ATTACHMENTS

CITY OF SHEBOYGAN

COMMITTEE OF THE WHOLE

OCTOBER 1, 2018

Chair Sorenson called the meeting to order 7:14 p.m. The pledge of allegiance followed.

COMMITTEE MEMBERS PRESENT: Chair Ryan Sorenson, Alderpersons Todd Wolf, Mary Lynne Donohue, Ron Rindfleisch, Dean Dekker, Rose Phillips, and Trey Mitchell.

STAFF / OFFICIALS PRESENT: Mayor Michael Vandersteen, City Clerk Meredith DeBruin, City Administrator Darrell Hofland, Police Chief Chris Domagalski, Fire Chief Mike Romas, Finance Director Marty Halverson, Director of Public Works David Biebel, Director of Planning and Development Chad Pelishek, Director of Information Technology Greg Vertelka, City Engineer Ryan Sazama, Mead Public Library Business Manager Debbie DeAmico, Budget Analyst Carrie Arenz, and Communications Specialist & Administrative Assistant Sarah Schwefel.

MINUTES

Motion by Alderperson Wolf, second by Alderperson Donohue to approve the minutes of April 30, 2018. Motion carried.

ITEMS FOR DISCUSSION AND POSSIBLE RECOMMENDATION TO THE COMMON COUNCIL

COMMITTEE OF THE WHOLE REVIEW OF THE 2019 PROPOSED BUDGET

3.1 R. C. No. 139-18-19 by Finance and Personnel Committee to whom was referred Res. No. 94-18-19 by Alderpersons Rindfleisch and Bohren establishing the 2019 Budget appropriations and the 2018 Tax Levy for use during the calendar year; recommends passing the Resolution with an amendment.

Motion by Alderperson Wolf, second by Alderperson Donohue to approve the resolution with amendment and recommend the Common Council accept and file. Motion carried.

3.2 R. C. No. 140-18-19 by Licensing, Hearings, and Public Safety Committee to whom was referred a copy of Res. No. 94-18-19 by Alderpersons Rindfleisch and Bohren establishing the 2019 Budget appropriations and the 2018 Tax Levy for use during the calendar year; recommends passing the Resolution.

Motion by Alderperson Donohue, second by Alderperson Wolf to recommend the Common Council accept and file. Motion carried.

3.3 R. C. No. 141-18-19 by Public Works Committee to whom was referred a copy of Res. No. 94-18-19 by Alderpersons Rindfleisch and Bohren establishing the 2019 Budget appropriations and the 2018 Tax Levy for use during the calendar year; recommends passing the Resolution. REFER TO COMMON COUNCIL.

Motion by Alderperson Wolf, second by Alderperson Donohue to recommend the Common Council accept and file. Motion carried.

NEXT MEETING DATE

October 15, 2018 at 6:30 p.m. or immediately following Common Council.

ADJOURN

Motion by Alderperson Wolf, second by Alderperson Donohue to adjourn at 7:30 p.m. Motion carried.

II

Other Matters

7.1

R. O. No. 180- 18 - 19. By FIRE CHIEF. November 19, 2018.

Submitting the Draft Summary Report of the Operational and Departmental Structure Review of the Sheboygan Fire Department prepared by Fitch & Associates.

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FIRE CHIEF

November 2018

City of
Sheboygan
spirit on the lake.

Draft Summary Report
Operational & Departmental Structure Review

Sheboygan Fire Department

Prepared by:

FITCH & ASSOCIATES

FITCH & ASSOCIATES, LLC
2901 Williamsburg Terrace #G ▪ Platte City ▪ Missouri ▪ 64079
816.431.2600 ▪ www.fitchassoc.com

CONSULTANT REPORT

SUMMARY REPORT
OPERATIONAL & DEPARTMENTAL STRUCTURE REVIEW
SHEBOYGAN, WISCONSIN

Table of Figures

SECTION 1: Executive Summary

Introduction

Fitch & Associates (*FITCH*) was engaged by the City of Sheboygan to undertake an operational review and organizational structure review of the Fire Department.

FITCH employs a two-pronged approach in undertaking this engagement. First is a quantitative perspective – derived largely from computer aided dispatch (CAD) data to evaluate the current system performance based on historical demand. Employing this data, geographic information system (GIS) modeling was performed to validate and model response time and coverage performance within the department's service area. National Fire Incident Reporting System (NFIRS) fire reports, as submitted by the department, offers a comparative assessment of the fire loss experience in the community. Finally, a separate assessment of risk, as embodied within an Insurance Services Office (ISO) batch report of independently evaluated properties within the City, were used to quantify potential risk, as contrasted with actual demand that was derived from CAD and fire incident level data. Second, from a qualitative perspective *FITCH,* spent significant time meeting with key stakeholders. These included members of the City Administrators Office, Fire Department command staff, and representatives of the fire fighter bargaining unit (IAFF Local 483).

The following pages provide an executive summary of the relevant findings and final recommendations from this study. This is then followed by sections encompassing more detailed analysis, conclusions, and information to offer additional background as the reader may desire. These sections include a summary PowerPoint appropriate for high level briefings of stakeholders; detailed data analysis, some of which is included in this section; full GIS modeling of various alternatives; and explanatory material related to the industry use of average and 90^{th} percentile descriptive statistics.

Methodology

We collected five years of CAD data (2013 to 2017) from Sheboygan Fire Department (SFD). In this report, we primarily focused our descriptive statistical analysis on the 2017 calendar year.

In this report, we utilized two distinct measures of call volume and workload. First, is the number of requests for service that are defined as either "dispatches" or "calls". Dispatches/calls are the number of times a distinct incident was created. Conversely, "responses" are the number of times that an individual unit (or units) responded to a call. Responses will be utilized on all Unit and Station level analyses, which account for all elements of workload and performance. Calls have been categorized as EMS, Fire, Hazard and Mutual aid respectively. We classified call types using nature of incident. Calls associated with a transport time were identified as transport calls.

Dispatch time in this report is calculated from the time a 911 call was answered by the dispatcher through the time a unit was dispatched. This report focuses on calls responded with lights and sirens, and mainly analyzes dispatch time, turnout time, travel time, and response time of the first arriving units.

Community Background

Sheboygan is a city of 48,329 as of 2017, down approximately 2% since the 2010 census.[1] Sheboygan is situated along the shores of Lake Michigan in east-central Sheboygan County. Sheboygan's one-hour commuter shed includes Milwaukee, Manitowoc, and the cities of the Fox Valley, with Green Bay just beyond on Interstate 43. Sheboygan lies north of the Milwaukee and Chicago metro areas, connecting it to these important global and national technology, business, and transportation hubs. Sheboygan is also well-connected to the Door County tourism circuit by Interstate 43 and Highway 42 and to the Lake Michigan tourism corridor in Michigan via the Manitowoc ferry. Sheboygan lies within Wisconsin's northeastern coast—an area which includes Sheboygan, Calumet, Fond du Lac, Manitowoc, Outagamie, and Winnebago Counties. Combined, Wisconsin's northern coastal counties contain a significant population concentration in the State that is not commonly realized or understood. The 2010 population of this region is nearly 700,000, accounting for 12 percent of the State's population.[2]

Sheboygan's homes are significantly more affordable compared to the County and neighboring communities. According to the Wisconsin Department of Revenue, the average assessed value of single-family homes in the City was $115,978 in 2011 compared to the State's average of $175,029. Per the 2010 Census, approximately 61 percent of Sheboygan's housing was owner occupied. Sheboygan's population is more diverse than neighboring communities and the County – a trend that is continuing in the City. In 2000, 87.6 percent of the City's population was white according to Census data; in 2010, this demographic group decreased to 82.5 percent of the City's population. According to 2000 Census data, the City's median household income was $40,066. Manufacturing is the City's leading industry, employing 40 percent of the City's workforce in 2000. The City's second leading industry is education, health, and social services with 17 percent of the workforce employed in those professions. Sheboygan's residents are educated, with 81 percent having received a high school diploma or higher and 15 percent having received a bachelor's degree or higher.[3]

Budget

For fiscal year 2018, the Fire Department's adopted budget totaled $8,076,089. This includes 7,462,094 in personal services (92.4%) and 613,995 (7.6%) in non-personal operating costs. Revenues from the ambulance special revenue fund are estimated at $1,000,000.[4]

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[1] U.S. Census Bureau (2017). Accessed from https://www.census.gov/quickfacts/fact/table/sheboygancitywisconsin,US/PST045217 on October 8, 2018

[2] City of Sheboygan Comprehensive Plan (2011). Accessed from http://www.sheboyganwi.gov/wp-content/uploads/2011/05/Sheboygan-Comp-Plan-Final-12.5.11.pdf on October 8, 2018

[3] Ibid

[4] 2018 Annual Program Budget – City of Sheboygan, Wisconsin. Accessed at http://www.sheboyganwi.gov/CityBudgetFiles/flipbook_2018_AnnualProgramBudget/inc/html/490.html?page=1 on October 23, 2018

Ambulance Revenue

In 2017, the City changed outside ambulance billing companies and contracted with Intermedix, a nationally known EMS billing agency. As reflected in the Figure below, in 2017 total collections were $1,193,274, up slightly from 2016 and representing 37% collection on the gross charges.

The City of Sheboygan's ambulance billing program and revenues are typical based on the number of incidents, geographic area, and payer mix. Collection rates, by program, are fairly typical, but should continue to be monitored with the recent change in the outside billing contractor and adjusting for any future changes in Federal reimbursement policies. The overall capital purchasing appears to have been aligned to department needs and operating expense values appear to be in line with expectations. The City's agreement with its current billing vendor has a favorable fee of 4.5%, compared to the 5.5% to 6% fee often seen with similar sized systems.

Figure 1: Payer Mix and Revenues for 2017

	2017 Total Collections		$1,193,274.45
	Percentage	Revenue	
Medicare	49.71%	$	593,192.65
Medicaid	26.10%	$	311,462.40
Commercial	14.46%	$	172,591.50
Self-pay	7.47%	$	89,196.45
Other	2.2%	$	26,831.45
Confirmation	100.00%	$	1,193,274.45

Collection percentages have stayed consistent for Medicare and Medicaid, but there is a projected 6% increase in commercial insurance for 2018. In 2016 and 2017 collections averaged 36% of Gross Charges. However, in 2018 year-to-date collections, they are currently averaging 29% of Gross Charges. This could be for a multitude of factors such as the billing company change over, contract collections for commercial insurance, or timing as funds may not be full recognized until April of 2019 when the balance on the accounts receivable (AR) have been documented.

Sheboygan Fire operates 3 ambulances, each staffed with 2 personnel, across 3 different working shifts. It was noted that the City's financials reflect a cost allocation to the EMS program which only contemplates 4 full-time equivalents (FTEs), rather than the 18 FTEs reflected by the 3 ambulances across 3 shifts with 2 personnel each. Elsewhere in this report it is noted these ambulances respond to approximately 75% for EMS related incidents and 25% for fire incidents.

The fire department has four total ambulances – three that were recently refurbished at the same time and one used vehicle that was recently acquired as a back-up unit. The City has also purchased four power stretchers for patient movement, and three cardiac monitors. The capital purchasing document shows an appropriate depreciation of $106,456 annually.

Organizational Structure

The Department's current authorized strength is 70.5 full-time equivalents (FTEs), which was reduced by 3 FTEs in 2017.[5] For fiscal year 2018, staffing includes the following positions:

Figure 2: Authorized FTEs - 2018

Position	Count
Fire Chief	1
Assistant Chief	1
Deputy Chief	1
Battalion Chief	4
Captain	5
Lieutenant	10
Fire Equipment Operator	15
Firefighter	18
Firefighter/Paramedic	14
Confidential Secretary	1
Office Assistant	0.5
TOTAL	**70.5**

As reflected elsewhere in report, the allocation of personnel and response resources are sufficient to handle the current levels of performance. However, administrative staffing is challenged to fully address ongoing training needs, public education, shift supervision and internal communications in an effective manner. There is a need to reconsider administrative staffing in order to more effectively manage these areas.

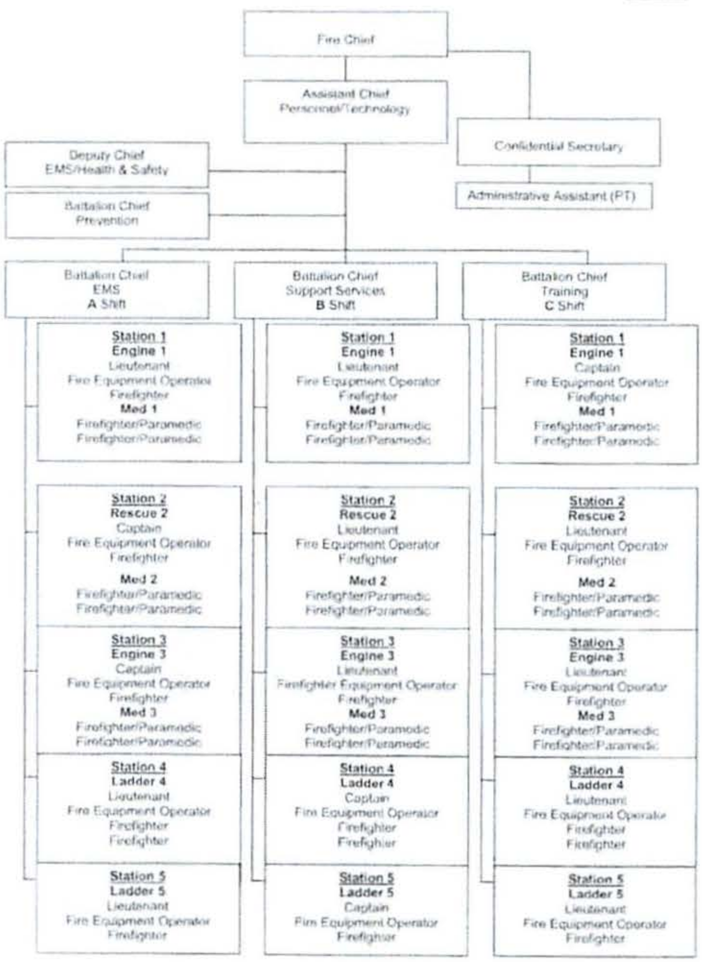
[5] Ibid

Fire Services

Current Deployment & Staffing

Overall, the fire department's organization is reflected below. The department utilizes a California shift schedule which employs a total of 62 personnel assigned to staff 5 stations. There is a total of three engines and two trucks – each staffed with a minimum of 2, or if available with 3 personnel; and three medical units each staffed daily with a minimum of 2 personnel. For each shift, minimum staffing is 16 for the 5 fire stations. In addition, each shift has a battalion chief as the commander responsible that 24-hour shift period.

Figure 3: Fire Department Organizational Structure[6]

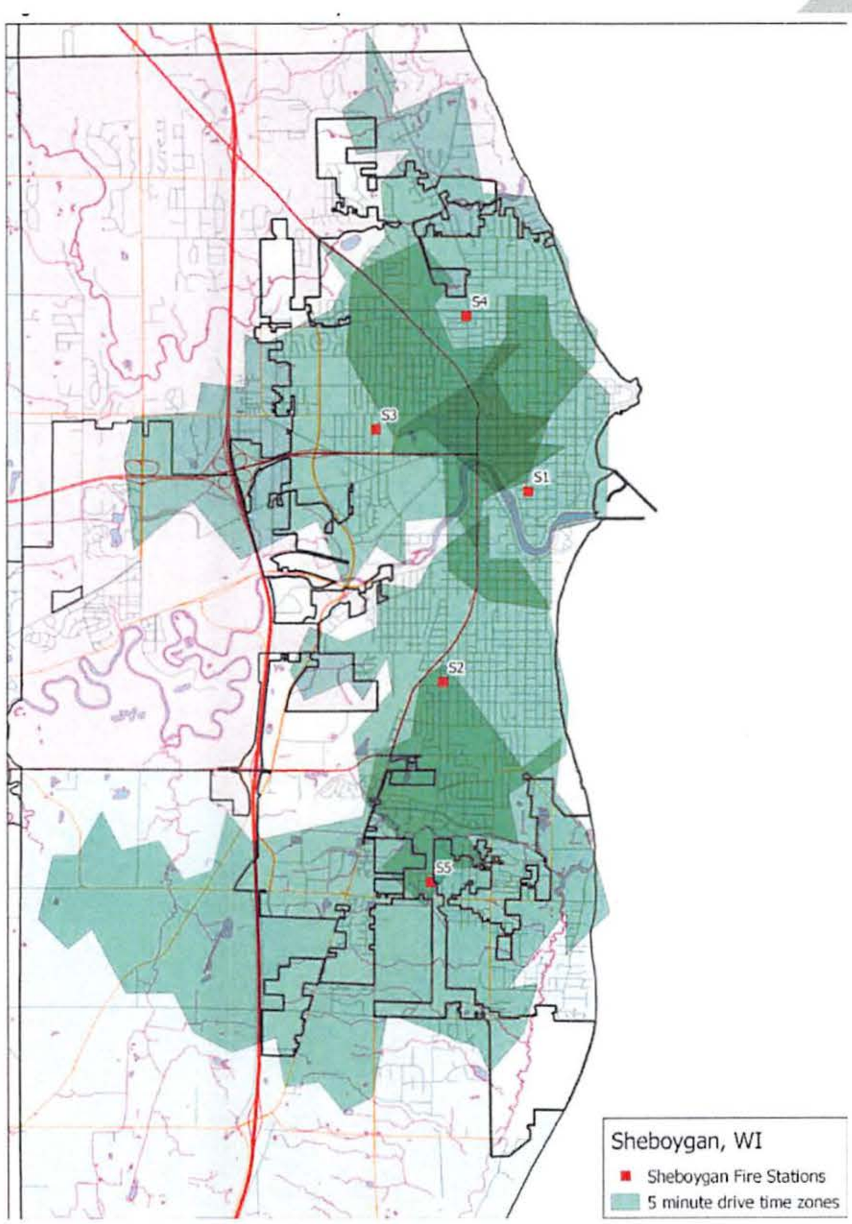


[6] 2017 Annual Report – City of Sheboygan Fire Department

Fire Stations

As reflected in the figure below, the City's 5 fire stations provide strong coverage to reach most areas of the community within a 5-minute travel time. Stations 1, 2 and 3 contain both a fire suppression unit (engine or truck) and a medical unit. Station 4 and 5 contain a fire suppression unit alone.

Figure 4: Current Fire Station Bleed Maps for 5-Minute Travel Time



Current Performance

Dispatch is provided by the County. The 911 center recently adopted the use of Emergency Medical Dispatch (EMD) which is considered a best practice. In 2017, the Department was dispatched to a total of 5,142 incidents as recorded in CAD, which reflected a year over year growth rate at 3.0%. EMS service requests totaled 3,943, accounting for 76.7% of the total number of incidents. The number of fire related calls were 1,050, which accounted for 20.4% of the total incidents. A total of 48 incidents were mutual aid outside SFD's jurisdiction. The Figure below reflects incident types and major categories.

Incident & Workload Measures

Figure 5: Number of Incidents by Category in 2017

Call Category	Number of Calls	Calls per Day	Call Percentage
Cardiac and stroke	349	1.0	6.8%
Seizure and unconsciousness	50	0.1	1.0%
Breathing difficulty	514	1.4	10.0%
Overdose and psychiatric	79	0.2	1.5%
Accident	166	0.5	3.2%
Fall and injury	532	1.5	10.3%
Illness and other	2,253	6.2	43.8%
EMS Total	**3,943**	**10.8**	**76.7%**
Structure fire	25	0.1	0.5%
Outside fire	63	0.2	1.2%
Alarm	342	0.9	6.7%
Public service	517	1.4	10.1%
Rescue	13	0.0	0.3%
Fire other	90	0.2	1.8%
Fire Total	**1,050**	**2.9**	**20.4%**
Hazmat	**101**	**0.3**	**2.0%**
Mutual aid	**48**	0.1	**0.9%**
Total	**5,142**	**14.1**	**100.0%**

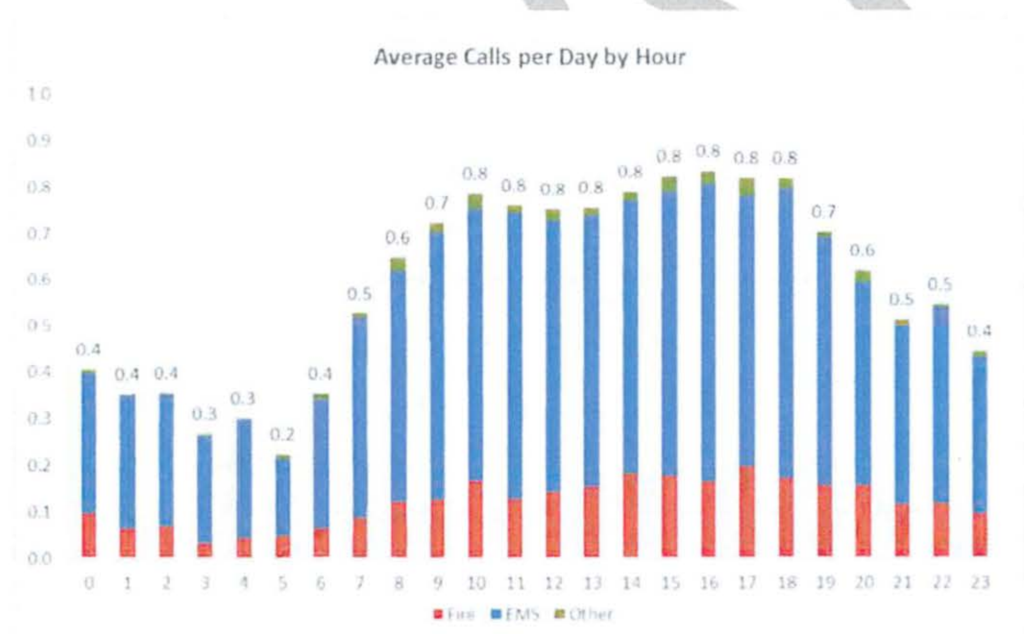
The number of individual unit responses is more reflective of total department workload since on average 2.0 SFD units responded to an incident. As summarized in the Figure below, all units in SFD combined made 10,408 responses, and were busy on emergency calls 3,509 hours. On average, each response lasted 20.2 minutes from dispatched to clear.

Figure 6: Number of Calls, Number of Responses, and Total Busy Time by Program in 2017

Program	Number of Calls	Number of Responses	Average Responses per Call	Total Busy Hours	Average Busy Minutes per Response	Percentage of Total Busy Hours
EMS	3,943	7,871	2.0	2,451	18.7	69.8%
Fire	1,050	2,118	2.0	850	24.1	24.2%
Hazmat	101	352	3.5	174	29.6	5.0%
Mutual aid	48	67	1.4	34	30.6	1.0%
Total	**5,142**	**10,408**	**2.0**	**3,509**	**20.2**	**100.0%**

Overall demands were evaluated by the hour of the day. Considerable variability exists in the time of day that requests for emergency services are received. The hours that from midnight to 0600 are low demand hours of the day. While the middle of the day has the greatest frequency of calls, specifically the hours that begin at 1000 and 1800 averaging above 0.75 calls per day and per hour. The average number of calls per hour is 0.59 per day. The data illustrates that the busiest times of the day are between 1500 and 1800. The hour with the peak demand is at 1600.

Figure 7: Overall Average Calls per Day by Hour



Unit Hour Utilization

Another measure, time on task, is necessary to evaluate best practices in efficient system delivery and consider the impact workload has on personnel. Unit Hour Utilization (UHU) determinants were developed by mathematical model. This model includes both the proportion of calls handled in each major service area (Fire, EMS, and Hazmat) and total unit time on task for these service categories in 2017. The resulting UHU's represent the percentage of the work period (24 hours) that is utilized responding to requests for service. Historically, the International Association of Fire Fighters (IAFF) has recommended that 24-hour units utilize 0.30, or 30% workload as an upper threshold.[7] In other words this recommendation would have personnel spend no more than 7.2 hours per day on emergency incidents. These thresholds take into consideration the necessity to accomplish non- emergency activities such as training, health and wellness, public education, and fire inspections.

The 4th edition of the IAFF EMS Guidebook no longer specifically identifies an upper threshold. However, FITCH recommends that an upper unit utilization threshold of approximately .30, or 30%, would be considered best practice. In other words, units and personnel should not exceed 30%, or 7.2 hours, of their workday responding to calls. These recommendations are also validated in the literature. For example, in their review of the City of Rolling Meadows, the Illinois Fire Chiefs Association utilized a UHU threshold of .30 as an indication to add additional resources.[8] Similarly, in a standards of cover study facilitated by the Center for Public Safety Excellence, the Castle Rock Fire and Rescue Department utilizes a UHU of .30 as the upper limit in their standards of cover due to the necessity to accomplish other non-emergency activities.[9]

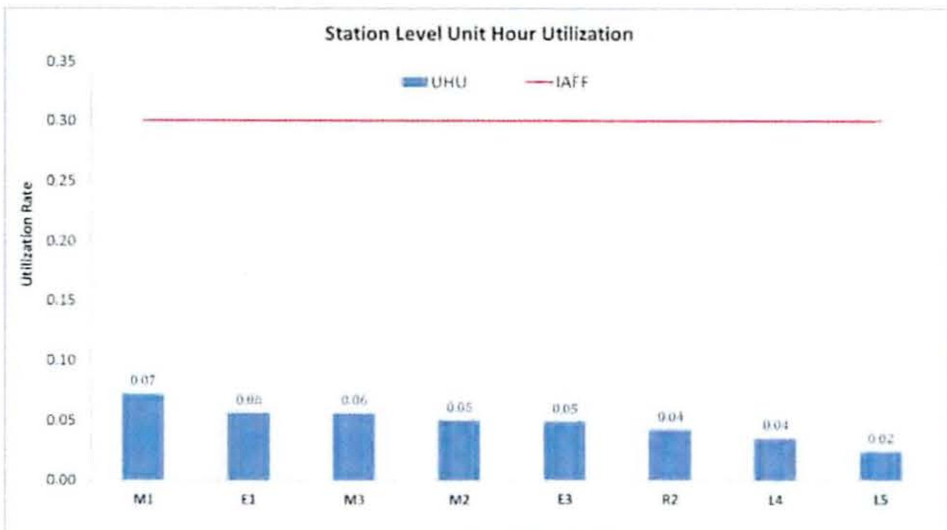
These thresholds take into consideration the necessity to accomplish non-emergency activities such as training, health and wellness, public education, and fire inspections.

Of all SFD stations, stations 1-3 were staffed with two 24/7 units and stations 4 and 5 were staffed with one 24/7 units. We provided UHU for eight 24/7 staffed units. All eight units had UHU less than 10%. M1 was utilized the most and L5 was utilized the least.

[7] International Association of Firefighters. (1995). Emergency *Medical Services: A Guidebook for Fire-Based Systems.* Washington, DC: Author. (p. 11)

[8] Illinois Fire Chiefs Association. (2012). An *Assessment of Deployment and Station Location: Rolling Meadows Fire Department.* Rolling Meadows, Illinois: Author. (pp.54-55)

[9] Castle Rock Fire and Rescue Department. (2011). Community *Risk Analysis and Standards of Cover.* Castle Rock, Colorado: Author. (p.58)



Heat maps were created to identify the concentration of the historic demand for services by program area. Therefore, the following Figures present the relative concentration of service demands for EMS and Fire. The Blue areas have the least demand and the dark red areas have the highest concentration of demand.

Figure 8: Heat Map for Fire Related Incidents

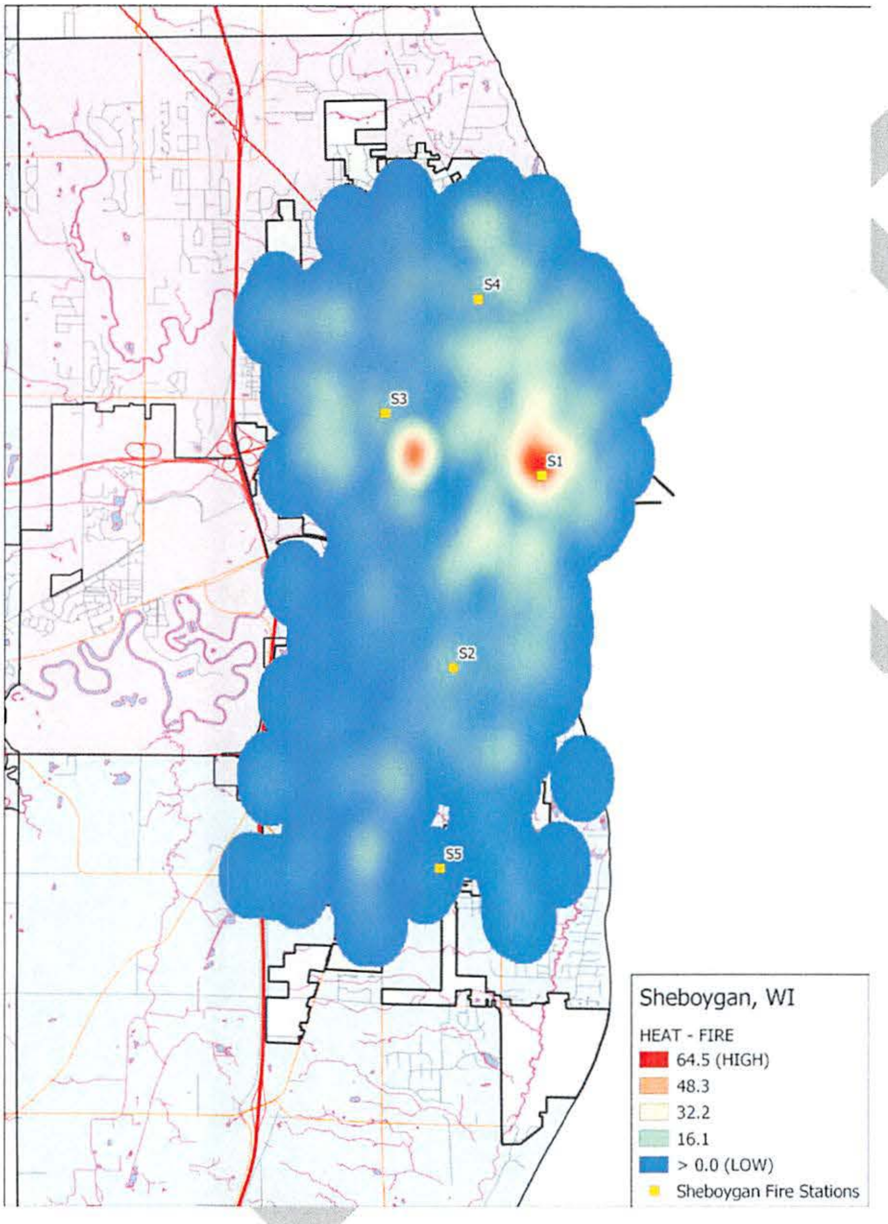
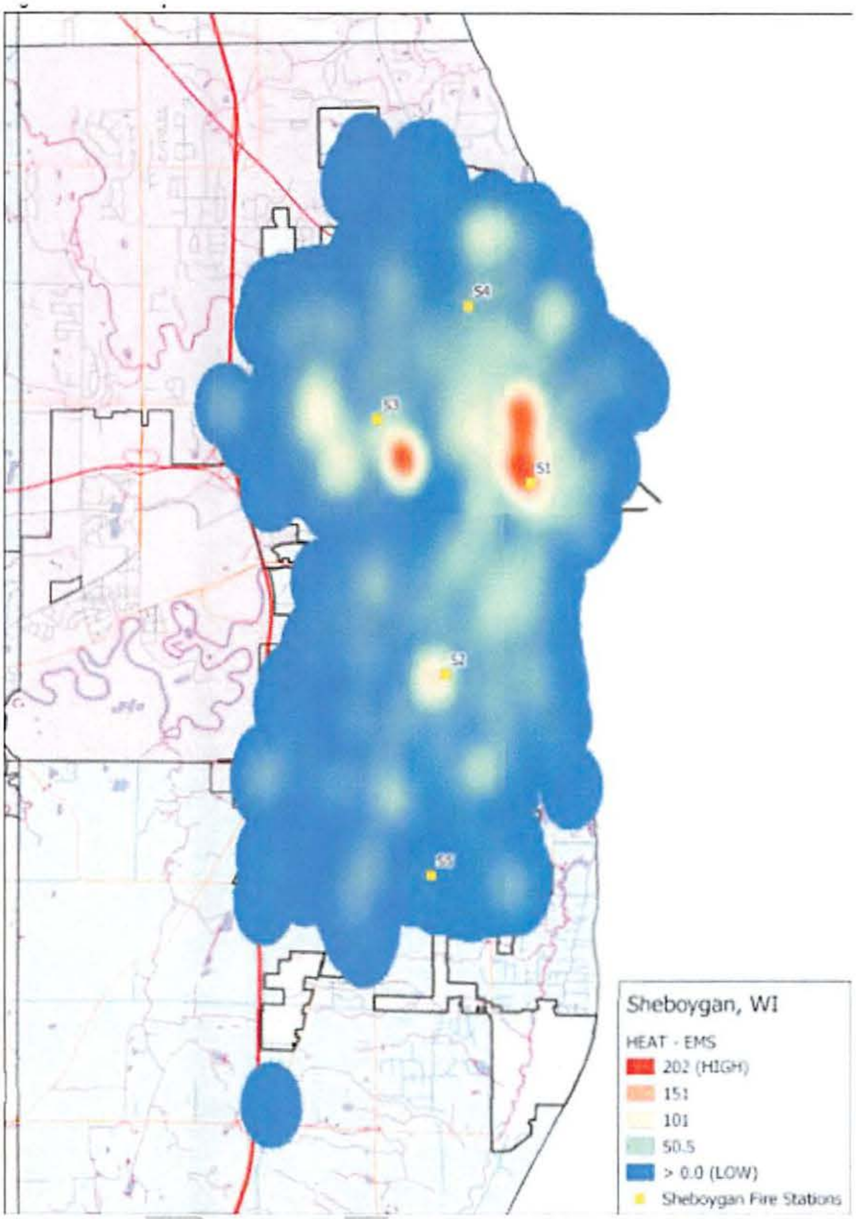


Figure 9: Heat Map for EMS Related Incidents



Response Time Performance

This analysis focused on lights and sirens responses and utilized the first arriving units of all distinct incidents excluding mutual aid incidents. The mean (average) dispatch time was 126 seconds. The mean (average) turnout time was 84 seconds, travel time was 168 seconds, and response time was 371 seconds (six minutes and 11 seconds). The average response time is the same as the sum of the average dispatch time and turnout and travel time.

However, a more conservative and reliable measure of performance is the fractile or percentile. This measure is more robust, or less influenced by outliers, than measures of central tendency such as the mean. Best practice is to measure at the 90th percentile. In other words, 90% of all performance is captured expecting that 10% of the time the department may experience abnormal conditions that would typically be considered an outlier. For example, if the department were to report an average response time of six minutes, then in a normally distributed set of data, half of the responses would be longer than six minutes and half of the responses would be less than six minutes. The 90th percentile communicates that 9 out of 10 times the department performance is predictable and thus more clearly articulated to policy makers and the community.

The performance for dispatch time at the 90th percentile was 204 seconds (three minutes and 24 seconds), turnout time at the 90th percentile was 134 seconds (2 minutes and 14 seconds), travel time was 284 seconds (four minutes and 44 seconds), and response time was 538 seconds (eight minutes and 58 seconds). Please note that the summation of 90th percentile dispatch time, 90th percentile turnout time and 90th percentile travel time is not the same as 90th percentile response time.

Figure 10: Average Dispatch, Turnout and Travel Time of First Arriving Units by Program

Program	Dispatch Time	Turnout Time	Travel Time	Response Time	Sample Size
EMS	2.1	1.3	2.7	6.1	3,361
Fire	1.8	1.6	3.4	6.8	340
Hazmat	1.6	1.6	3.5	6.7	84
Total	**2.1**	**1.4**	**2.8**	**6.2**	**3,785**

Figure 11: 90th Percentile Turnout and Travel Time of First Arriving Units by Program

Program	Dispatch Time	Turnout Time	Travel Time	Response Time	Sample Size
EMS	3.5	2.2	4.6	8.9	3,361
Fire	2.9	2.4	5.7	9.7	340
Hazmat	2.7	2.3	6.2	9.8	84
Total	**3.4**	**2.2**	**4.7**	**9.0**	**3,785**

Relevant Findings

Based on an independent evaluation done by the Insurance Services Office (ISO) earlier in 2018, the City's fire public protection classification was established at a Class 2. This places the City's fire rating in the top 3.4% of fire departments nationwide.

Occupancy risk was evaluated across the jurisdiction utilizing the most recent ISO batch reports. The ISO Batch report provided specific building occupancy information for the needed fire flow, the number of stories, location, and square footage. Ultimately, a quantifiable risk-rating matrix was developed that categorized 940 occupancies within the jurisdiction into high, moderate, and low risks. The results of the risk assessment process categorized the 940 occupancies into 21 high-risk structures, 566 moderate structures, and 353 low risk structures.

Geospatial analyses were completed to map the locations of each of the commercial occupancies included in the risk matrix process and specifically overlaid within each of the fire station locations. This analysis lends validity to the risk assessment matrix and the process utilized by the Department as the concentration of risks is correlated with the historical demand for fire related services. The results of the geospatial analyses both high and moderate structures are presented in the below Figures.

