Incident Type	Average	80th Percentile	90th Percentile
Emergency medical service	2:26	3:22	4:28
Fire & special operations	2:02	2:58	3:56
(all)	2:24	3:20	4:26

Table 6: Turnout Time by Incident Type, CY2010

Incident Type	Average	80th Percentile	90th Percentile
Emergency medical service	1:20	2:00	2:41
Fire & special operations	1:51	2:44	3:15
(all)	1:26	2:12	2:52

Table 7: Travel Time (First Arriving Unit) by Incident Type, CY2010

Incident Type	Average	80th Percentile	90th Percentile
Emergency medical service	6:22	9:03	11:11
Fire & special operations	3:58	5:41	7:38
(all)	6:09	8:48	10:59

Table 8: Total Reflex Time (First Arriving Unit) by Incident Type, CY2010

Incident Type	Average	80th Percentile	90th Percentile
Emergency medical service	10:18	13:21	16:05
Fire & special operations	7:38	10:07	12:55
(all)	10:04	13:10	15:52

Table 9: Responses by Station and Unit, CY2010

Station and Unit	Ambulance	EMS Supervisor	Engine	Rescue	Truck
ST1	4206	–	2265	1668	1262
ST2	–	1337	2235	1316	925
ST3	–	–	1158	–	–
ST4	–	–	1441	–	–
ST5	–	–	1033	–	–
ST6	2931	–	1453	–	–
ST7	4208	–	1224	–	–
ST8	3892	–	1521	–	–
ST9	–	–	561	–	–

Table 10: Unit Workload (Unit Hours), CY2010

	EMS	False Alarm	Service	Fire	Canceled	Other	MVA	HazCond	Rupt/Explosion	Unfounded	Good Intent	TechRescue	Standby	(all)
EMS Supervisor	121.1	50.0	1.9	23.8	12.8	7.6	6.3	1.2	8.2	2.5	1.3	0.3	1.0	237.9
Engine 451	193.7	40.7	99.0	59.4	16.6	31.4	24.5	18.3	4.3	2.9	7.4	3.6	0.4	502.3
Engine 452	198.8	56.0	54.6	75.2	9.8	23.6	34.8	18.6	3.7	3.6	5.8	2.8	0.1	487.5
Engine 453	115.8	54.9	44.3	39.2	4.4	5.4	23.4	16.0	1.7	1.7	3.4	1.1	0.5	311.8
Engine 454	115.8	23.1	68.4	51.0	7.0	10.7	12.1	10.1	3.5	2.0	4.4	2.7	1.2	312.1
Engine 455	51.4	14.4	66.3	38.1	2.6	3.2	10.3	16.4	1.5	1.0	1.4	0.9	0.6	208.2
Engine 456	163.7	50.9	44.1	41.5	20.3	27.6	39.0	15.8	4.3	11.0	1.9	0.6	0.0	420.6
Engine 457	82.3	27.3	48.0	63.9	5.2	6.7	8.1	12.1	0.0	3.4	2.4	2.4	0.3	261.9
Engine 458	183.3	25.7	34.0	66.8	9.4	3.4	22.3	25.8	3.0	1.0	4.8	1.5	0.2	381.2
Engine 459	54.6	27.1	28.6	7.8	4.3	5.3	8.3	3.3	0.6	1.3	1.8	0.3	0.5	143.9
Medic 431	712.2	90.0	8.0	8.6	127.8	70.8	8.4	1.9	8.0	2.3	1.8	1.1	1.8	1042.8
Medic 436	543.9	64.8	3.7	9.6	134.5	25.4	10.9	1.3	3.6	3.8	2.7	0.2	0.0	804.4
Medic 437	824.4	134.3	10.4	13.7	85.9	49.7	13.9	1.8	8.3	7.7	4.3	0.4	0.9	1155.7
Medic 438	790.7	63.5	10.9	23.4	116.5	39.0	12.5	4.4	2.4	4.2	1.7	0.8	0.8	1071.0
Rescue 481	14.7	63.6	90.5	60.5	4.9	14.3	9.9	6.9	14.2	5.2	2.0	2.8	0.5	290.0
Rescue 482	6.8	67.0	42.0	66.2	3.2	9.4	7.7	8.9	8.4	2.8	1.8	2.0	1.4	227.6
Truck 461	6.2	1.8	79.5	61.4	2.0	5.4	31.0	2.0	2.8	0.4	0.7	3.0	0.4	196.7
Truck 462	3.4	3.8	49.1	55.3	0.8	1.8	7.9	5.9	1.1	1.1	0.9	1.7	0.0	132.9
(all)	4182.7	859.0	783.3	765.3	568.2	340.8	291.2	170.8	79.9	58.1	50.5	28.2	10.6	8188.6

Table 11: Workload Statistics by Unit, CY2010

	Total Runs	Runs per Day	Total Unit Hours	Unit Hours per Day	Unit Hours per Run
EMS Supervisor	845	2.3	372	1.0	0.44
Engine 451	2169	5.9	529	1.4	0.24
Engine 452	2167	5.9	520	1.4	0.24
Engine 453	1090	3.0	328	0.9	0.30
Engine 454	1381	3.8	339	0.9	0.25
Engine 455	994	2.7	239	0.7	0.24
Engine 456	1384	3.8	459	1.3	0.33
Engine 457	1157	3.2	284	0.8	0.25
Engine 458	1456	4.0	404	1.1	0.28
Engine 459	530	1.5	162	0.4	0.31
Medic 431	3800	10.4	3138	8.6	0.83
Medic 436	2704	7.4	2558	7.0	0.95
Medic 437	3784	10.4	2908	8.0	0.77
Medic 438	3548	9.7	2932	8.0	0.83
Rescue 481	1539	4.2	327	0.9	0.21
Rescue 482	1229	3.4	247	0.7	0.20
Truck 461	1141	3.1	211	0.6	0.18
Truck 462	827	2.3	144	0.4	0.17
All Units	31745	87.0	16101	44.1	0.51

Table 12: Comparison of Populations Served by Various Jurisdictions, 2009

Jurisdiction	Population (July 2009)	Area (Square Miles)	Density (Population/ Square Mile)	Daytime Population Change	% Daytime Population Change
Roanoke, VA *	94,482	43	2,202	25,853	27.36%
Jackson, TN	63,732	50	1,288	22,922	35.97%
Owensboro, KY	55,745	17	3,204	9,204	16.51%
Elyria, OH	54,969	20	2,762	3,326	6.05%
Hattiesburg, MS	53,533	49	1,086	17,845	33.33%
Kettering, OH	53,460	19	2,859	(1,504)	-2.81%
Elkhart, IN *	53,060	21	2,479	18,955	35.72%
Valdosta, GA	52,087	30	1,742	12,264	23.55%
Mentor, OH *	51,894	27	1,936	6,215	11.98%
Battle Creek, MI	51,843	43	1,211	15,429	29.76%
Middletown, OH	51,601	26	2,008	2,100	4.07%
Burlington, NC	51,577	21	2,421	11,522	22.34%
Cuyahoga Falls, OH	51,095	26	2,004	(5,510)	-10.78%
Mansfield, OH *	49,406	30	1,652	11,865	24.02%
Huntington, WV	49,129	16	3,090	18,429	37.51%
Wilson, NC	48,721	23	2,091	8,527	17.50%
Hendersonville, TN	48,332	27	1,770	(9,159)	-18.95%
Newark, OH *	47,413	20	2,419	2,087	4.40%
Biloxi, MS	45,768	38	1,204	17,005	37.15%
Kokomo, IN	45,396	16	2,802	19,897	43.83%
Southaven, MS	45,395	34	1,343	(4,525)	-9.97%
Kingsport, TN	44,758	44	1,015	23,859	53.31%
Kannapolis, NC	43,404	30	1,452	(3,080)	-7.10%
Warren, OH	43,402	16	2,696	7,984	18.40%
Covington, KY	43,082	13	3,289	4,534	10.52%
Hagerstown, MD	39,996	11	3,738	7,643	19.11%
Average	**51,280**	**27**	**2,145**	**9,373**	**17.80%**
Median	**50,251**	**26**	**2,049**	**8,866**	**18.75%**
Charleston, WV	***50,267***	***32***	***1,591***	***38,087***	***75.77%***

* Jurisdictions with ALS transport units.

Table 13: Comparison of Population Served per Stations, 2009

Jurisdiction	Population (July 2009)	Area Served (Square Miles)	Number of Stations	Population/ Station	Square Miles/ Station
Roanoke, VA*	94,482	43	11	8,589	3.9
Jackson, TN	63,732	50	6	10,622	8.3
Owensboro, KY	55,745	17	5	11,149	3.5
Elyria, OH	54,969	20	3	18,323	6.6
Hattiesburg, MS	53,533	49	8	6,692	6.2
Kettering, OH	53,460	19	7	7,637	2.7
Elkhart, IN*	53,060	21	7	7,580	3.1
Valdosta, GA	52,087	30	7	7,441	4.3
Mentor, OH*	51,894	27	5	10,379	5.4
Battle Creek, MI	51,843	43	5	10,369	8.6
Middletown, OH	51,601	26	5	10,320	5.1
Burlington, NC	51,577	21	5	10,315	4.3
Cuyahoga Falls, OH	51,095	26	5	10,219	5.1
Mansfield, OH*	49,406	30	5	9,881	6.0
Huntington, WV	49,129	16	6	8,188	2.7
Wilson, NC	48,721	23	5	9,744	4.7
Hendersonville, TN	48,332	27	6	8,055	4.6
Newark, OH*	47,413	20	4	11,853	4.9
Biloxi, MS	45,768	38	9	5,085	4.2
Kokomo, IN	45,396	16	6	7,566	2.7
Southaven, MS	45,395	34	4	11,349	8.5
Kingsport, TN	44,758	44	7	6,394	6.3
Kannapolis, NC	43,404	30	5	8,681	6.0
Warren, OH	43,402	16	3	14,467	5.4
Covington, KY	43,082	13	5	8,616	2.6
Hagerstown, MD	39,996	11	6	6,666	1.8
Average	**51,280**	**27**	**6**	**9,469**	**4.9**
Median	**50,251**	**26**	**5**	**9,213**	**4.8**
Charleston, WV	***50,267***	***32***	***9***	***5,585***	***3.5***

* Jurisdictions with ALS transport units.

Table 14: Comparison of Fire Apparatus's, 2009

Jurisdiction	Population (July 2009)	Engine Companies	Truck Companies	Rescue Companies	Quints
Roanoke, VA*	94,482	10	3	1	1
Jackson, TN	63,732	11	3	0	2
Owensboro, KY	55,745	5	2	1	1
Elyria, OH	54,969	3	1	1	0
Hattiesburg, MS	53,533	8	0	0	2
Elkhart, IN*	53,060	6	1	0	1
Valdosta, GA	52,087	7	3	1	0
Mentor, OH*	51,894	5	1	0	0
Burlington, NC	51,577	5	1	2	0
Mansfield, OH*	49,406	4	1	0	1
Wilson, NC	48,721	3	1	1	2
Newark, OH*	47,413	3	1	1	1
Kingsport, TN	44,758	8	1	0	0
Kannapolis, NC	43,404	5	0	0	1
Warren, OH	43,402	3	1	1	1
Hagerstown, MD	39,996	5	2	0	0
Average	**53,011**	**6**	**1**	**1**	**1**
Median	**51,736**	**5**	**1**	**1**	**1**
Charleston, WV	***50,267***	***8***	***2***	***2***	***1***

* Jurisdictions with ALS transport units.

Table 15: Suppression Equipment Ratios, 2009

Jurisdiction	Engine : Truck Ratio	Engine : Special Service Ratio	Engines/ 10,000 Population
Roanoke, VA*	3.3	2.0	1.06
Jackson, TN	3.7	2.2	1.73
Owensboro, KY	2.5	1.3	0.90
Elyria, OH	3.0	1.5	0.55
Hattiesburg, MS	N/A	4.0	1.49
Elkhart, IN*	6.0	3.0	1.13
Valdosta, GA	2.3	1.8	1.34
Mentor, OH*	5.0	5.0	0.96
Burlington, NC	5.0	1.7	0.97
Mansfield, OH*	4.0	2.0	0.81
Wilson, NC	3.0	0.8	0.62
Newark, OH*	3.0	1.0	0.63
Kingsport, TN	8.0	8.0	1.79
Kannapolis, NC	N/A	5.0	1.15
Warren, OH	3.0	1.0	0.69

Jurisdiction	Engine : Truck Ratio	Engine : Special Service Ratio	Engines/ 10,000 Population
Roanoke, VA*	3.3	2.0	1.06
Jackson, TN	3.7	2.2	1.73
Hagerstown, MD	2.5	2.5	1.25
Average	**3.9**	**2.7**	**1.1**
Median	**3.2**	**2.0**	**1.0**
Charleston, WV	***4.0***	***1.6***	***1.6***

* Jurisdictions with ALS transport units.