Figure 12: High Risk Occupancies

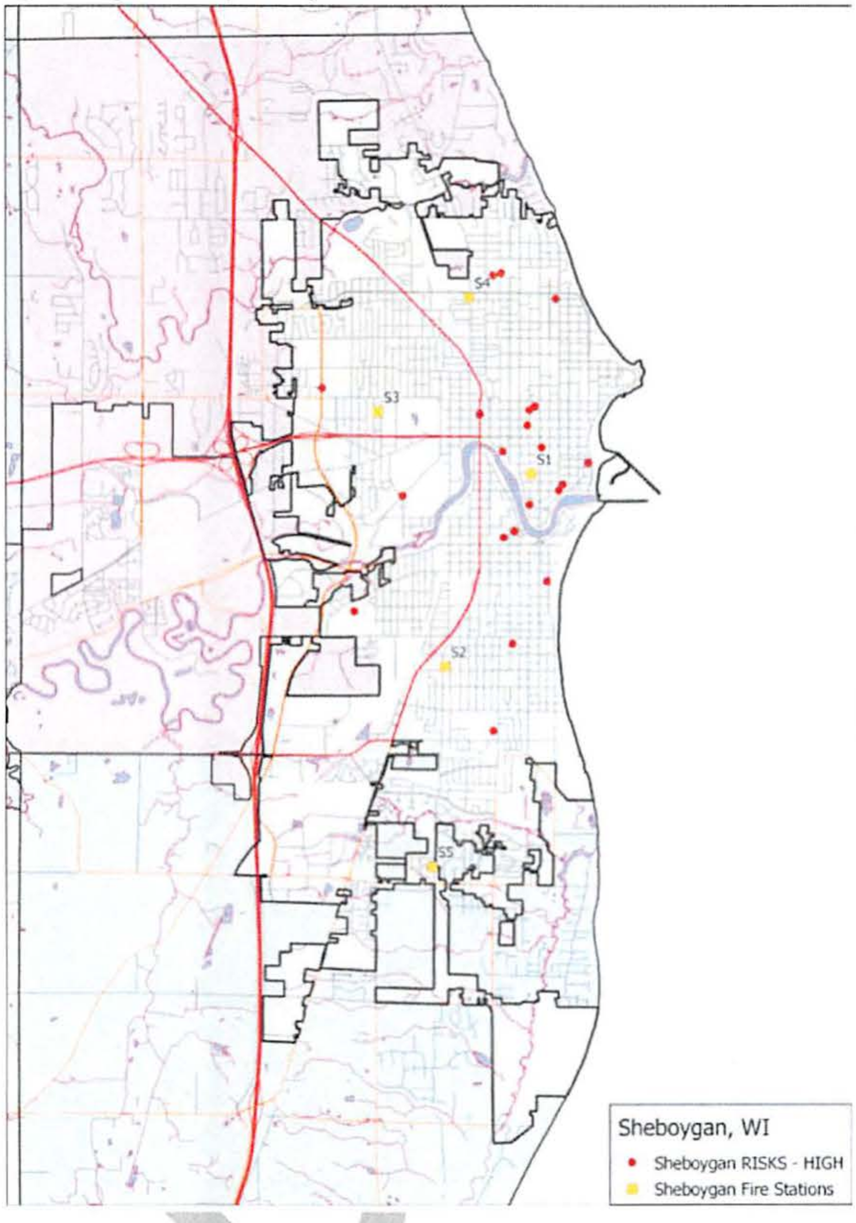
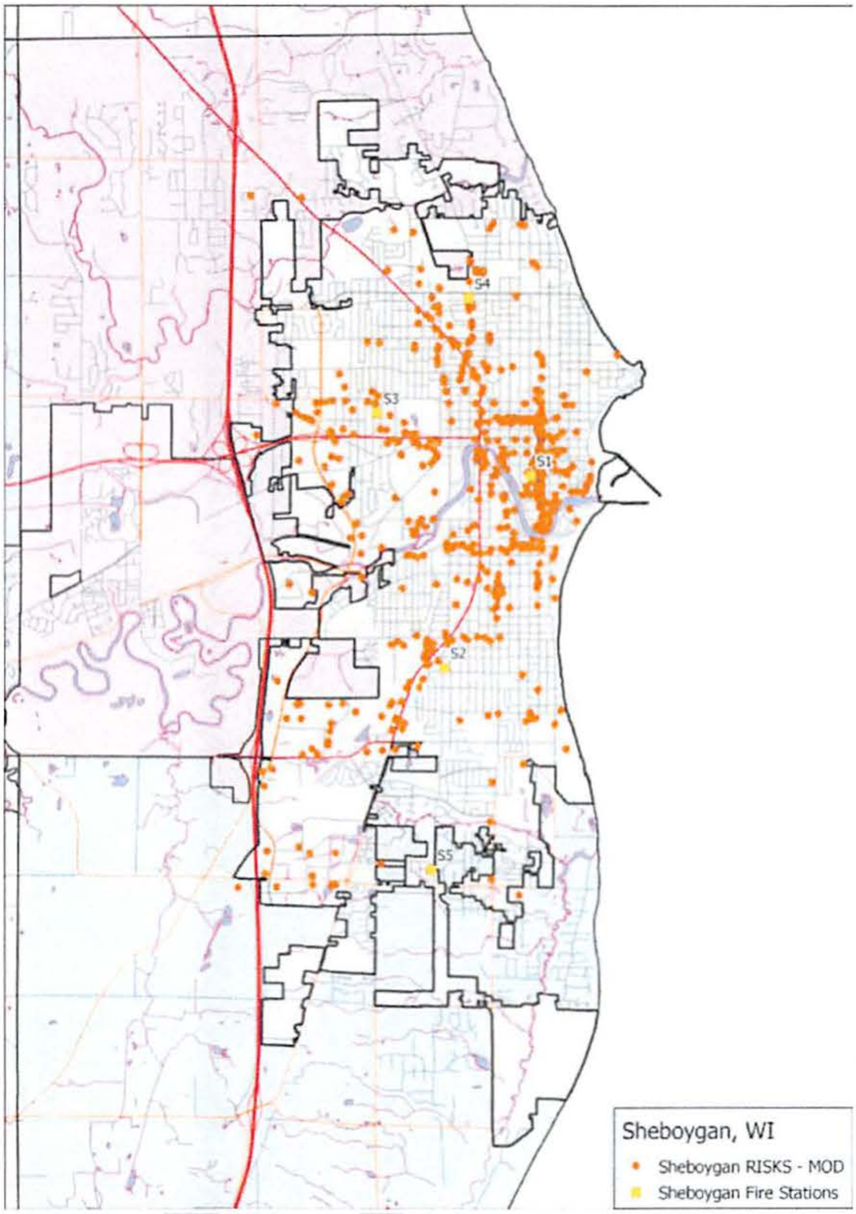


Figure 13: Medium Risk Occupancies



Comparative & Benchmark Performance

The following information reports performance for the City of Sheboygan and compares their NFIRS reported performance to that of national and regional data as reported by NFPA's national estimates; and performance reflected in NFIRS PDR files for 2012 thru 2016 for both the City and selected benchmark communities.

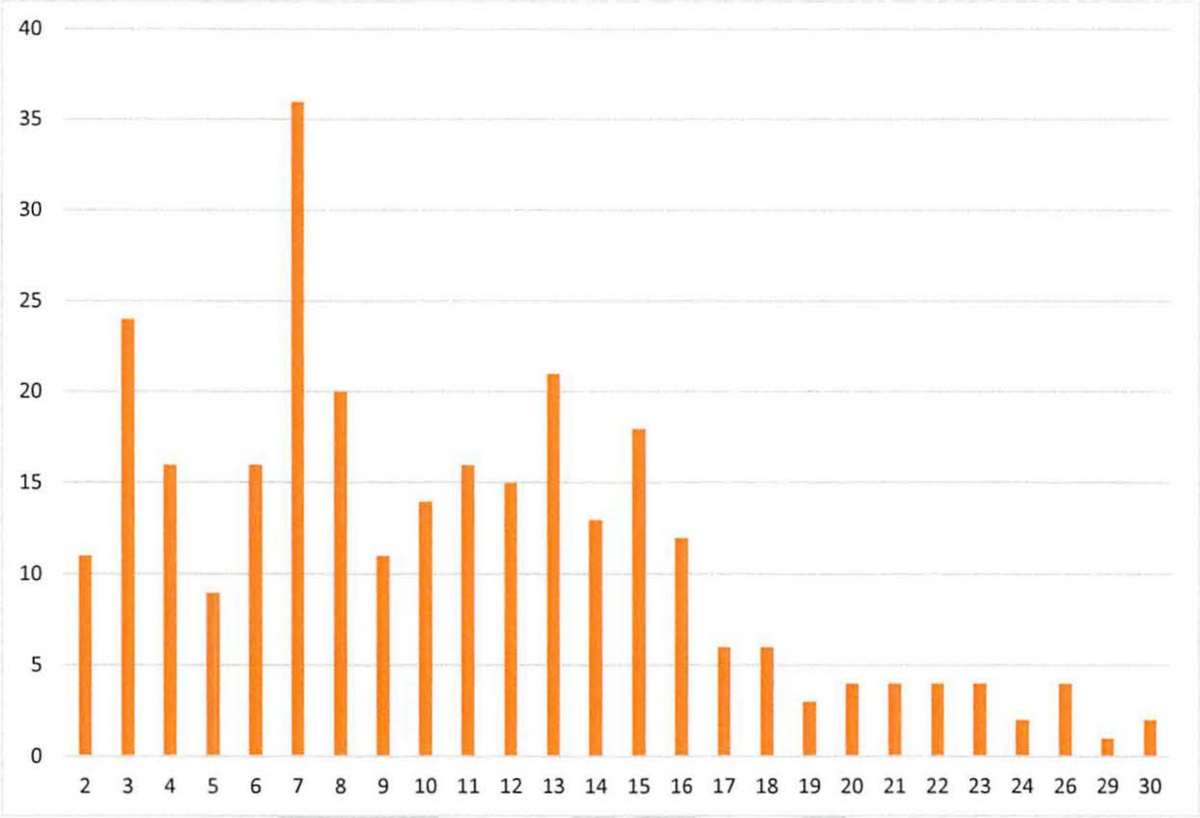
The NFPA utilizes a national estimate methodology to report losses from fire at the national and regional levels. However, it is important to emphasize that this analysis makes use of NFIRS data as the underlying data source. Depending on the quality of NFIRS data reported by individual fire departments and specifically how each agency addresses unknown or missing data, as well as the use of any quality assurance reviews of fire reports, there may be some unusual findings for the City when making comparisons against national, regional or other benchmark communities. Accordingly, policy makers should consider the following comparisons recognizing these limitations.

Figure 14: NFIRS Comparative Measures

Community	Fire per Thousand Population	Civilian Deaths per Million Population	Civilian Injuries per Million Population	Property Loss per Capita
Sheboygan	**2.94**	**12.4**	**136.6**	**$ 26.72**
Fond Du Lac	5.34	0	0	10.48
La Cross	8.28	12.4	33.1	7.93
Wauwatosa	3.27	0	12.4	5.53
West Allis	6.67	12.4	144.8	14.7
Midwest: 50K - 100K	2.40	7.7	47.4	$ 22.60
NFPA: Nationwide	4.20	10.5	45.3	$ 32.90

The Fire Department's reported NFIRS information from 2012 through 2016 was also analyzed to assess the ability to place a sufficient number of personnel on scene of a building fire. That information is reflected in the Figure below. A common benchmark in the fire service is to ensure the assembly of 15 personnel to manage the multitude of tasks required on the fire ground. With its current staffing levels, the department is able to assemble an effective response force assuming other emergency activity does not impede the response from all fire units.

Figure 15: Response Force to Building Fires - 2012 thru 2016



Relevant Findings – Pros & Cons

PROS

- Response times are strong – 4.7 minutes travel & 9.0 minutes total at the 90th percentile
- Existing workloads reflect significant system capacity
- Overall risk profile is *moderate*

CONS

- Depending on desired staffing levels for structure fires, challenges may exist in the assembly of an effective response force
- Fire death & injury rates may reflect an opportunity for increased fire prevention education

Policy Alternatives

After considering the quantitative and qualitative data derived during this project, including that information highlighted above as well as the more detailed descriptive and modeled performance in subsequent sections, various policy alternatives were developed. These include:

- Maintain current response time performance of 5 minutes for 90% of incidents with the existing 5 stations
- Maintain current response time performance of 5 minutes for 90% of incidents employing 4 optimized stations
- Improve current response time performance of 4 minutes for 90% of incidents by employing 6 optimized stations
- Reduce current response time performance to 6 minutes for 90% of incidents by employing 5 current stations (6 minutes for 90% of incidents)

Status Quo Performance – 5 Existing Stations

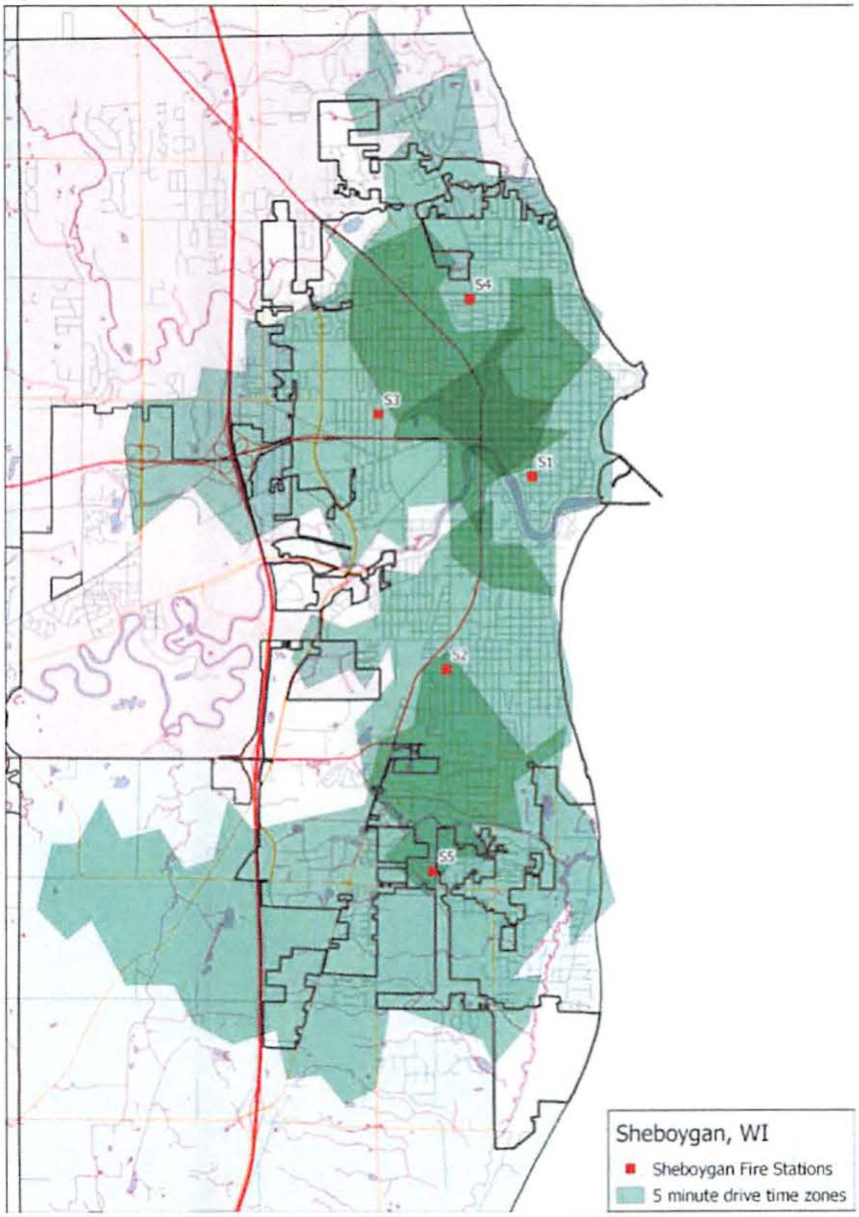
The analysis demonstrates that the current station configuration could capture 90% of the incidents within 5 minutes with the utilization of 4 fire stations. Station 5 improves performance by 3.51% with a 5-minute travel time. However, under this alternative, the Department could utilize this analysis to codify a move-up policy to ensure the greater coverage at all times. For example, if only two stations are available to respond to calls during busy times, Stations 3 and 2 would cover the greatest number of calls, 66%, within the performance objective of 5 minutes.

Figure 16: Marginal Fire Station Contribution for 5-Minute Travel Time

Rank	Station Number	Station Capture	Total Capture	Percent Capture
1	S3	2,183	2,183	42.53%
2	S2	1,238	3,421	66.65%
3	S1	797	4,218	82.17%
4	S4	413	4,631	90.22%
5	S5	180	4,811	93.73%

When referring to the mapping output below, the areas of the city that are not shaded with green, represent a maximum of 10% of the incidents that would not be responded to within 5-minutes. All requests for service would be answered, but they may be answered between 5:01 and 8:00 minutes. Finally, any areas that is shaded with progressively darker shades of green represent areas where more than one station can cover the same territory within the respective travel time being evaluated

Figure 17: Current Stations with a 5-Minute Travel Time at the 90th Percentile



Status Quo Performance – 4 Optimized Stations

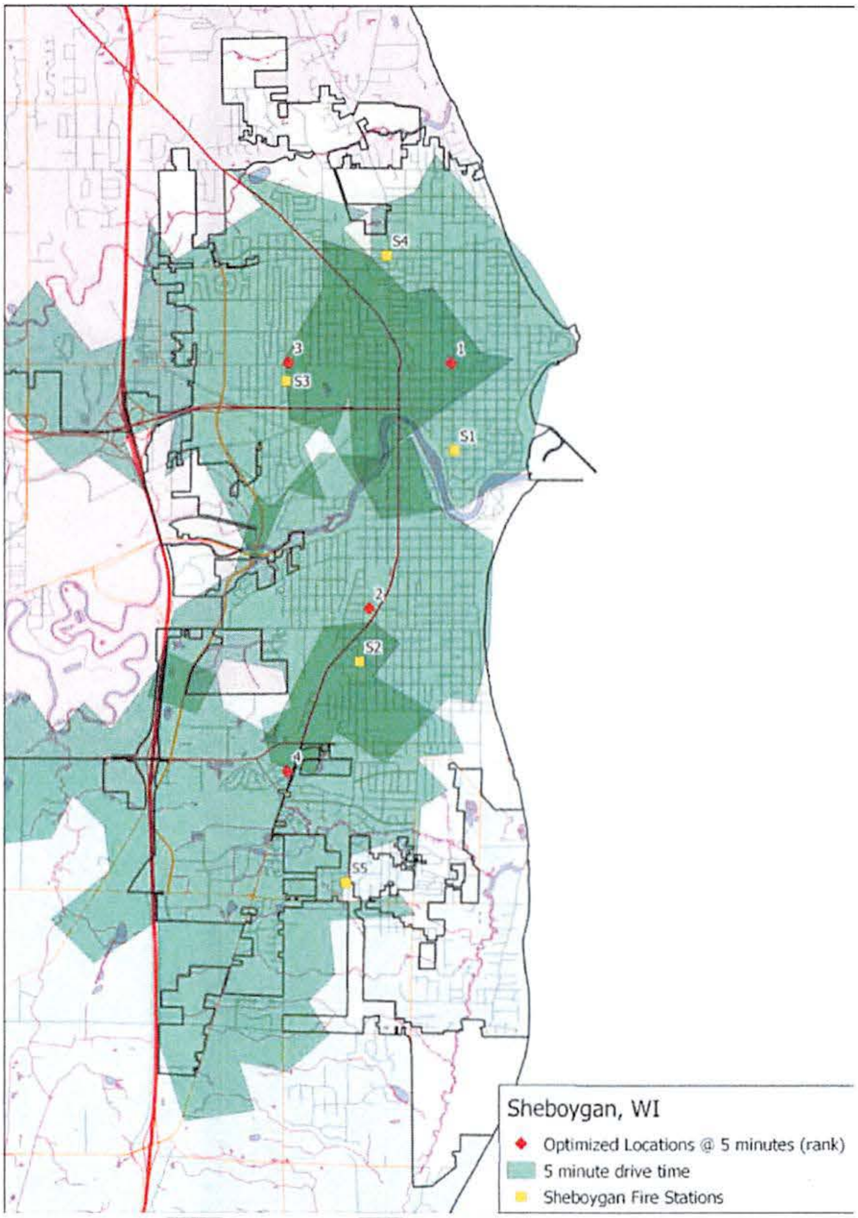
Analyses were completed to develop an optimized station distribution model for a 5-minute travel time. This evaluation suggests, that an optimized 4-station model can provide for approximately 93% effectiveness covering all incidents within 5-minutes. This optimized configuration only improves performance by approximately 3%, compared to the current 4-station configuration. Considering the current 5-station deployment, this model would maintain the same performance with 4-stations at 93%. The following Figures provide both tabular and graphic illustration. The elimination of a single apparatus related to this option would have a potential impact of $813,368.[10]

Figure 18: Optimized Station Location with 5-Minute Travel Time

Rank	PostCapture	TotalCapture	PercentCapture
1	2440	2440	47.54%
2	1137	3577	69.69%
3	758	4335	84.45%
4	420	4755	92.64%
5	167	4922	95.89%

[10] The estimation is based on the following assumptions: Budgeted line personnel represent 87.3% of FTEs and staff a total of 8 apparatus with minimum staffing of 2 personnel each. Accordingly, each apparatus represents 10.9% of personnel costs. Should the City elect to pursue any of the options outlined herein, a more detailed analysis of costs per apparatus should be undertaken.

Figure 19: Optimized Station Deployment Plan - 5-Minute Travel Time



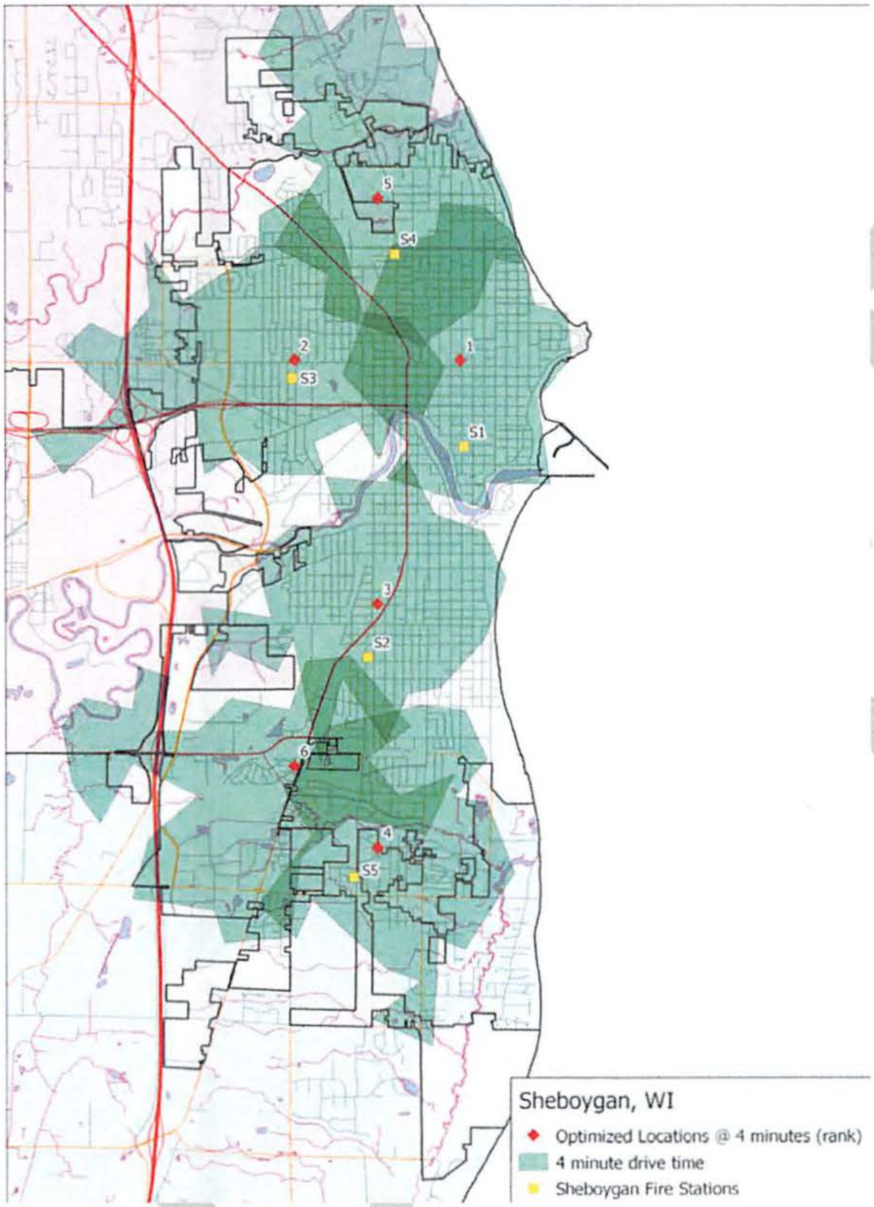
Improved Performance of 4-Minute Travel Time – 6 Optimized Stations

Analyses were completed to develop an optimized station distribution model for a 4-minute travel time consistent with NFPA 1710. This evaluation suggests, that an optimized 6-station model can provide for greater than 92% effectiveness covering all incidents within 4-minutes or less travel time. In comparison, the current 5-station configuration achieved 4 minutes or less approximately 82% of the time, or an improvement of approximately 10%. The addition of a single apparatus related to this option would have a potential impact of $813,368.[11]

A graphic illustration is presented below that includes the proposed station locations as well as the existing facilities.

[11] Ibid.

Figure 20: Optimized Station Deployment Plan - 4-Minute Travel Time



Reduce Current Response Time Performance to 6-Minutes

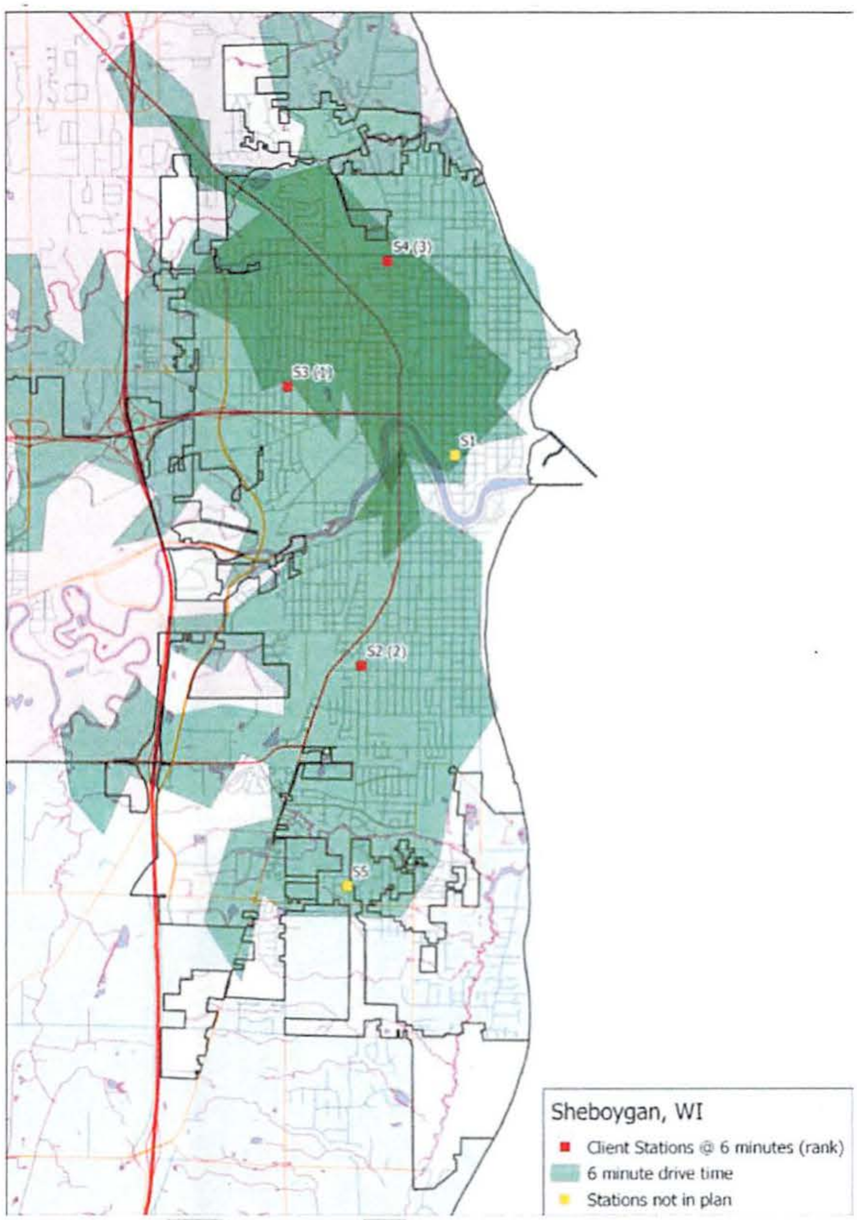
The analysis demonstrates that the current station configuration could capture nearly 92% of the incidents within 6 minutes with the utilization of 3 fire stations and 97% with all five stations. Stations 1 improves coverage by approximately 3.14% and Station 5 improves performance by an additional 2.32% with a 5-minute travel time. Collectively, stations 1 and 5 improve performance by 5.46%.

However, the Department could utilize this analysis to codify a move-up policy to ensure the greater coverage at all times. For example, if only two stations are available to respond to calls during busy times, Stations 3 and 2 would cover the greatest number of calls, 83%, within the performance objective of 6 minutes. The following Figures provide both tabular and graphic illustration.

Figure 21: Marginal Fire Station Contribution for 6-Minute Travel Time

Rank	Station Number	Station Capture	Total Capture	Percent Capture
1	S3	2,857	2,857	55.66%
2	S2	1,405	4,262	83.03%
3	S4	440	4,702	91.60%
4	S1	161	4,863	94.74%
5	S5	119	4,982	97.06%

Figure 22: Current Stations with 6-Minute Travel Time at the 90th Percentile



Recommendations

RECOMMENDATION: From a program accounting perspective, the City should consider adjusting their financials to reflect 18 FTEs adjusted to 75% as a more representative cost allocation for EMS staffing requirements.

RECOMMENDATION: Prospectively, the City will benefit from an ambulance replacement schedule that is staggered. This will allow the rolling fleet to be continuously updated while keeping maintenance cost more consistent.

RECOMMENDATION: The City should consider allocating additional resources for fire administration.

RECOMMENDATION: The City should codify a status quo performance baseline of 5-minute travel time for 90% of incidents utilizing their 5 existing stations

SECTION 2: Summary PowerPoint

FITCH & ASSOCIATES

City of
Sheboygan
spirit on the lake.

Operational Consulting & Fire Department Structure Review

Summary PowerPoint

November 2018

FITCH & ASSOCIATES

Overview

- High-level review of reports on data and GIS analysis
- Discussion of relevant findings
- Exploration of various alternatives

Current Performance

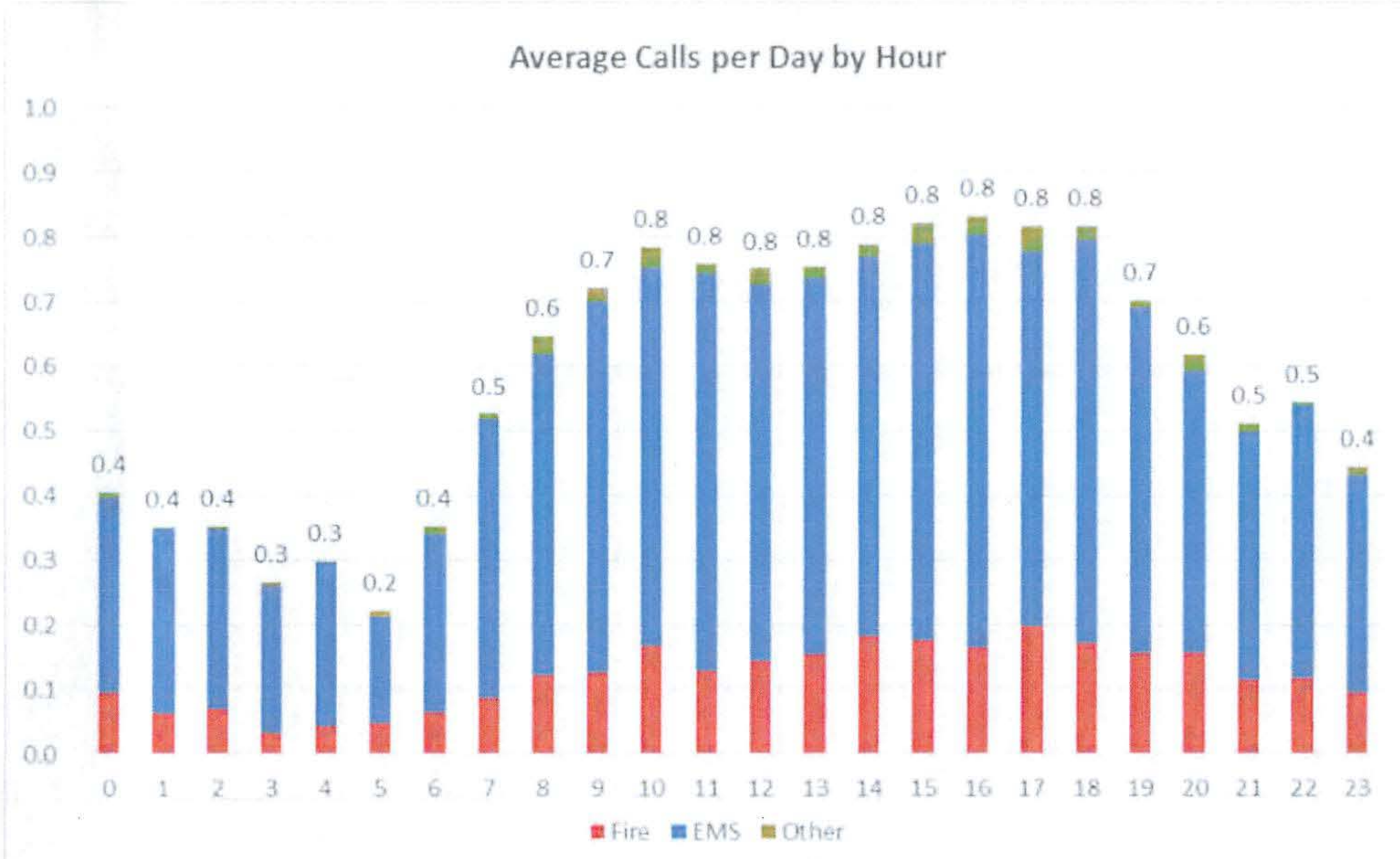
Current Performance

2017 Incident Types

Call Category	Number of Calls	Calls per Day	Call Percentage
Cardiac and stroke	349	1.0	6.8%
Seizure and unconsciousness	50	0.1	1.0%
Breathing difficulty	514	1.4	10.0%
Overdose and psychiatric	79	0.2	1.5%
Accident	166	0.5	3.2%
Fall and injury	532	1.5	10.3%
Illness and other	2,253	6.2	43.8%
EMS Total	**3,943**	**10.8**	**76.7%**
Structure fire	25	0.1	0.5%
Outside fire	63	0.2	1.2%
Alarm	342	0.9	6.7%
Public service	517	1.4	10.1%
Rescue	13	0.0	0.3%
Fire other	90	0.2	1.8%
Fire Total	**1,050**	**2.9**	**20.4%**
Hazmat	**101**	**0.3**	**2.0%**
Mutual aid	**48**	**0.1**	**0.9%**
Total	**5,142**	**14.1**	**100.0%**

Current Performance

2017 Incidents by Hour-of-Day



Where Incidents Occur

Figure 19: Heat Map for Fire Related Incidents

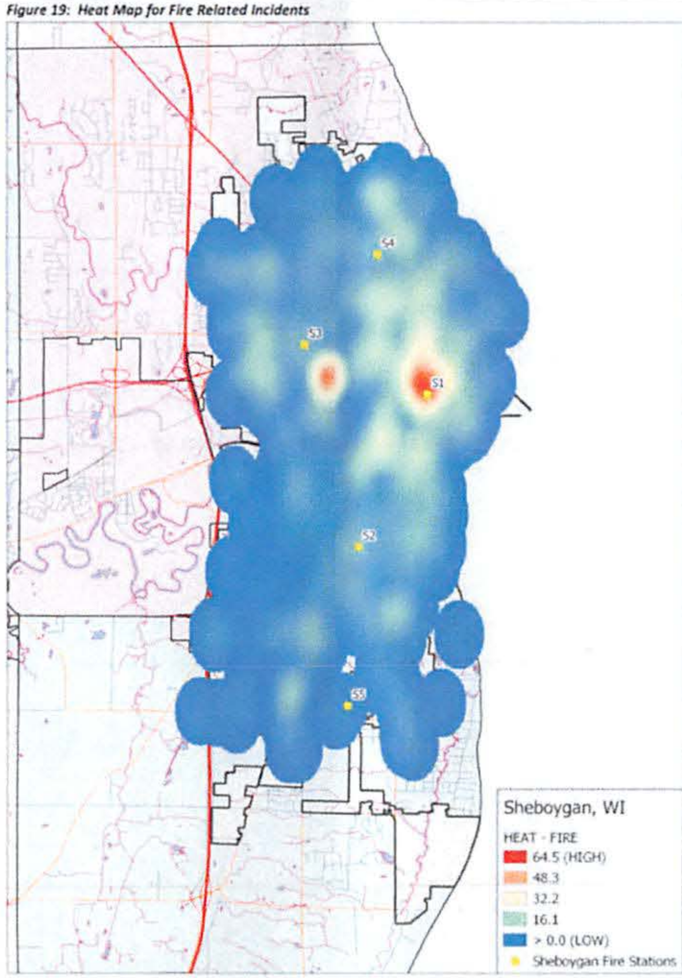
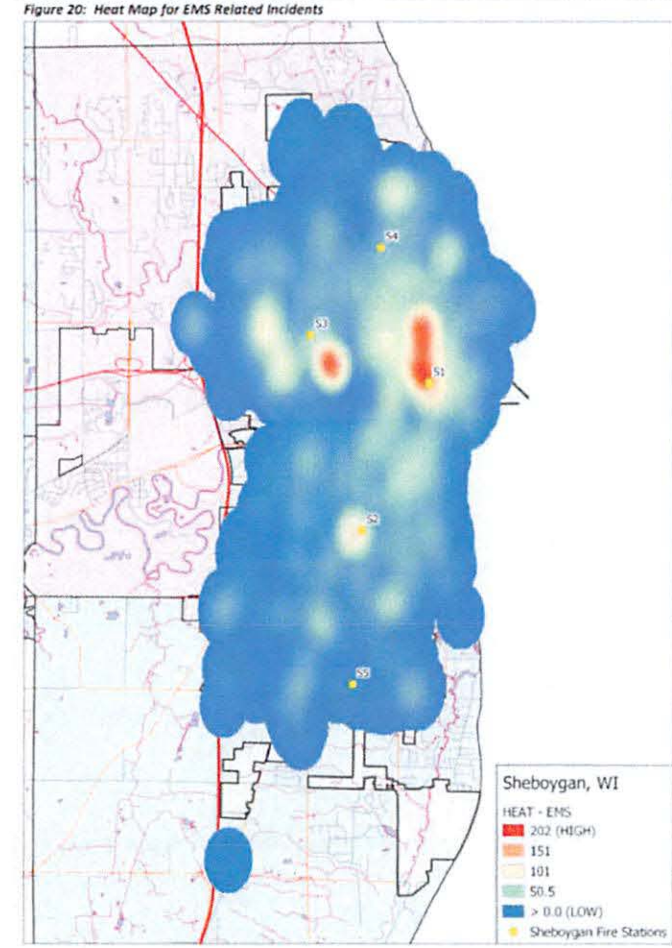


Figure 20: Heat Map for EMS Related Incidents



Current Performance

2017 Unit & Station Workloads

Station	Unit	Type	Avg. Busy Minutes per Response	Annual Busy Hours	Annual Total Responses	Busy Hours per Day	Unit Responses per Day
1	M1	Ambulance	19.8	629	1,909	1.7	5.2
	E1	Engine	18.0	491	1,639	1.3	4.5
	Station 1 Total		**18.9**	**1,120**	**3,548**	**3.1**	**9.7**
2	M2	Ambulance	20.8	438	1,264	1.2	3.5
	R2	Rescue Engine	21.2	370	1,048	1.0	2.9
	Station 2 Total		**21.0**	**807**	**2,312**	**2.2**	**6.3**
3	M3	Ambulance	19.6	490	1,500	1.3	4.1
	E3	Engine	18.4	430	1,399	1.2	3.8
	BC	Pickup	39.4	134	204	0.4	0.6
	AC	Assistant Chief	125.6	8	4	0.0	0.0
	DC	Deputy Chief	88.2	3	2	0.0	0.0
	Station 3 Total		**20.5**	**1,065**	**3,109**	**2.9**	**8.5**
4	L4	Ladder	20.8	307	883	0.8	2.4
	M6	Ambulance	17.0	2	7	0.0	0.0
	E6	Engine	0.4	0	1	0.0	0.0
	Station 4 Total		**20.8**	**309**	**891**	**0.8**	**2.4**
5	L5	Ladder	22.8	208	548	0.6	1.5
SFD Total			**20.2**	**3,509**	**10,408**	**9.6**	**28.5**

Current UHU

Figure 18: Unit Hour Utilization

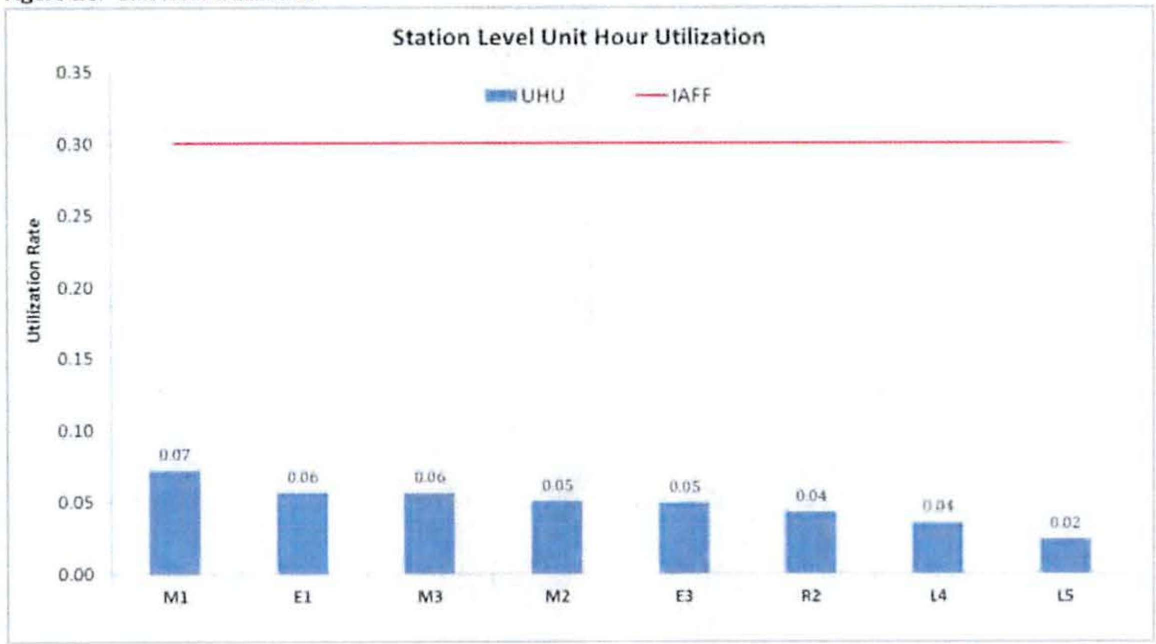


Table 19: Unit Hour Utilization

Station	Unit	Unit Type	Busy Hours	UHU
1	M1	Ambulance	629	0.07
1	E1	Engine	491	0.06
3	M3	Ambulance	490	0.06
2	M2	Ambulance	438	0.05
3	E3	Engine	430	0.05
2	R2	Rescue Engine	370	0.04
4	L4	Ladder	307	0.04
5	L5	Ladder	208	0.02

Current Performance

2017 Average & 90th Percentile Response Components & Times

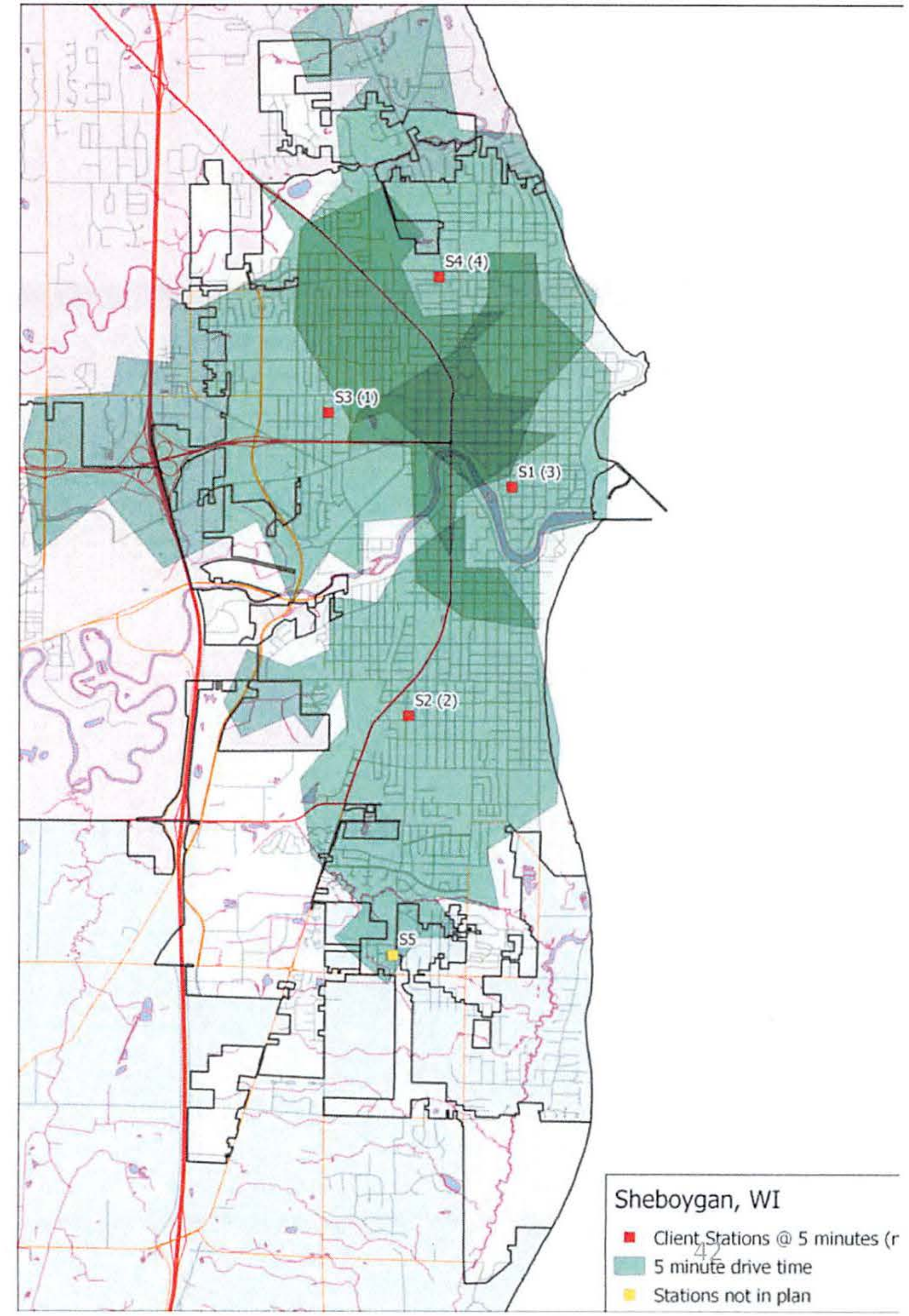
Program	Dispatch Time	Turnout Time	Travel Time	Response Time	Sample Size
EMS	2.1	1.3	2.7	6.1	3,361
Fire	1.8	1.6	3.4	6.8	340
Hazmat	1.6	1.6	3.5	6.7	84
Total	**2.1**	**1.4**	**2.8**	**6.2**	**3,785**

Program	Dispatch Time	Turnout Time	Travel Time	Response Time	Sample Size
EMS	3.5	2.2	4.6	8.9	3,361
Fire	2.9	2.4	5.7	9.7	340
Hazmat	2.7	2.3	6.2	9.8	84
Total	**3.4**	**2.2**	**4.7**	**9.0**	**3,785**

Marginal Utility

Table 4: Marginal Fire Station Contribution for 5-Minute Travel Time

Rank	Station Number	Station Capture	Total Capture	Percent Capture
1	S3	2,183	2,183	42.53%
2	S2	1,238	3,421	66.65%
3	S1	797	4,218	82.17%
4	S4	413	4,631	90.22%
5	S5	180	4,811	93.73%



Relevant Findings

ISO Rating as of Oct 1st 2018

FSRS Feature	Earned Credit	Credit Available
Emergency Communications		
414. Credit for Emergency Reporting	3.00	3
422. Credit for Telecommunicators	3.20	4
432. Credit for Dispatch Circuits	2.76	3
440. Credit for Emergency Communications	8.96	10
Fire Department		
513. Credit for Engine Companies	5.87	6
523. Credit for Reserve Pumpers	0.50	0.50
532. Credit for Pump Capacity	3.00	3
549. Credit for Ladder Service	2.74	4
553. Credit for Reserve Ladder and Service Trucks	0.00	0.50
561. Credit for Deployment Analysis	9.05	10
571. Credit for Company Personnel	6.79	15
581. Credit for Training	6.51	9
730. Credit for Operational Considerations	2.00	2
590. Credit for Fire Department	36.46	50
Water Supply		
616. Credit for Supply System	27.77	30
621. Credit for Hydrants	2.92	3
631. Credit for Inspection and Flow Testing	7.00	7
640. Credit for Water Supply	37.69	40
Divergence	-4.26	--
1050. Community Risk Reduction	5.18	5.50
Total Credit	84.03	105.50

ISO Perspective
Engine & Ladder Placement

Figure 10: 1.5 Mile Engine Polygons

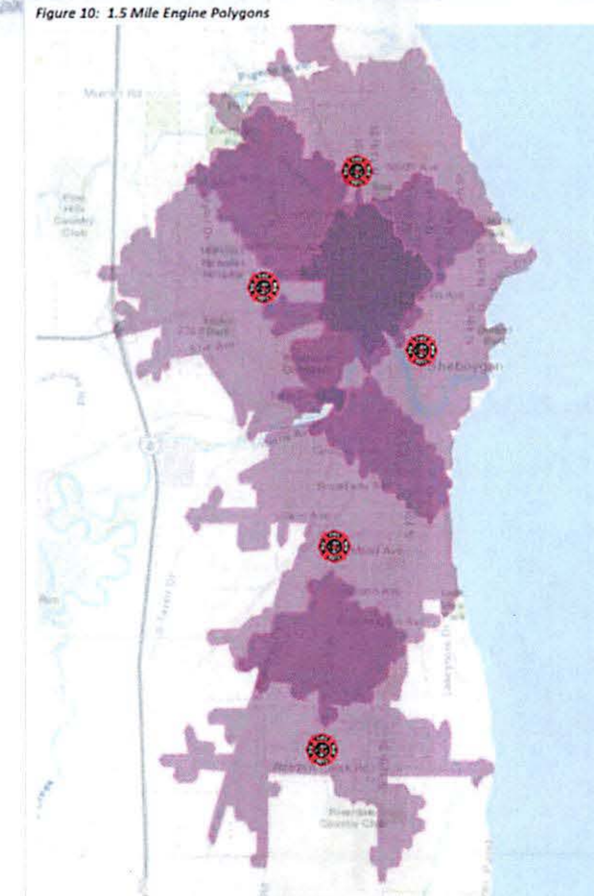


Figure 11: Current Stations 4 and 5 with Ladder Trucks - ISO 2.5 Mile

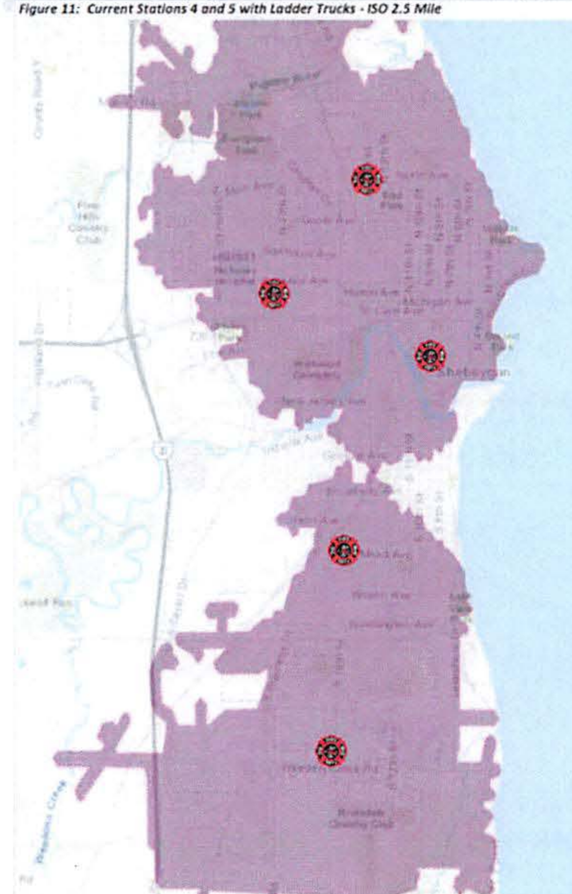
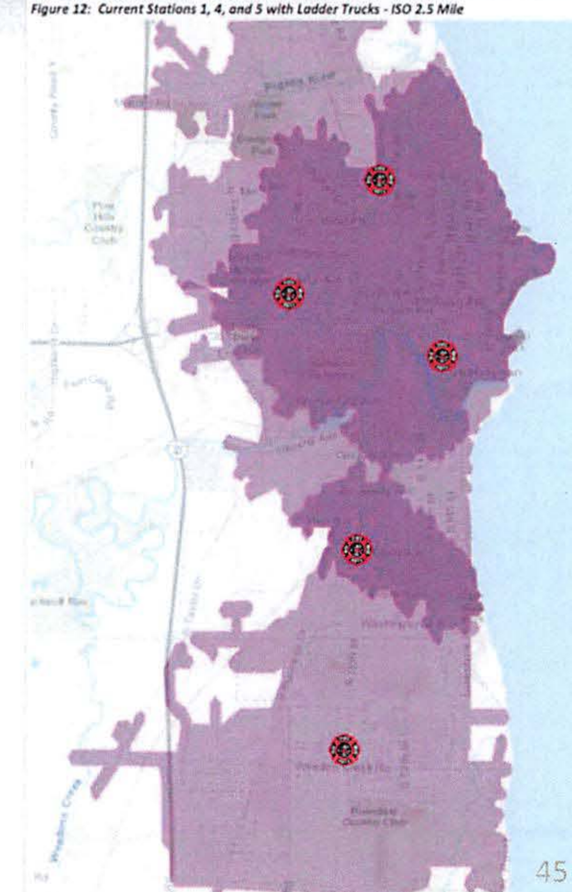
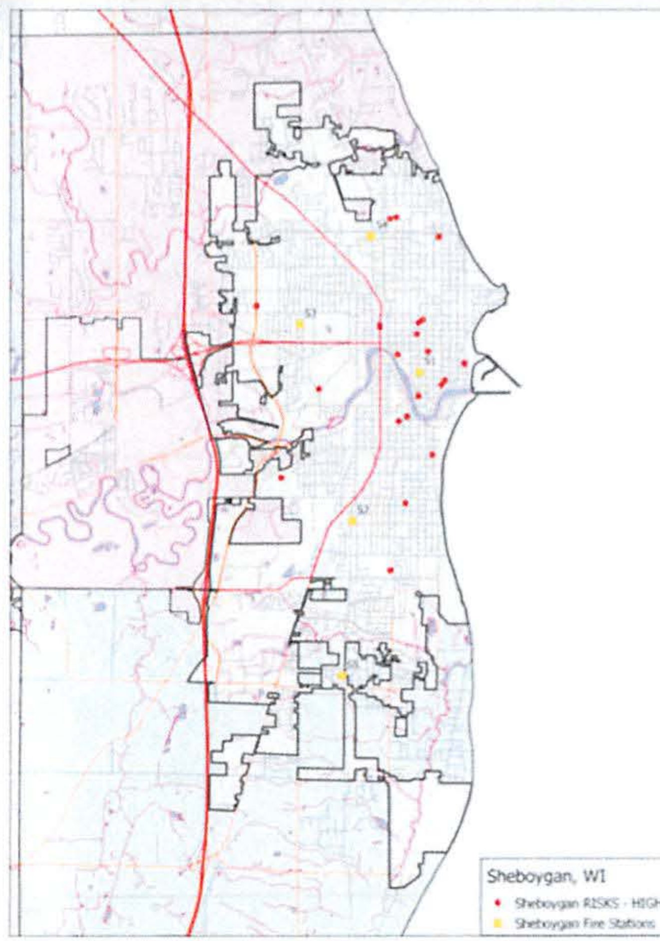
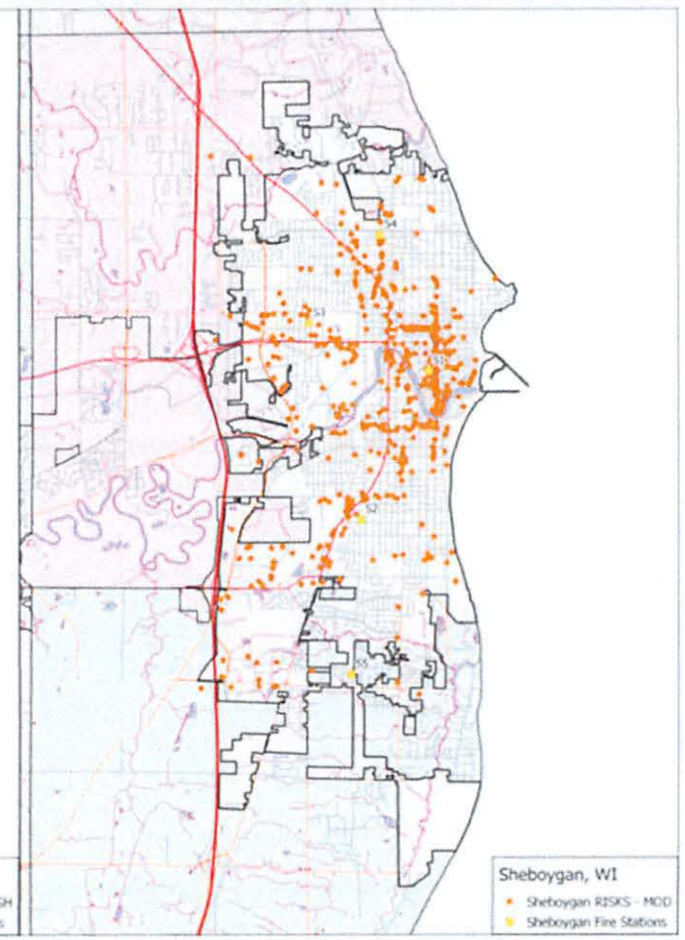


Figure 12: Current Stations 1, 4, and 5 with Ladder Trucks - ISO 2.5 Mile



ISO Independently Rated Properties





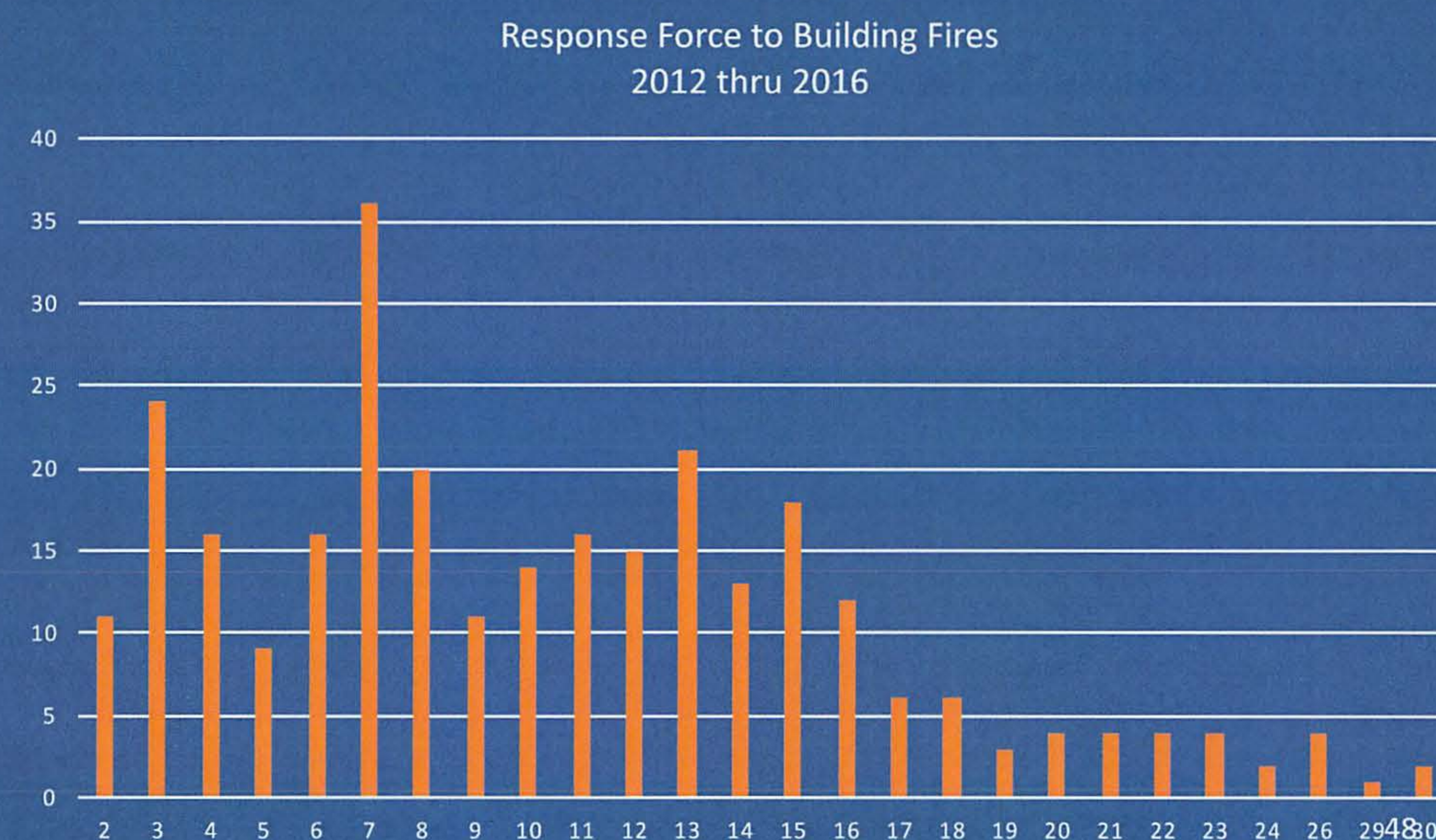
NFIRS Related Metrics

NFIRS Reported Fire Loss Statistics – 2012 thru 2016

Community	Fire per Thousand Population	Civilian Deaths per Million Population	Civilian Injuries per Million Population	Property Loss per Capita
Sheboygan	**2.94**	**12.4**	**136.6**	**$ 26.72**
Midwest: 50K - 100K	2.40	7.7	47.4	$ 22.60
NFPA: Nationwide	4.20	10.5	45.3	$ 32.90

NFIRS Reported Response Force to Building Fires

- There were a reported 292 building fires reported during the fire year period, or an average of just over 1 per week.
- Average of 11.2 to each building fire



Relevant Findings

PROS

- Response times are strong – 4.7 minutes travel & 9.0 minutes total at the 90th percentile
- Existing workloads reflect significant system capacity
- Overall risk profile is ***moderate***

CONS

- Depending on desired staffing levels for structure fires, challenges may exist in the assembly of an effective response force
- Fire death & injury rates may reflect an opportunity for increased fire prevention education

Working Alternatives

Various Policy Alternatives

- 4 potential policies re: deployment
  - Maintain current response time performance (5 minutes for 90% of incidents) w/ existing 5 stations
  - Maintain current response time performance employing 4 optimized stations
  - Improve current response time performance (4 minutes for 90% of incidents) by employing 5 optimized stations
  - Reduce current response time performance by employing 5 current stations (6 minutes for 90% of incidents)

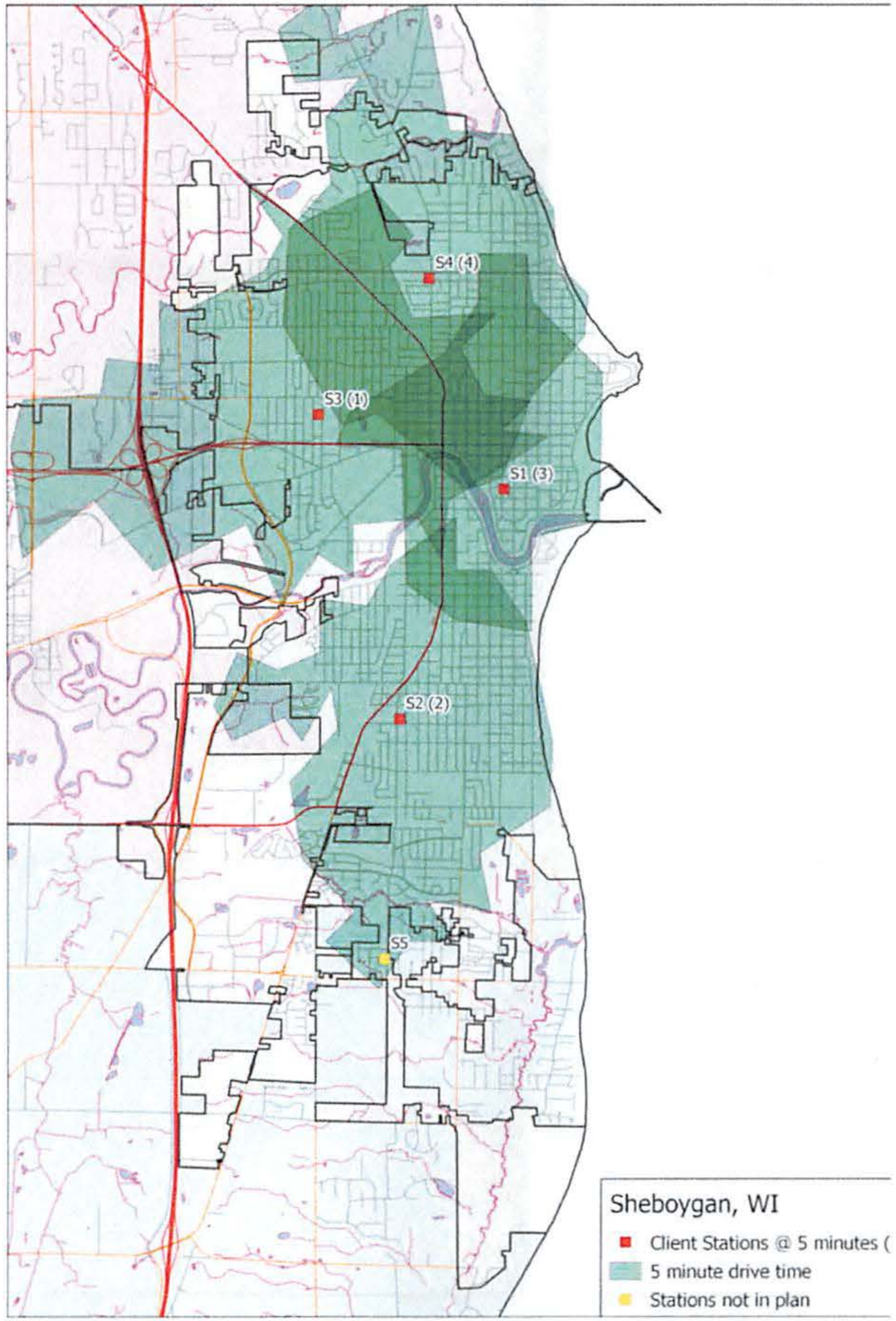


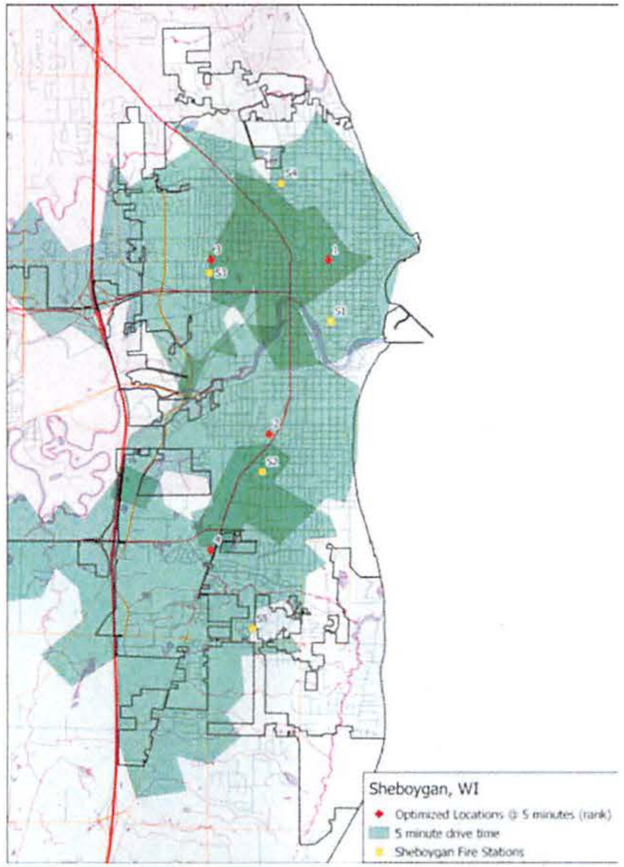
Table 4: Marginal Fire Station Contribution for 5-Minute Travel Time

Rank	Station Number	Station Capture	Total Capture	Percent Capture
1	S3	2,183	2,183	42.53%
2	S2	1,238	3,421	66.65%
3	S1	797	4,218	82.17%
4	S4	413	4,631	90.22%
5	S5	180	4,811	93.73%

When referring to the mapping output below, the areas of the city that are not shaded with green, represent a maximum of 10% of the incidents that would not be responded to within 5-minutes. All requests for service would be answered, but they may be answered between 5:01 and 8:00 minutes. Finally, any areas that is shaded with progressively darker shades of green represent areas where more than one station can cover the same territory within the respective travel time being

Status Quo Performance with 5 Minute @ 90th – Current 5 Stations

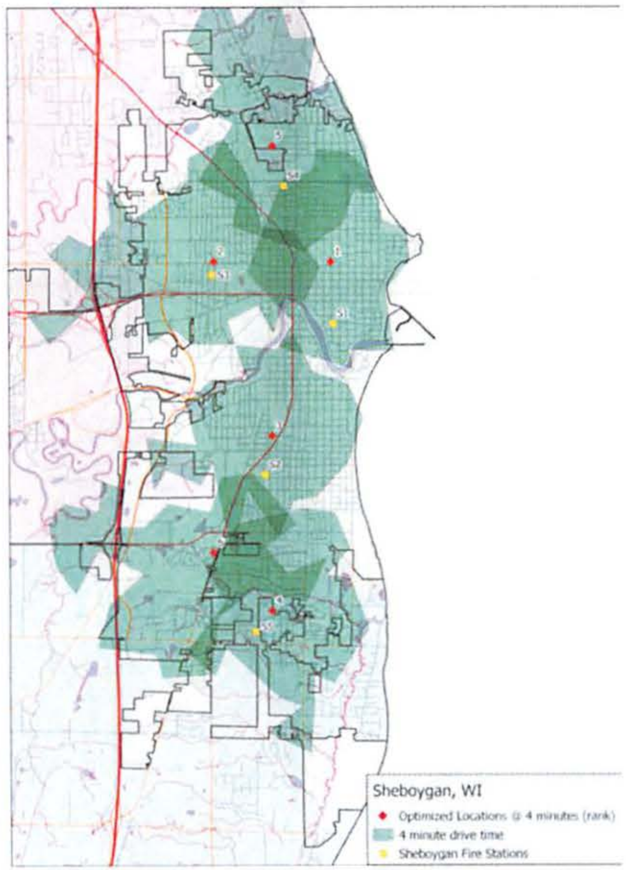
Status Quo Performance with 5 Minute @ 90th - Optimized 4 Stations



Analyses were completed to develop an optimized station distribution model for a 5-minute travel time. This evaluation suggests, that an optimized 4-station model can provide for approximately 93% effectiveness covering all incidents within 5-minutes. This optimized configuration only improves performance by approximately 3%, compared to the current 4-station configuration. Considering the current 5-station deployment, this model would maintain the same performance with 4-stations at 93%.

Therefore, the city and department could consider the following policy options:

- Operate out of 4 stations until the call volume in Station 5's territory increases
- Continue to operate out of all 5 stations to cover the geographic area irrespective of the current community demands
- Continue to operate out of all 5 stations, but utilize Station 5 as a flexible resource when needed
- Utilize this analysis to codify a move-up policy to ensure the greater coverage at all times. For example, if only two stations are available to respond to calls during busy times, Stations 3 and 2 would cover the greatest number of calls, 66%, within the performance objective of 5 minutes.



Analyses were completed to develop an optimized station distribution model for a 4-minute travel time consistent with NFPA 1710. This evaluation suggests, that an optimized 6-station model can provide for greater than 92% effectiveness covering all incidents within 4-minutes or less travel time. In comparison, the current 5-station configuration achieved 4 minutes or less approximately 82% of the time, or an improvement of approximately 10%.

A graphic illustration is presented below that includes the proposed station locations as well as the existing facilities.

Improved Performance with Optimized 4-Minute Travel Time – Optimized 5 Stations

Performance with 6-Minute Travel Time – Current 5 Stations

The analysis demonstrates that the current station configuration could capture nearly 92% of the incidents within 6 minutes with the utilization of 3 fire stations and 97% with all five stations. Stations 1 improves coverage by approximately 3.14% and Station 5 improves performance by an additional 2.32% with a 5-minute travel time. Collectively, stations 1 and 5 improve performance by 5.46%.

Therefore, the city and department could consider the following policy options:

- Operate out of 3 stations until the call volume in Station 5's territory increases
- Continue to operate out of all 5 stations to cover the geographic area irrespective of the current community demands
- Continue to operate out of all 5 stations, but utilize Station 5 and 1 as a flexible resources when needed
- Utilize this analysis to codify a move-up policy to ensure the greater coverage at all times. For example, if only two stations are available to respond to calls during busy times, Stations 3 and 2 would cover the greatest number of calls, 83%, within the performance objective of 6 minutes.