Table 16: EMS Transport Units, 2009

Jurisdiction	Population (July 2009)	EMS Transport Units	EMS Units/ 10,000 Population
Roanoke, VA	94,482	8.5	0.9
Elkhart, IN	53,060	4	0.8
Mentor, OH	51,894	5	1.0
Mansfield, OH	49,406	3	0.6
Newark, OH	47,413	3	0.6
Average	**59,251**	**5**	**0.8**
Median	**51,894**	**4**	**0.8**
Charleston, WV	**50,267**	**4**	**0.8**

Table 17: Cost Per Capita, 2009

Jurisdiction	Population (July 2009)	Annual Budget	Budget per Capita	Budget per Daytime Population
Roanoke, VA*	94,482	$19,000,000	$201	$158
Jackson, TN	63,732	$11,491,558	$180	$133
Owensboro, KY	55,745	$8,100,000	$145	$125
Elyria, OH*	54,969	$6,186,108	$113	$106
Hattiesburg, MS	53,533	$7,021,608	$131	$98
Elkhart, IN*	53,060	$7,900,000	$149	$110
Valdosta, GA	52,087	$6,700,000	$129	$104
Mentor, OH*	51,894	$9,538,361	$184	$164
Burlington, NC	51,577	$5,907,553	$115	$94
Mansfield, OH*	49,406	$7,019,205	$142	$115
Wilson, NC	48,721	$8,029,544	$165	$140
Newark, OH*	47,413	$9,376,476	$198	$189
Kingsport, TN	44,758	$7,743,800	$173	$113
Kannapolis, NC	43,404	$5,310,438	$122	$132

Jurisdiction	Population (July 2009)	Annual Budget	Budget per Capita	Budget per Daytime Population
Warren, OH	43,402	$5,700,000	$131	$111
Hagerstown, MD	39,996	$6,281,465	$157	$132
Average	**53,011**	**$8,206,632**	**$152**	**$126**
Median	**51,736**	**$7,382,704**	**$147**	**$120**
Charleston, WV	**50,267**	**$15,723,846**	**$313**	**$178**

* Jurisdictions with ALS transport units.

Table 18: Cost Per Capita When ALS Transport Is Provided, 2009

Jurisdiction	Population (July 2009)	Annual Budget	Budget per Capita
Roanoke, VA	94,482	$19,000,000	$201
Elkhart, IN	53,060	$7,900,000	$149
Mentor, OH	51,894	$9,538,361	$184
Mansfield, OH	49,406	$7,019,205	$142
Newark, OH	47,413	$9,376,476	$198
Average	**59,251**	**$10,566,808**	**$175**
Median	**51,894**	**$9,376,476**	**$184**
Charleston, WV	***50,267***	***$15,723,846***	***$313***

Table 19: Percentage of Annual Budget Spent On Overtime, 2009

Jurisdiction	Annual Budget	2010 Overtime	Overtime Percentage of Budget
Roanoke, VA*	$19,000,000	$77,000	0.4%
Jackson, TN	$11,491,558	$198,511	1.7%
Owensboro, KY	$8,100,000	$150,000	1.9%
Elyria, OH	$6,186,108	$224,398	3.6%
Hattiesburg, MS	$7,021,608	$260,449	3.7%
Elkhart, IN*	$7,900,000	$385,000	4.9%
Valdosta, GA	$6,700,000	$175,000	2.6%
Mentor, OH*	$9,538,361	$312,400	3.3%
Burlington, NC	$5,907,553	$172,277	2.9%
Mansfield, OH*	$7,019,205	$521,732	7.4%
Wilson, NC	$8,029,544	$101,792	1.3%
Newark, OH*	$9,376,476	$193,599	2.1%
Kingsport, TN	$7,743,800	$150,000	1.9%
Kannapolis, NC	$5,310,438	$365,000	6.9%
Warren, OH	$5,700,000	$68,000	1.2%
Hagerstown, MD	$6,281,465	$126,864	2.0%

Jurisdiction	Annual Budget	2010 Overtime	Overtime Percentage of Budget
Average	**$8,206,632**	**$217,626**	**3.0%**
Median	**$7,382,704**	**$184,300**	**2.3%**
Charleston, WV	***$15,723,846***	***$1.160.267***	***7.4%***

* Jurisdictions with ALS transport units.

Table 20: Calls For Service Per 1,000 Residents, 2009

Jurisdiction	Total Calls per 1,000 Population	Total Calls per 1,000 DAYTIME Population	Fire Calls per 1,000 Population	EMS Calls per 1,000 Population	Other Calls per 1,000 Population
Roanoke, VA*	258.1	202.6	55.6	202.5	
Jackson, TN	38.4	28.2	2.6	7.9	27.9
Owensboro, KY	76.9	66.0	8.0	53.0	15.8
Elyria, OH	50.1	47.3	4.5	26.8	18.8
Hattiesburg, MS	48.8	36.6	5.0	31.5	12.3
Elkhart, IN*	135.3	99.7	12.8	121.7	0.8
Valdosta, GA	50.9	41.2	7.8	12.1	31.0
Mentor, OH*	126.8	113.2	3.1	26.9	96.8
Burlington, NC	140.9	115.2	45.8	95.1	
Mansfield, OH*	168.5	135.9	31.3	137.2	
Wilson, NC	82.9	70.6	5.6	48.7	28.7
Newark, OH*	308.0	295.0	135.0	166.0	7.0
Kingsport, TN	156.6	102.1	4.2	108.9	43.4
Kannapolis, NC	135.8	146.1	4.5	92.9	38.3
Warren, OH	29.8	25.1	5.6	1.2	23.0
Hagerstown, MD	60.0	50.4	7.9	15.6	36.5
Average	**116.7**	**98.5**	**21.2**	**71.8**	**29.3**
Median	**104.9**	**85.1**	**6.7**	**50.9**	**27.9**
Charleston, WV	***332.1***	***188.9***	***12.5***	***249.4***	***70.1***

Note: 1) The fire calls per 1,000 population is slightly higher than the number of fires per 1,000 population listed in Chapter 2. The reason for this is fire calls can include such things as cancelled in route, etc., whereas the fires per 1,000 population only account for actual fires. 2) The numbers for total calls, fire calls and other calls come from the Charleston Fire Department, Incident Type Report (Summary), Alarm Date Between {01/01/2009} And {12/31/2009}. 3) The numbers for the EMS calls comes from Charleston Fire Department Annual Report 2009. 4) The asterisks denote those jurisdictions with ALS transport units.

Table 21: EMS Calls By Jurisdictions With Transport Units, 2009

Jurisdiction	Population (July 2009)	EMS Calls	EMS Calls per 1,000 Population
Roanoke, VA	94,482	19,129	202
Elkhart, IN	53,060	6,460	121.7
Mentor, OH	51,894	1,395	26.9
Mansfield, OH	49,406	6,777	137.2
Newark, OH	47,413	7,871	166.0
Average	**59,251**	**8,326**	**131**
Median	**51,894**	**6,777**	**137**
Charleston, WV	***50,267***	***12,538***	***249.4***

Note: The number of EMS calls comes from the Charleston Fire Department, Annual Report 2009.

Table 22: Staffing Comparison, 2009

Jurisdiction	Total Staffing	Uniformed FF (Career)	Uniformed FF/10,000 Population	Minimum On-Duty Staffing	Minimum On-Duty Staffing/ 10,000 Pop	% of Total Staffing in Uniform
Roanoke, VA*	247	237	25.1	61	6.5	96%
Jackson, TN	164	153	24.0	38	6.0	93%
Owensboro, KY	95	94	16.9	25	4.5	99%
Elyria, OH	76	70	12.7	N/A		92%
Hattiesburg, MS	126	118	22.0	29	5.4	94%
Elkhart, IN*	128	112	21.1	31	5.8	88%
Valdosta, GA	106	102	19.6	28	5.4	96%
Mentor, OH*	135	127	24.5	21	4.0	94%
Burlington, NC	92	81	15.7	22	4.3	88%
Mansfield, OH*	86	79	16.0	21	4.3	92%
Wilson, NC	94	81	16.6	22	4.5	86%
Newark, OH*	85	77	16.2	19	4.0	91%
Kingsport, TN	106	N/A		26	5.8	
Kannapolis, NC	81	74	17.0	18	4.1	91%
Warren, OH	63	N/A		11	2.5	
Hagerstown, MD	83	78	19.5	15	3.8	94%
Average	**110**	**106**	**19.1**	**26**	**4.7**	**92%**
Charleston, WV	**186**	**184**	**36.8**	**47**	**9.4**	**99%**

* Jurisdictions with ALS transport units.

Table 23: Staffing By Apparatus

Apparatus	Staffing
Engines, Trucks, Rescues	4 personnel maximum/3 personnel minimum
Ambulances	2 personnel (1PM and 1 EMT) 5 ambulances using a 24 hour shift
Staff Vehicles	1 personnel

Table 24: 8 Station Staffing

Assigned	Minimum
8 E @ 4 = 32 firefighters	8 E @ 3 = 24 firefighters
2 L @ 4 = 8 firefighters	2 L @ 3 = 6 firefighters
1 R @ 4 = 4 firefighters	1 R @ 3 = 3 firefighters
5 A @ 2 = 10 firefighters	5 A @ 2 = 10 firefighters
Staff 3 = 3 firefighters	Staff 3 = 3 firefighters
Total = 57 firefighters per shift x 3 shifts = 171	**Total = 46 firefighters per shift x 3 shifts = 138**
Administration = 12 positions	**Administration = 12 positions**
CFD departmental staff = 183 firefighters	**Minimum complement = 150 firefighters**

Table 25: 7 Station Staffing

Assigned	Minimum
7 E @ 4 = 28 firefighters	7 E @ 3 = 21 firefighters
2 L @ 4 = 8 firefighters	2 L @ 3 = 6 firefighters
1 R @ 4 = 4 firefighters	1 R @ 3 = 3 firefighters
5 A @ 2 = 10 firefighters	5 A @ 2 = 10 firefighters
Staff 3 = 3 firefighters	Staff 3 = 3 firefighters
Total = 53 firefighters per shift x 3 shifts = 159	**Total = 43 firefighters per shift x 3 shifts = 129**
Administration = 12 positions	**Administration = 12 positions**
CFD departmental staff = 171firefighters	**Minimum complement = 141 firefighters**

Table 26: 6 Station Staffing

Assigned	Minimum
6 E @ 4 = 24 firefighters	6 E @ 3 = 18 firefighters
2 L @ 4 = 8 firefighters	2 L @ 3 = 6 firefighters
1 R @ 4 = 4 firefighters	1 R @ 3 = 3 firefighters
5 A @ 2 = 10 firefighters	5 A @ 2 = 10 firefighters
Staff 3 = 3 firefighters	Staff 3 = 3 firefighters
Total = 49 firefighters per shift x 3 shifts = 147	**Total = 40 firefighters per shift x 3 shifts = 120**
Administration = 12 positions	**Administration = 12 positions**
CFD departmental staff = 159 firefighters	**Minimum complement = 132 firefighters**

Figure 1: Planning Areas (Census Tracts)