Table 5: Marginal Fire Station Contribution for 6-Minute Travel Time

Rank	Station Number	Station Capture	Total Capture	Percent Capture
1	S3	2,857	2,857	55.66%
2	S2	1,405	4,262	83.03%
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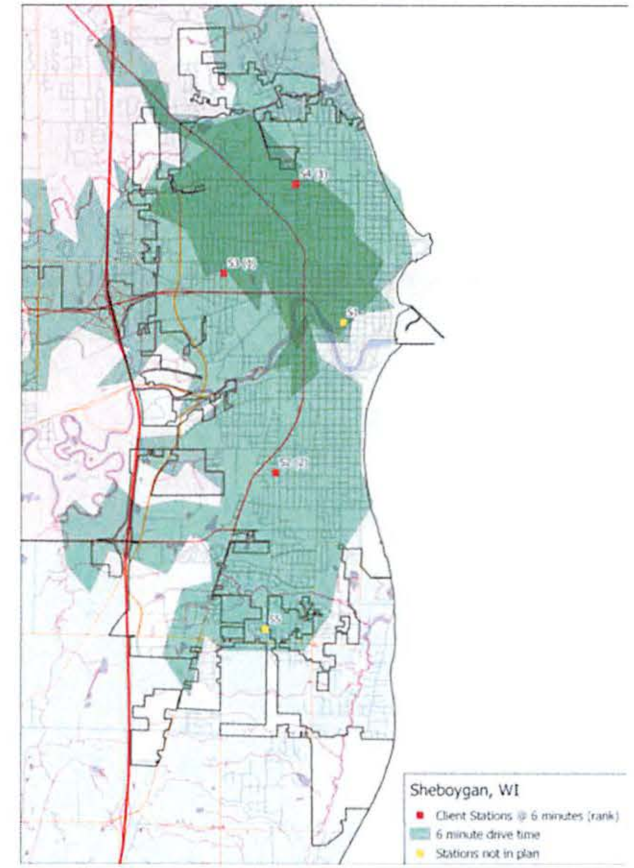
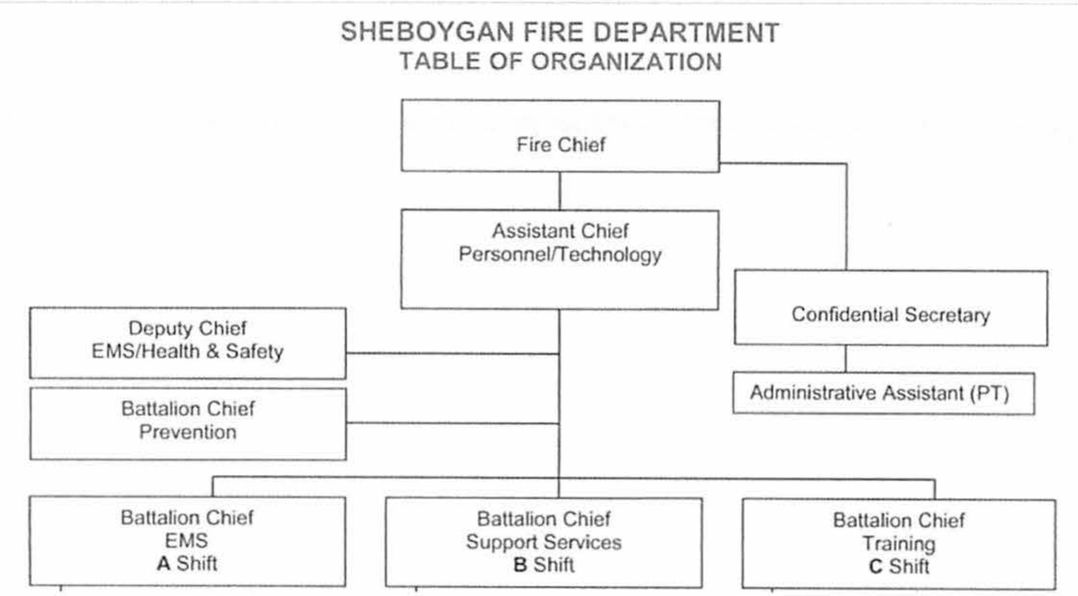


- Response resources are sufficient to handle current levels of performance
- Administrative staffing is challenged to fully address ongoing training, public education, shift supervision and internal communications effectively
  - The City should consider allocating an additional resources for fire administration



Organizational Structure

Recommendations

From a program accounting perspective, the City should consider adjusting their financials to reflect 18 FTEs adjusted to 75% as a more representative cost allocation for EMS staffing requirements.

Prospectively, the City will benefit from an ambulance replacement schedule that is staggered. This will allow the rolling fleet to be continuously updated while keeping maintenance cost more consistent.

The City should consider allocating additional resources for fire administration.

The City should codify a status quo performance baseline of 5-minute travel time for 90% of incidents utilizing their 5 existing stations


The End

SECTION 3: Data Analysis

FITCH & ASSOCIATES

Methodology

We collected five years of CAD data (2013 to 2017) from Sheboygan Fire Department (SFD). In this report, we primarily focused our analysis on the 2017 calendar year.

In this report, we utilized two distinct measures of call volume and workload. First, is the number of requests for service that are defined as either "dispatches" or "calls". Dispatches/calls are the number of times a distinct incident was created. Conversely, "responses" are the number of times that an individual unit (or units) responded to a call. Responses will be utilized on all Unit and Station level analyses, which account for all elements of workload and performance. Calls have been categorized as EMS, Fire, Hazard and Mutual aid respectively. We classified call types using nature of incident. Calls associated with a transport time were identified as transport calls.

Dispatch time in this report is calculated from the time a 911 call was answered by the dispatcher through the time a unit was dispatched. Thus, dispatch time includes time the dispatcher created the incident request in the system. On average, a dispatcher spent 49 seconds to create an emergency request (lights and sirens response) in the system. This report focuses on calls responded with lights and sirens, and mainly analyzes dispatch time, turnout time, travel time, and response time of the first arriving units. However, we also present response time performance on calls responded without lights and sirens for comparison.

Community Response History

In the year of 2017, a total of 5,142 incidents were recorded in CAD, which reflected a year over year growth rate at 3.0%. EMS service requests totaled 3,943, accounting for 76.7% of the total number of incidents. The number of fire related calls were 1,050, which accounted for 20.4% of the total incidents. A total of 48 incidents were mutual aid outside SFD's jurisdiction.

The number of individual unit responses will be more reflective of total department workload since on average 2.0 SFD units responded to an incident. As summarized in Table 3, all units in SFD combined made 10,408 responses, and were busy on emergency calls 3,509 hours. On average, each response lasted 20.2 minutes from dispatched to clear.

Table 1: 2013-2017: Number of Incidents by Call Category

Program	Number of Calls				
	2013	2014	2015	2016	2017
EMS	3,773	3,877	3,877	3,890	3,943
Fire	1,082	1,007	1,001	978	1,050
Hazmat	109	95	117	92	101
Mutual	29	36	21	30	48
Total	**4,993**	**5,015**	**5,016**	**4,990**	**5,142**
Calls per Day	**13.7**	**13.7**	**13.7**	**13.7**	**14.1**
YoY Growth	**NA**	**0.4%**	**0.0%**	**-0.5%**	**3.0%**

Table 2: Number of Incidents by Category in 2017

Call Category	Number of Calls	Calls per Day	Call Percentage
Cardiac and stroke	349	1.0	6.8%
Seizure and unconsciousness	50	0.1	1.0%
Breathing difficulty	514	1.4	10.0%
Overdose and psychiatric	79	0.2	1.5%
Accident	166	0.5	3.2%
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EMS Total	**3,943**	**10.8**	**76.7%**
Structure fire	25	0.1	0.5%
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Alarm	342	0.9	6.7%
Public service	517	1.4	10.1%
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Fire other	90	0.2	1.8%
Fire Total	**1,050**	**2.9**	**20.4%**
Hazmat	**101**	**0.3**	**2.0%**
Mutual aid	**48**	**0.1**	**0.9%**
Total	**5,142**	**14.1**	**100.0%**

Figure 23: Percentage of Total Incidents Dispatched by Program in 2017

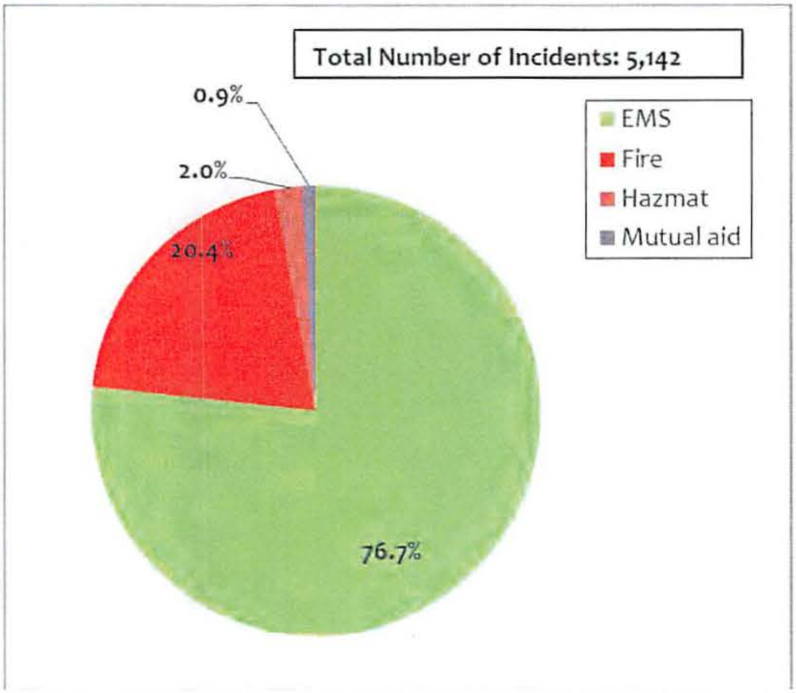


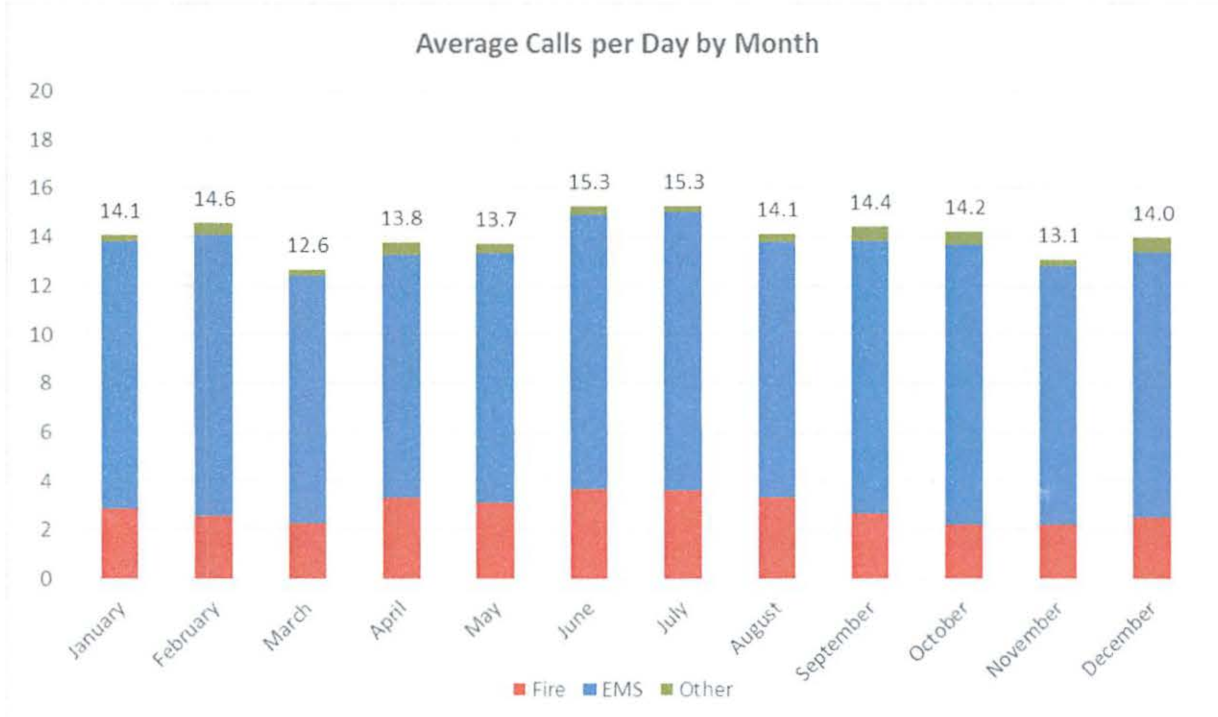
Table 3: Number of Calls, Number of Responses, and Total Busy Time by Program in 2017

Program	Number of Calls	Number of Responses	Average Responses per Call	Total Busy Hours	Average Busy Minutes per Response	Percentage of Total Busy Hours
EMS	3,943	7,871	2.0	2,451	18.7	69.8%
Fire	1,050	2,118	2.0	850	24.1	24.2%
Hazmat	101	352	3.5	174	29.6	5.0%
Mutual aid	48	67	1.4	34	30.6	1.0%
Total	**5,142**	**10,408**	**2.0**	**3,509**	**20.2**	**100.0%**

Temporal analyses were conducted to evaluate patterns in community demands. These measures examined the frequency of requests for service by month, day of week, and hour of day. In the following temporal analysis, hazmat and mutual aid calls were grouped into the other category for presentation purposes.

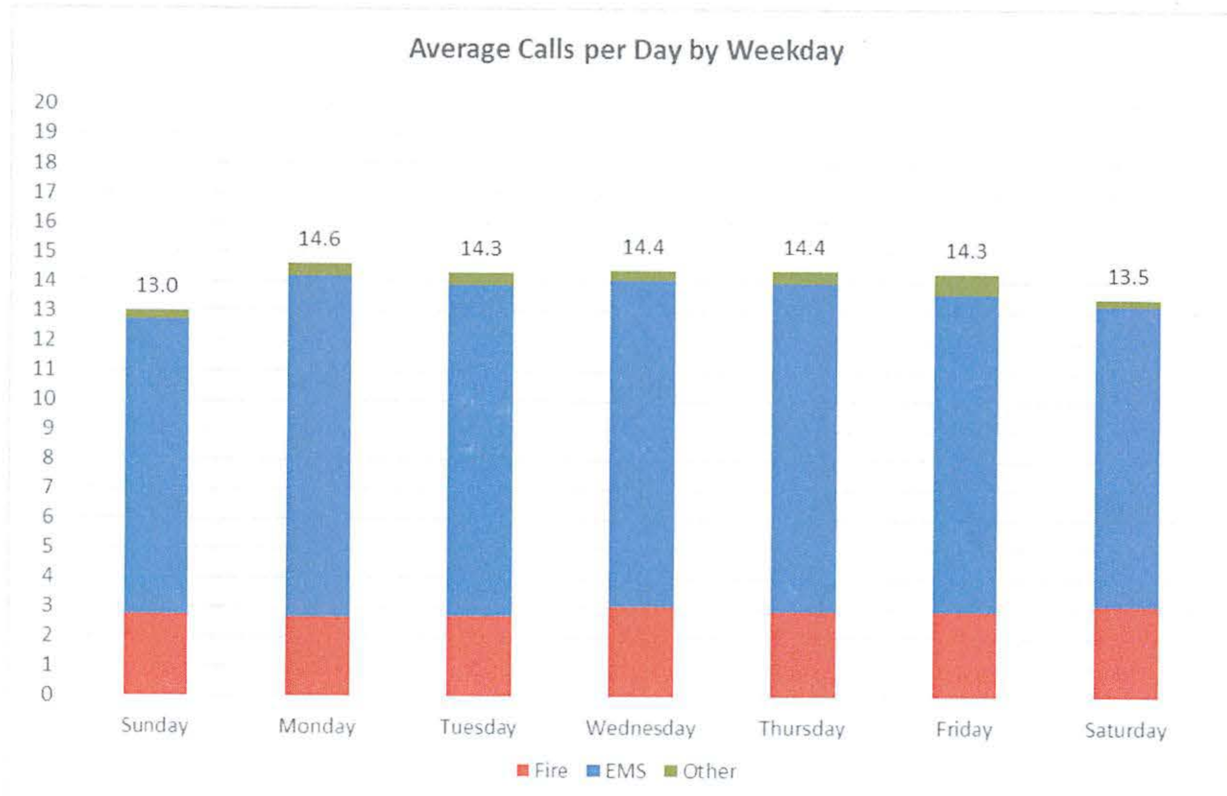
Overall, average requests per month ranged from a low of 12.6 per day in March to a high of 15.3 per day in June and July. The top three months with the most demands in the descending order are: July (15.3 per day), June (15.3 per day) and February (14.6 per day).

Figure 24: Overall: Average Calls per Day by Month



Similar analyses were conducted for requests by day of week. The data revealed that there is minor variability in the demand for services by day of week. Sunday was the lowest for the week at 13.0 calls per day. Monday has the highest frequency of requests for services at 14.6 calls per day.

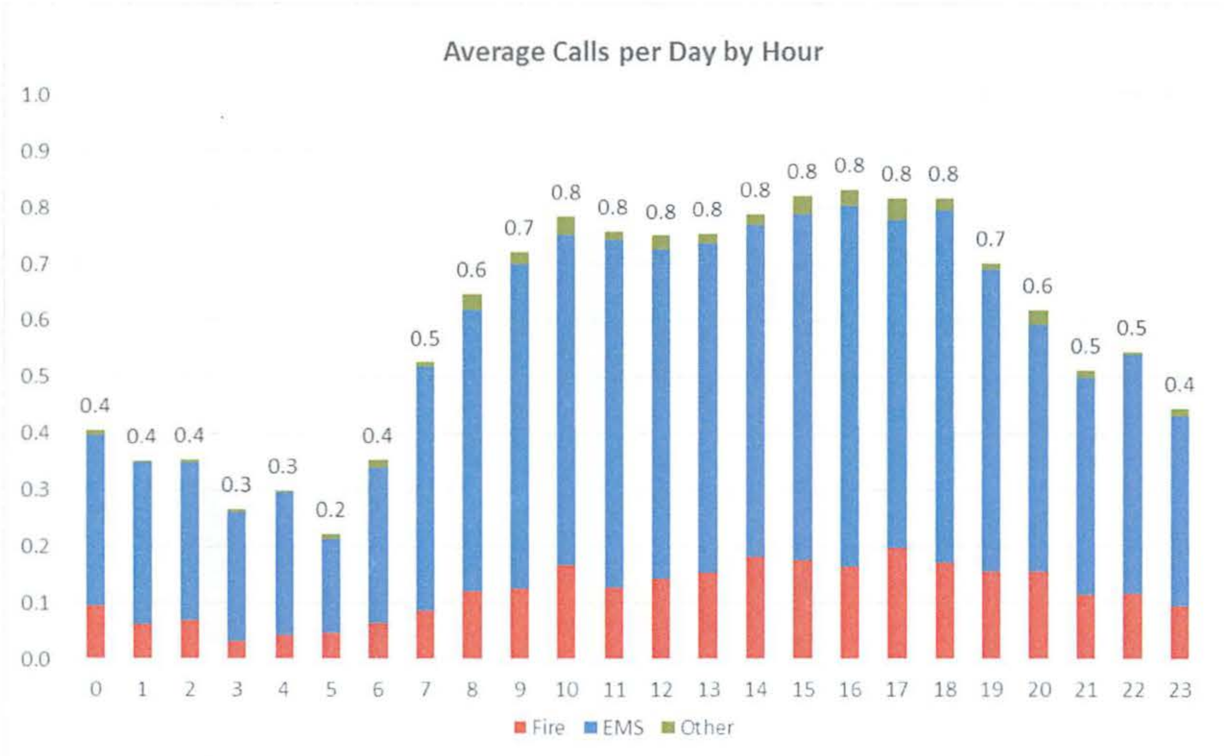
Figure 25: Overall: Average Calls per Day by Weekday



Overall demands were evaluated by the hour of the day. Considerable variability exists in the time of day that requests for emergency services are received. The hours that from midnight to 0600 are low demand hours of the day. While the middle of the day has the greatest frequency of calls, specifically the hours that begin at 1000 and 1800 averaging above 0.75 calls per day and per hour. The average number of calls per hour is 0.59 per day. The data illustrates that the busiest times of the day are between 1500 and 1800. The hour with the peak demand is at 1600.

To provide a more granular understanding of the community's demand for emergency services, this temporal analysis included the average number of calls per hour. In other words, when referring to the figure below, the busiest hour is at 1600 with 304 calls during that hour. The average number of calls per hour is a daily average for those 304 calls if they were equally distributed. Therefore, the busiest hour per day would be at 1600 with an average hourly call volume at 0.83 calls per day. The second busiest hour is at 1500 with 300 calls during the hour, and averaged 0.82 calls per hour.

Figure 26: Overall: Average Calls per Day by Hour



Overall, SFD's units made 10,408 unit responses, and the total busy hours were 3,509 hours. SFD has 5 stations. Station 1 was the busiest station, and their average number of unit responses per day was 9.7. Station 5 had the least unit responses, averaging 1.5 responses per day.

Table 4: Overall Workload by Unit

Station	Unit	Type	Avg. Busy Minutes per Response	Annual Busy Hours	Annual Total Responses	Busy Hours per Day	Unit Responses per Day
1	M1	Ambulance	19.8	629	1,909	1.7	5.2
	E1	Engine	18.0	491	1,639	1.3	4.5
	Station 1 Total		**18.9**	**1,120**	**3,548**	**3.1**	**9.7**
2	M2	Ambulance	20.8	438	1,264	1.2	3.5
	R2	Rescue Engine	21.2	370	1,048	1.0	2.9
	Station 2 Total		**21.0**	**807**	**2,312**	**2.2**	**6.3**
3	M3	Ambulance	19.6	490	1,500	1.3	4.1
	E3	Engine	18.4	430	1,399	1.2	3.8
	BC	Pickup	39.4	134	204	0.4	0.6
	AC	Assistant Chief	125.6	8	4	0.0	0.0
	DC	Deputy Chief	88.2	3	2	0.0	0.0

Station	Unit	Type	Avg. Busy Minutes per Response	Annual Busy Hours	Annual Total Responses	Busy Hours per Day	Unit Responses per Day
	Station 3 Total		**20.5**	**1,065**	**3,109**	**2.9**	**8.5**
4	L4	Ladder	20.8	307	883	0.8	2.4
	M6	Ambulance	17.0	2	7	0.0	0.0
	E6	Engine	0.4	0	1	0.0	0.0
	Station 4 Total		**20.8**	**309**	**891**	**0.8**	**2.4**
5	L5	Ladder	22.8	208	548	0.6	1.5
SFD Total			**20.2**	**3,509**	**10,408**	**9.6**	**28.5**

This analysis focused on lights and sirens responses and utilized the first arriving units of all distinct incidents excluding mutual aid incidents. The mean (average) dispatch time was 126 seconds. The mean (average) turnout time was 84 seconds, travel time was 168 seconds, and response time was 371 seconds (six minutes and 11 seconds). The average response time is the same as the sum of the average dispatch time and turnout and travel time.

However, a more conservative and reliable measure of performance is the fractile or percentile. This measure is more robust, or less influenced by outliers, than measures of central tendency such as the mean. Best practice is to measure at the 90th percentile. In other words, 90% of all performance is captured expecting that 10% of the time the department may experience abnormal conditions that would typically be considered an outlier. For example, if the department were to report an average response time of six minutes, then in a normally distributed set of data, half of the responses would be longer than six minutes and half of the responses would be less than six minutes. The 90th percentile communicates that 9 out of 10 times the department performance is predictable and thus more clearly articulated to policy makers and the community.

The performance for dispatch time at the 90th percentile was 204 seconds (three minutes and 24 seconds), turnout time at the 90th percentile was 134 seconds (2 minutes and 14 seconds), travel time was 284 seconds (four minutes and 44 seconds), and response time was 538 seconds (eight minutes and 58 seconds). Please note that the summation of 90th percentile dispatch time, 90th percentile turnout time and 90th percentile travel time is not the same as 90th percentile response time.

Table 5: Average Dispatch, Turnout and Travel Time of First Arriving Units by Program

Program	Dispatch Time	Turnout Time	Travel Time	Response Time	Sample Size
EMS	2.1	1.3	2.7	6.1	3,361
Fire	1.8	1.6	3.4	6.8	340
Hazmat	1.6	1.6	3.5	6.7	84
Total	**2.1**	**1.4**	**2.8**	**6.2**	**3,785**

Figure 27: Average Turnout and Travel Time by Call Category

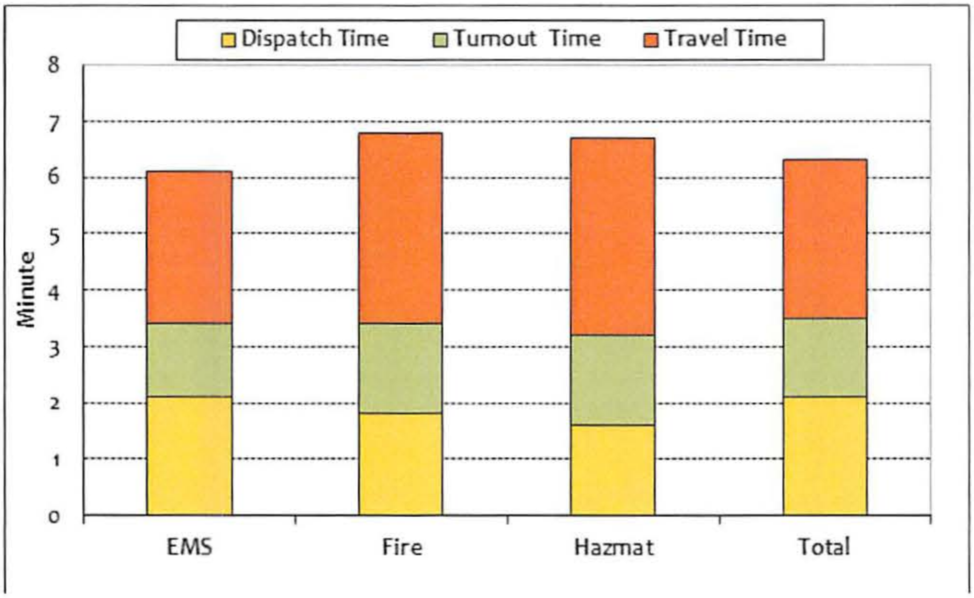


Table 6: 90th Percentile Turnout and Travel Time of First Arriving Units by Program

Program	Dispatch Time	Turnout Time	Travel Time	Response Time	Sample Size
EMS	3.5	2.2	4.6	8.9	3,361
Fire	2.9	2.4	5.7	9.7	340
Hazmat	2.7	2.3	6.2	9.8	84
Total	**3.4**	**2.2**	**4.7**	**9.0**	**3,785**

The distributions of turnout and travel time were also analyzed. A total of 27% of calls had turnout time of one minute or less, and 84% of calls had turnout time of two minutes or less. A total of 37% calls had travel time of two minutes or less, and 92% of calls had travel time of five minutes or less.

Figure 28: All Calls: Distribution of Turnout Time of First Arriving Unit

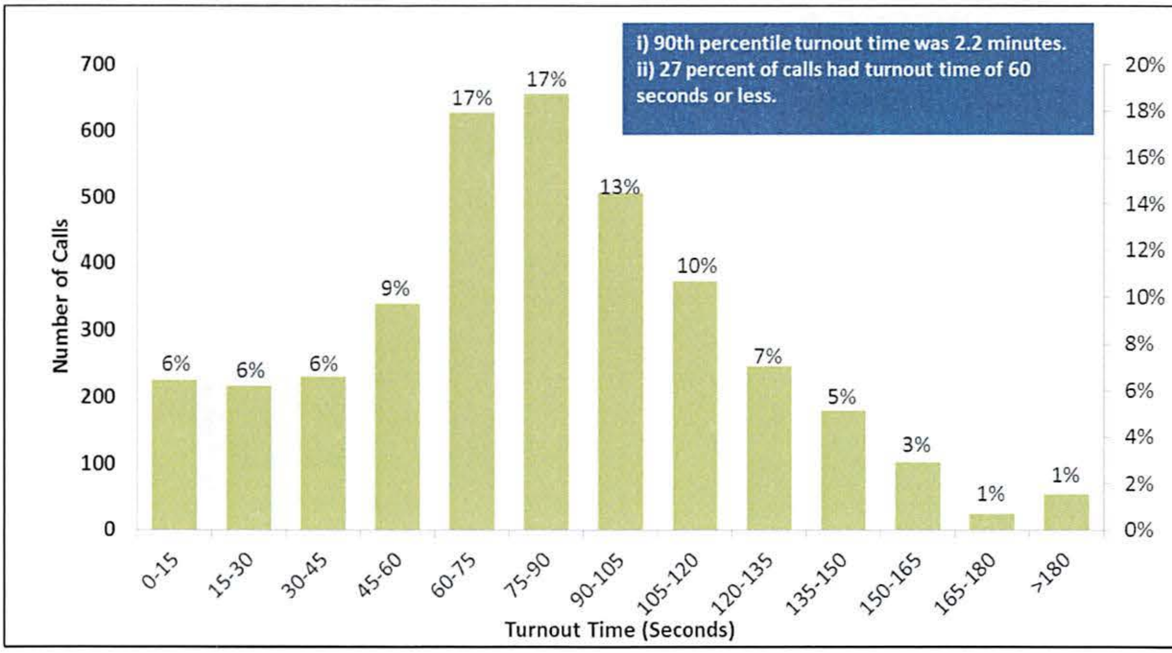
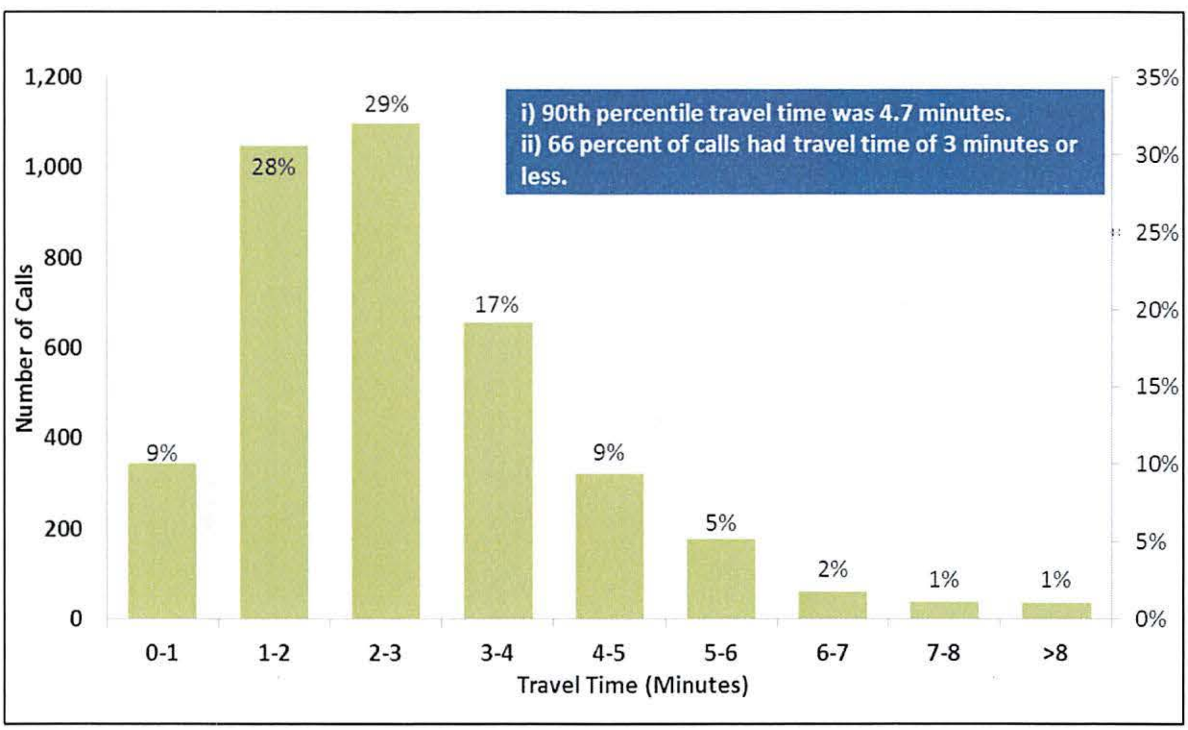


Figure 29: All Calls: Distribution of Travel Time of First Arriving Unit



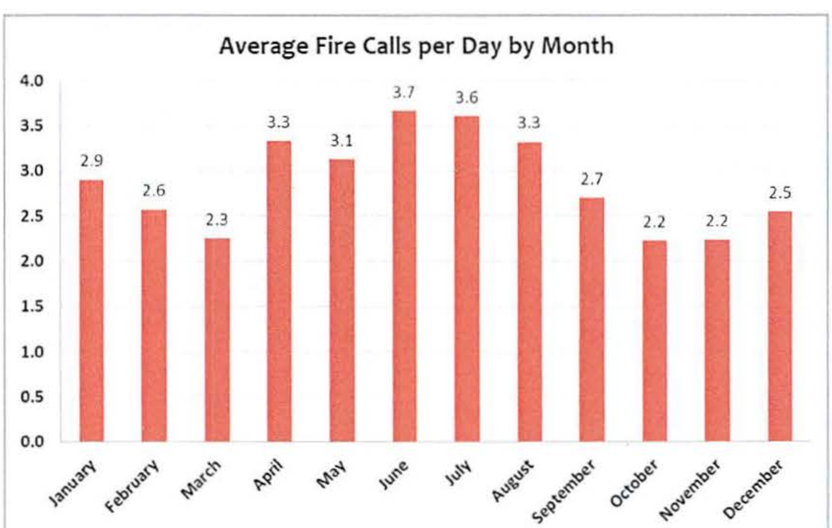
Fire Services

Temporal analyses were conducted to evaluate patterns in community demands for fire related services. These measures examined the frequency of requests for service in 2017 calendar year by month, day of week, and hour of day. Results found that there was variability by month. The three months with most fire calls in order were: June (3.7 per day), July (3.6 per day), and August (3.3 per day). The three months with least fire calls in order were: November (2.2 per day), October (2.2 per day), and March (2.3 per day). Results are presented below.

Table 7: Total Fire Related Calls per Month

Month	Number of Calls	Calls per Day	Call Percentage
January	90	2.9	8.6
February	72	2.6	6.9
March	70	2.3	6.7
April	100	3.3	9.5
May	97	3.1	9.2
June	110	3.7	10.5
July	112	3.6	10.7
August	103	3.3	9.8
September	81	2.7	7.7
October	69	2.2	6.6
November	67	2.2	6.4
December	79	2.5	7.5
Total	**1,050**	**2.9**	**100.0**

Figure 30: Average Fire Related Calls per Month

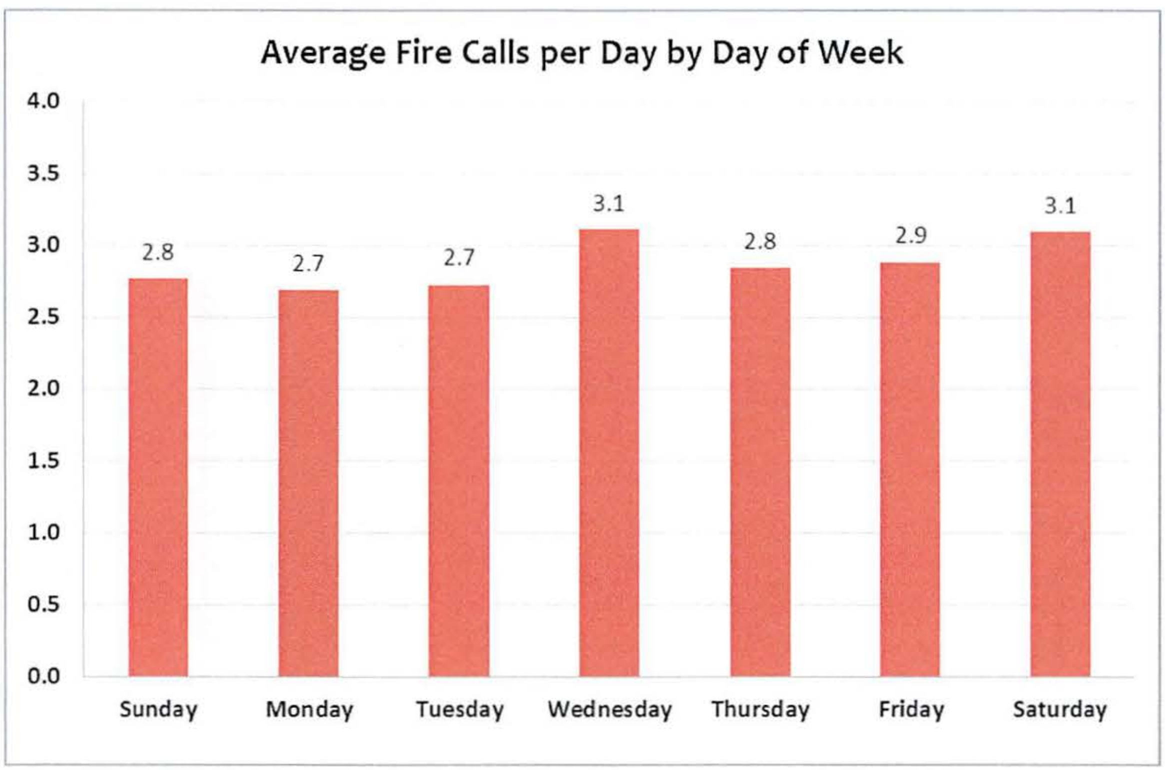


Similar analyses were conducted for fire related calls per day of week. The data revealed that there is minor variability in the demand for services by day of week. Monday was the lowest for the week, averaging 2.7 per day or 13.3 percent of the fire related calls for the week. Wednesday has the highest frequency of requests for fire related services averaging 3.1 calls per day and 15.4%. Results for this analysis are presented below.

Table 8: Total Fire Related Calls by Day of Week

Day of Week	Number of Calls	Calls per Day	Call Percentage
Sunday	144	2.8	13.7
Monday	140	2.7	13.3
Tuesday	142	2.7	13.5
Wednesday	162	3.1	15.4
Thursday	151	2.8	14.4
Friday	150	2.9	14.3
Saturday	161	3.1	15.3
Total	**1,050**	**2.9**	**100.0**

Figure 31: Average Fire Related Calls by Day of Week



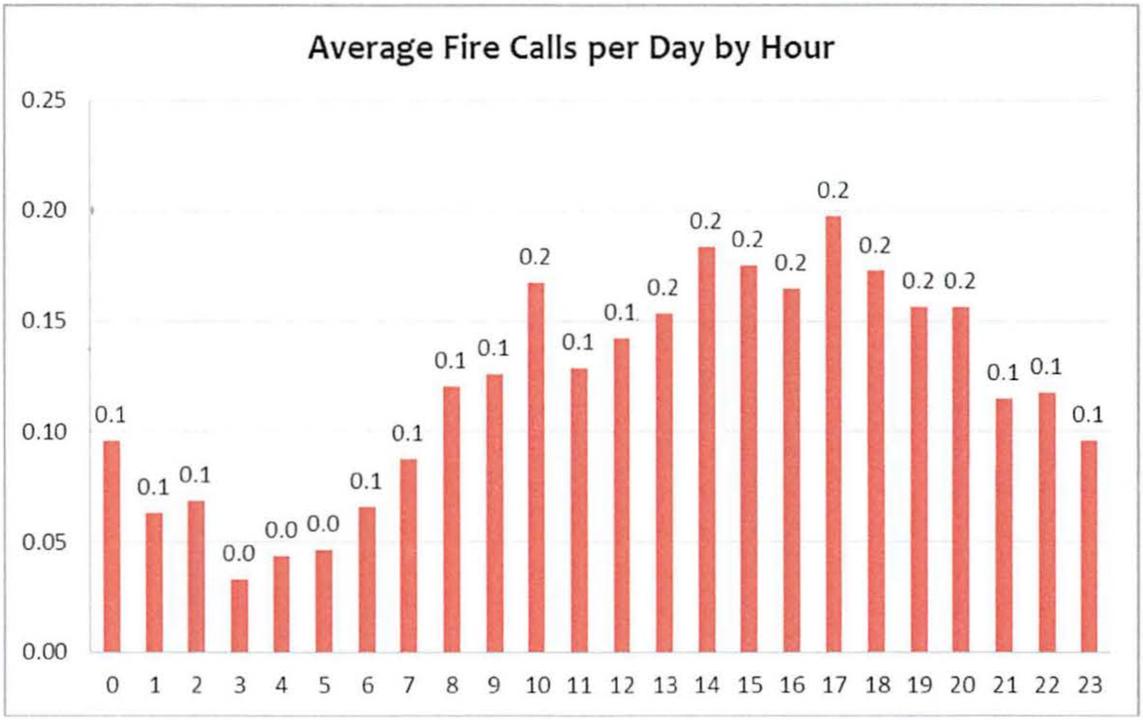
Fire related calls were evaluated by hour of the day. Considerable variability exists in the time of day that requests for fire related services are received. The hours that include midnight to

0700 have the lowest demands. While the middle of the day has the greatest frequency of calls, specifically from 1400 through 1800 are above 60 calls in a year. The average number of calls per hour in a year is 44. Finally, in an effort to provide a more granular understanding of the community's demand for fire related services, this temporal analysis included the average number of calls per hour. In other words, when referring to the Table below, the busiest hour is at 1700 with 72 calls during that hour in 2017. The average number of calls per hour is a daily average for those 72 calls if they were equally distributed. Therefore, the busiest hour per day would be at 1700 with an average hourly call volume of 0.20 calls per hour.