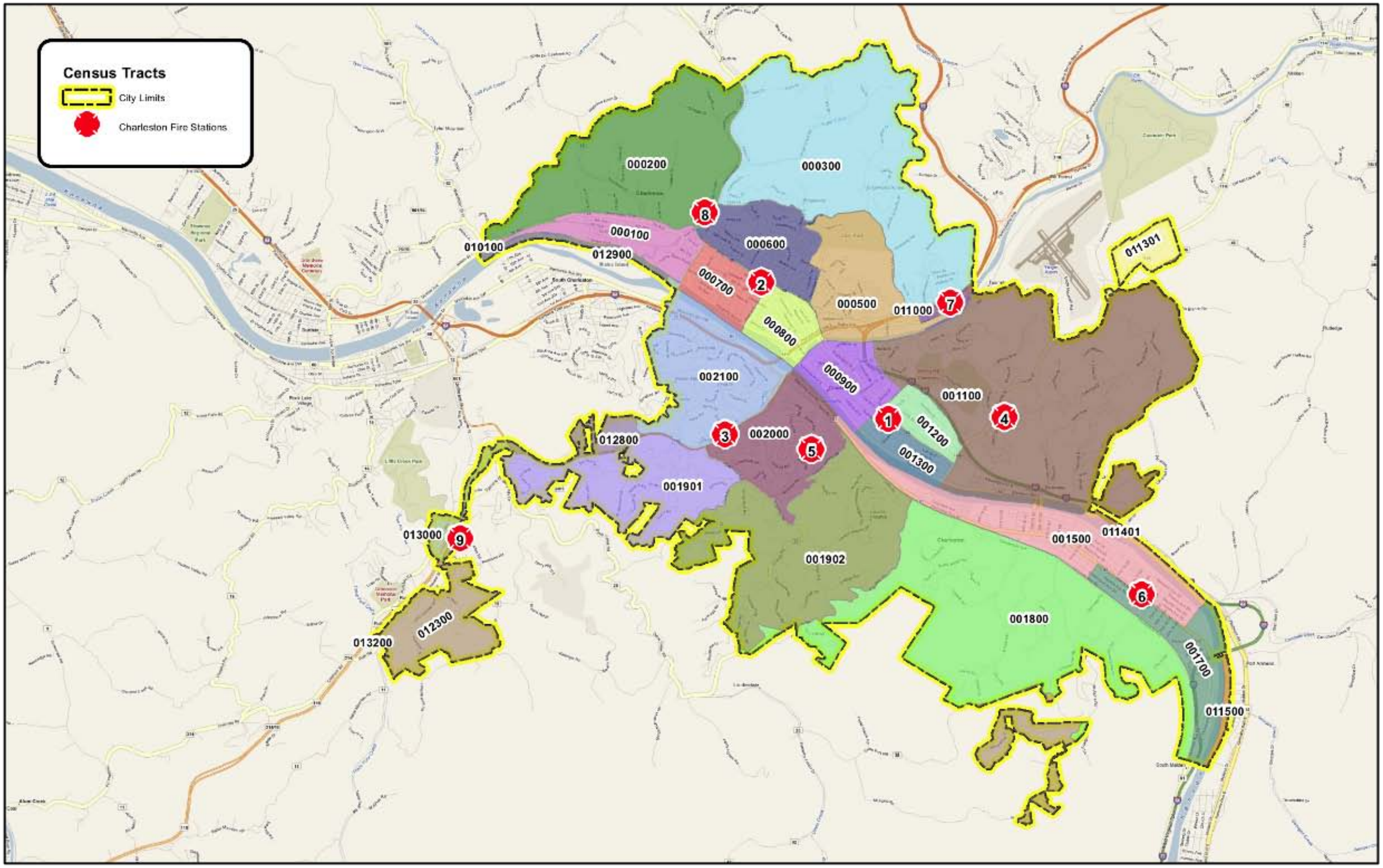


Figure 2: Actual (solid) and Projected (dashed) Population, 1850-2030

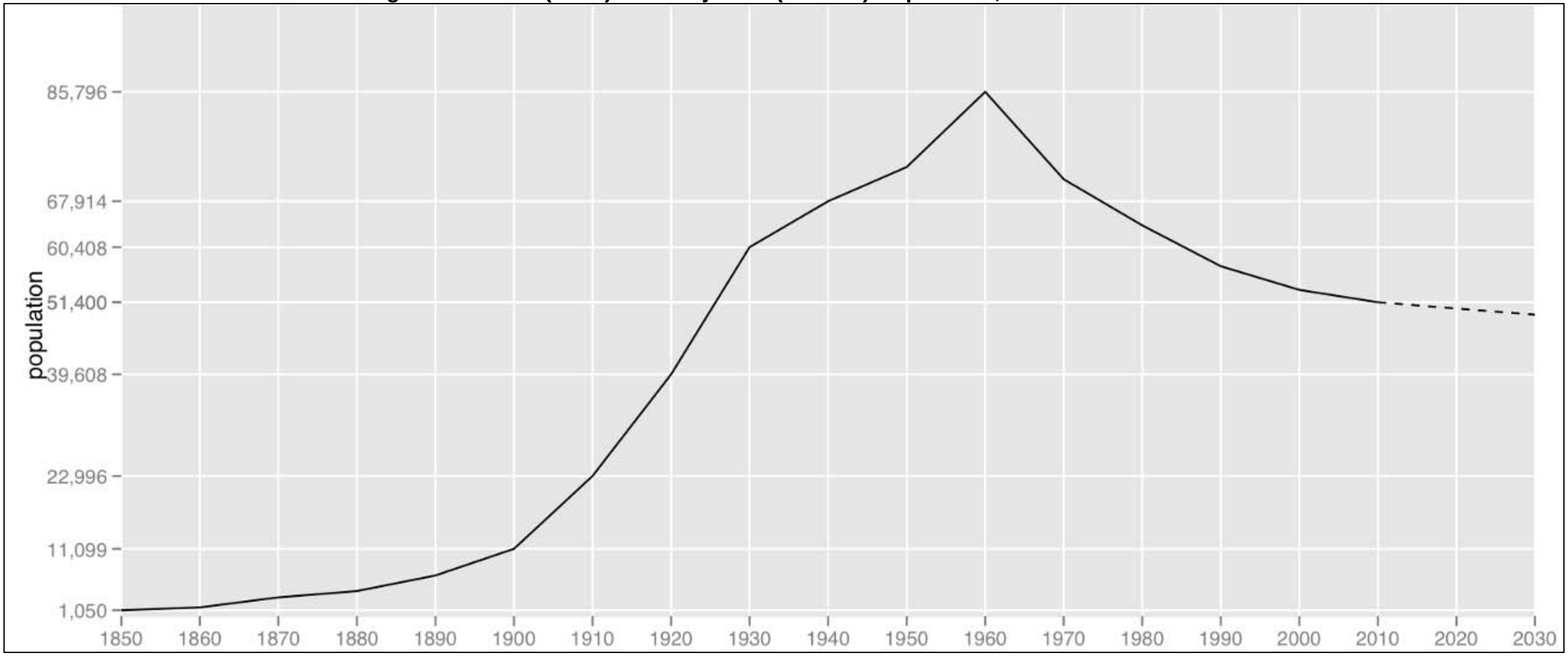


Figure 3: Population Density, 2007

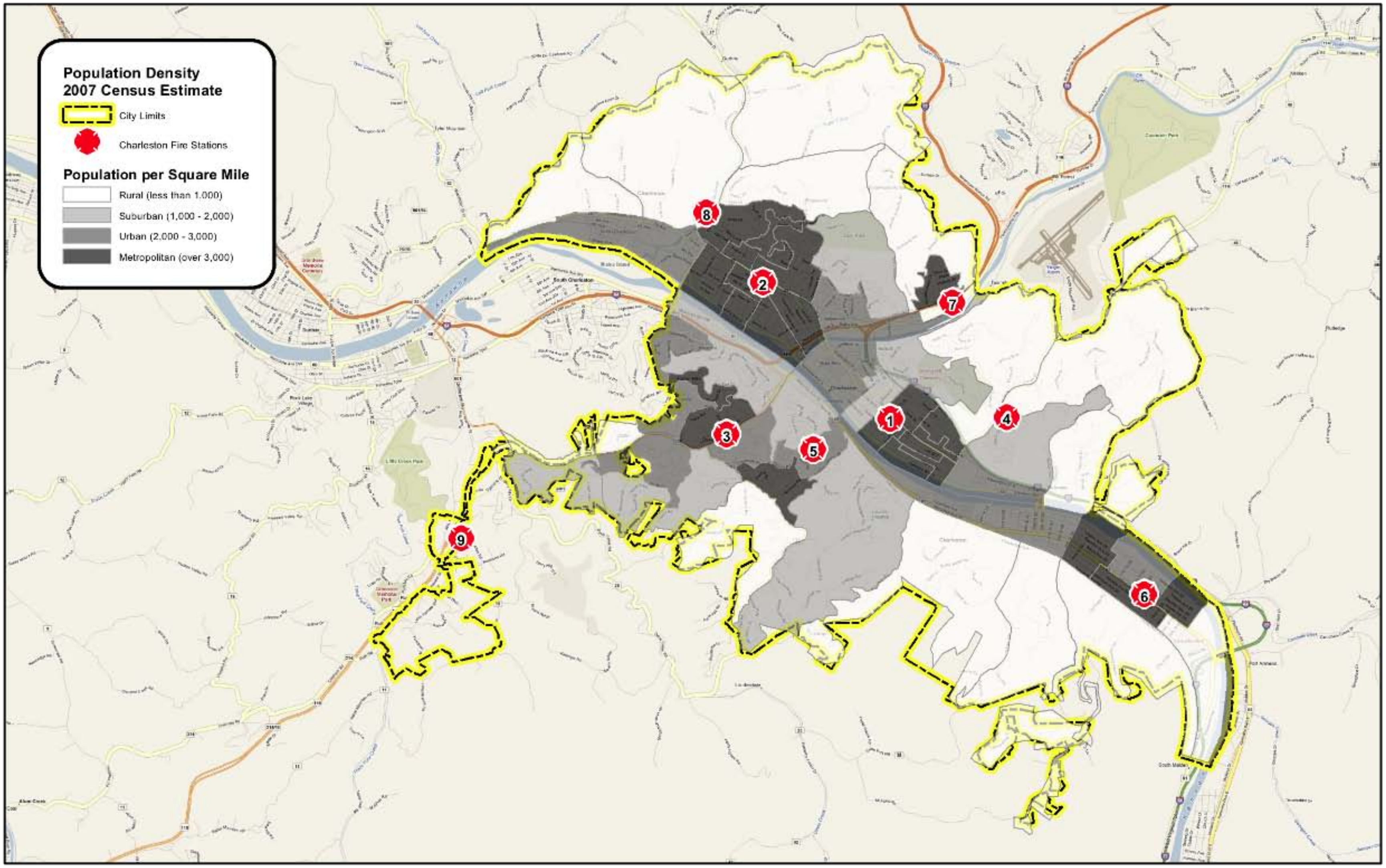


Figure 4: Emergency Incidents by Incident Type and Planning Area, CY2010

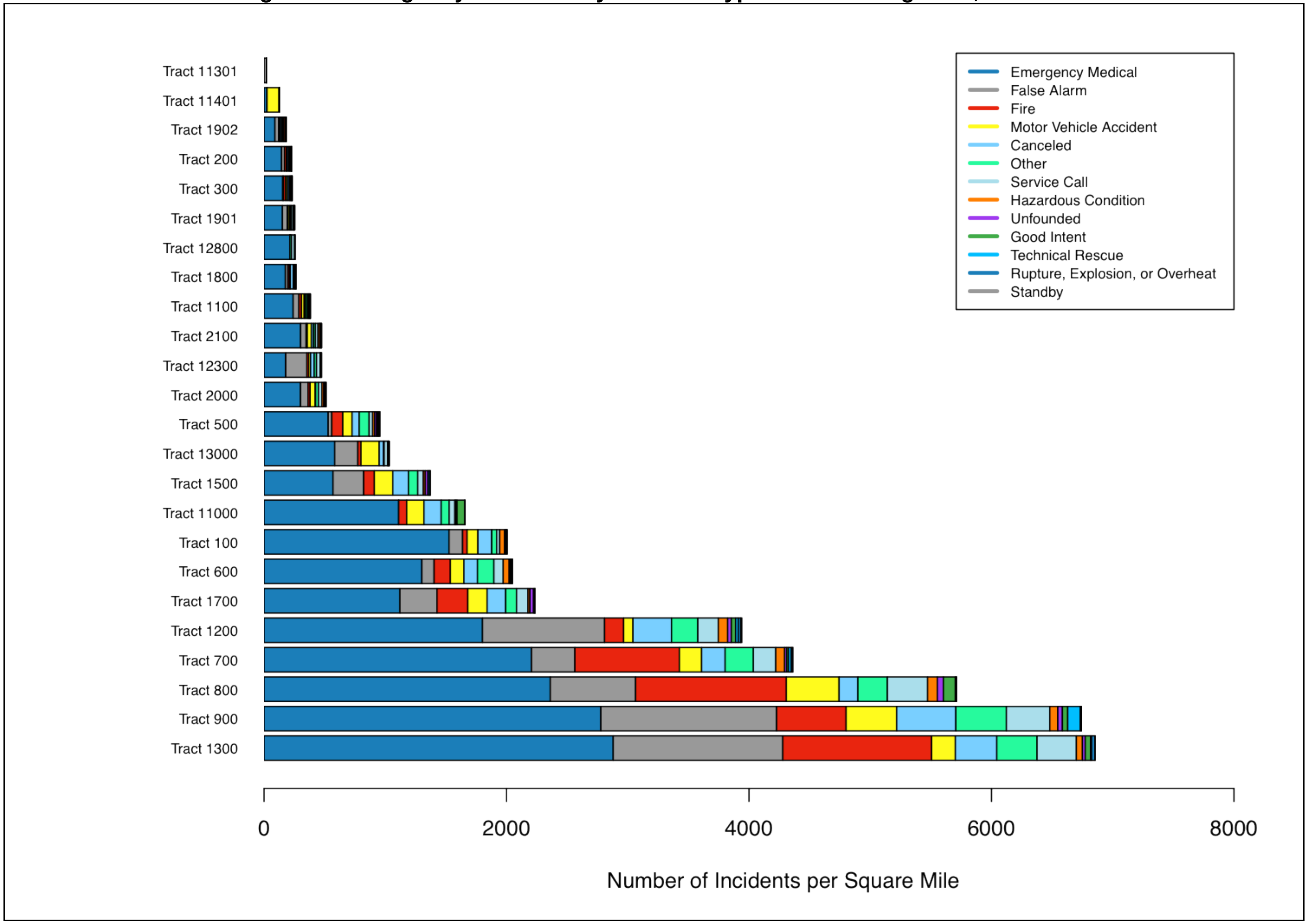


Figure 5: Fire Incident Density

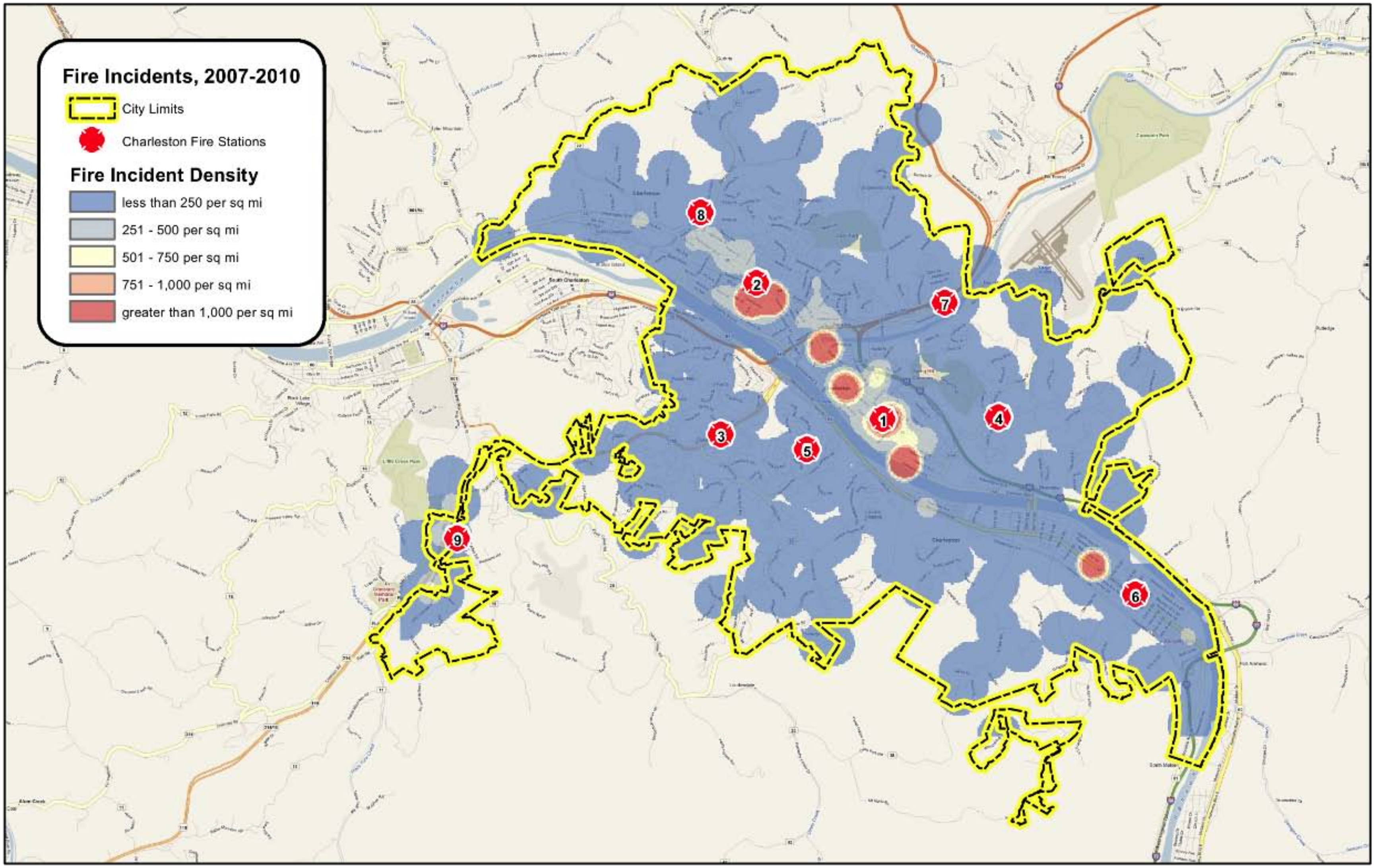


Figure 6: EMS Incident Density

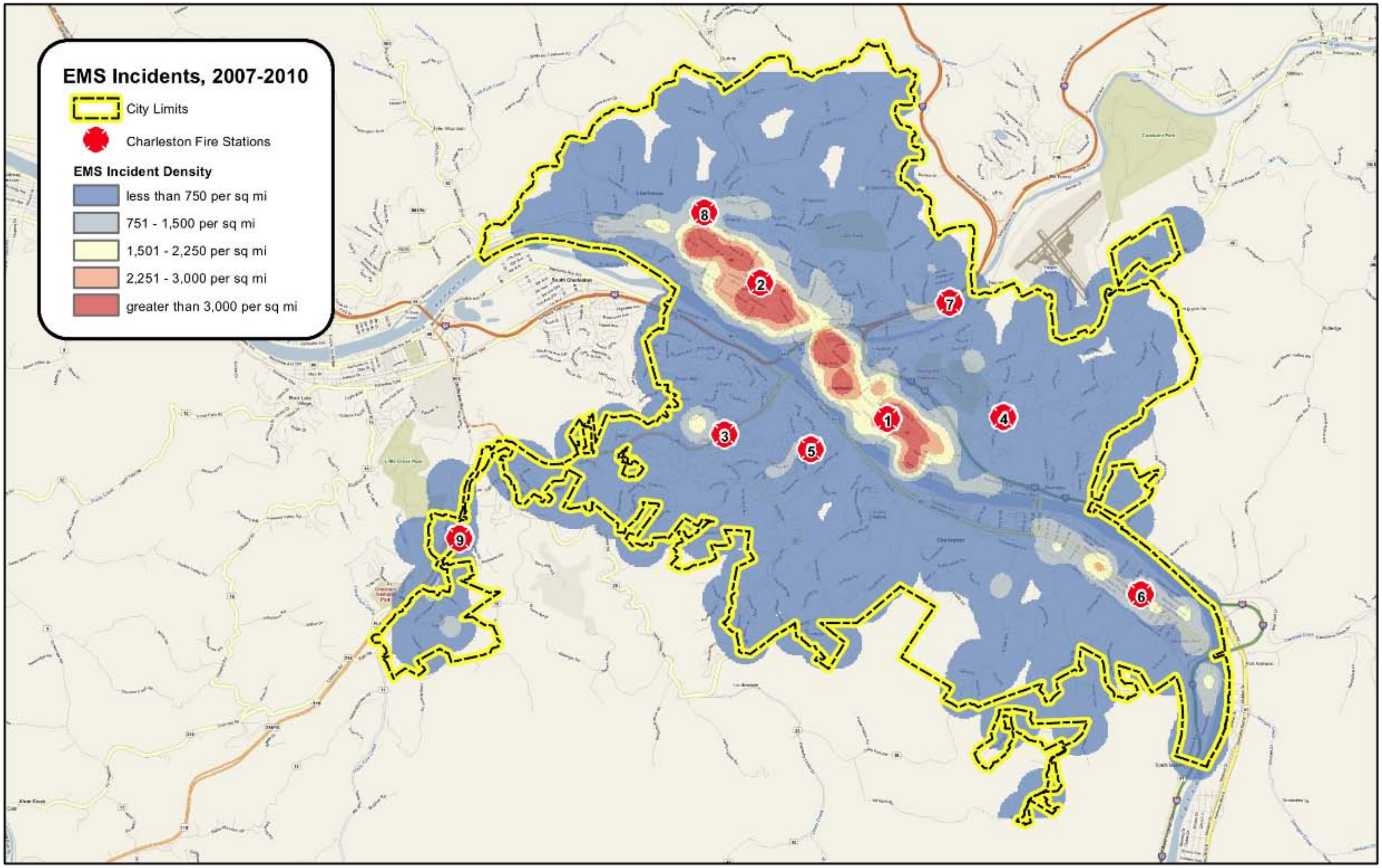


Figure 7: Structure Fire Locations

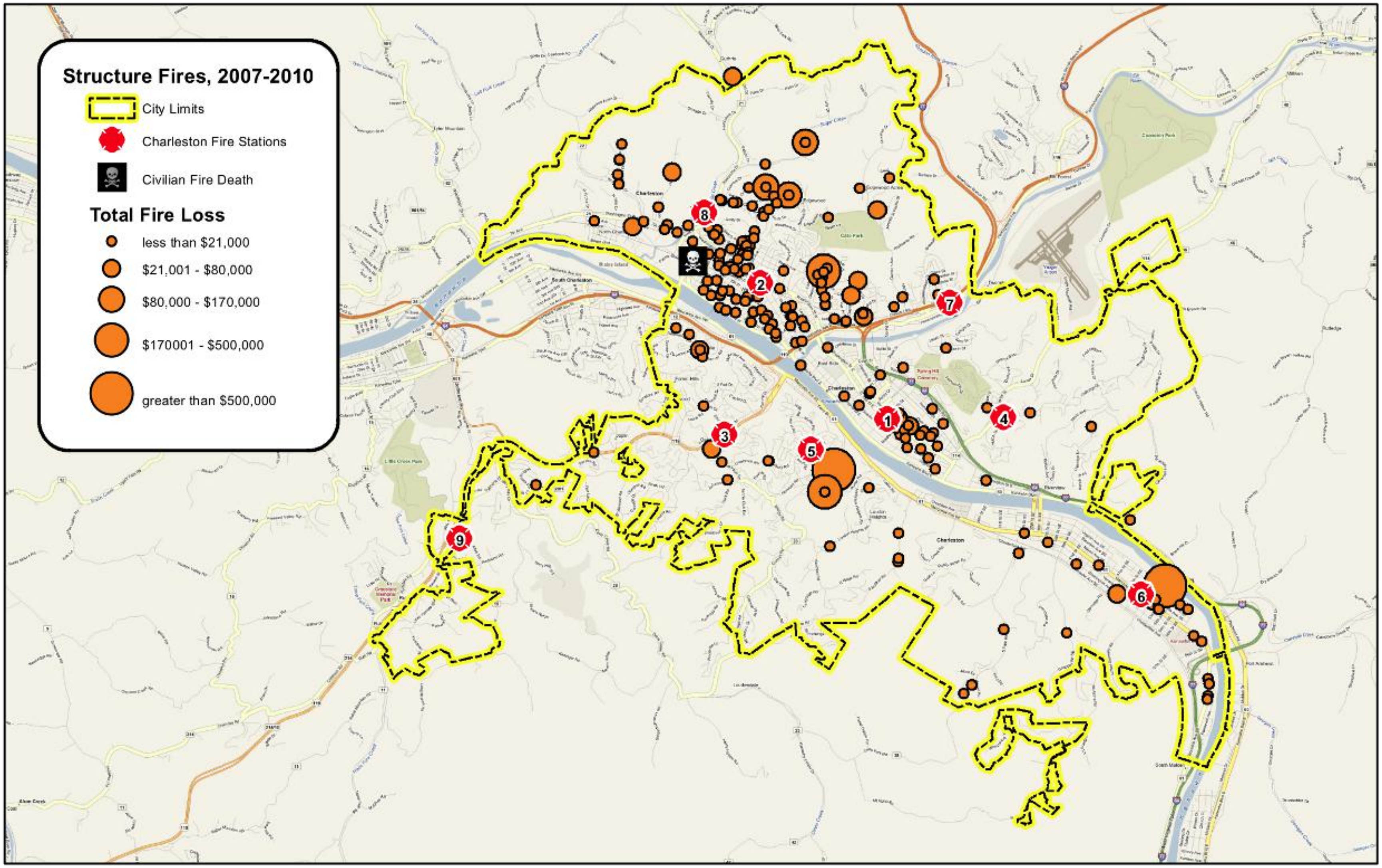


Figure 8: High Fire Risk Areas (Census Tracts)