Table 9: Total and Average Fire Related Calls by Hour of Day

Hour of Day	Number of Calls	Calls per Day	Call Percentage
0	35	0.1	3.3
1	23	0.1	2.2
2	25	0.1	2.4
3	12	0.0	1.1
4	16	0.0	1.5
5	17	0.0	1.6
6	24	0.1	2.3
7	32	0.1	3.0
8	44	0.1	4.2
9	46	0.1	4.4
10	61	0.2	5.8
11	47	0.1	4.5
12	52	0.1	5.0
13	56	0.2	5.3
14	67	0.2	6.4
15	64	0.2	6.1
16	60	0.2	5.7
17	72	0.2	6.9
18	63	0.2	6.0
19	57	0.2	5.4
20	57	0.2	5.4
21	42	0.1	4.0
22	43	0.1	4.1
23	35	0.1	3.3
Total	**1,050**	**2.88**	**100.0**

Figure 32: Average Fire Related Calls per Day by Hour of Day



SFD made a total of 2,118 responses to fire related calls. The total time on task was 850 hours, and the average time on task was 24.1 minutes. Of the 5 stations, station 3 had the most responses to fire calls. Stations 4 and 5 had the least responses to fire calls.

Table 10: Workload by Unit for Fire Calls

Station	Unit	Type	Avg. Busy Minutes per Response	Annual Busy Hours	Annual Total Responses	Busy Hours per Day	Unit Responses per Day
1	M1	Ambulance	22.1	86	233	0.2	0.6
	E1	Engine	20.0	139	416	0.4	1.1
	Station 1 Total		**20.7**	**224**	**649**	**0.6**	**1.8**
2	M2	Ambulance	23.4	50	127	0.1	0.3
	R2	Rescue Engine	25.3	103	245	0.3	0.7
	Station 2 Total		**24.6**	**153**	**372**	**0.4**	**1.0**
3	M3	Ambulance	21.8	69	190	0.2	0.5
	E3	Engine	20.9	119	341	0.3	0.9
	BC	Pickup	41.0	99	145	0.3	0.4
	AC	Assistant Chief	115.1	6	3	0.0	0.0
	DC	Deputy Chief	158.3	3	1	0.0	0.0
	Station 3 Total		**26.1**	**295**	**680**	**0.8**	**1.9**

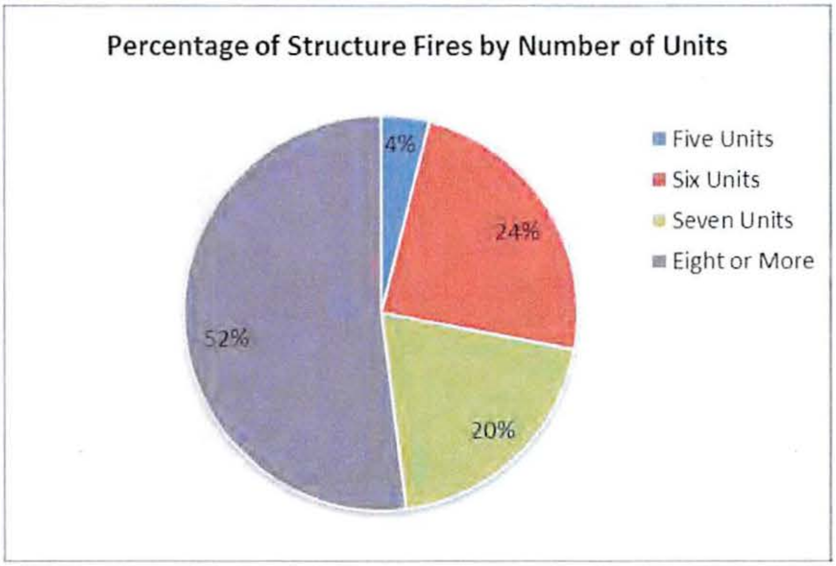
	L4	Ladder	24.6	109	267	0.3	0.7
4	M6	Ambulance	19.4	0	1	0.0	0.0
	Station 4 Total		**24.6**	**110**	**268**	**0.3**	**0.7**
5	L5	Ladder	27.2	68	149	0.2	0.4
SFD Total			**24.1**	**850**	**2,118**	**2.3**	**5.8**

We analyzed number of responding SFD units by call type. Overall, 56% of fire calls were responded by one unit driven by public service calls, and 10% were responded to by two units. However, all structure fire calls were responded to by five or more units. A total of 32% of the outside fires were responded to by one unit. A total of 78% fire other calls were responded to by one unit.

Table 11: Number of Responding Units by Fire Call Type

Call Category	Number of SFD Units					Total
	1	2	3	4	5 or more	
Structure fire	0	0	0	0	25	25
Outside fire	20	17	10	12	4	63
Alarm	70	9	193	59	11	342
Public service	429	57	18	11	2	517
Rescue	0	4	5	1	3	13
Fire other	70	18	2	0	0	90
Total	**589**	**105**	**228**	**83**	**45**	**1,050**
Percentage	**56.1%**	**10.0%**	**21.7%**	**7.9%**	**4.3%**	**100.0%**

Figure 33: Percentage of Structure Fire Calls by Number of Responding Units



Emergency Medical Services

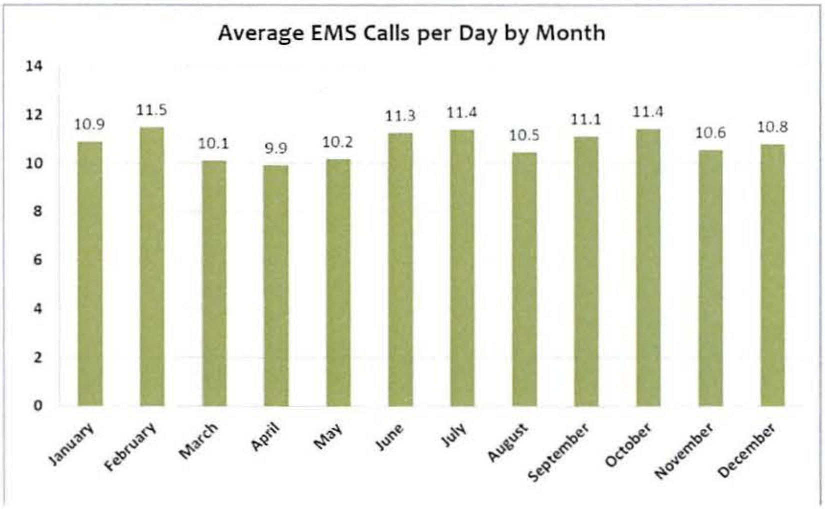
SFD provides emergency Medical Services (EMS) and transport services. Requests for EMS are categorized as granular call categories using the final CAD call description.

Temporal analyses were completed to describe the community's demands for emergency medical services. These analyses were completed by month of year, day of week, and hour of day. There is variability between months of the year with October (11.4 EMS requests per day) receiving the most requests for service and April (9.9 EMS requests per day) the least. September received 12% more requests than April.

Table 12: Annual Total and Average per Day of EMS Calls by Month of Year

Month	Number of Calls	Calls per Day	Call Percentage
January	338	10.9	8.6
February	322	11.5	8.2
March	314	10.1	8.0
April	298	9.9	7.6
May	316	10.2	8.0
June	338	11.3	8.6
July	353	11.4	9.0
August	324	10.5	8.2
September	334	11.1	8.5
October	354	11.4	9.0
November	317	10.6	8.0
December	335	10.8	8.5
Total	**3,943**	**10.8**	**100.0**

Figure 34: Average EMS Calls per Day by Month of Year

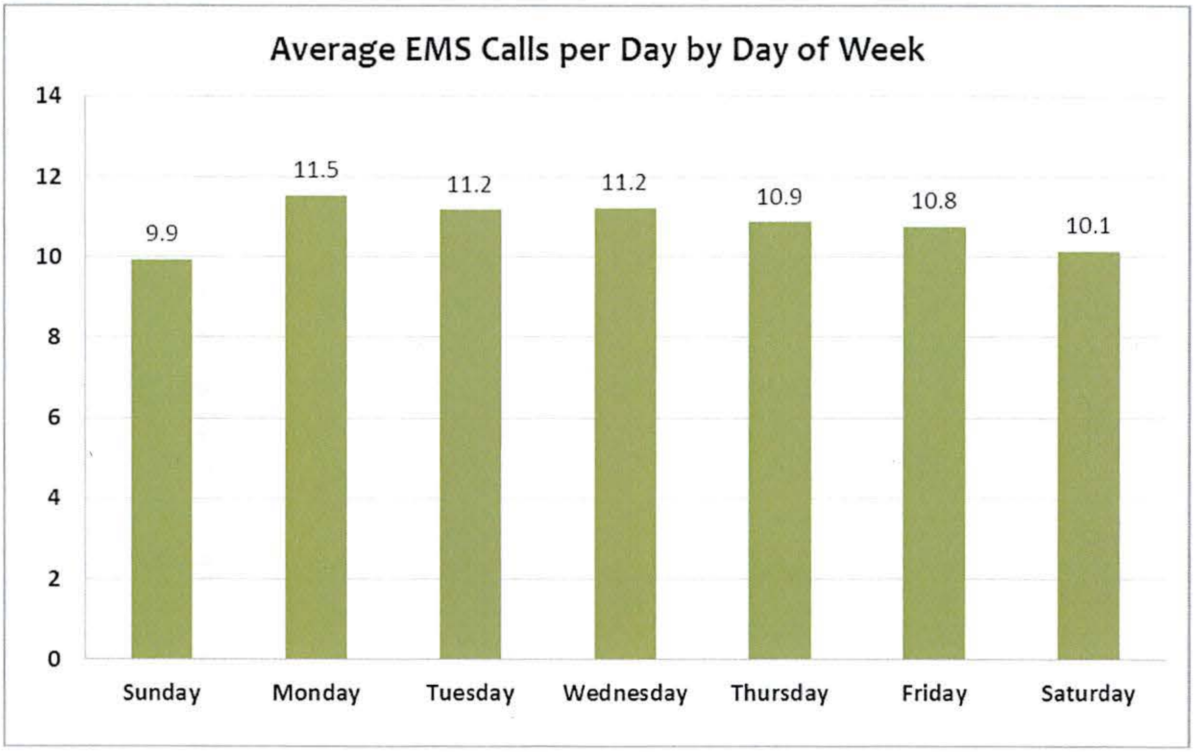


Similar analyses were conducted examining the frequency of requests for service by the day of the week. Once again, there is only minor variability in the demand for services by the day of the week. Monday receives the most requests for service and Sunday the least. Results are provided below. Monday received 16% more requests than Sunday.

Table 13: Annual Total and Average per Day of EMS Calls by Day of Week

Day of Week	Number of Calls	Calls per Day	Call Percentage
Sunday	517	9.9	13.1
Monday	599	11.5	15.2
Tuesday	581	11.2	14.7
Wednesday	584	11.2	14.8
Thursday	576	10.9	14.6
Friday	559	10.8	14.2
Saturday	527	10.1	13.4
Total	**3,943**	**10.8**	**100.0**

Figure 35: Average EMS Calls per Day by Day of Week

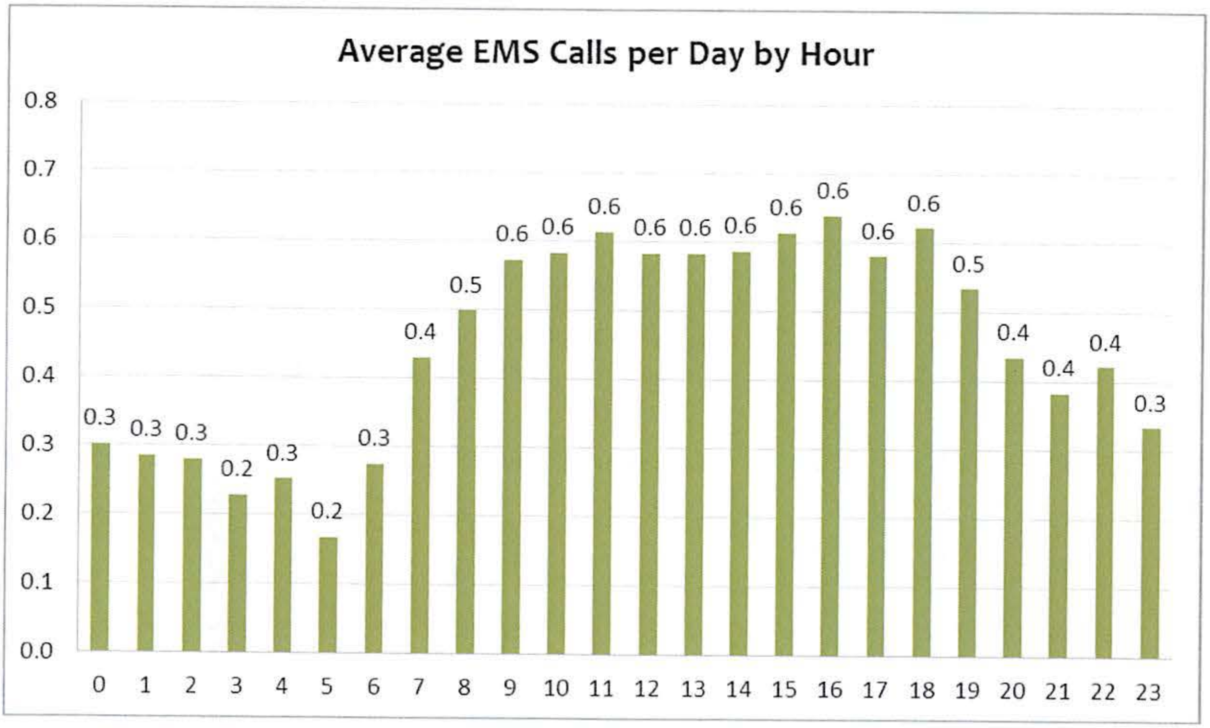


Finally, the analyses for EMS services are concluded by identifying the EMS calls by hour of day and the average hourly rate of EMS calls per hour. The demand curve for requests for EMS service follows an expected pattern experienced in similar communities across the nation. The higher frequency of service calls begins from 0900 to 1800 and each hour had more than 200 calls. The demand peaked at 1600 with 233 calls in a year. The average hourly rate of service requests is 4.2 for any hour during the day with the peak occurring at 1600 at 5.9 calls on average during the hour, and a low at 0500 of 1.5 calls on average during that hour. Results are provided below.

Table 14: Annual Total and Average per Day of EMS Calls by Hour of Day

Hour of Day	Number of Calls	Calls per Day	Call Percentage
0	110	0.30	2.8
1	104	0.28	2.6
2	102	0.28	2.6
3	83	0.23	2.1
4	92	0.25	2.3
5	61	0.17	1.5
6	100	0.27	2.5
7	157	0.43	4.0
8	182	0.50	4.6
9	209	0.57	5.3
10	213	0.58	5.4
11	224	0.61	5.7
12	213	0.58	5.4
13	213	0.58	5.4
14	214	0.59	5.4
15	224	0.61	5.7
16	233	0.64	5.9
17	212	0.58	5.4
18	227	0.62	5.8
19	195	0.53	4.9
20	159	0.44	4.0
21	140	0.38	3.6
22	154	0.42	3.9
23	122	0.33	3.1
Total	**3,943**	**10.80**	**100.0**

Figure 36: Average EMS Calls per Day by Hour of Day



For these analyses, EMS incidents are an aggregated category of the various granular EMS requests categorized based upon CAD call description. EMS requests accounted for 76.7% of the total requests and averaged 10.8 requests per day. Illness and other was the most frequent community demand (averaging 6.2 requests per day), followed by fall and injury (averaging 1.5 requests per day). Cardiac and stroke requests totaled 349, averaging 1.0 requests per day.

SFD sends two or more units to 95 percent of the EMS requests. On average, 2.0 SFD units were dispatched per EMS call. SFD units made a total of 7,871 responses to EMS calls. The total time on task was 2,451 hours, and the average time on task was 18.7 minutes. Station 1 and 3 had most EMS responses, and station 5 had the least.

Table 15: Workload by Unit for EMS Calls

Station	Unit	Type	Avg. Busy Minutes per Response	Annual Busy Hours	Annual Total Responses	Busy Hours per Day	Unit Responses per Day
1	M1	Ambulance	19.1	519	1,630	1.4	4.5
	E1	Engine	16.3	314	1,158	0.9	3.2
	Station 1 Total		**17.9**	**833**	**2,788**	**2.3**	**7.6**
2	M2	Ambulance	20.4	373	1,096	1.0	3.0
	R2	Rescue Engine	19.5	246	757	0.7	2.1
	Station 2 Total		**20.0**	**618**	**1,853**	**1.7**	**5.1**

3	M3	Ambulance	18.9	401	1,270	1.1	3.5
	E3	Engine	17.1	284	996	0.8	2.7
	BC	Pickup	24.2	8	19	0.0	0.1
	DC	Deputy Chief	18.1	0	1	0.0	0.0
	Station 3 Total		**18.2**	**693**	**2,286**	**1.9**	**6.3**
4	L4	Ladder	18.5	176	570	0.5	1.6
	M6	Ambulance	15.4	1	5	0.0	0.0
	E6	Engine	0.4	0	1	0.0	0.0
	Station 4 Total		**18.5**	**177**	**576**	**0.5**	**1.6**
5	L5	Ladder	21.2	130	368	0.4	1.0
SFD Total			**18.7**	**2,451**	**7,871**	**6.7**	**21.6**

Transport

We analyzed outcomes for the requests for EMS services. The number of EMS transports totaled 3,022, averaging 8.3 transports per day. Approximately 77% of EMS calls have patients being transported to the hospital. Cardiac and stroke calls had the highest transport rate at 91%, followed by seizure and unconsciousness at 90%, and breathing difficulty calls at 87%.

We analyzed variation of total EMS requests and transport requests by the hour of the day and the average hourly rate of requests. The variation of total EMS requests and EMS transport reports followed a similar pattern. The busiest period for EMS and EMS transport requests was between 0900 and 1800. The average number of transports per hour was 0.45 and the transport demand peaked at 1600. Requests by hour of the day are represented below.

Table 16: EMS Transports by Call Category

	Non-Transport		Transport		
Call Category	**Duration (minute)**	**Number of Calls**	**Duration (minute)**	**Number of Calls**	**Transport Rate**
Cardiac and stroke	26.6	32	21.6	317	90.8%
Seizure and unconsciousness	16.9	5	20.0	45	90.0%
Breathing difficulty	22.2	66	21.3	448	87.2%
Overdose and psychiatric	17.5	21	21.2	58	73.4%
Accident	28.7	69	31.9	97	58.4%
Fall and injury	18.9	159	21.7	373	70.1%
Illness and other	19.9	569	20.8	1,684	74.7%
EMS Total	**20.7**	**921**	**21.4**	**3,022**	**76.6%**

Figure 37: Average EMS Calls and EMS Transports per Day by Hour of Day

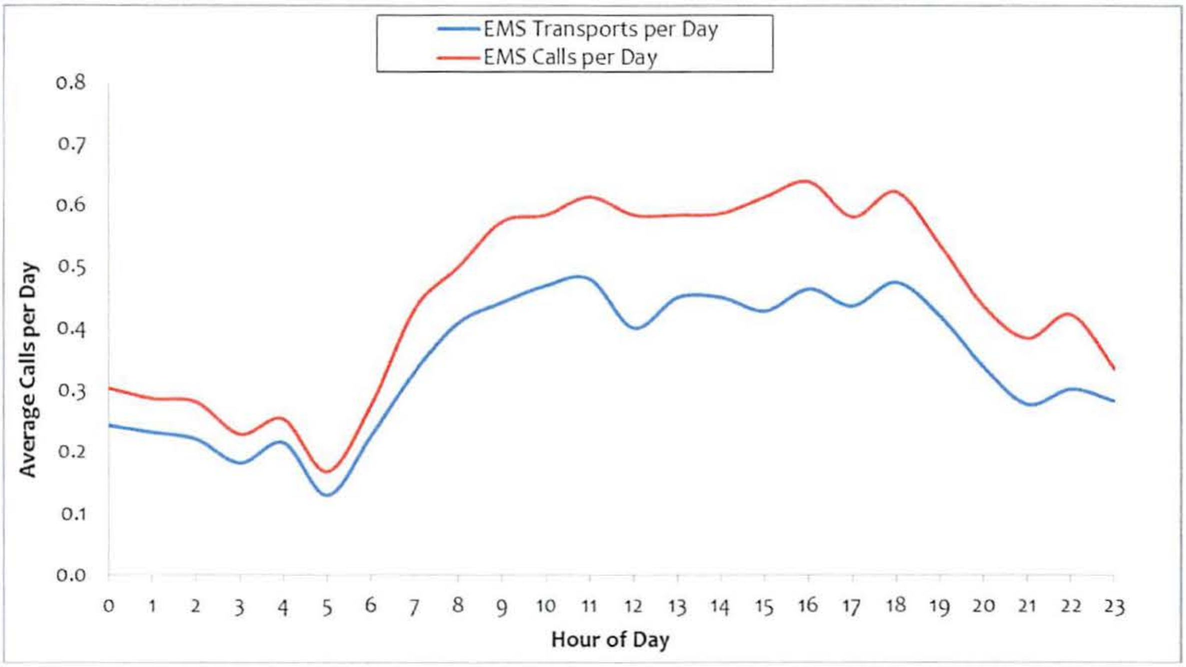


Table 17: Total EMS Calls and EMS Transports and Average per Day by Hour of Day

Hour	Number of EMS Transports	Number of EMS Calls	EMS Transports per Day	EMS Calls per Day	Transport Rate
0	88	110	0.24	0.30	80.0
1	84	104	0.23	0.28	80.8
2	80	102	0.22	0.28	78.4
3	66	83	0.18	0.23	79.5
4	78	92	0.21	0.25	84.8
5	47	61	0.13	0.17	77.0
6	82	100	0.22	0.27	82.0
7	120	157	0.33	0.43	76.4
8	149	182	0.41	0.50	81.9
9	161	209	0.44	0.57	77.0
10	171	213	0.47	0.58	80.3
11	175	224	0.48	0.61	78.1
12	146	213	0.40	0.58	68.5
13	164	213	0.45	0.58	77.0
14	164	214	0.45	0.59	76.6
15	156	224	0.43	0.61	69.6
16	169	233	0.46	0.64	72.5
17	159	212	0.44	0.58	75.0
18	173	227	0.47	0.62	76.2
19	153	195	0.42	0.53	78.5
20	123	159	0.34	0.44	77.4
21	101	140	0.28	0.38	72.1
22	110	154	0.30	0.42	71.4
23	103	122	0.28	0.33	84.4

SECTION 4: GIS Analysis

FITCH & ASSOCIATES

Review of System Performance

The first step in determining the current state of the system's deployment model is to establish baseline measures of performance. This analysis is crucial to the ability to discuss alternatives to the status quo and in identifying opportunities for improvement. This portion of the analysis will focus efforts on elements of response time and the cascade of events that lead to timely response with the appropriate apparatus and personnel to mitigate the event. Response time goals should be looked at in terms of total reflex time, or total response time, which includes the dispatch or call processing time, turnout time, and travel time, respectively.

Cascade of Events

The cascade of events is the sum of the individual elements of time beginning with a state of normalcy and continuing until normalcy is once again returned through the mitigation of the event. The elements of time that are important to the ultimate outcome of a structure fire or critical medical emergency begin with the initiation of the event. For example, the first on-set of chest pain begins the biological and scientific time clock for heart damage irrespective of when 911 is notified. Similarly, a fire may begin and burn undetected for a period of time before the fire department is notified. The emergency response system does not have control over the time interval for recognition or the choice to request assistance.

Therefore, SFD utilize quantifiable "hard" data points to measure and manage system performance. These elements include alarm processing (with updated CAD), turnout time, travel time, and the time spent on-scene. An example of the cascade of events and the elements of performance utilized by SFD is provided as Figure 16 below.[12]

Detection

Is the element of time between the time an event occurs and someone detects it and the emergency response system has been notified. This is typically accomplished by calling the 911 Primary Safety Answering Point (PSAP).

Call Processing

This is the element of time measured between when 911 answers the 911 call, processes the information, and subsequently dispatches SFD.

Turnout Time

This is the element of time that is measured between the time the fire department is dispatched or alerted of the emergency incident and the time when the fire apparatus or ambulance is enroute to the call.

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[12] Olathe Fire Department. (2012). Adapted from Community Risk and Emergency Services Analysis: Standard of Cover. Olathe, Kansas: Author.

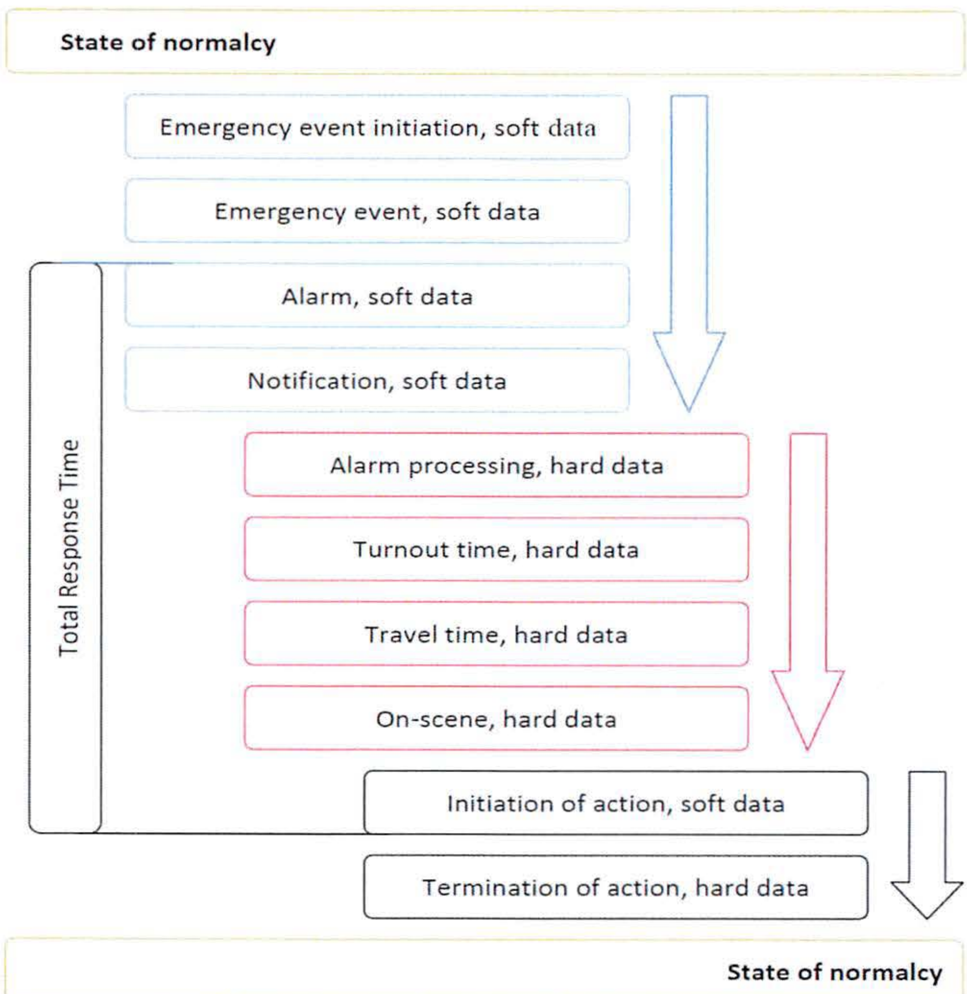
Travel Time

The travel time is the element of time between when the unit went enroute, or began to travel to the incident, and their arrival on-scene.

Total Response Time

The total response time, or total reflex time, is the total time required to arrive on-scene beginning with 911 answering the phone request for service and the time that the units arrive on-scene.

Figure 38: Cascade of Events



Comparison of Workloads by Demand Zone

Another method of assessing the effectiveness of the distribution model is to analyze the demand for services across the distribution model. Workload is assessed at the station demand zone level and at the individual unit level.

Analyses illustrate that Station 1 the top demand zone, and answer 30.7% of the total responses for services. Station 5 had the least demand, and answered 9.1% of the total departmental workload. Results are presented below.

Figure 39: Department Workload by Station Demand Zone

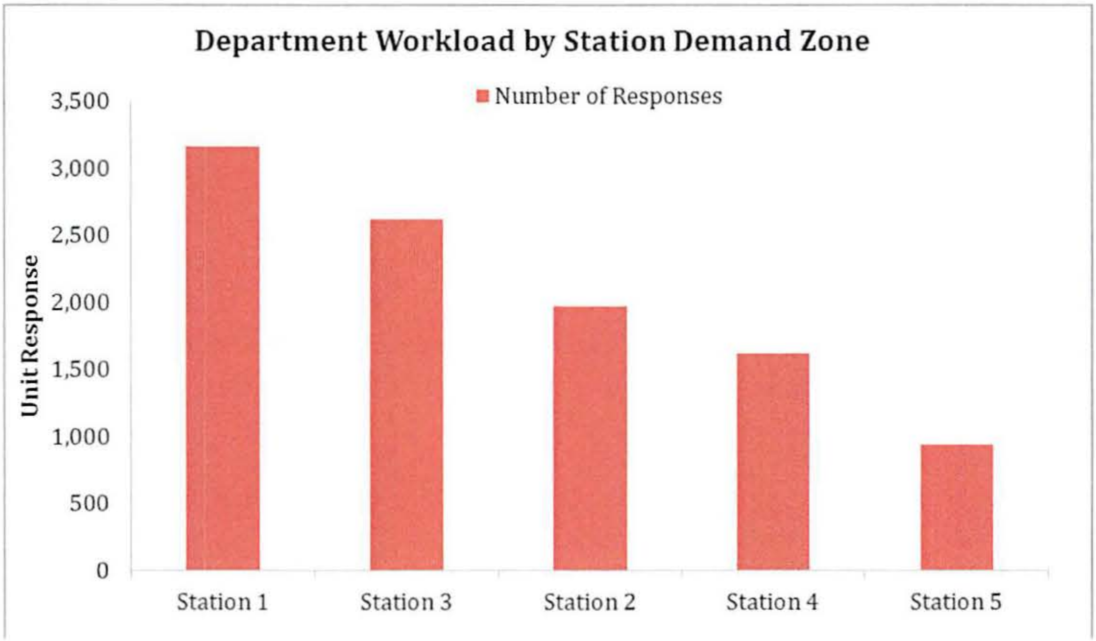


Table 18: Department Workload by Station Demand Zone

First Due Station	Number of Responses	Responses per Day	Percent of Department Workload	Cumulative Percent of Department Workload
Station 1	3,165	8.7	30.7	30.7
Station 3	2,624	7.2	25.4	56.1
Station 2	1,969	5.4	19.1	75.2
Station 4	1,624	4.4	15.7	90.9
Station 5	940	2.6	9.1	100.0

Another measure, time on task, is necessary to evaluate best practices in efficient system delivery and consider the impact workload has on personnel. Unit Hour Utilization (UHU) determinants were developed by mathematical model. This model includes both the proportion of calls handled in each major service area (Fire, EMS, and Hazmat) and total unit time on task for these service categories in 2017. The resulting UHU's represent the percentage of the work period (24 hours) that is utilized responding to requests for service. Historically, the International Association of Fire Fighters (IAFF) has recommended that 24-hour units utilize

0.30, or 30% workload as an upper threshold.[13] In other words this recommendation would have personnel spend no more than 7.2 hours per day on emergency incidents. These thresholds take into consideration the necessity to accomplish non-emergency activities such as training, health and wellness, public education, and fire inspections. The 4th edition of the IAFF EMS Guidebook no longer specifically identifies an upper threshold. However, *FITCH* recommends that an upper unit utilization threshold of approximately .30, Or 30%, would be considered best practice. In other words, units and personnel should not exceed 30%, or 7.2 hours, of their workday responding to calls. These recommendations are also validated in the literature. For example, in their review of the City of Rolling Meadows, the Illinois Fire Chiefs Association utilized a UHU threshold of .30 as an indication to add additional resources.[14] Similarly, in a standards of cover study facilitated by the Center for Public Safety Excellence, the Castle Rock Fire and Rescue Department utilizes a UHU of .30 as the upper limit in their standards of cover due to the necessity to accomplish other non-emergency activities.[15]

These thresholds take into consideration the necessity to accomplish non-emergency activities such as training, health and wellness, public education, and fire inspections.

Of all SFD stations, stations 1-3 were staffed with two 24/7 units and stations 4 and 5 were staffed with one 24/7 units. We provided UHU for eight 24/7 staffed units. All eight units had UHU less than 10%. M1 was utilized the most and L5 was utilized the least.

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[13] International Association of Firefighters. (1995). Emergency *Medical Services: A Guidebook for Fire-Based Systems.* Washington, DC: Author. (p. 11)

[14] Illinois Fire Chiefs Association. (2012). An *Assessment of Deployment and Station Location: Rolling Meadows Fire Department.* Rolling Meadows, Illinois: Author. (pp. 54-55)

[15] Castle Rock Fire and Rescue Department. (2011). Community *Risk Analysis and Standards of Cover.* Castle Rock, Colorado: Author. (p. 58)

Figure 40: Unit Hour Utilization

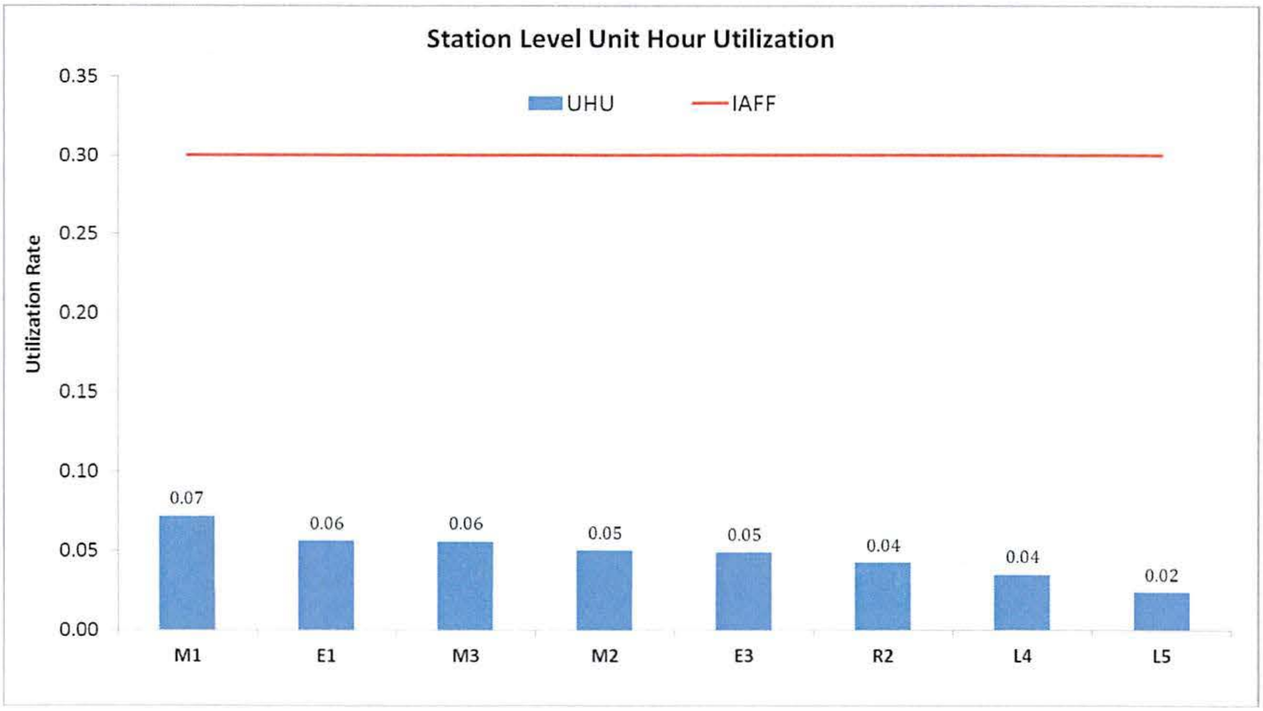


Table 19: Unit Hour Utilization

Station	Unit	Unit Type	Busy Hours	UHU	IAFF
1	M1	Ambulance	629	0.07	0.30
1	E1	Engine	491	0.06	0.30
3	M3	Ambulance	490	0.06	0.30
2	M2	Ambulance	438	0.05	0.30
3	E3	Engine	430	0.05	0.30
2	R2	Rescue Engine	370	0.04	0.30
4	L4	Ladder	307	0.04	0.30
5	L5	Ladder	208	0.02	0.30

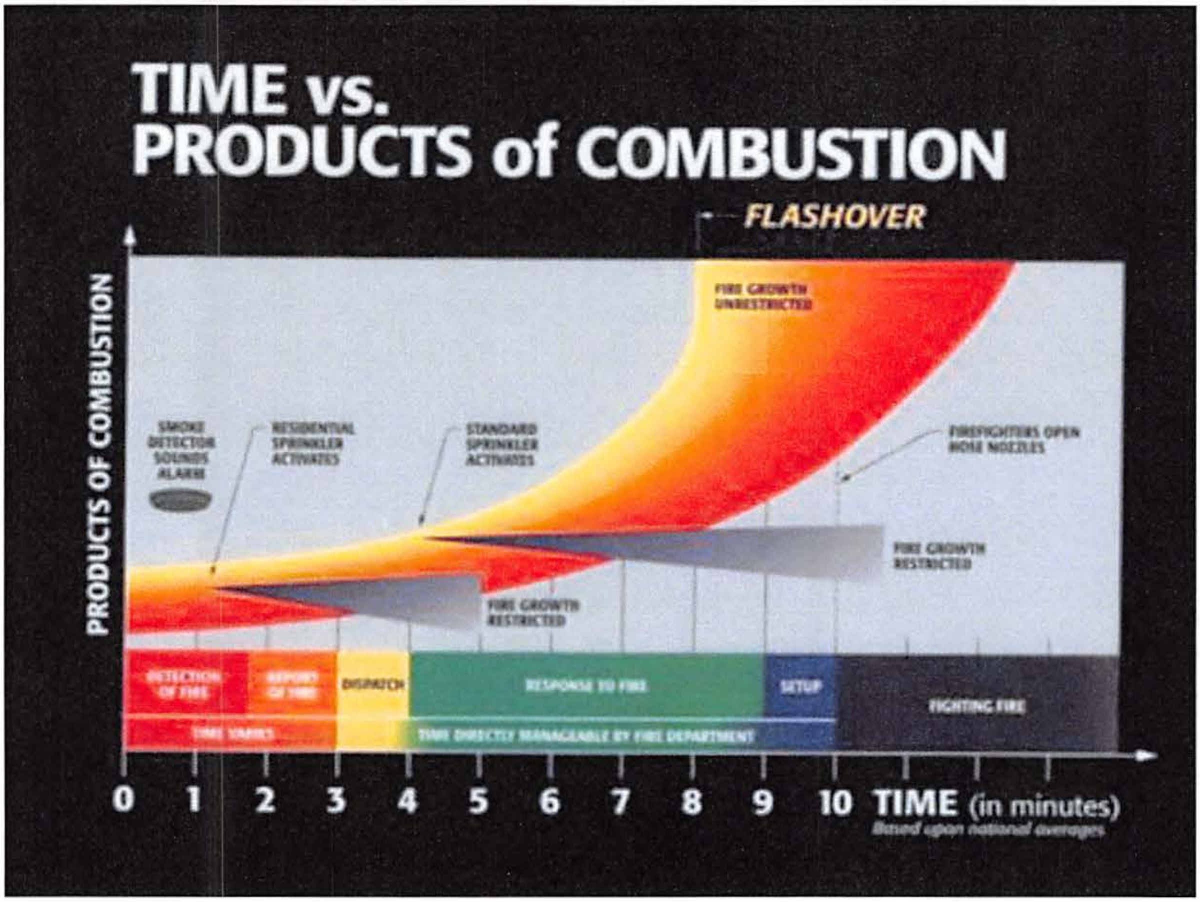
Response Time Continuum

Fire

The number one priority with structural fire incidents is to save lives followed by the minimization of property damage. A direct relationship exists between the timeliness of the response and the survivability of unprotected occupants and property damage. The most identifiable point of fire behavior is Flashover.