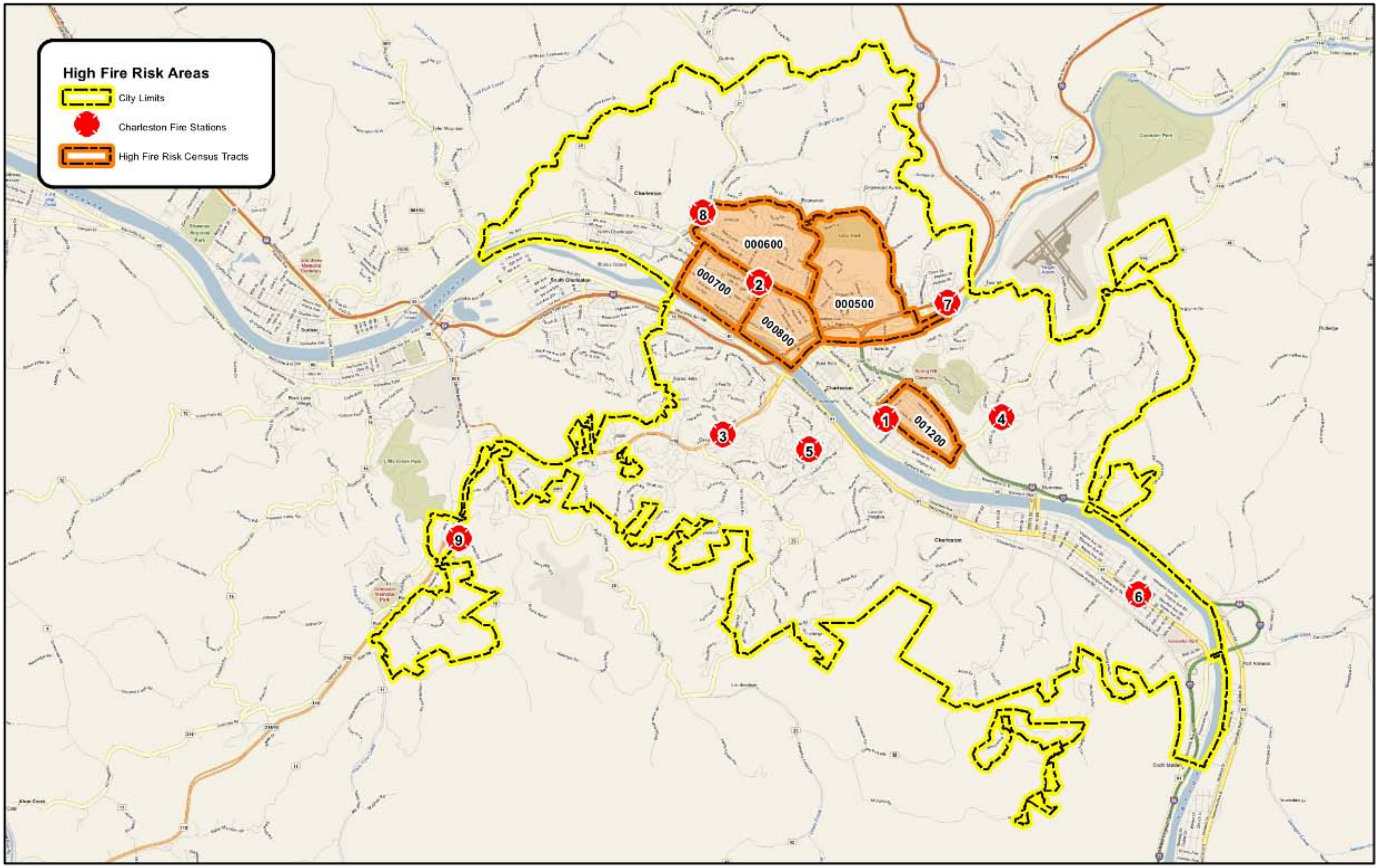


Figure 9: Call Processing Time by Hour of the Day, CY2010

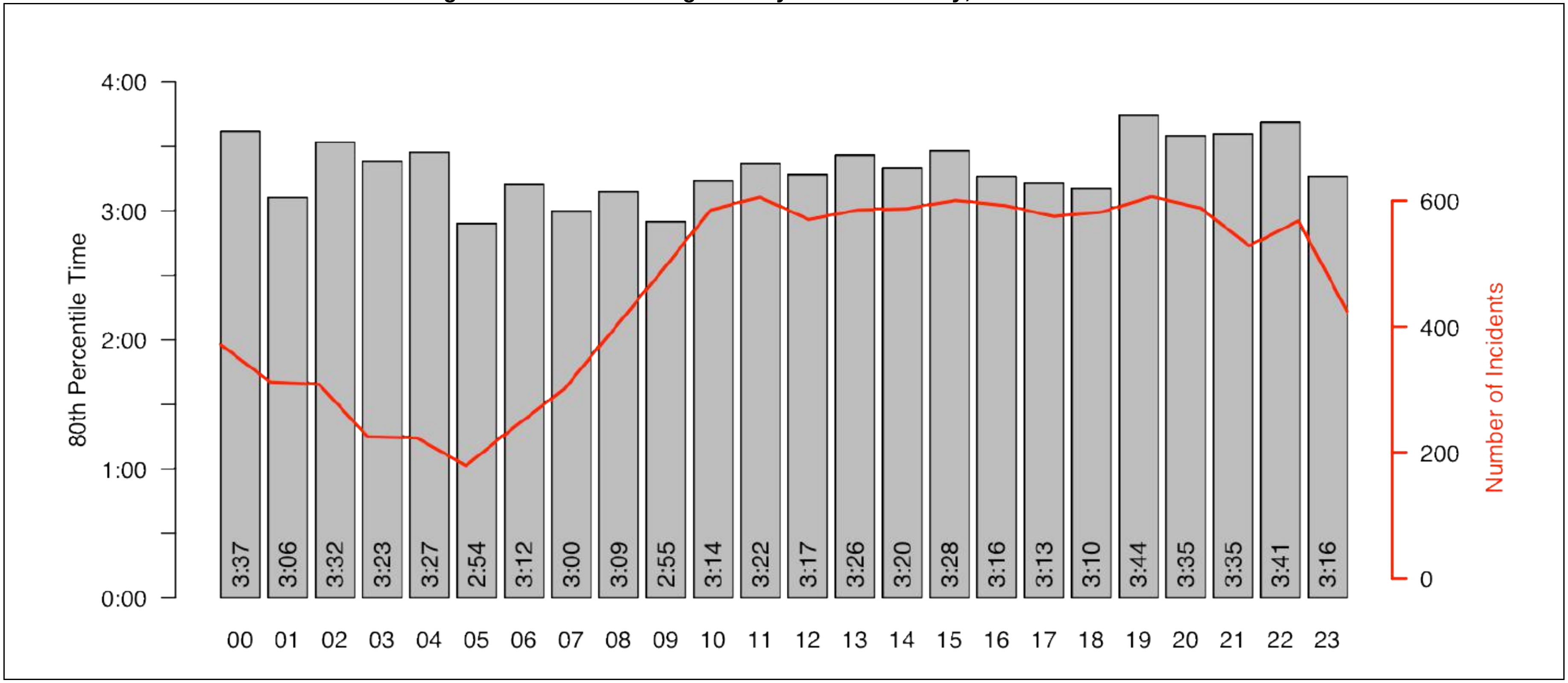


Figure 10: Turnout Time by Hour of the Day, CY2010

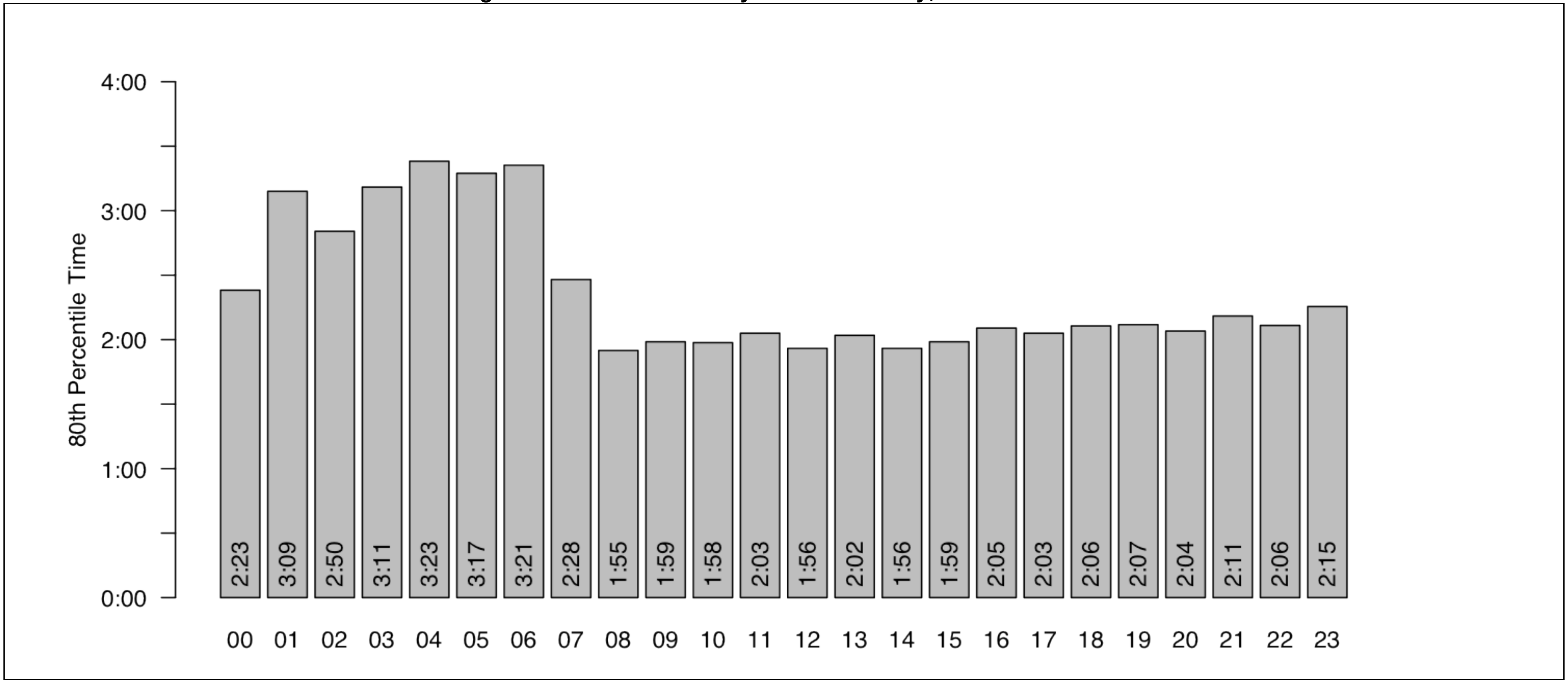


Figure 11: Travel Time (First Arriving Unit) by Hour of the Day, CY2010

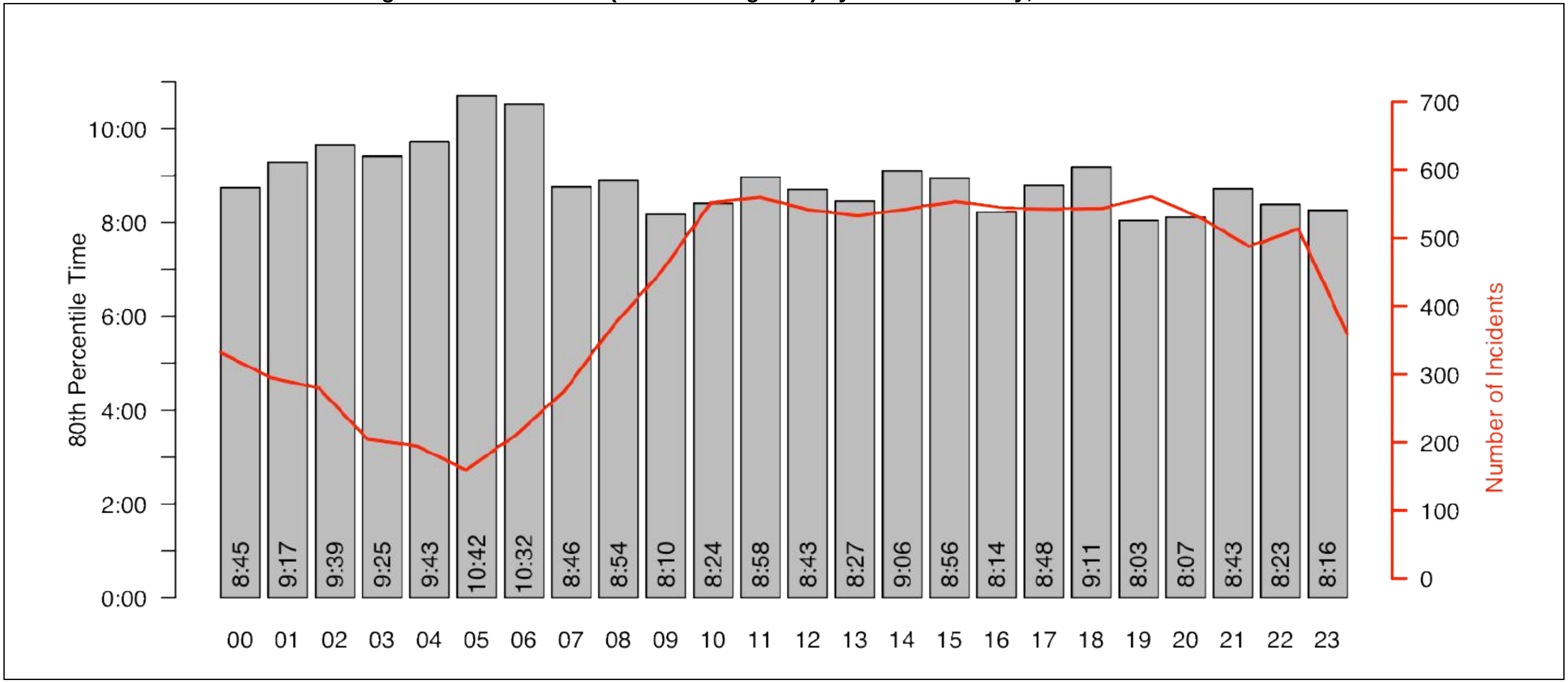