Flashover is the point in fire growth where the contents of an entire area, including the smoke, reach their ignition temperature, resulting in a rapid-fire growth rendering the area un-survivable by civilians and untenable for firefighters. Best practices would result in the fire department arriving and attacking the fire prior to the point of flashover. A representation of the traditional time temperature curve and the cascade of events are provided as Figure 19 below.[16]

Figure 41: Example of Traditional Time Temperature Curve

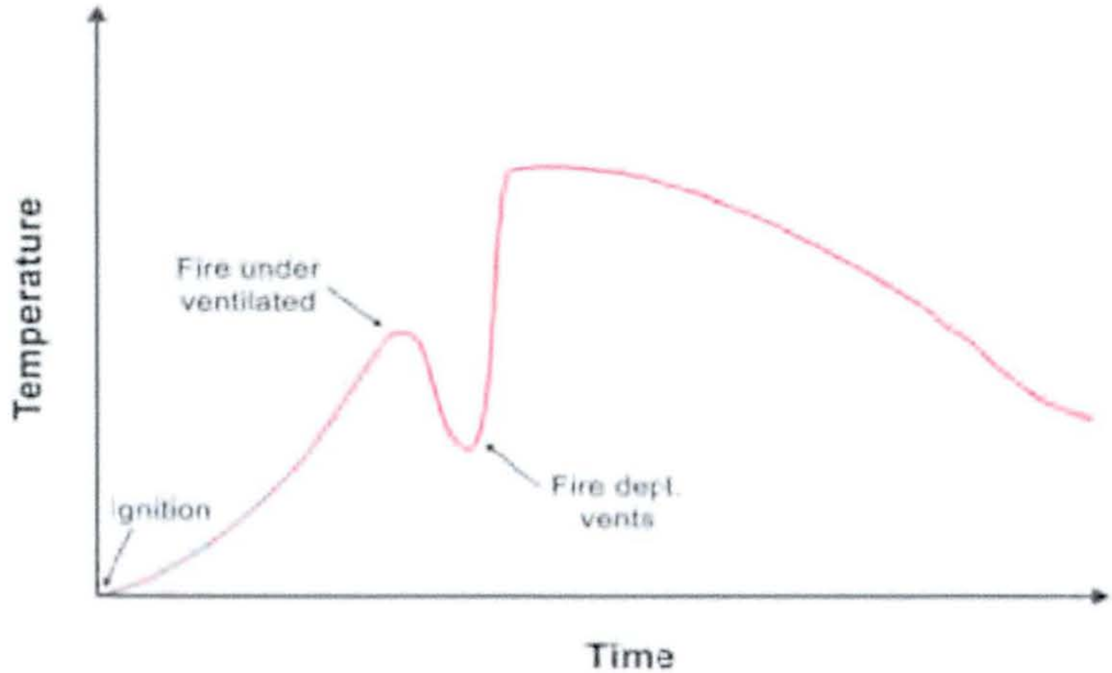


Recent studies by Underwriter's Laboratories (UL) have found that in compartment fires such as structure fires, flashover occurs within 4 minutes in modern fire environment. In addition, the UL research has identified an updated time temperature curve due to fires being ventilation controlled rather than fuel controlled as represented in the traditional time temperature curve. While this ventilation controlled environment continues to provide a high risk to unprotected occupants to smoke and high heat, it does provide some advantage to property conservation efforts as water may be applied to the fire prior to ventilation and the subsequent flashover.

[16] Example of Traditional Time Temperature Curve. Retrieved at http://www.usfa.fema.gov/downloads/pdf/coffee-break/time-vs-products-of-combustion.pdf

An example of UL's ventilation controlled time temperature curve is provided as Figure 20 below.[17]

Figure 42: Ventilation Controlled Time Temperature Curve



EMS

The effective response to Emergency Medical Service (EMS) incidents also has a direct correlation to the ability to respond within a specified period of time. However, unlike structure fires, responding to EMS incidents introduces considerable variability in the level of clinical acuity. From this perspective, the association of response time and clinical outcome varies depending on the severity of the injury or the illness. Research has demonstrated that the overwhelming majority of requests for EMS services are not time sensitive between 5 minutes and 11 minutes for emergency and 13 minutes for non-emergency responses.[18] The 12-minute upper threshold is only the upper limit of the available research and is not a clinically significant time measure, as patients were not found to have a significantly different clinical outcome when the 12-minute threshold was exceeded.[19]

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[17] UL/NIST Ventilation Controlled Time Temperature Curve. Retrieved from http://www.nist.gov/fire/fire_behavior.cfm

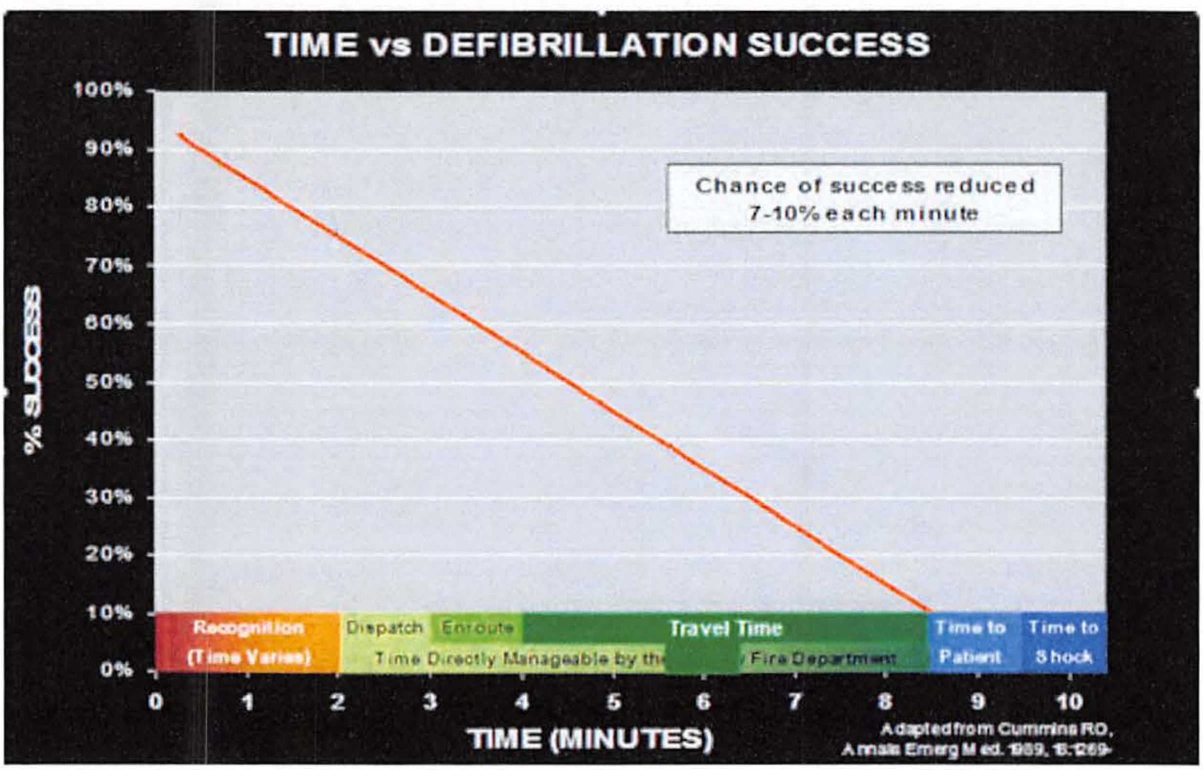
[18] Blackwell, T.H., & Kaufman, J.S. (April 2002). Response time effectiveness: Comparison of response time and survival in an urban emergency medical services system. *Academic Emergency Medicine,* 9(4): 289-295.

[19] Blackwell, T.H., et al. (Oct-Dec 2009). Lack of association between prehospital response times and patient

Out of hospital sudden cardiac arrest is the most identifiable and measured incident type for EMS. In an effort to demonstrate the relationship between response time and clinical outcome, a representation of the cascade of events and the time to defibrillation (shock) is presented as Figure 21 below. The American Heart Association (AHA) has determined that brain damage will begin to occur between four and six minutes and become irreversible after 10 minutes without intervention.

Modern sudden cardiac arrest protocols recognize that high quality Cardio-Pulmonary Resuscitation (CPR) at the Basic Life Support (BLS) level is a quality intervention until defibrillation can be delivered in shockable rhythms. Figure 21[20] below is representative of a sudden cardiac arrest that is presenting in a shockable heart rhythm such as Ventricular Fibrillation or Ventricular Tachycardia.

Figure 43: Cascade of Events for Sudden Cardiac Arrest with Shockable Rhythm



outcomes. *Prehospital Emergency Care,* 13(4): 444-450.

[20] Olathe Fire Department. (2012). Adapted from Community Risk and Emergency Services Analysis: Standard of Cover. Olathe, Kansas: Author.

Description of First Arriving Unit Performance

Analyses of the response characteristics of the first arriving units were conducted. The travel time for all first arriving unit responses were calculated irrespective of their assigned station FDZ. In other words, this analysis describes the first arriving unit to the scene. The "response time" is defined as from call entry through unit arriving on scene. Please note, Table 20 is the only place we analyzed response time performance for non-emergency calls.

Dispatch time and travel time are longer for non-emergency calls than emergency calls (lights and sirens). Thus, the average response time for non-emergency calls was 1.9 minutes longer. For emergency calls, the average response time was 6.2 minutes, and 90th percentile response time was 9.0 minutes.

Table 20: Description of First Arriving Unit Emergency Response Performance

Measure	Lights and Sirens		No Lights and Sirens	
	Average	90th Percentile	Average	90th Percentile
Dispatch Time	2.1	3.4	3.1	6.7
Turnout Time	1.4	2.2	1.7	3.0
Travel Time	2.8	4.7	3.3	5.9
Turnout and Travel	4.2	6.3	5.0	8.0
Response Time	6.2	9.0	8.1	13.7

First Arriving Unit Response Time by Station Demand Zone

Further analyses were conducted to measure the performance of the first arriving unit in each demand zone. Response times are reported below at both the mean and 90th percentile respectively.

Examination of the overall performance at the 90th percentile reveals that Station 1 and 3 had the quickest response times followed by Stations 2, 4 and 5 in order of performance. Station 4 and 5 also had the lowest demand. An illustrative comparison of FDZ performance at the 90th percentile is provided below.

Table 21: Mean First Arrival Performance by First Due Station

First Due Station	Dispatch Time	Turnout Time	Travel Time	Turnout and Travel	Response Time	Sample Size
Station 1	2.3	1.3	2.2	3.5	5.8	1,175
Station 2	1.9	1.3	3.0	4.3	6.3	738
Station 3	1.9	1.5	2.4	3.8	5.8	953
Station 4	1.9	1.4	3.4	4.9	6.8	563
Station 5	2.1	1.4	4.1	5.5	7.6	356
Total	**2.1**	**1.4**	**2.8**	**4.1**	**6.2**	**3,785**

Table 22: 90th Percentile First Arrival Performance by Station FDZ

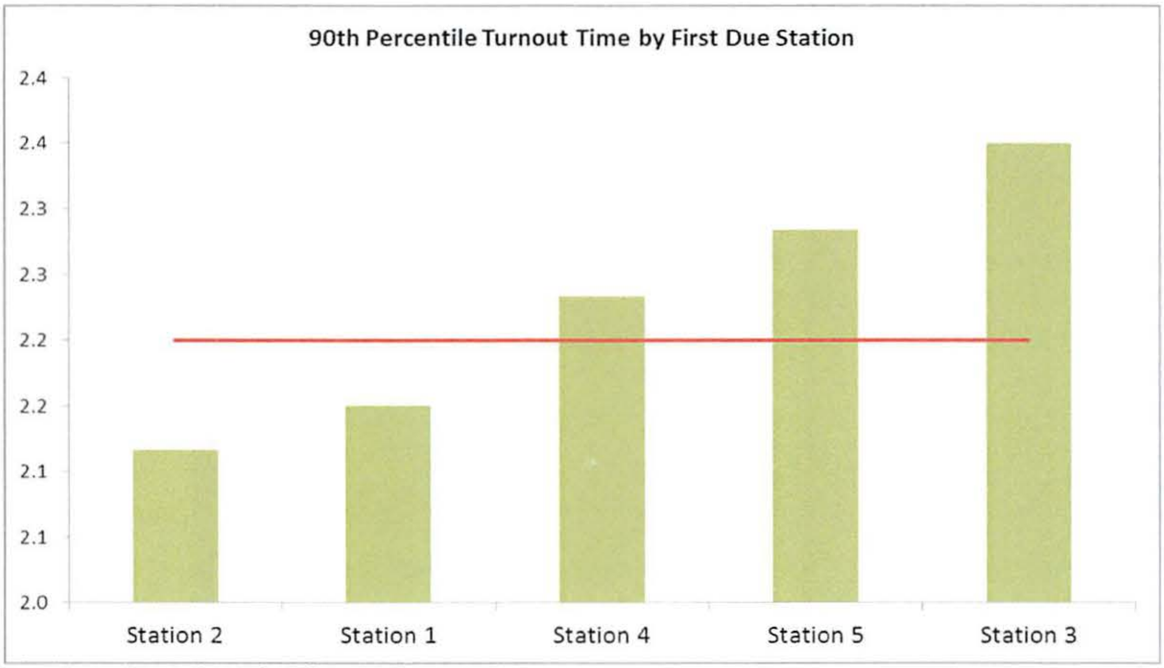
First Due Station	Dispatch Time	Turnout Time	Travel Time	Turnout and Travel	Response Time	Sample Size
Station 1	3.8	2.2	3.7	5.2	8.4	1,175
Station 2	3.2	2.1	4.8	6.3	8.9	738
Station 3	3.3	2.4	3.9	5.6	8.3	953
Station 4	3.1	2.2	5.6	7.2	9.5	563
Station 5	3.5	2.3	5.8	7.6	10.2	356
Total	**3.4**	**2.2**	**4.7**	**6.3**	**9.0**	**3,785**

The data were further analyzed to compare the individual station FDZ performances. With respect to turnout time, Station 2 had the shortest 90th percentile turnout time and station 3 had the longest turnout time. However the difference between the slowest and fastest is only 0.3 minutes or 18 seconds.

Conversely, when examining the travel time performance, performances for calls in station 1 had the shortest 90th percentile travel time. Calls in stations 4 and 5 had significantly longer 90th percentile travel time than calls in other first due stations. Similarly, since travel time is the single largest indicator of overall response performance, stations 1 and 3 had the shortest

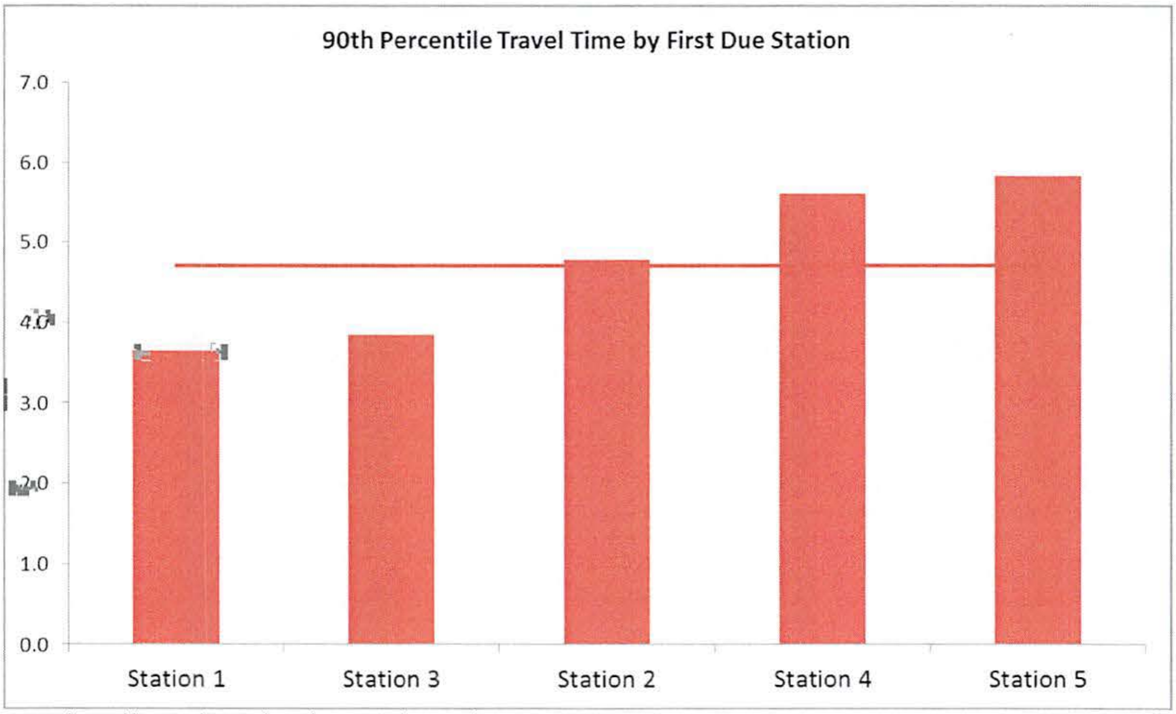
90th percentile response time, and stations 4 and 5 had the longest 90th percentile response time.

Figure 44: 90th Percentile Turnout Time by Station FDZ



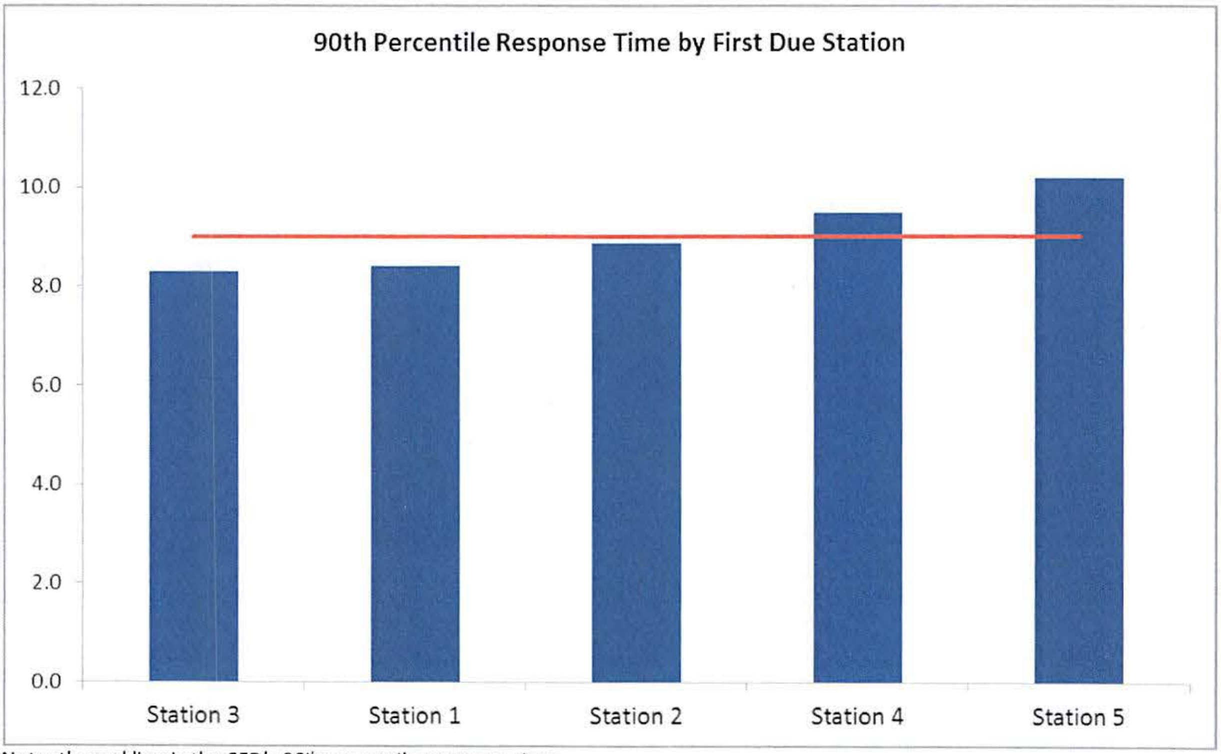
Note: the red line is the SFD's 90th percentile turnout time.

Figure 45: 90th Percentile Travel Time Performance by Station FDZ



Note: the red line is the SFD's 90th percentile travel time.

Figure 46: 90th Percentile Response Time Performance by Station FDZ



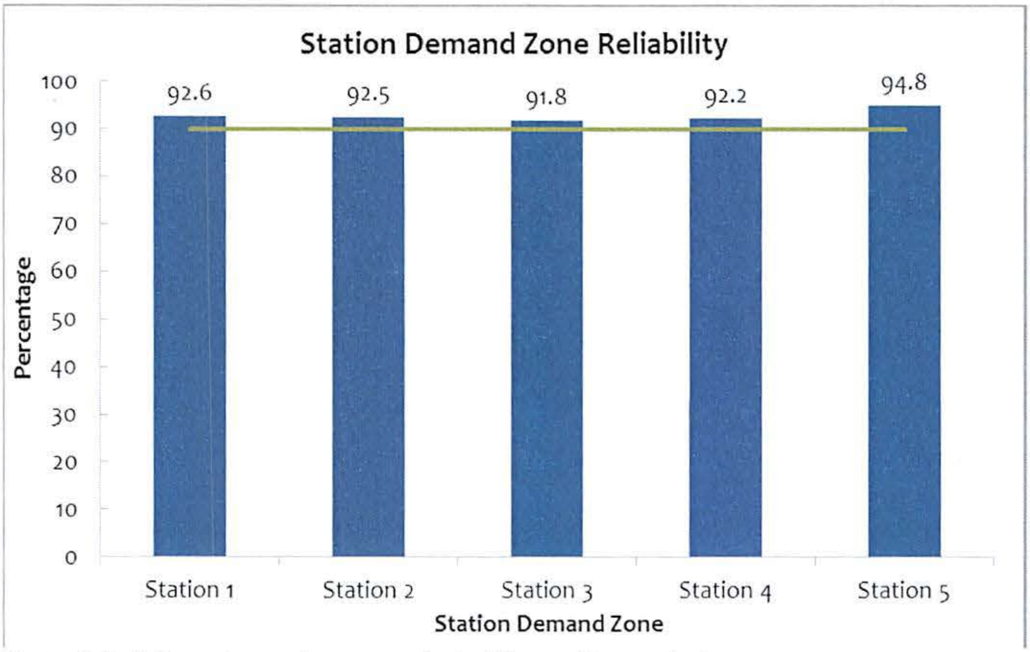
Note: the red line is the SFD's 90th percentile response time.

Reliability Factors

Percentage of First Due Compliance

The reliability of the distribution model is a factor of how often the response model is available and able to respond to the call within the assigned demand zone. If at least one unit from the first due station is able to respond to a call, we consider the station is able to response to the call within the assigned demand zone. Utilizing the Fire Station Demand Zones (FDZ), analyses reveal that all five stations have reliability higher than 90%.

Figure 47: Percentage Reliability by Station FDZ



Note: Administrative units are excluded from this analysis.

Overlapped or Simultaneous Call Analysis

Overlapped calls are defined as the rate at which another call was received for the same first due station while there were one or more ongoing calls in the same first due station. For example, if there is one call in station 1's zone, before the call was cleared another request in station 1's zone occurred and those two calls would be captured as overlapped calls. Some studies also refer as simultaneous calls. Understanding the probability of overlapped or simultaneous calls occurs will help to determine the number of units to staff for each station. In general, the larger the call volume a first due station has, it is more likely to have overlapped or simultaneous calls. The distribution of the demand throughout the day will impact the chance of having overlapped or simultaneous calls. The duration of a call will also have major influences, since the longer time it takes to clear a request, the more likely to have an overlapped request.

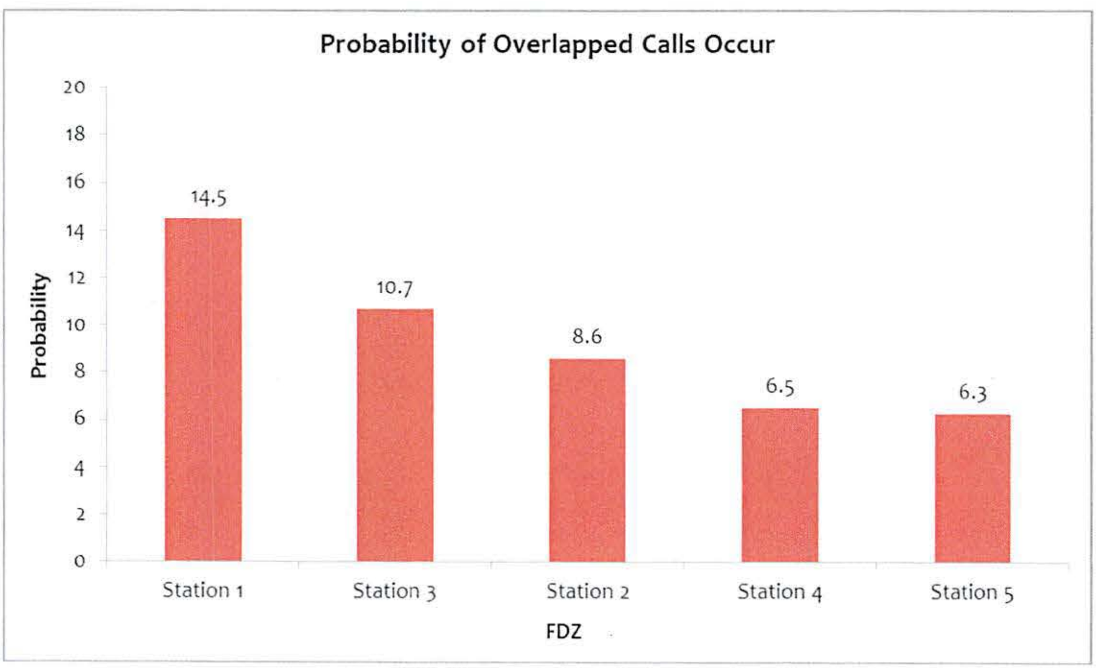
Since three of five stations have two units staffed 24/7, structurally the station level staffing model is able to respond to two overlapped calls assuming each call is dispatched with one unit. Stations 4 and 5 and had only one unit staffed 24/7, and will need responses from neighbor stations for concurrent or overlapped calls.

Station 1 has the highest probability of having overlapped calls at 14.5% since it has the highest number of calls of all demand zones averaging 4.2 calls a day, followed by station 3 at 10.7%, station 2 at 8.6%, station 4 at 6.5%, and station 5 at 6.3%. It is important in these stations the staffing model needs to reflect the capability to respond to overlapped EMS requests.

Table 23: Overlapped Calls by First Due Station

First Due Station	Overlapped Calls	Total Calls	Probability of Overlapped Calls Occur
Station 1	223	1,536	14.5
Station 3	139	1,301	10.7
Station 2	84	980	8.6
Station 4	53	814	6.5
Station 5	28	447	6.3

Figure 48: Probability of Overlapped Calls Occur by Station FDZ



SECTION 4: GIS Analysis

FITCH & ASSOCIATES

Establishing Baseline Performance

The first step in completing GIS planning analyses is to establish the desired performance parameters. Measures of total response time can be significantly influenced by both internal and external influences. For example, the dispatch time, defined as the time from pick up at the 911-center to the dispatching of units, contributes to the customer's overall response time experience. Another element in the total response time continuum is the turnout time, defined as the time from when the units are notified of the incident until they are actually responding. Turnout time can have a significant impact to the overall response time for the customer and is generally considered under management's control. However, the travel time, defined as the period from when the units are actually responding until arrival at the incident is a factor of the number of fire stations, the ability to travel unimpeded on the road network, the existing road network's ability to navigate the community, and the availability of the units. Largely, travel time is the most stable variable to utilize in system design regarding response time performance.

Therefore, these GIS planning analyses will focus on travel time capability as the unit of measure. The calendar year 2017 (January 1, 2017 – December 31, 2017) performance for travel time across programs is provided below. Overall, the travel time is 4.7 minutes or less for 90% of the incidents.

Table 24: 90th Percentile Turnout and Travel Time of First Arriving Units by Program

Program	Dispatch Time	Turnout Time	Travel Time	Response Time	Sample Size
EMS	3.5	2.2	4.6	8.9	3,361
Fire	2.9	2.4	5.7	9.7	340
Hazmat	2.7	2.3	6.2	9.8	84
Total	**3.4**	**2.2**	**4.7**	**9.0**	**3,785**

Comparison to National References

There are two notable references for travel time available to the fire service in National Fire Protection Association (NFPA) 1710[21] and the Commission on Fire Accreditation International (CFAI)[22]. NFPA 1710 suggests a 4-minute travel time at the 90th percentile for first due arrival of Basic Life Support (BLS) and Fire incidents and the CFAI recommends a 5 minute and 12 seconds travel time for first due arrival in an urban/Suburban population density and 13-minutes travel time for rural populations of less than 1,000 per square mile. The arrival of an Advanced Life Support (ALS) unit is recommended at 8-minutes travel time by NFPA 1710. It is important to note that the latest edition (9th edition) of the CFAI guidelines have de-emphasized response

[21] National Fire Protection Association. (2010). NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*. Boston, MA: National Fire Protection Association.

[22] CFAI. (2009). Fire & emergency service self-assessment manual, (8th ed.). Chantilly, Virginia: Author. (page 71)

time and only reference the legacy standards with a separately provided companion document[23].

Validation of Planning Analysis

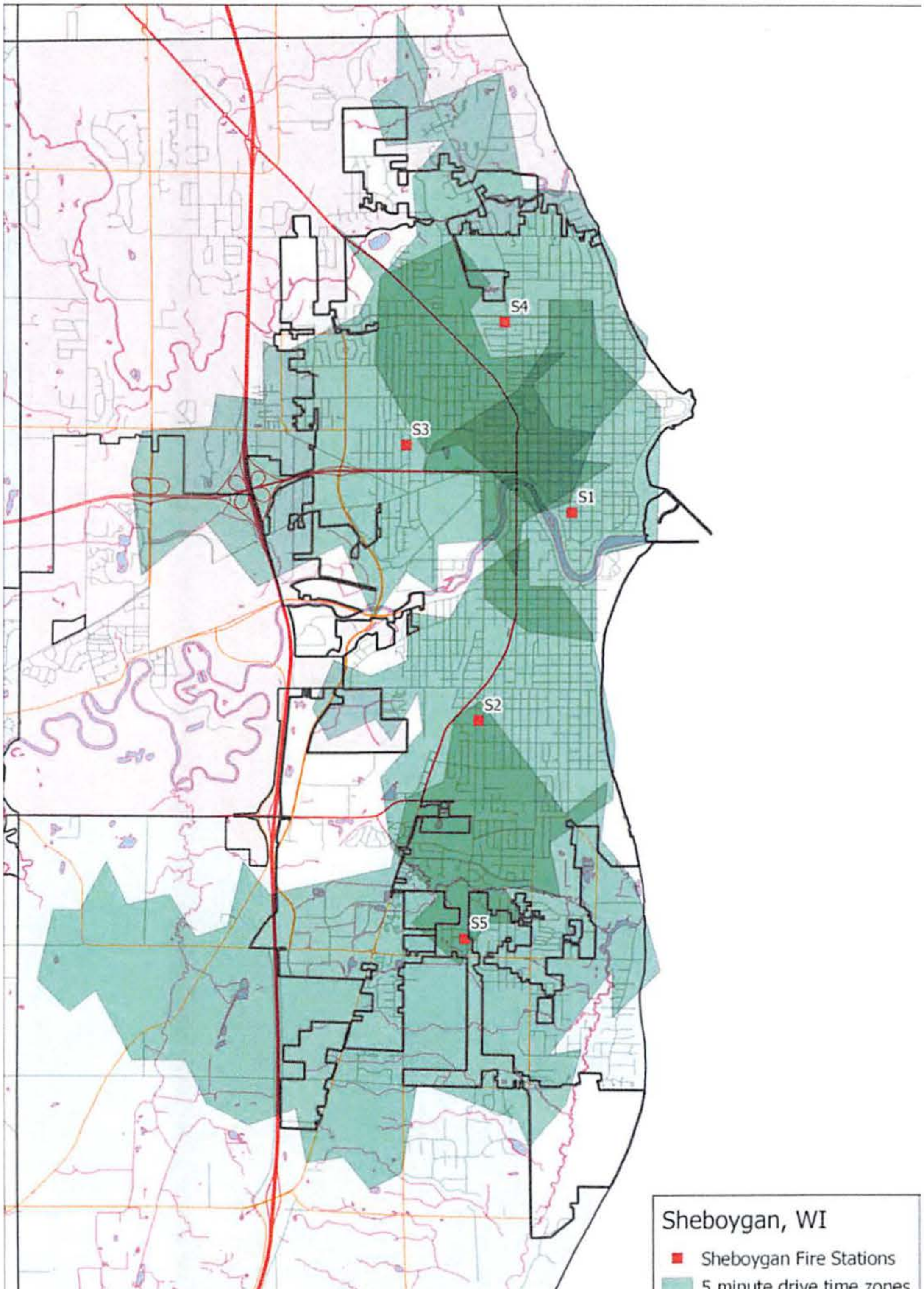
The first step in this validation analysis is to utilize the historical performance to validate the planning analyses utilized by the GIS system. The historical performance demonstrated a 4.7 overall department performance and a 5.7-minute fire travel time capability from the existing fire stations at the 90^{th} percentile. Utilizing average road speeds, the planning assessments estimated approximately 94% of the incidents could be responded to within 5-minutes travel time from the existing five stations. In other words, there is a high degree of agreement between the quantitative analyses and the GIS planning analyses. Therefore, considerable confidence can be maintained across the various GIS modeling. Results are provided below.

Table 25: Marginal Fire Station Contribution for 5-Minute Travel Time

Rank	Station Number	Station Capture	Total Capture	Percent Capture
1	S3	2,183	2,183	42.53%
2	S2	1,238	3,421	66.65%
3	S1	797	4,218	82.17%
4	S4	413	4,631	90.22%
5	S5	180	4,811	93.73%

Figure 49: Current Fire Station Bleed Maps for 5-Minute Travel Time

[23] CFAI. (2016). Fire & emergency service self-assessment manual, (9^{th} ed.). Chantilly, Virginia: Author.


S4
S3
S1
S2
S5
Sheboygan, WI
Sheboygan Fire Stations
5 minute drive time zones

Internal Performance Objectives

The Sheboygan Fire Department does not currently utilize an internal performance objective. However, the department is considering adopted service levels for the future. Therefore, the following alternatives are provided for consideration by the department.

Evaluation of Various Distribution models

As previously discussed, these analyses utilized 2017 historical performance as the desired performance for system designs. Therefore, 4, 5, 6, and 8-minute travel times were completed to consider opportunities for improvement and incremental alternatives compared to the current performance of 4.7 minutes overall and 5.7 minutes for fire related responses. The following analyses are utilized to compare and contrast the various potential distribution models.

Current Stations Configurations-Minute Travel Time

When referring to the marginal utility analysis provided below, the ascending rank order is the station's capability to cover risk (incidents) in relation to the total historical call volume of the sample period (CY 2017). The Station number is the current Sheboygan Fire Department (SFD) fire station identifier. The station capture is the number of calls the station would capture within a 4-minute travel time. The total capture is the cumulative number of calls captured with the addition of each fire station. The percent capture is the total cumulative percentage of risk covered by each station. The goal would be to achieve at least 90 percent capture.

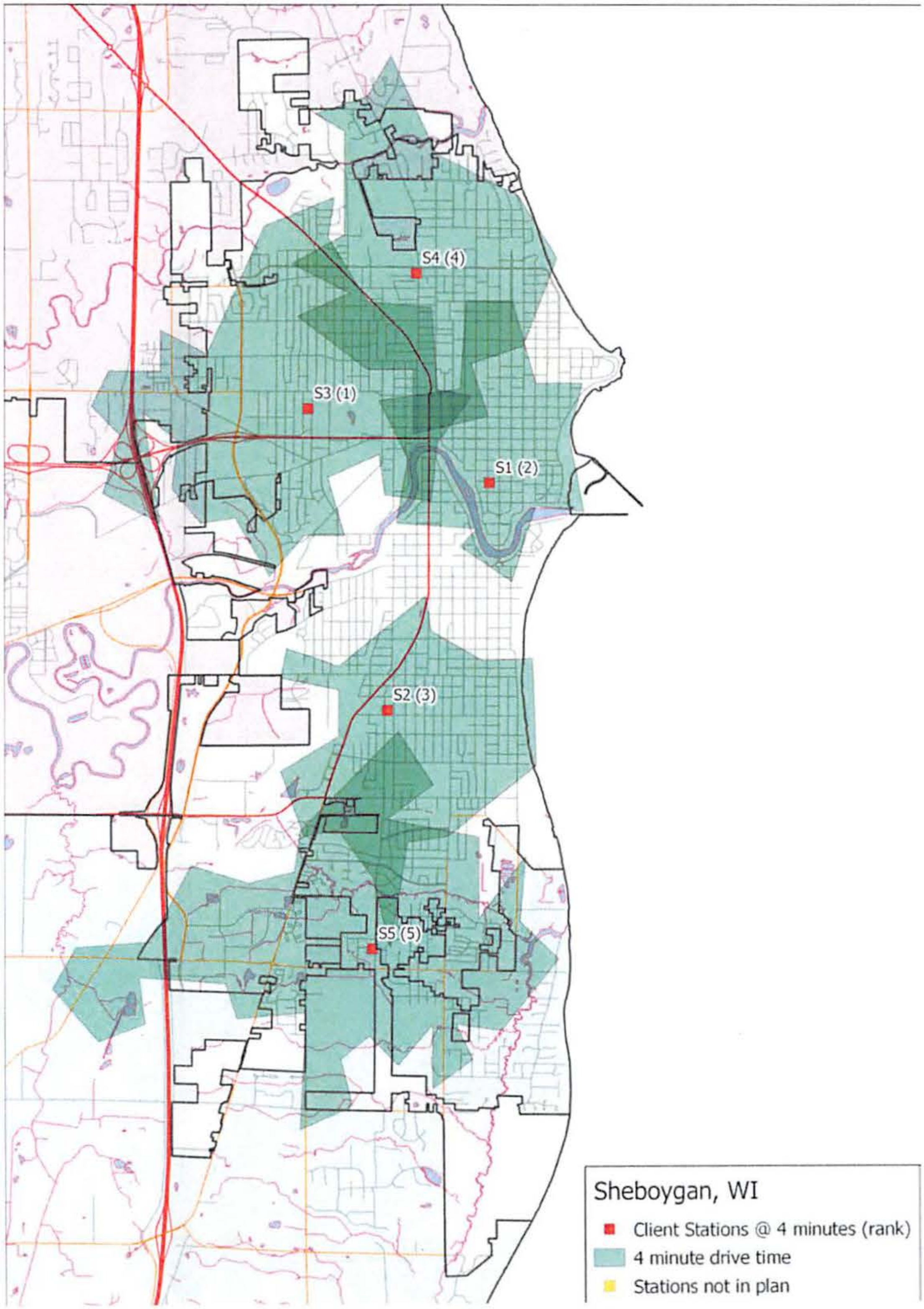
Therefore, the station that contributed the most to the overall system's performance was Station 3 in the first row and would capture 28.66% of the risks within 4 minutes. Station 1 would cover an additional 23.67% of the risk bringing the cumulative total to 52.33% between Stations 3 and 1. In total, with all 5 fixed fire stations, 81.9% of the incidents could be responded to within 4 minutes travel time.

In other words, within the current configuration of stations, the department could not achieve a 4-minute travel time, as recommended by NFPA 1710 without additional stations and resources. Results are provided as Table 3 and in drive time mapping format as Figure 2 below.

Table 26: Marginal Fire Station Contribution for 4-Minute Travel Time

Rank	Station Number	Station Capture	Total Capture	Percent Capture
1	S3	1,471	1,471	28.66%
2	S1	1,215	2,686	52.33%
3	S2	693	3,379	65.83%
4	S4	558	3,937	76.70%
5	S5	267	4,204	81.90%

Figure 50: Current Fire Station Bleed Maps for 4-Minute Travel Time


S4 (4)
S3 (1)
S1 (2)
S2 (3)
S5 (5)
Sheboygan, WI
Client Stations @ 4 minutes (rank)
4 minute drive time
Stations not in plan

5-Minute Travel Time

The analysis demonstrates that the current station configuration could capture 90% of the incidents within 5 minutes with the utilization of 4 fire stations. Station 5 improves performance by 3.51% with a 5-minute travel time.

Therefore, the city and department could consider the following policy options:

- Operate out of 4 stations until the call volume in Station 5's territory increases
- Continue to operate out of all 5 stations to cover the geographic area irrespective of the current community demands
- Continue to operate out of all 5 stations, but utilize Station 5 as a flexible resource when needed
- Utilize this analysis to codify a move-up policy to ensure the greater coverage at all times. For example, if only two stations are available to respond to calls during busy times, Stations 3 and 2 would cover the greatest number of calls, 66%, within the performance objective of 5 minutes.

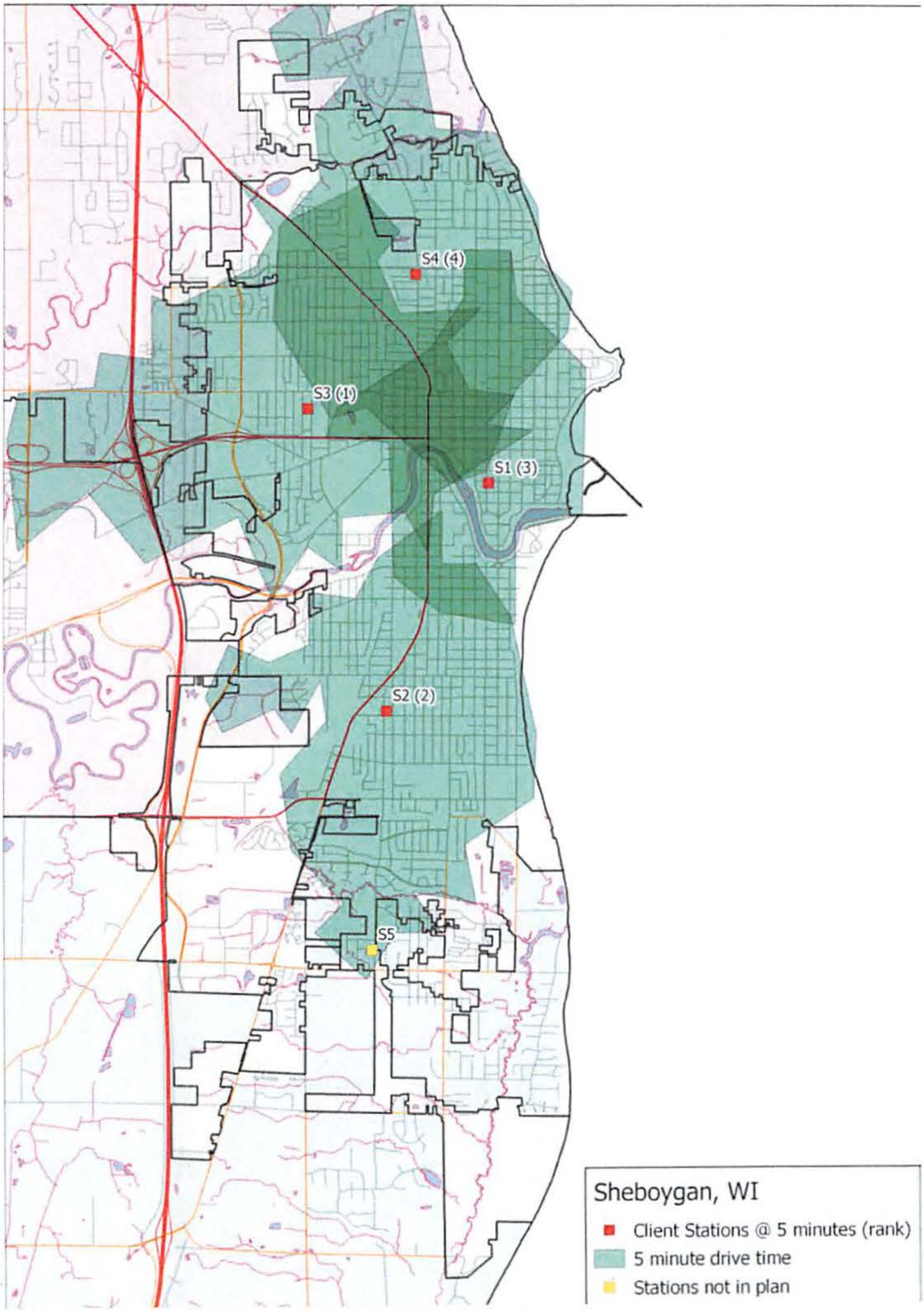
This list above is not intended to be all-inclusive.

Table 27: Marginal Fire Station Contribution for 5-Minute Travel Time

Rank	Station Number	Station Capture	Total Capture	Percent Capture
1	S3	2,183	2,183	42.53%
2	S2	1,238	3,421	66.65%
3	S1	797	4,218	82.17%
4	S4	413	4,631	90.22%
5	S5	180	4,811	93.73%

When referring to the mapping output below, the areas of the city that are not shaded with green, represent a maximum of 10% of the incidents that would not be responded to within 5-minutes. All requests for service would be answered, but they may be answered between 5:01 and 8:00 minutes. Finally, any areas that is shaded with progressively darker shades of green represent areas where more than one station can cover the same territory within the respective travel time being evaluated.

Figure 51: Current Stations with a 5-Minute Travel Time at the 90th Percentile



S4 (4)
S3 (1)
S1 (3)
S2 (2)
S5
Sheboygan, WI
Client Stations @ 5 minutes (rank)
5 minute drive time
Stations not in plan

6-Minute Travel Time

The analysis demonstrates that the current station configuration could capture nearly 92% of the incidents within 6 minutes with the utilization of 3 fire stations and 97% with all five stations. Stations 1 improves coverage by approximately 3.14% and Station 5 improves performance by an additional 2.32% with a 5-minute travel time. Collectively, stations 1 and 5 improve performance by 5.46%.

Therefore, the city and department could consider the following policy options:

- Operate out of 3 stations until the call volume in Station 5's territory increases
- Continue to operate out of all 5 stations to cover the geographic area irrespective of the current community demands
- Continue to operate out of all 5 stations, but utilize Station 5 and 1 as a flexible resources when needed
- Utilize this analysis to codify a move-up policy to ensure the greater coverage at all times. For example, if only two stations are available to respond to calls during busy times, Stations 3 and 2 would cover the greatest number of calls, 83%, within the performance objective of 6 minutes.

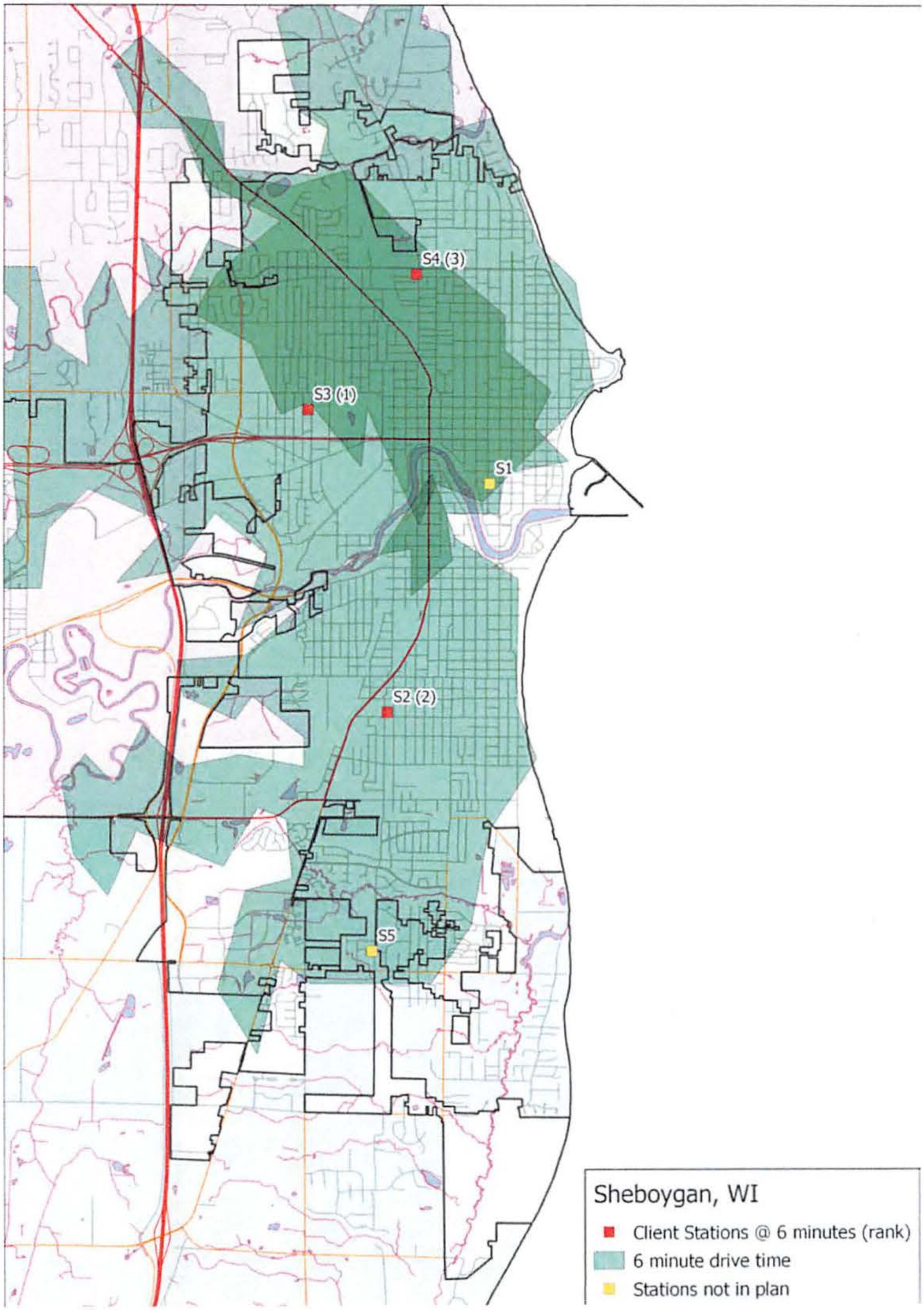
This list above is not intended to be all-inclusive.

Table 28: Marginal Fire Station Contribution for 6-Minute Travel Time

Rank	Station Number	Station Capture	Total Capture	Percent Capture
1	S3	2,857	2,857	55.66%
2	S2	1,405	4,262	83.03%
3	S4	440	4,702	91.60%
4	S1	161	4,863	94.74%
5	S5	119	4,982	97.06%

When referring to the mapping output below, the areas of the city that are not shaded with green, represent a maximum of 9% of the incidents that would not be responded to within 6-minutes. All requests for service would be answered, but they may be answered between 6:01 and 8:00 minutes. Finally, any areas that is shaded with progressively darker shades of green represent areas where more than one station can cover the same territory within the respective travel time being evaluated.

Figure 52: Current Stations with a 6-Minute Travel Time at the 90th Percentile


S4 (3)
S3 (1)
S1
S2 (2)
S5
Sheboygan, WI
Client Stations @ 6 minutes (rank)
6 minute drive time
Stations not in plan

8-Minute Travel Time

The analysis demonstrates that the current station configuration could capture nearly 96% of the incidents within 8 minutes with the utilization of 2 fire stations and 99% with 3 stations. Stations 3, 4, and 5 collectively improve coverage by approximately 4.13%. If 3 stations are utilized, then Stations 4 and 5 would collectively improve coverage by less than 0.5%.

Therefore, the city and department could consider the following policy options:

- Operate out of 2 stations and adjust response time objectives from 4.7 (fire) to 8 minutes
- Continue to operate out of all 5 stations to cover the geographic area irrespective of the current community demands
- Continue to operate out of all 5 stations, but utilize Stations 5, 4, and 3 as a flexible resources when needed
- Utilize this analysis to codify a move-up policy to ensure the greater coverage at all times. For example, if only two stations are available to respond to calls during busy times, Stations 1 and 2 would cover the greatest number of calls, 95%, within the performance objective of 8 minutes.

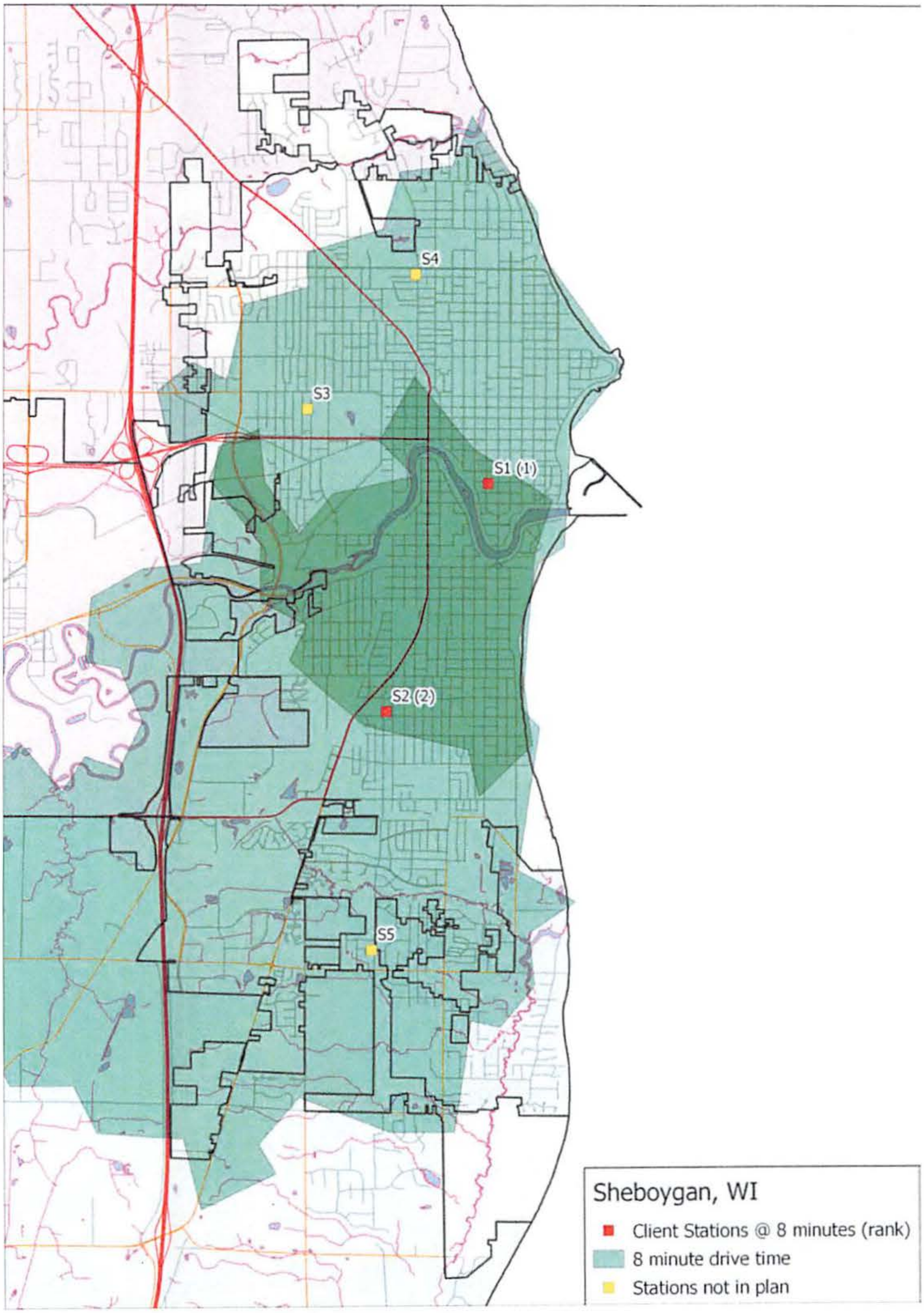
This list above is not intended to be all-inclusive.

Table 29: Marginal Fire Station Contribution for 8-Minute Travel Time

Rank	Station Number	Station Capture	Total Capture	Percent Capture
1	S1	4,143	4,143	80.71%
2	S2	759	4,902	95.50%
3	S3	188	5,090	99.16%
4	S4	16	5,106	99.47%
5	S5	8	5,114	99.63%

When referring to the mapping output below, the areas of the city that are not shaded with green, represent a maximum of 5% of the incidents that would not be responded to within 8-minutes. All requests for service would be answered, but they may be answered greater than 8:00 minutes. Finally, any areas that is shaded with progressively darker shades of green represent areas where more than one station can cover the same territory within the respective travel time being evaluated.

Figure 53: Current Stations with an 8-Minute Travel Time at the 90th Percentile


S4
S3
S1 (1)
S2 (2)
S5
Sheboygan, WI
Client Stations @ 8 minutes (rank)
8 minute drive time
Stations not in plan

Optimized Station Distribution Plans

Optimized locations were created for the department's consideration. Optimized plans utilize a "white board" approach where all existing locations are disregarded and we allow the data to indicate the best station locations. It is understood that stations are placed for a variety of reasons and that few agencies would have the flexibility in land availability, purchase price, capital investment, and political considerations to build a brand new deployment model.

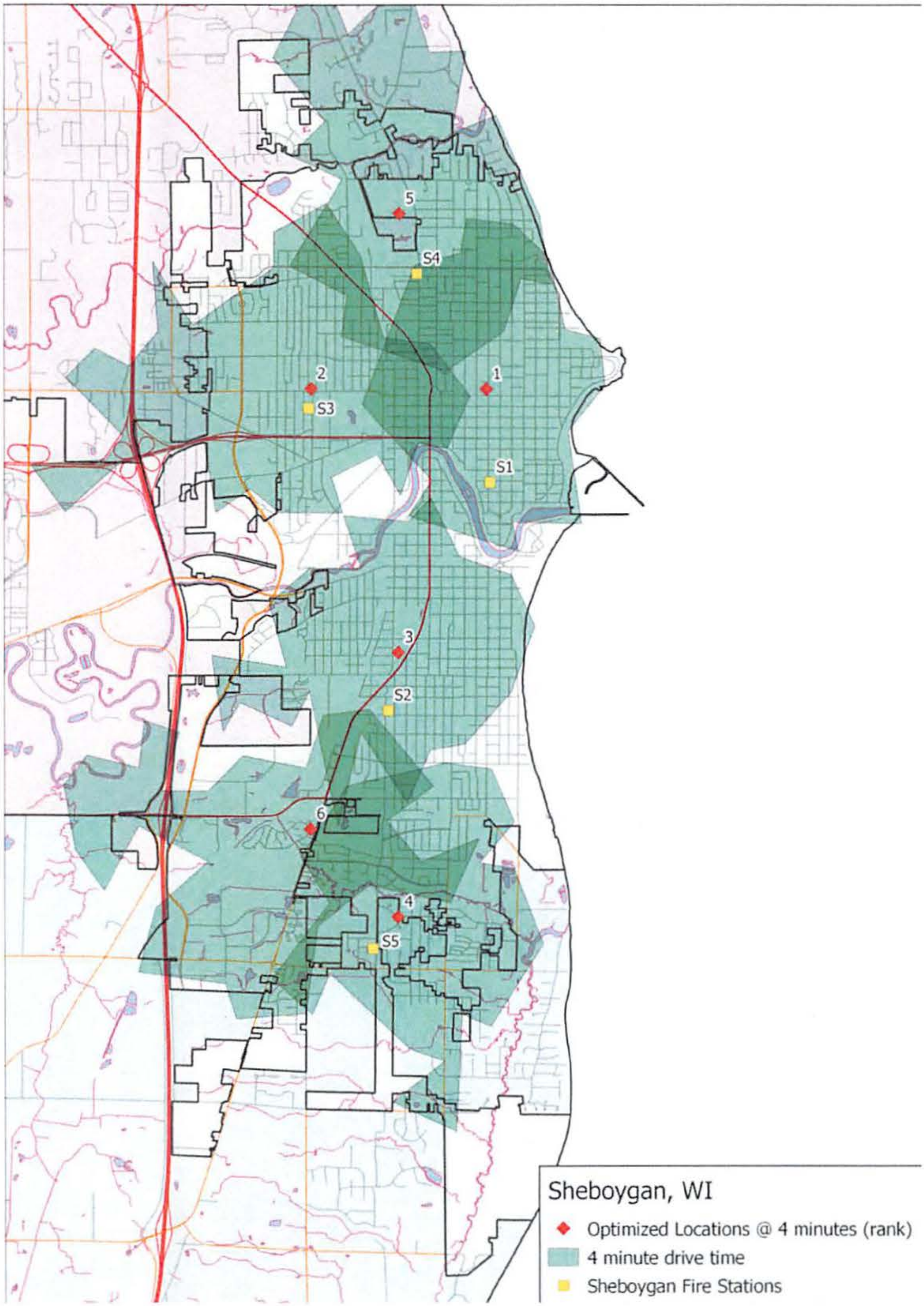
However, these analyses are beneficial for validating existing stations where applicable and identifying potential areas of future need for either new stations or station relocations.

4-Minute Travel Time

Analyses were completed to develop an optimized station distribution model for a 4-minute travel time consistent with NFPA 1710. This evaluation suggests, that an optimized 6-station model can provide for greater than 92% effectiveness covering all incidents within 4-minutes or less travel time. In comparison, the current 5-station configuration achieved 4 minutes or less approximately 82% of the time, or an improvement of approximately 10%.

A graphic illustration is presented below that includes the proposed station locations as well as the existing facilities.

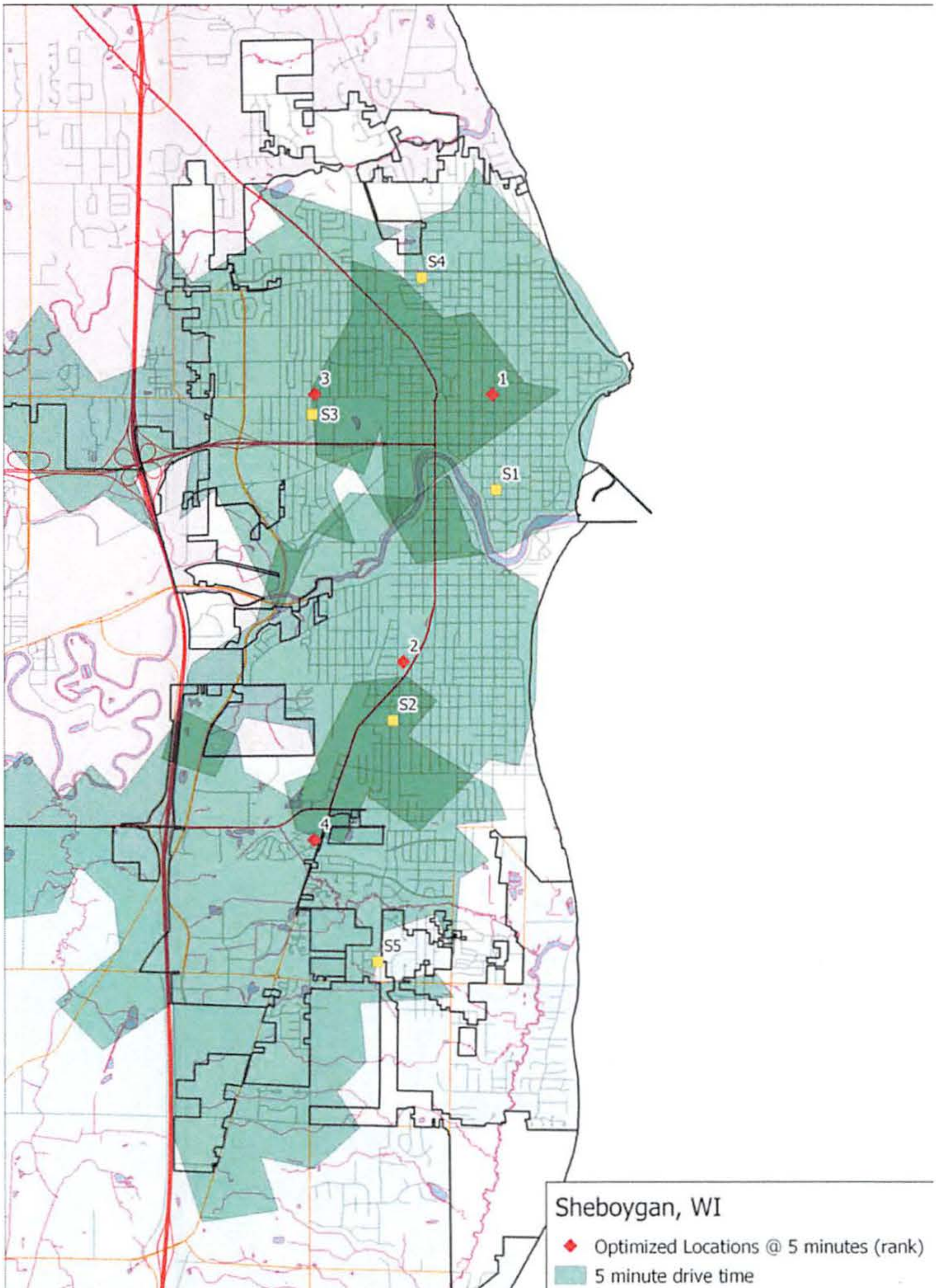
Figure 54: Optimized Station Deployment Plan - 4-Minute Travel Time


5
S4
2
S3
1
S1
3
S2
6
4
S5
Sheboygan, WI
Optimized Locations @ 4 minutes (rank)
4 minute drive time
Sheboygan Fire Stations

Optimized 5-Minute Travel Time

Analyses were completed to develop an optimized station distribution model for a 5-minute travel time. This evaluation suggests, that an optimized 4-station model can provide for approximately 93% effectiveness covering all incidents within 5-minutes. This optimized configuration only improves performance by approximately 3%, compared to the current 4-station configuration. Considering the current 5-station deployment, this model would maintain the same performance with 4-stations at 93%. A graphic illustration is presented below.

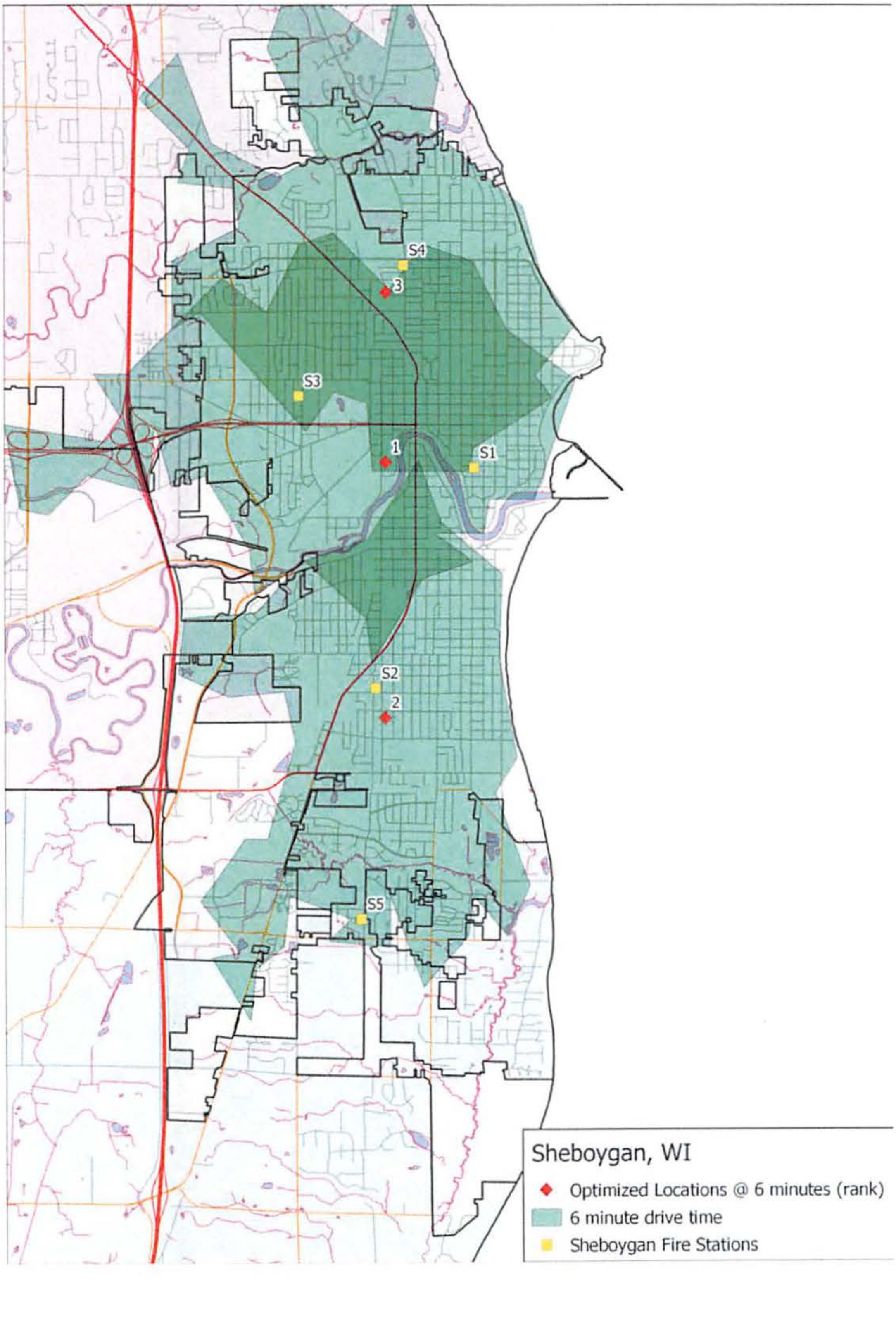
Figure 55: Optimized Station Deployment Plan – 5--Minute Travel Time


S4
3
1
S3
S1
2
S2
4
S5
Sheboygan, WI
Optimized Locations @ 5 minutes (rank)
5 minute drive time
Sheboygan Fire Stations

Optimized 6-Minute Travel Time

Analyses were completed to develop an optimized station distribution model for a 6-minute travel time. This evaluation suggests, that an optimized 3-station model can provide for approximately 94% effectiveness covering all incidents within 6-minutes. This optimized configuration improves performance by approximately 3%, compared to the current 3=station configuration presented previously. A graphic illustration is presented below.