Figure 12: Total Reflex Time (First Arriving Unit) by Hour of the Day, CY2010

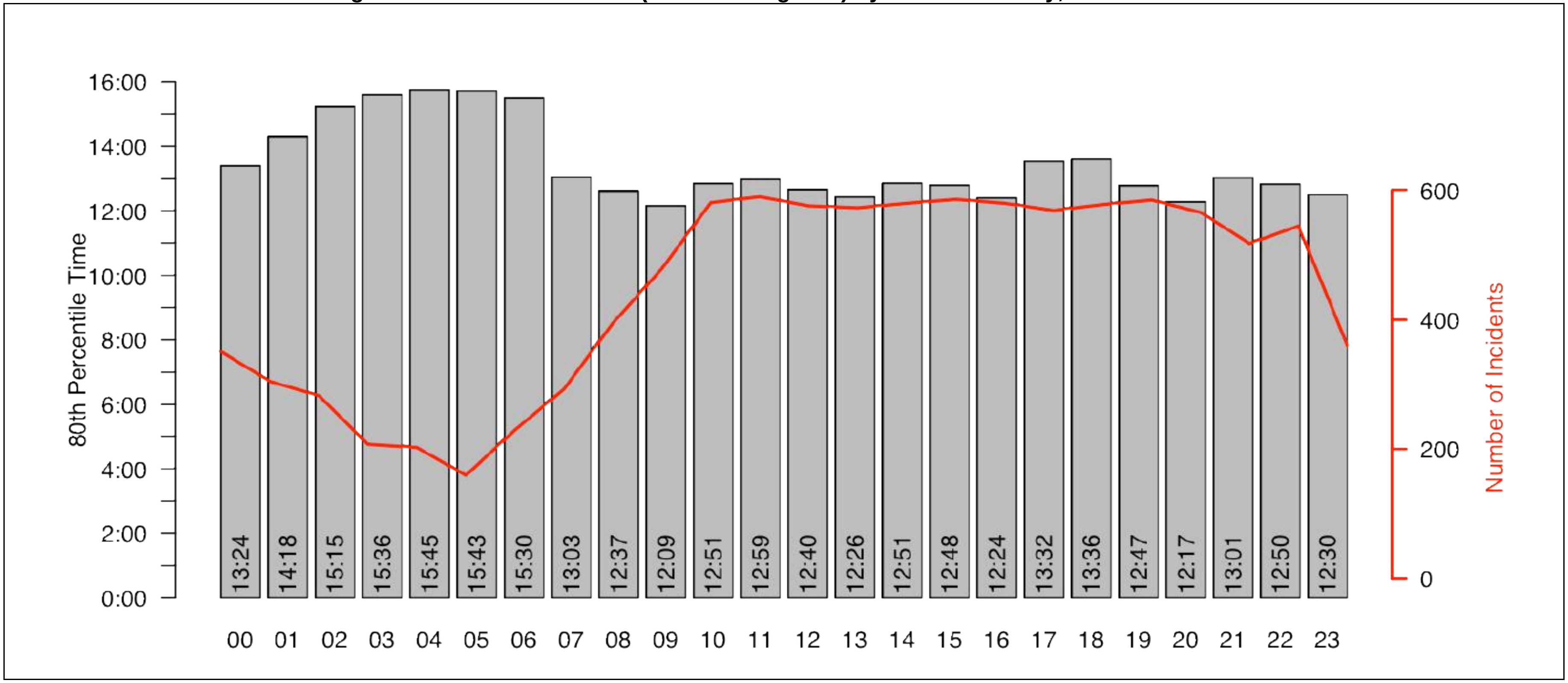


Figure 13: Workload (Unit Hours) by Unit and Incident Type, CY2010

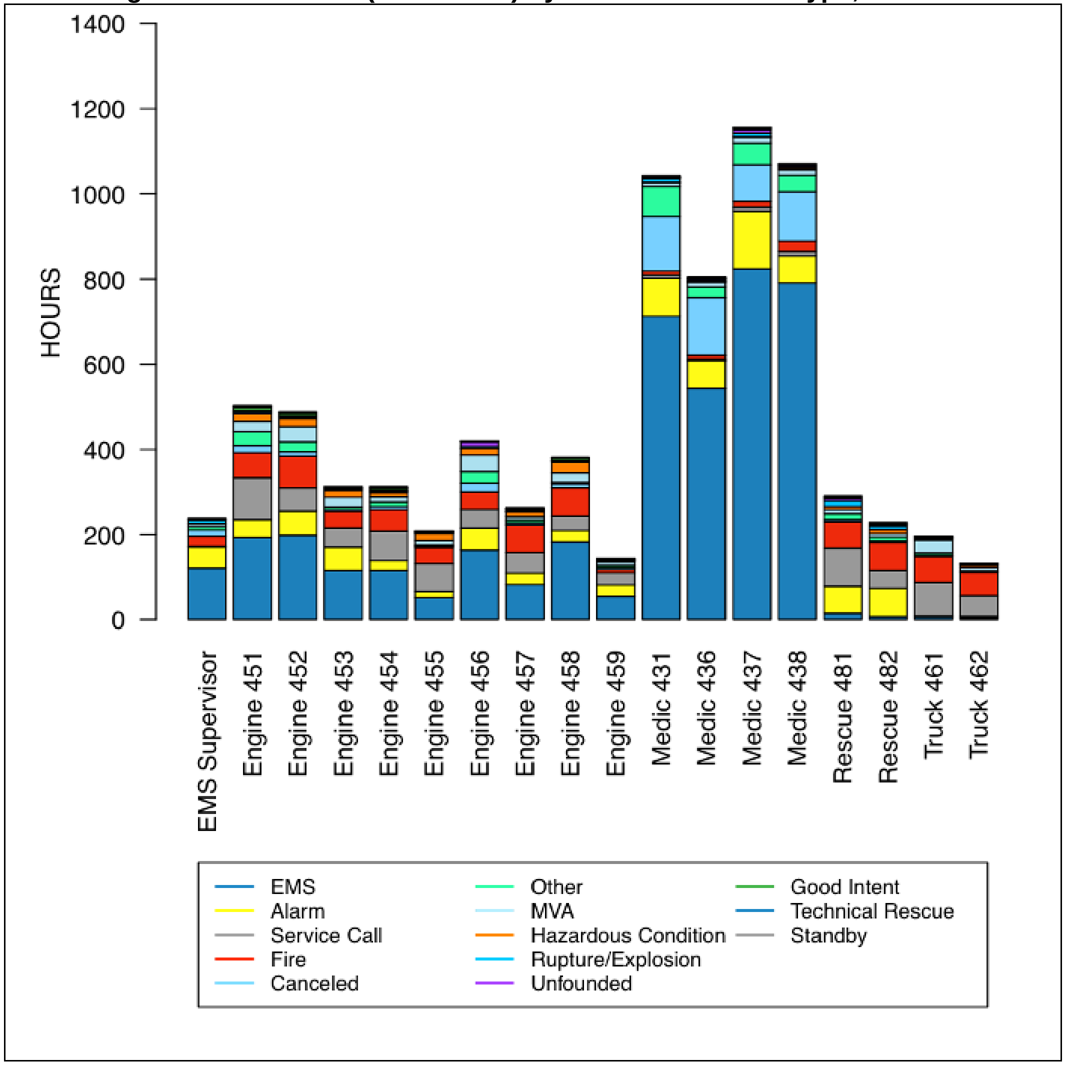


Figure 14: Current Fire Station Locations

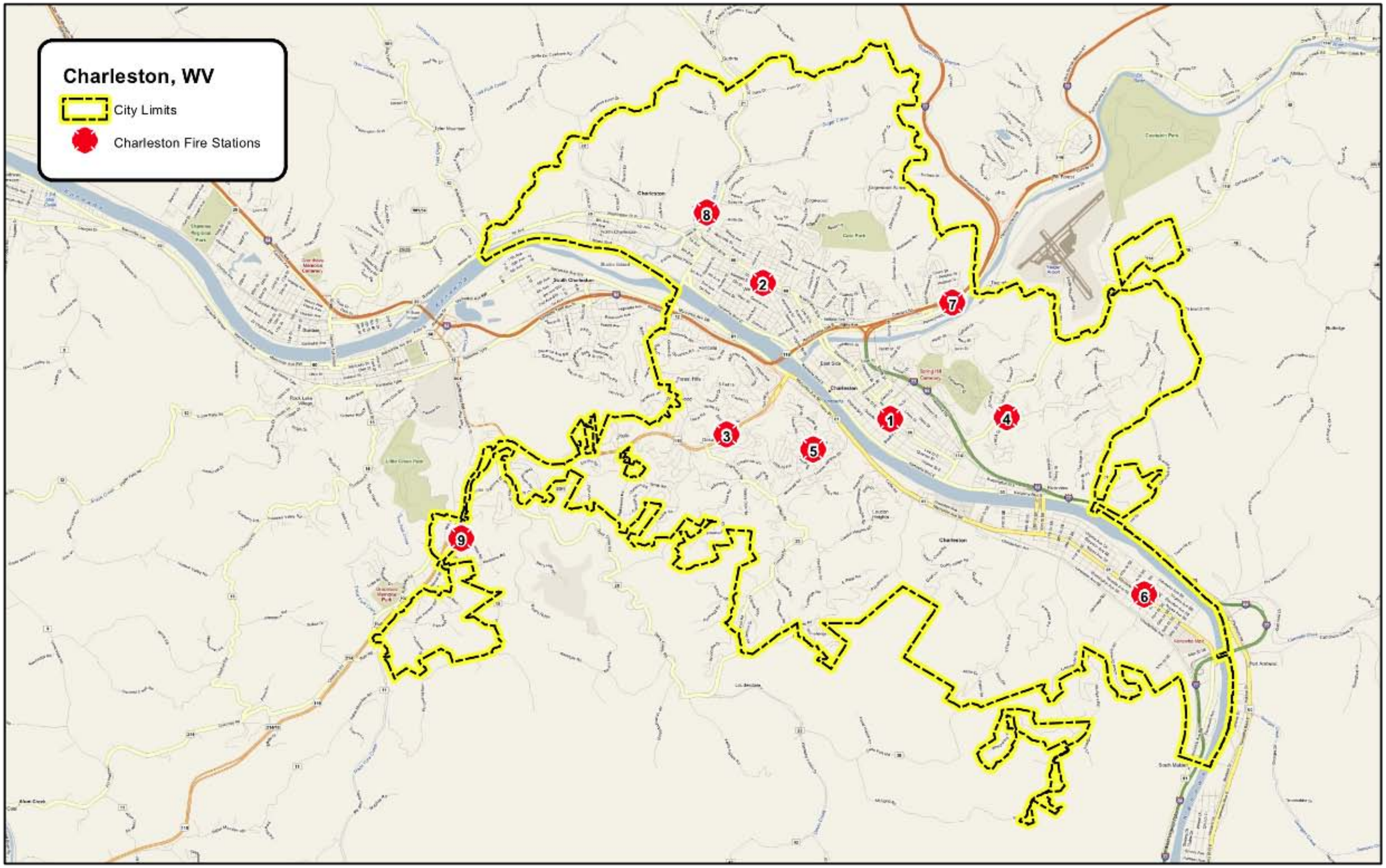


Figure 15: Four- and Six-Minute Travel Time Analysis

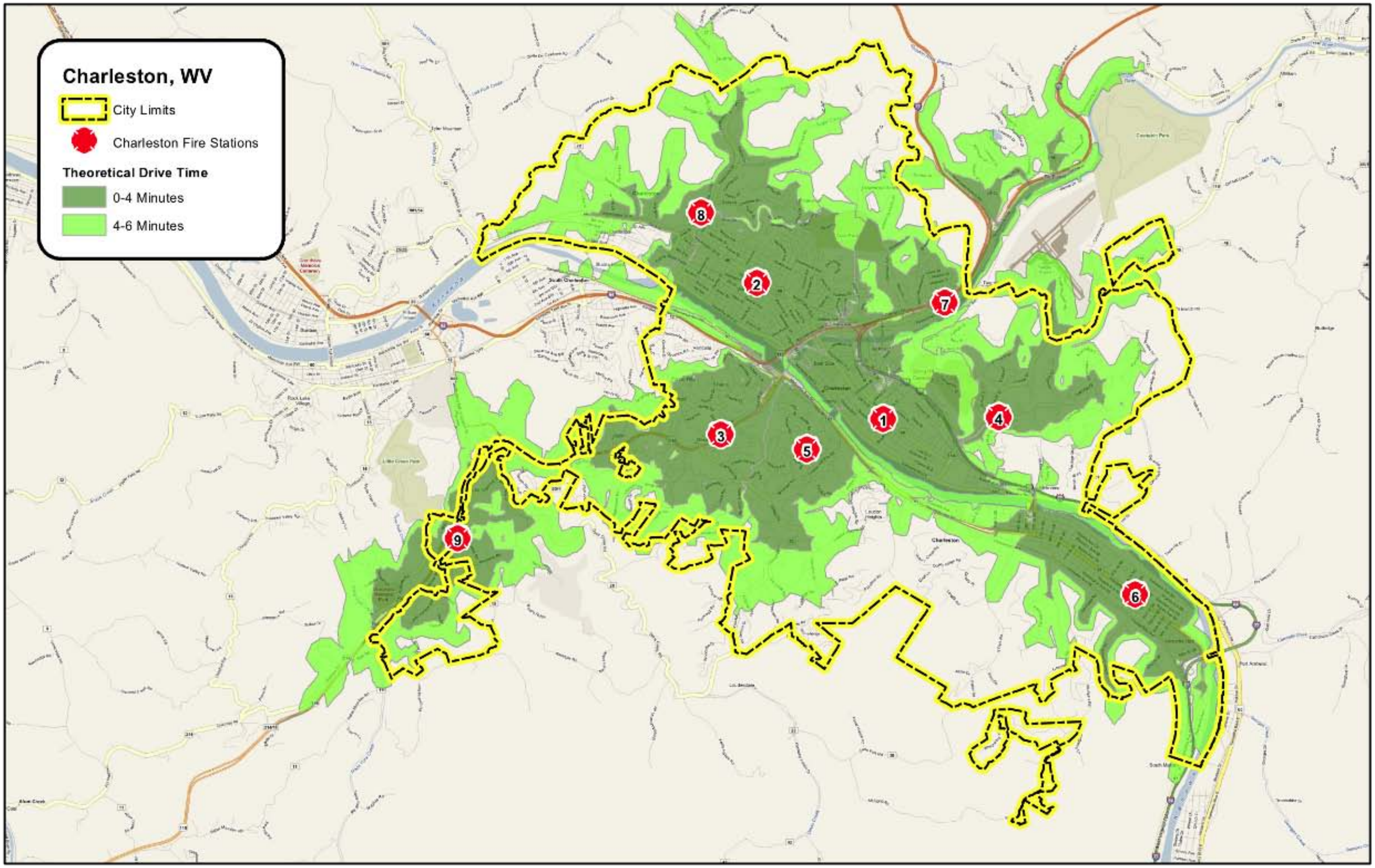


Figure 16: Current Station Overlap

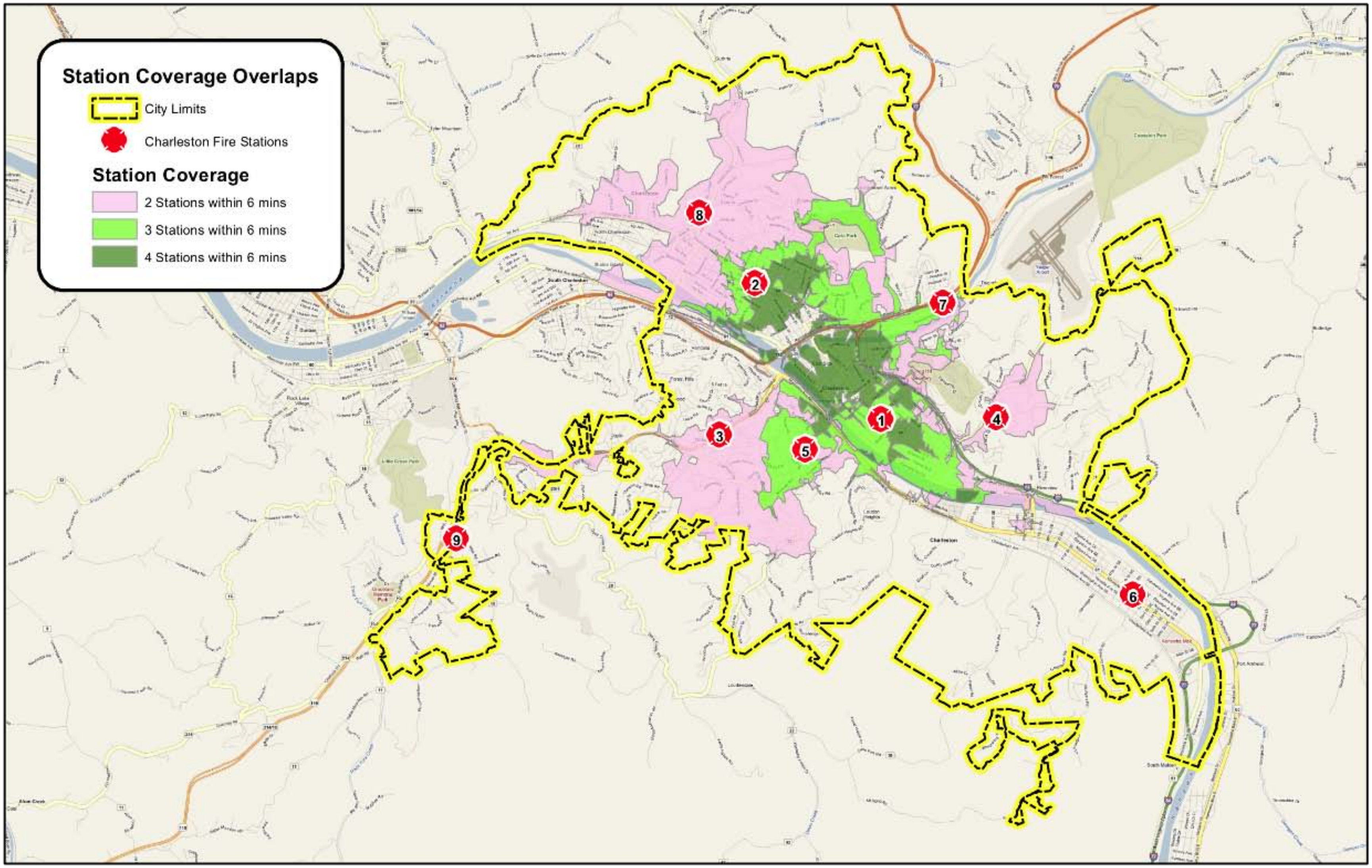


Figure 17: Alternative Station Layout with Theoretical Drive Times

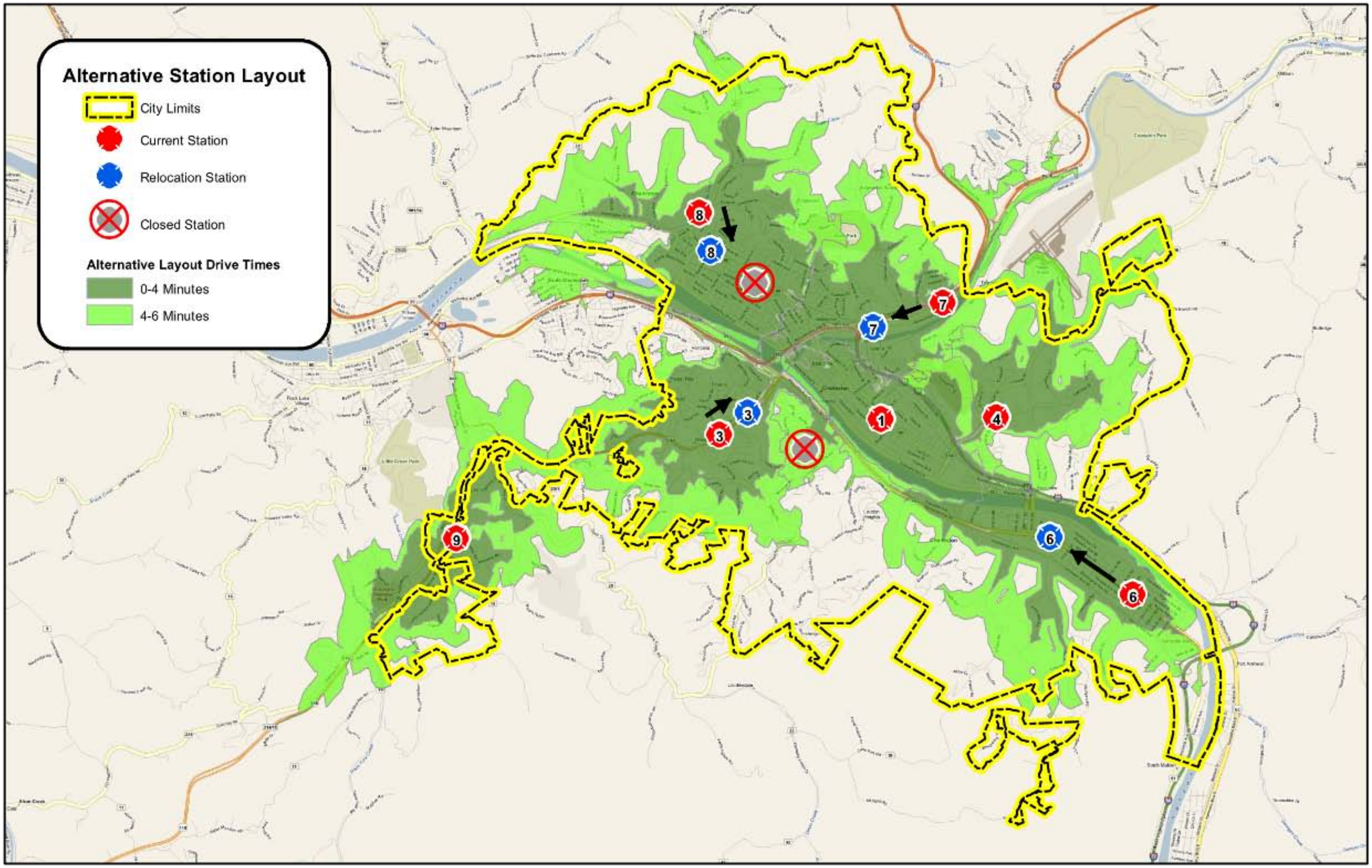


Figure 18: Alternative Station Layout with Station Coverage Overlaps

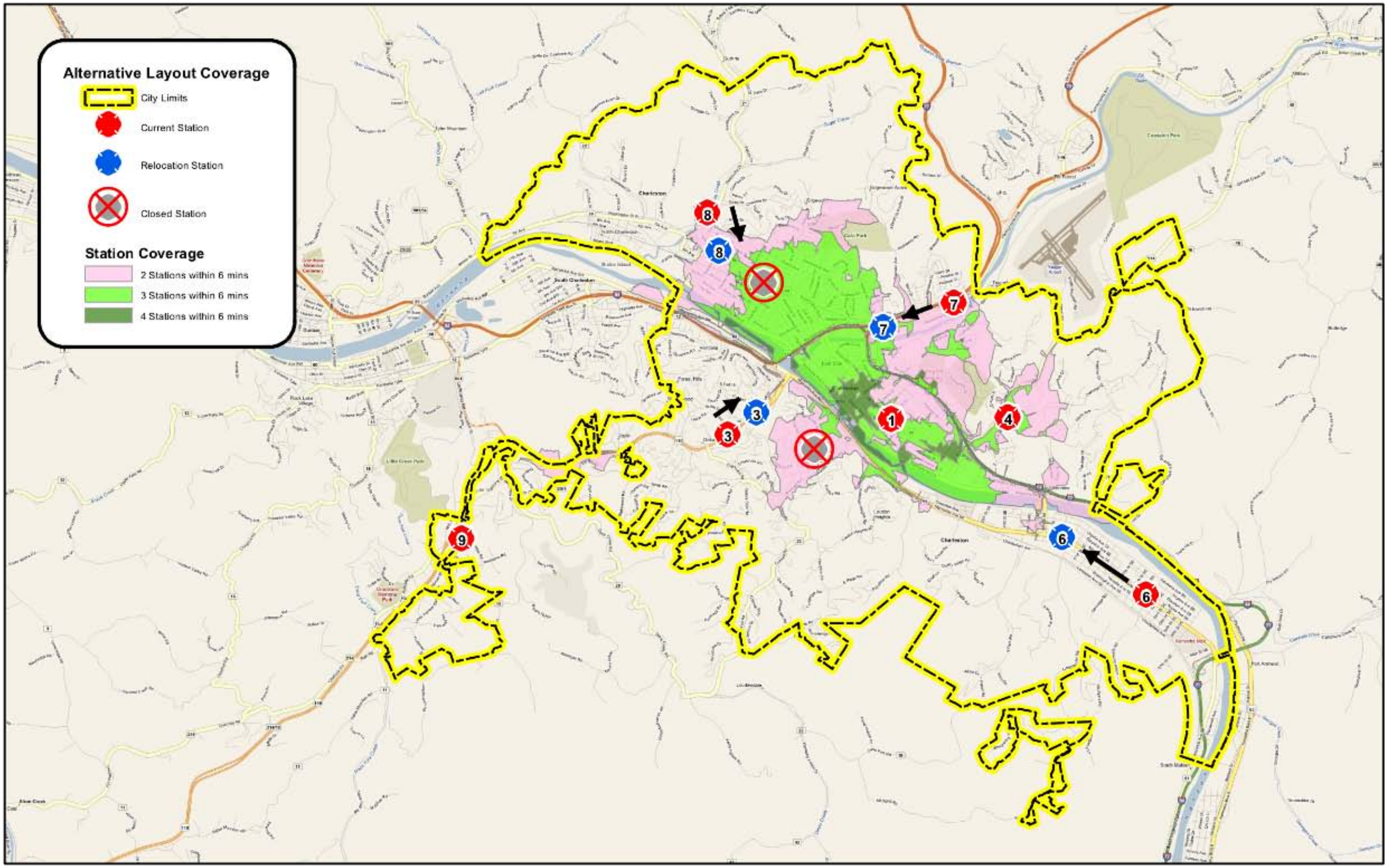


Figure 19: Current 8-min Travel Complement Staffing

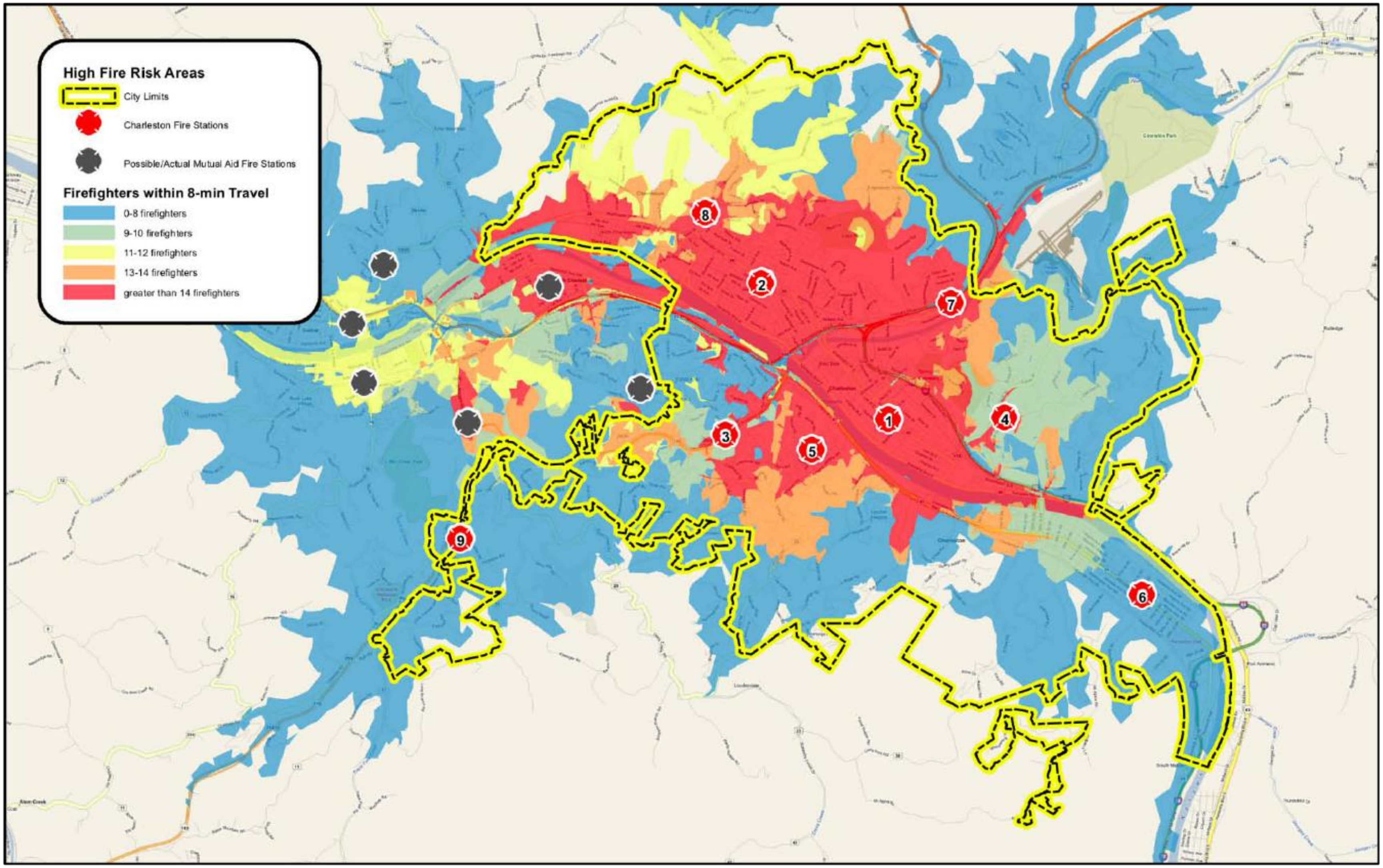


Figure 20: Moving Station 7 to Current Training Center

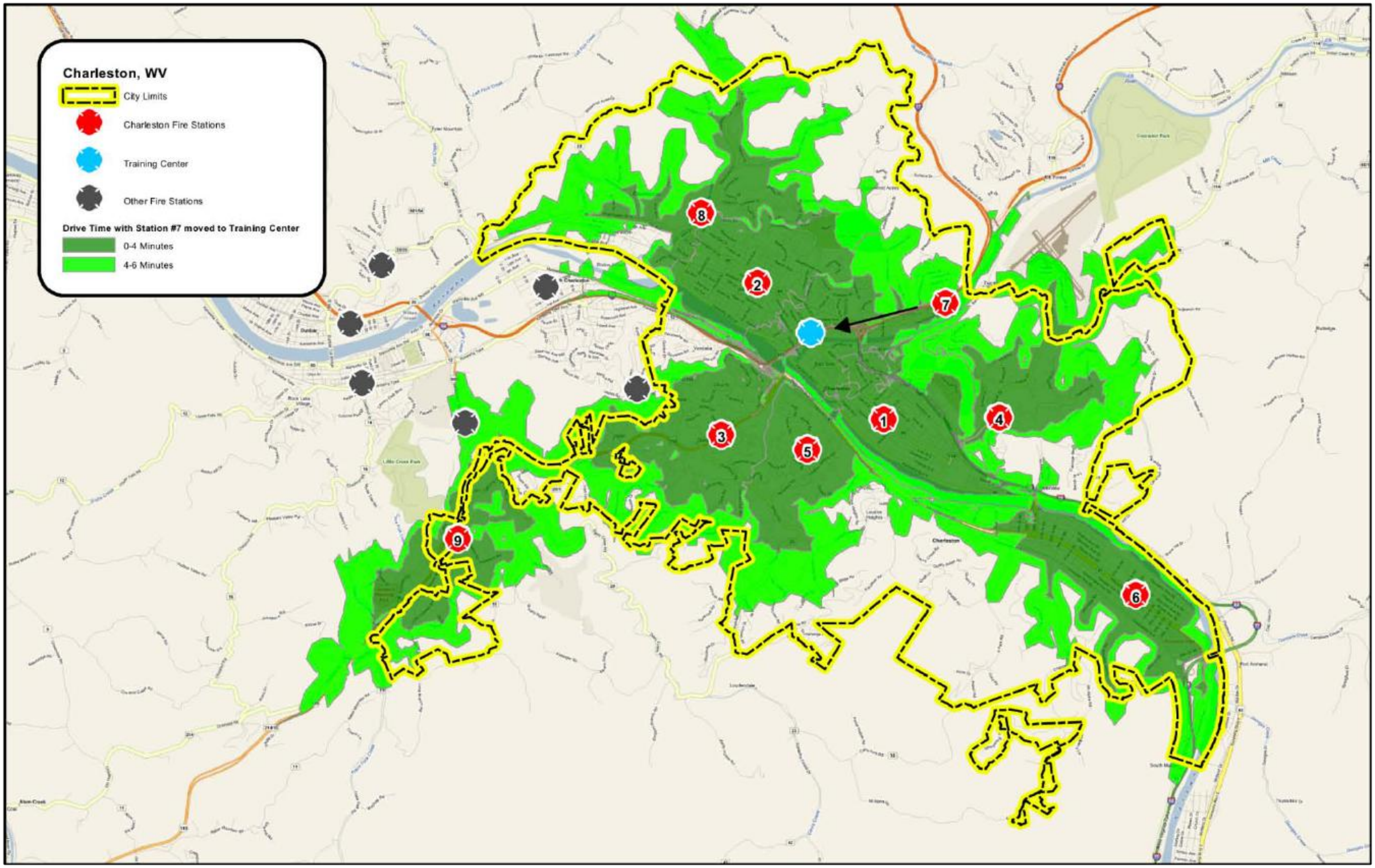


Figure 21: Move Station 7 to Current Training Center and Close Station 3

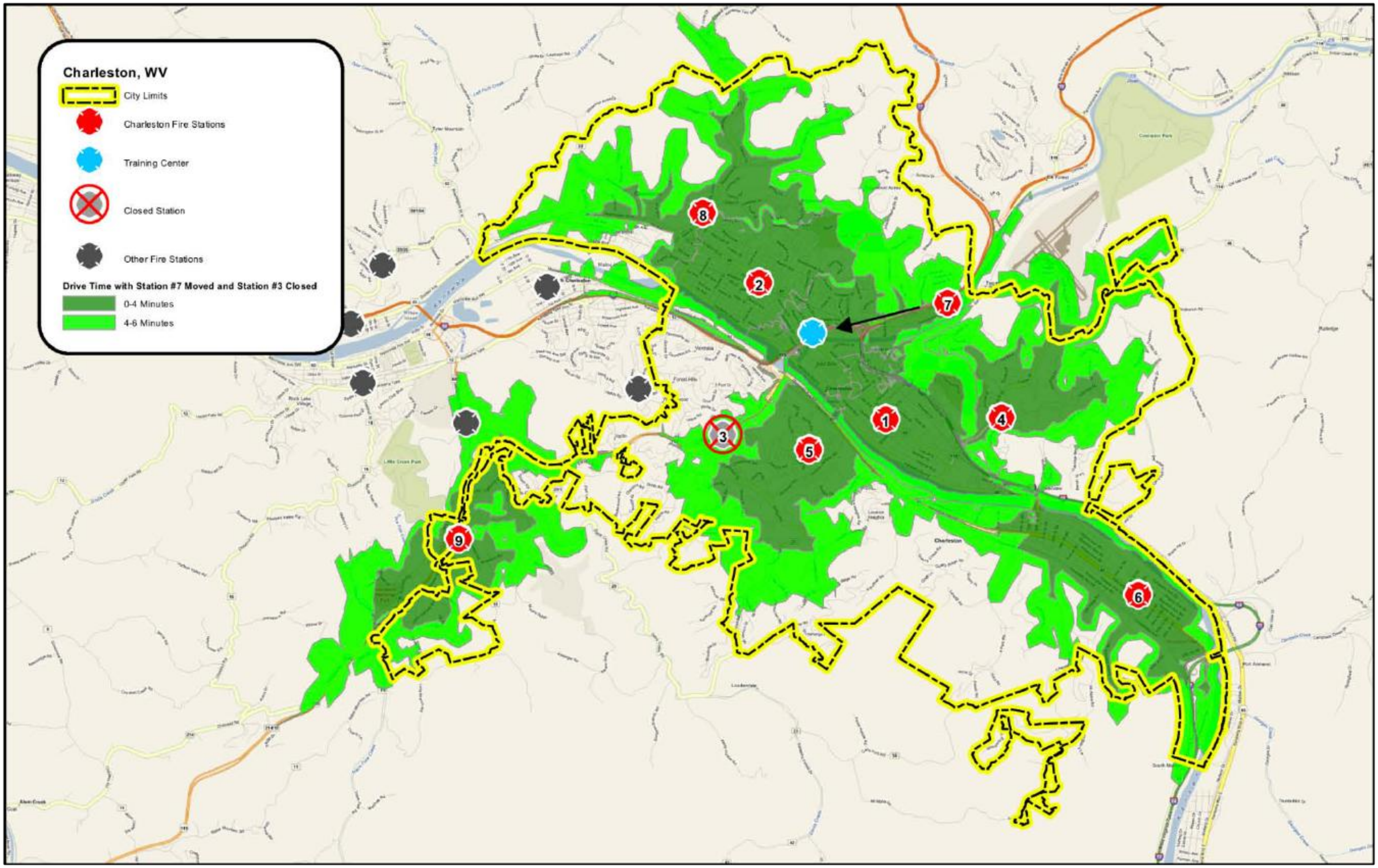


Figure 22: Closed Station 7