Figure 56: Optimized Station Deployment Plan – 6--Minute Travel Time

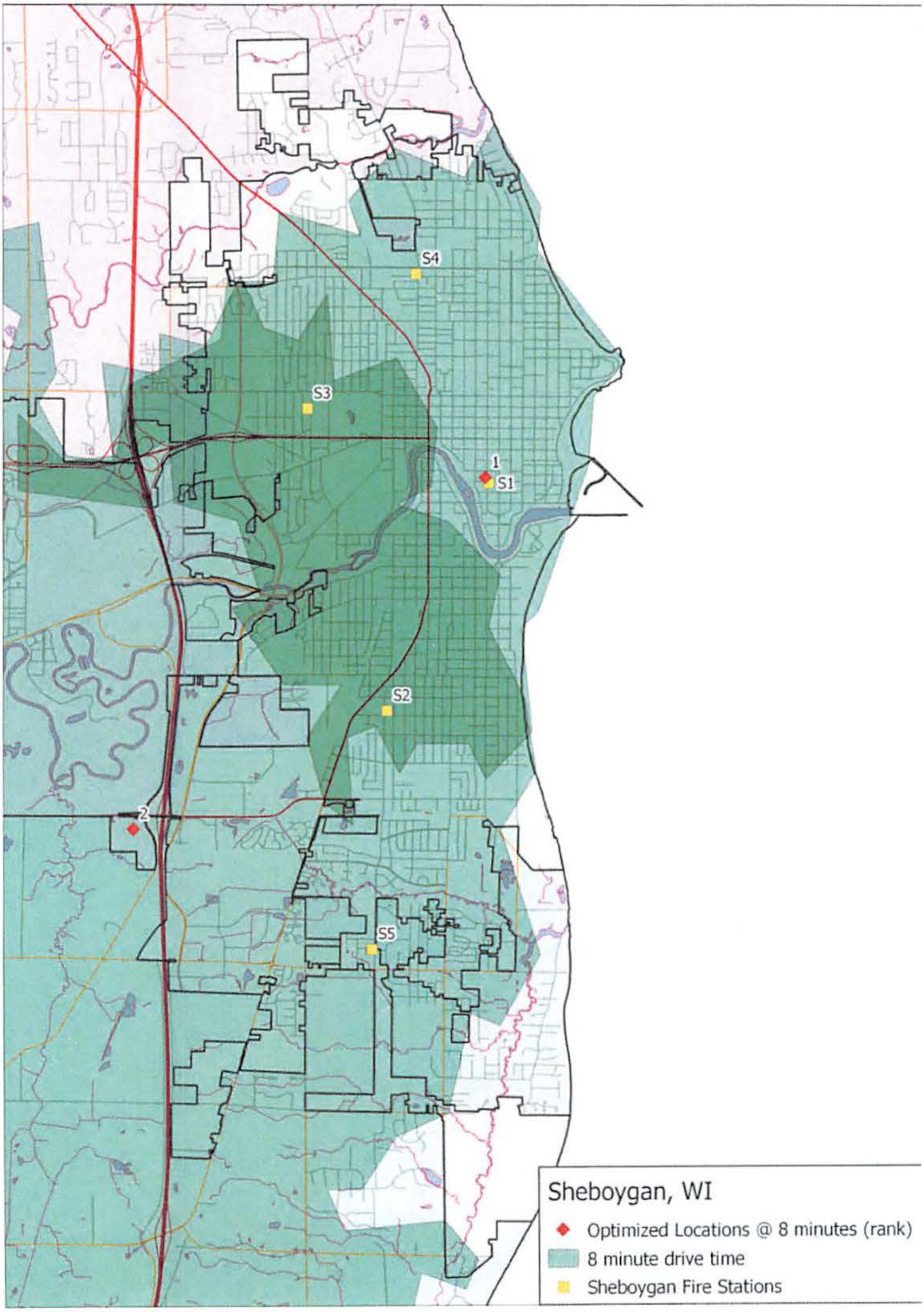


S4
3
S3
1
S1
S2
2
S5
Sheboygan, WI
Optimized Locations @ 6 minutes (rank)
6 minute drive time
Sheboygan Fire Stations

Optimized 8-Minute Travel Time

Analyses were completed to develop an optimized station distribution model for an 8-minute travel time. This evaluation suggests, that an optimized 2-station model can provide for approximately 97% effectiveness covering all incidents within 8-minutes. This optimized configuration improves performance by 2.5%, compared to the current station configuration. A graphic illustration is presented below.

Figure 57: Optimized Station Deployment Plan – 8--Minute Travel Time



S4
S3
1
S1
S2
2
S5
Sheboygan, WI
Optimized Locations @ 8 minutes (rank)
8 minute drive time
Sheboygan Fire Stations

Geographic Coverage without Consideration for Call Distribution

While there are multiple deployment strategies that may be adopted, two clear policy positions emerge in communities. First, position stations that are best prepared to meet the community's historical distribution of calls or demand for services. The advantage to this approach is that it is a more efficient model to address meeting 90% of the risk within the desired performance. This is a very stable outlook for communities that are established and are growing in density or in-fill rather than through significant annexations or urban growth.

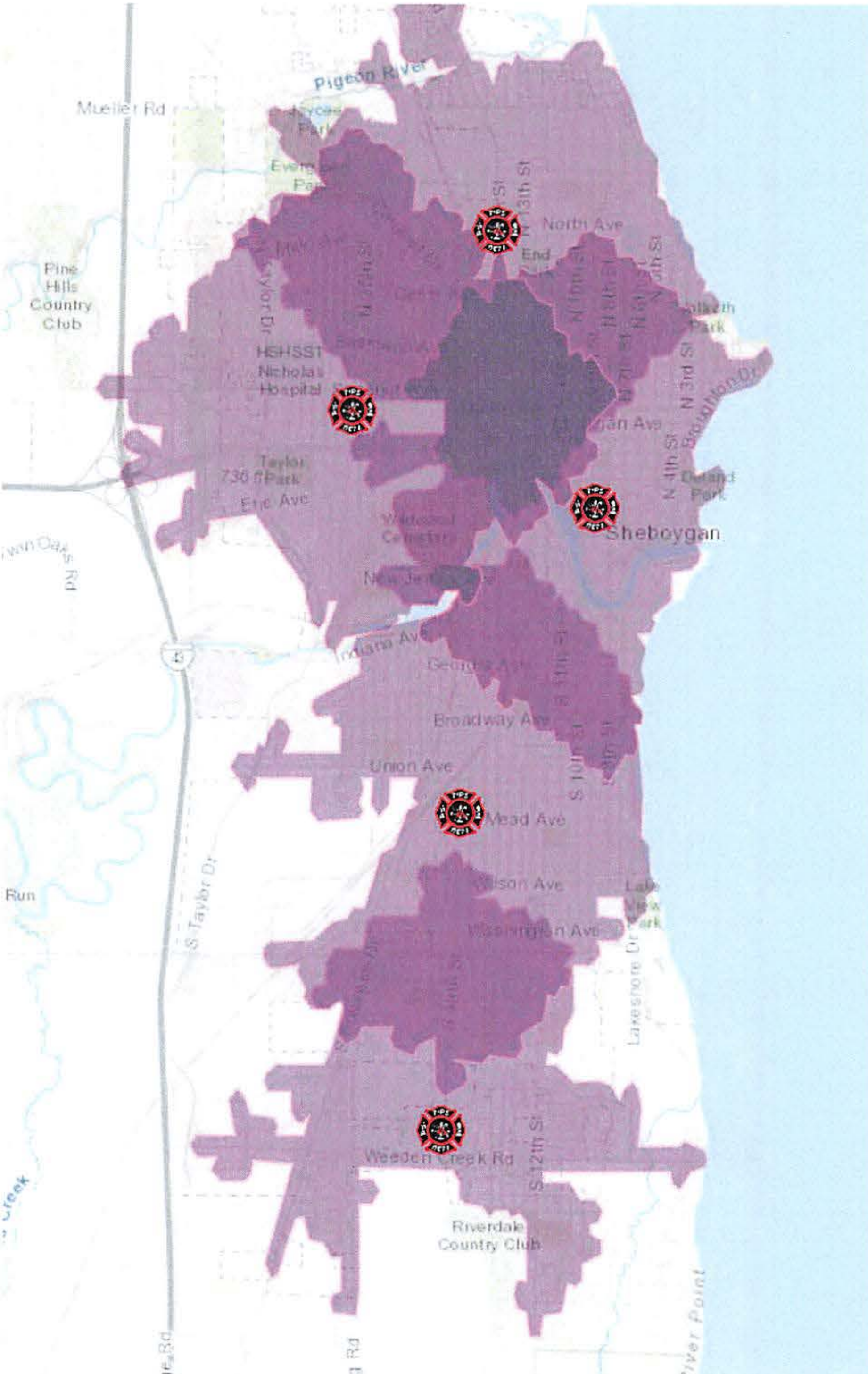
A second strategy is to provide station response coverage purely through a geographic lens without any consideration for how calls are distributed throughout the community. In addition, this analysis utilized distance without consideration to the relative impendence and/or the robustness of the road network. For example, when time is the unit of measure, a station could travel a farther distance on a highway then through a school zone but this approach caps the coverage area at 1.5 miles regardless of available travel speeds. This strategy more closely follows the recommendations of the Insurance Services Office (ISO). Therefore, the following analyses examine the current coverage areas through the lens of ISO utilizing 1.5-mile engine, 2.5-mile truck polygons, and 5-mile station locations, respectively.

Engine Coverage

All analyses utilize the existing road network and average travel impedance for the jurisdiction. When examining the 1.5-mile polygons for engine coverage, it is evident that all 5 stations maintain contiguous road miles within 1.5-mile drive times.

Where the road networks are not as robust a less efficient drive time capability emerges. For example, in more traditional metropolitan areas, the polygons will have a diamond shape, as the road network is equally accessible and efficient in all directions.

Figure 58: 1.5 Mile Engine Polygons



Pigeon River
Mueller Rd
North Ave
Pine Hills Country Club
HSHSST Nicholas Hospital
Taylor Park
Erie Ave
Sheboygan
Indiana Ave
Broadway Ave
Union Ave
Mead Ave
Wilson Ave
S Taylor Dr
Lakeshore Dr
Weeden Creek Rd
Riverdale Country Club
River Point

Ladder Truck Coverage

When examining the 2.5-mile polygons for truck coverage, the Department is challenged with ladder truck coverage based on the potential geographic coverage only and without consideration for the distribution of risk. ISO will afford additional points for having either a ladder/tower truck or quint at more than 50% of the stations. Therefore, the department may benefit from a restructure of distribution strategies that also encompasses a Quint concept if additional points are needed in the future. Results are provided below.

The following mapping includes a view of stations through the 2.5-mile attribute. The first map includes the current stations with aerial devices.

The department's current deployment strategy is to have a ladder truck at both Stations 4 and 5 at the north and southern most points of the city. The mapping illustrates that the greatest degree of coverage is provided through this strategy and that the ladder coverage areas do have some contiguous road network.

Analyses of the placement of a potential 3rd ladder truck, or future quint, were evaluated to provide insight into the best location for geographic coverage. Therefore, the subsequent mapping output compares the following truck configurations:

- Trucks at 1, 4, and 5
- Trucks at 2, 4, and 5
- Trucks at 3, 4, and 5

The mapping illustrates that the utilization of Station 1 provides nearly 100% duplication of service area between Stations 4 and 5. Stations 2 and 3 provide additional coverage area, but Station 3 may be the best option if considering a 3rd aerial asset.

Figure 59: Current Stations 4 and 5 with Ladder Trucks - ISO 2.5 Mile

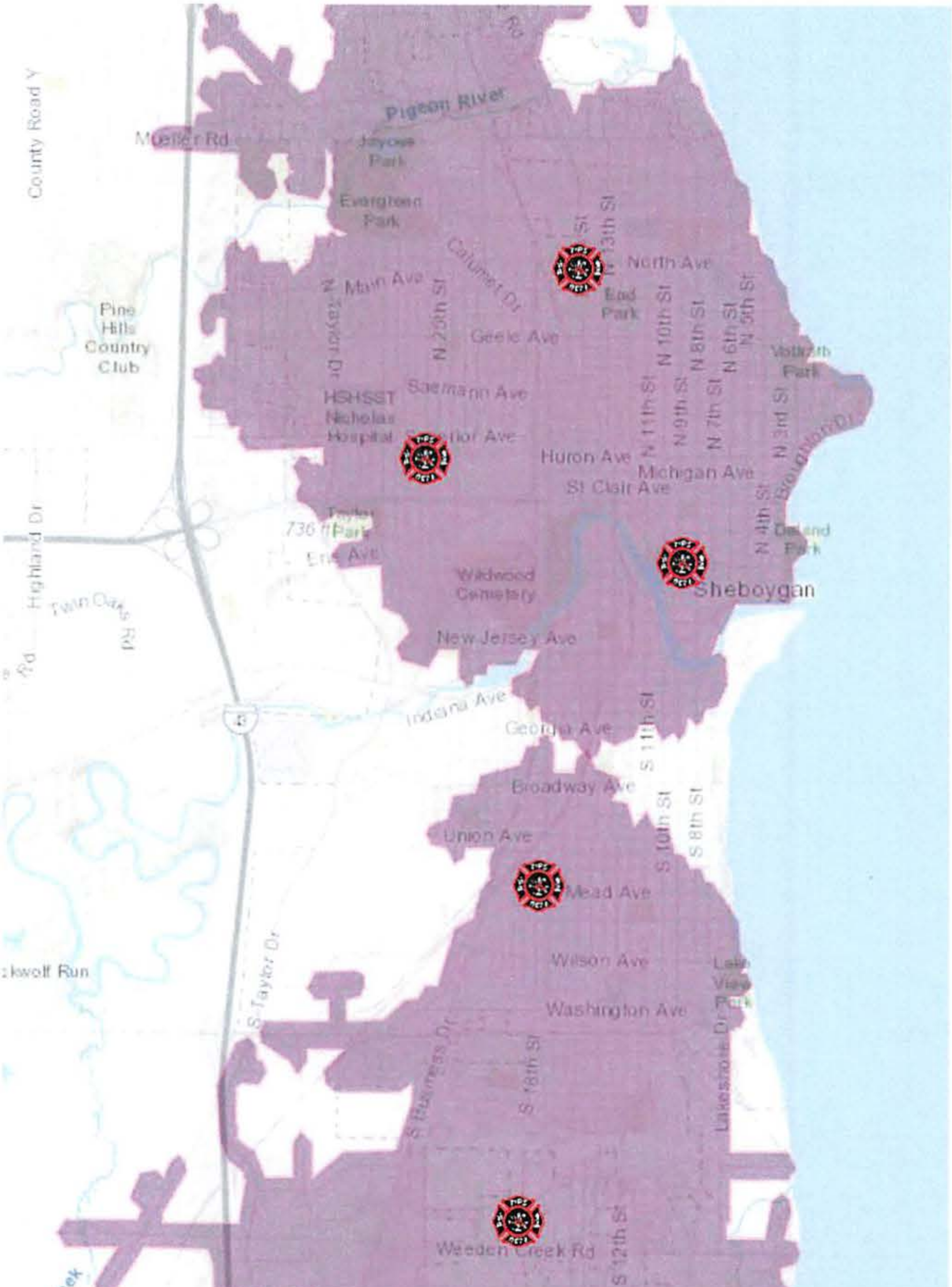


Figure 60: Current Stations 1, 4, and 5 with Ladder Trucks - ISO 2.5 Mile

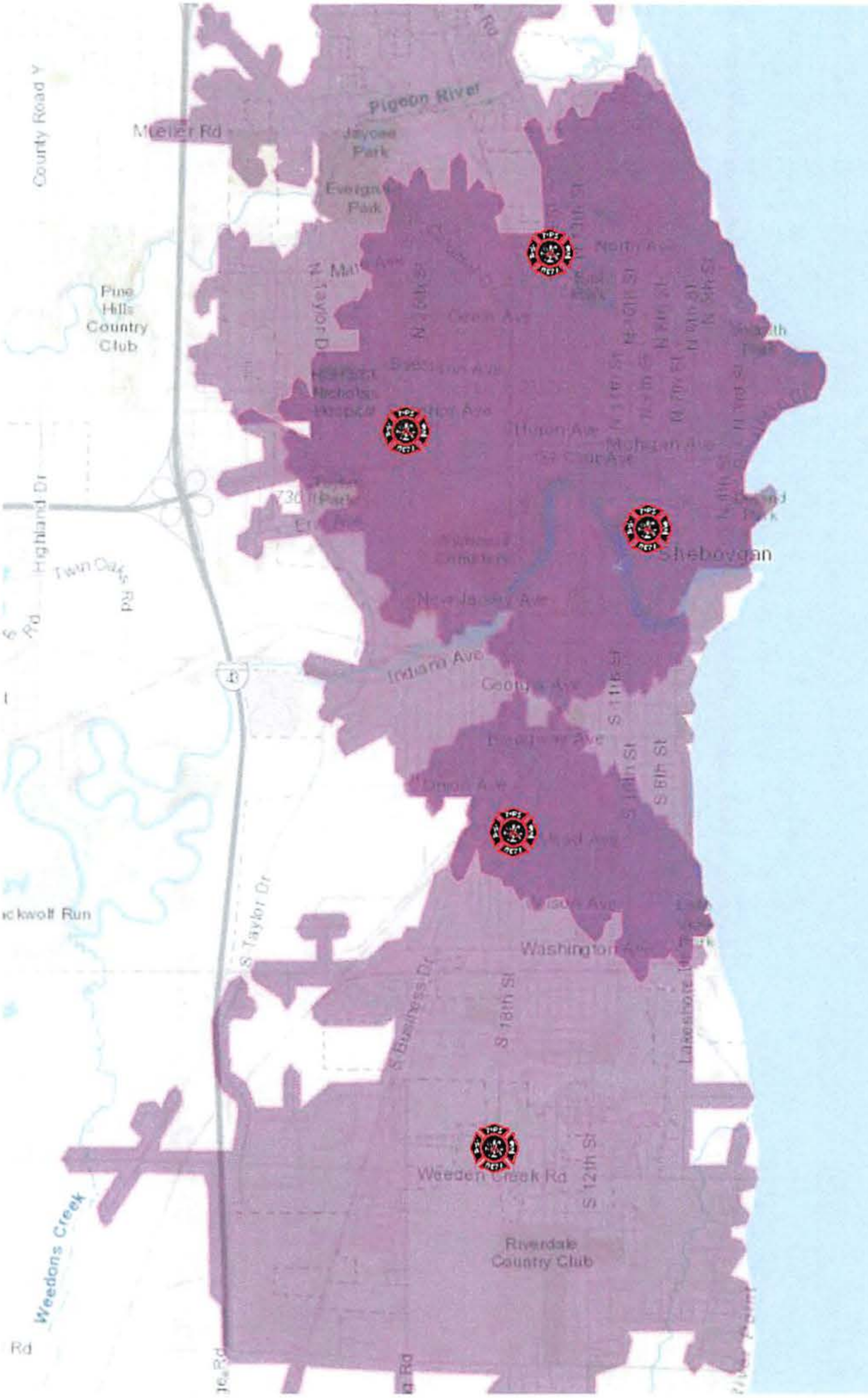


Figure 61: Current Stations 2, 4, and 5 with Ladder Trucks - ISO 2.5 Mile

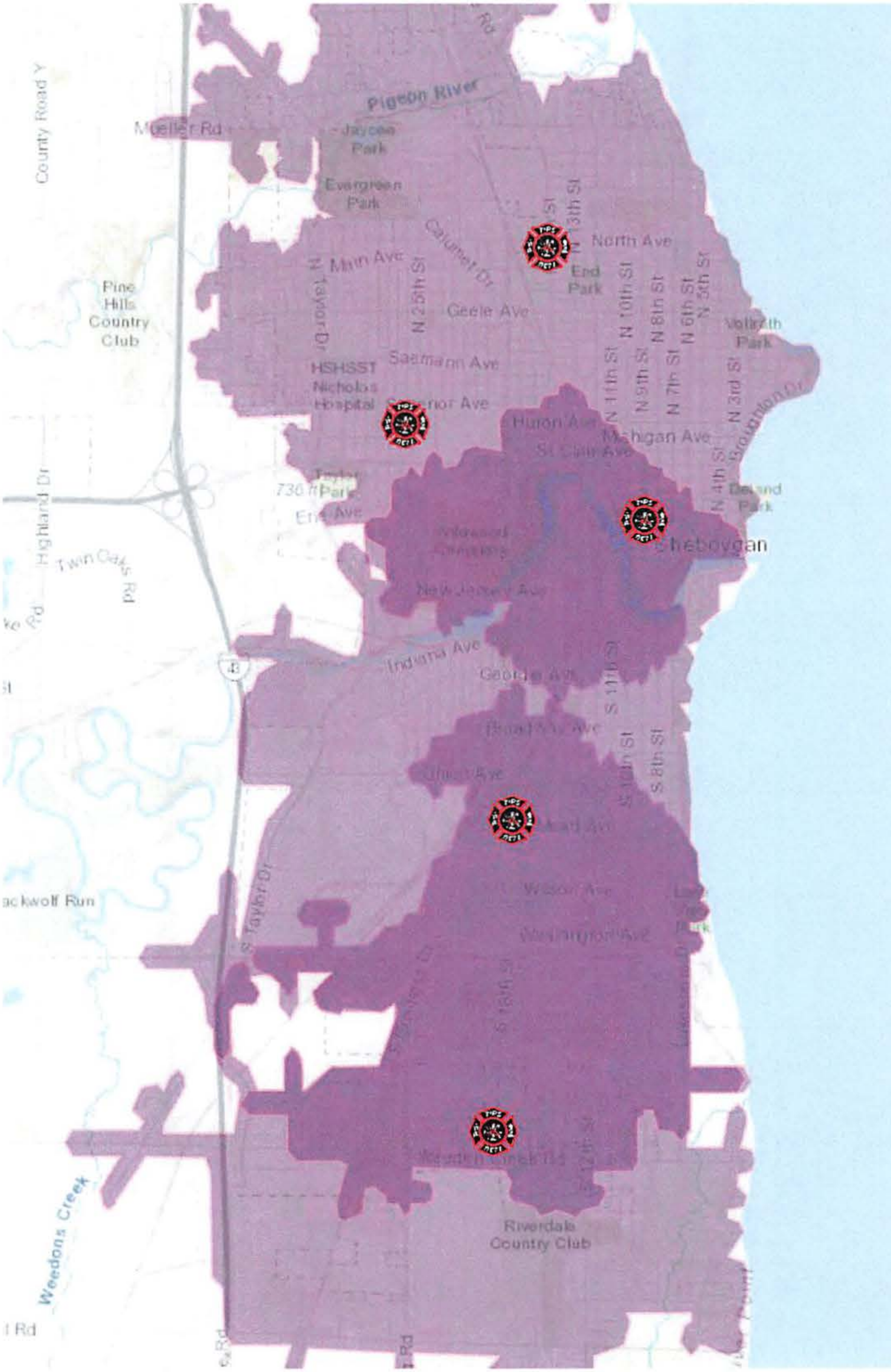
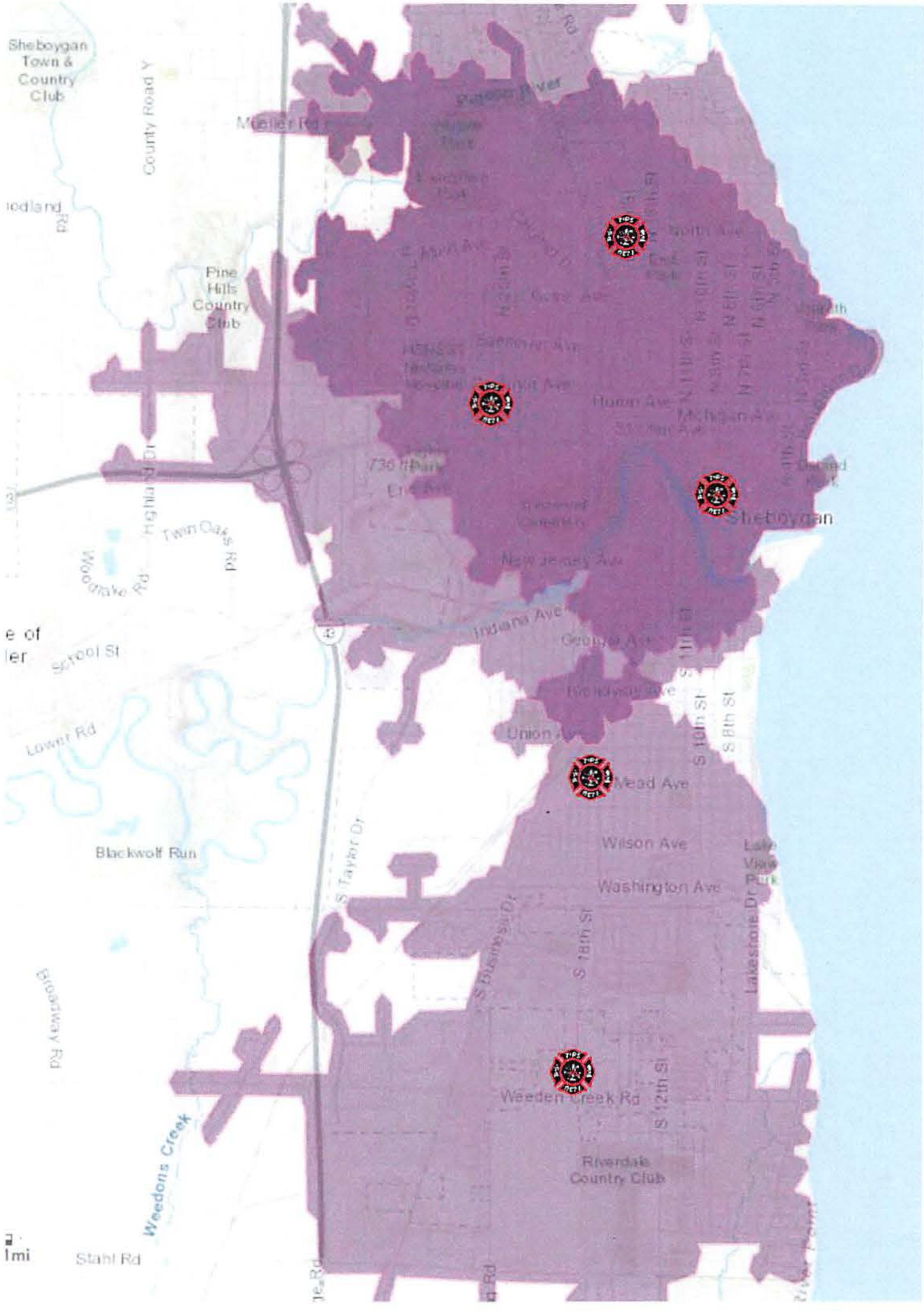
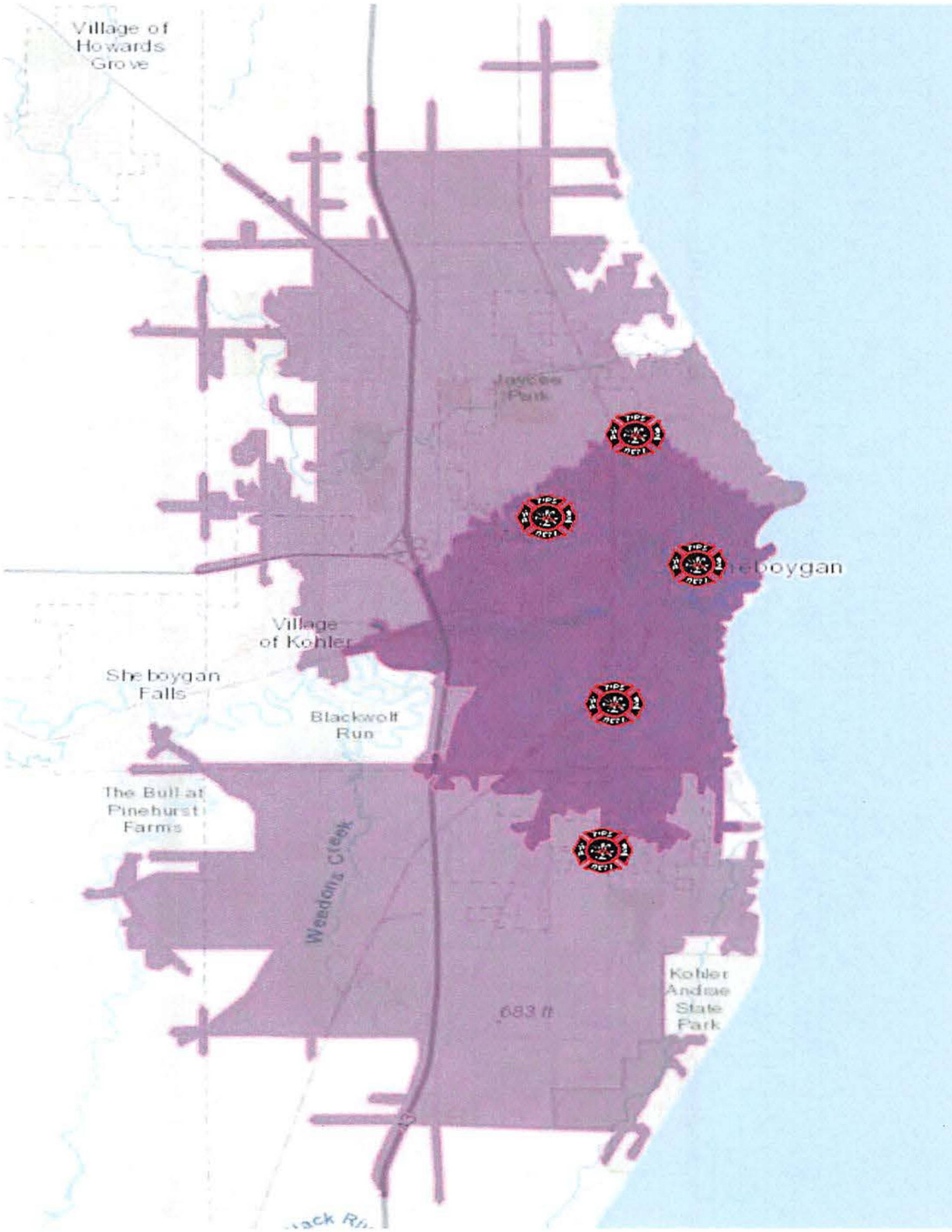


Figure 62: Current Stations 3, 4, and 5 with Ladder Trucks - ISO 2.5 Mile


Sheboygan Town & Country Club
County Road Y
Mueller Rd
Pine Hills Country Club
Highland Dr
Twin Oaks Rd
Woodlake Rd
School St
Lower Rd
Blackwolf Run
Broadway Rd
Weedons Creek
Stahl Rd
North Ave
Humm Ave
Michigan Ave
Erie Ave
Sheboygan
New Jersey Ave
Indiana Ave
Georgia Ave
Union Ave
Mead Ave
Wilson Ave
Washington Ave
S Taylor Dr
S Business Dr
S 18th St
S 12th St
S 10th St
S 8th St
S 11th St
Lakeshore Dr
Weeden Creek Rd
Riverdale Country Club

Finally, mapping analyses for the ISO 5-Mile configuration is provided below. The analyses suggests that there are contiguous road miles for each of the five stations. This illustration only utilizes the northern and southern most stations for clarity (Stations 4 and 5).

Figure 63: Current Station Configuration (Stations 4 and 5 only) - ISO 5 Mile



Effective Response Force Mapping

Similar to previous discussions, there are two prevailing recommendations for the time to assemble an effective response force for structure fires. First, NFPA 1710 suggests that the Effective Response Force (ERF) should arrive in eight (8) minutes travel time or less. Second, the CFAI provides a baseline travel time performance objective of 10 minutes and 24 seconds 90% of the time or less for urban densities as well as a 13-minute travel time ERF for suburban areas and 18-minutes for rural areas. Since the current first due travel time performance is at approximately 5 to 6-minutes minutes; 8, 10, and 13-minute travel times were created to demonstrate the relative ERF coverage throughout the jurisdiction.

For these purposes ERF was defined as the arrival in two person increments from 10-16 personnel and is restricted to the city jurisdiction.

Table 30: Comparisons of Effective Response Force Configurations

Travel Time Objective	10 Personnel	12 Personnel	14 Personnel	16 Personnel
8-Minute	36.38%	7.21%	2.97%	0.15%
10-Minute	70.70%	31.54%	30.10%	7.12%
13-Minute	93.28%	76.08%	76.08%	43.77%

Overall, the ERF has more robust coverage in the core of the City where the greatest historical demand exists. Mapping outputs are provided below.

Figure 64: 8-Minute ERF from Current Stations – Current Staffing

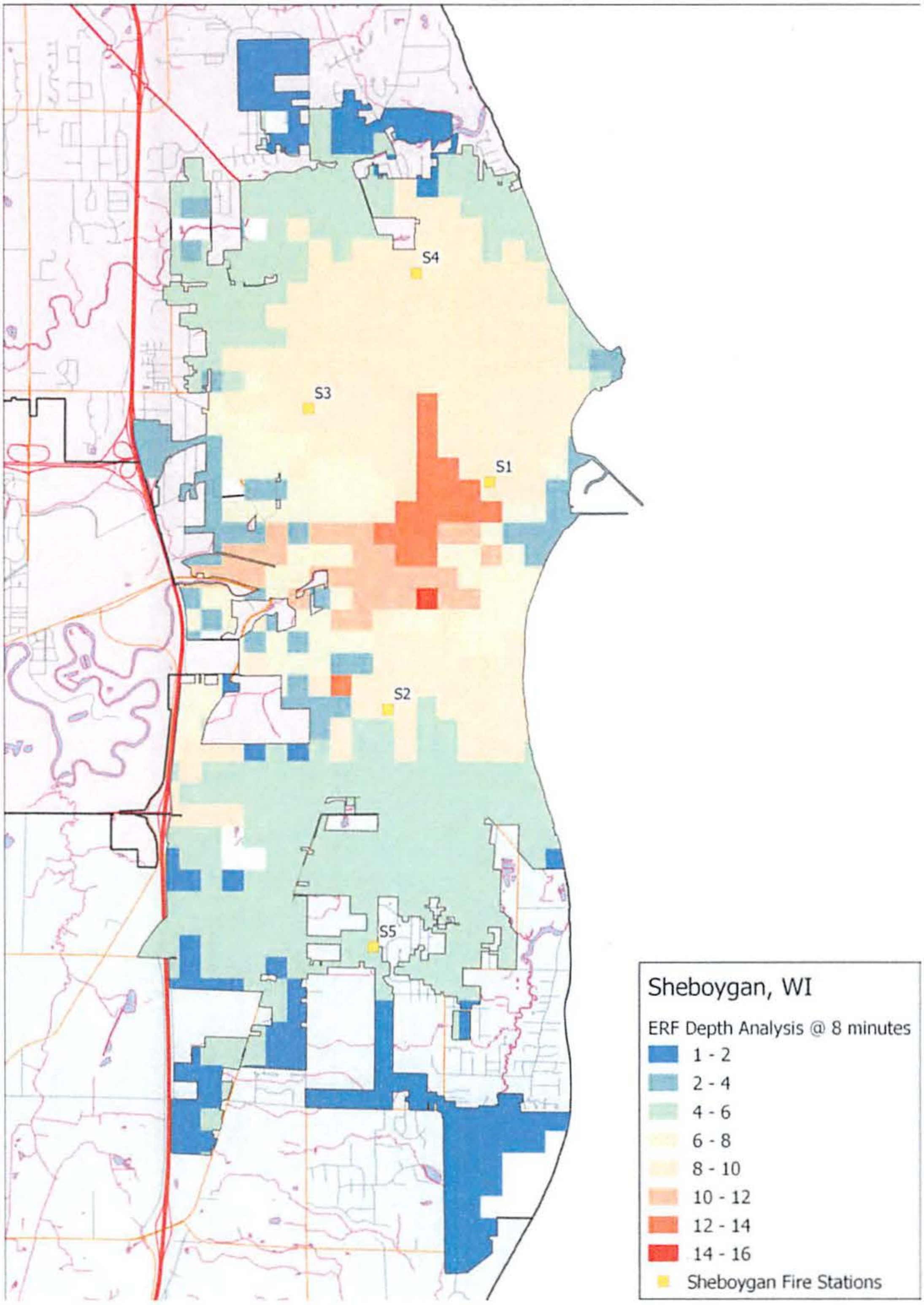


Figure 65: 10-Minute ERF from All Current Stations – Current Staffing

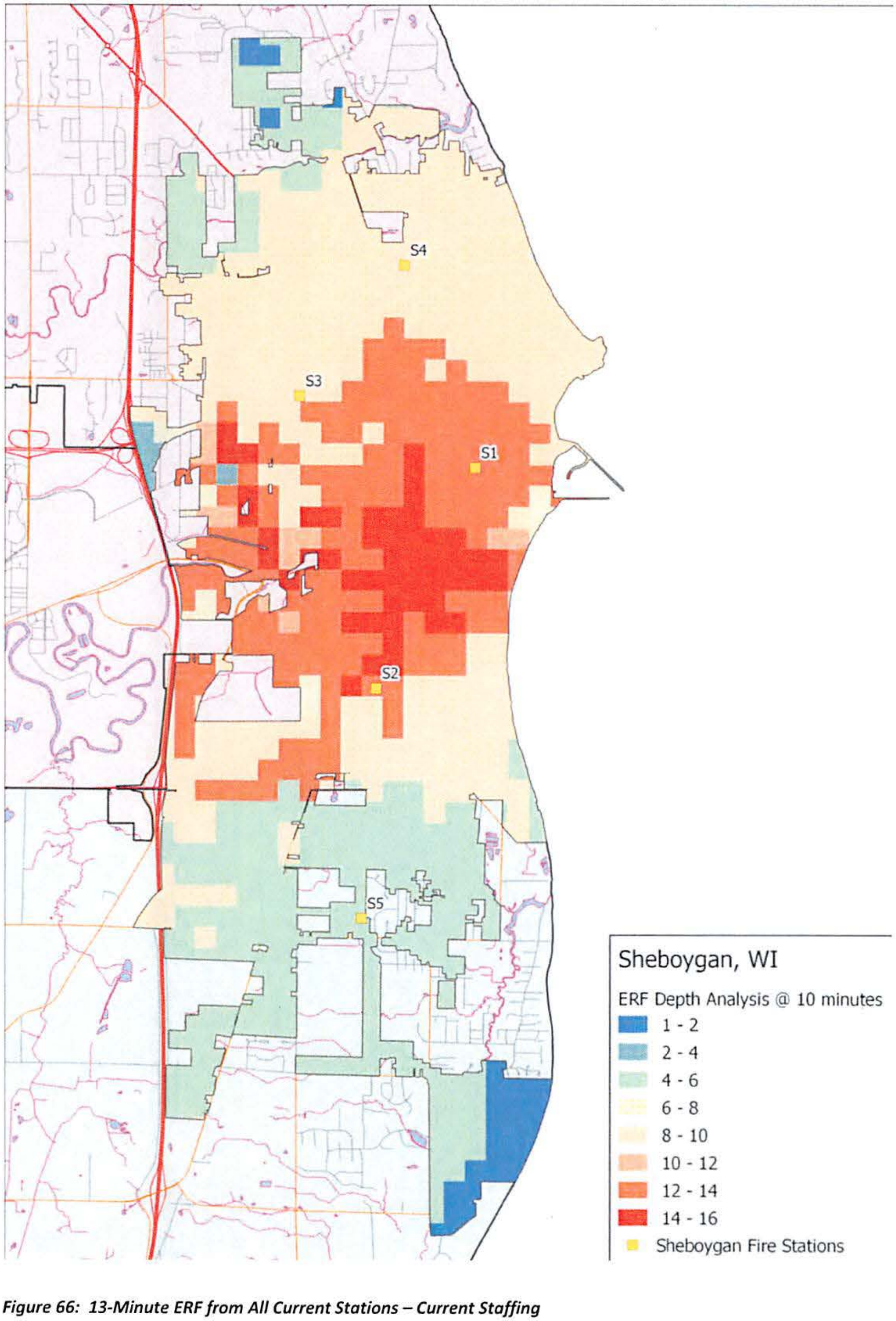
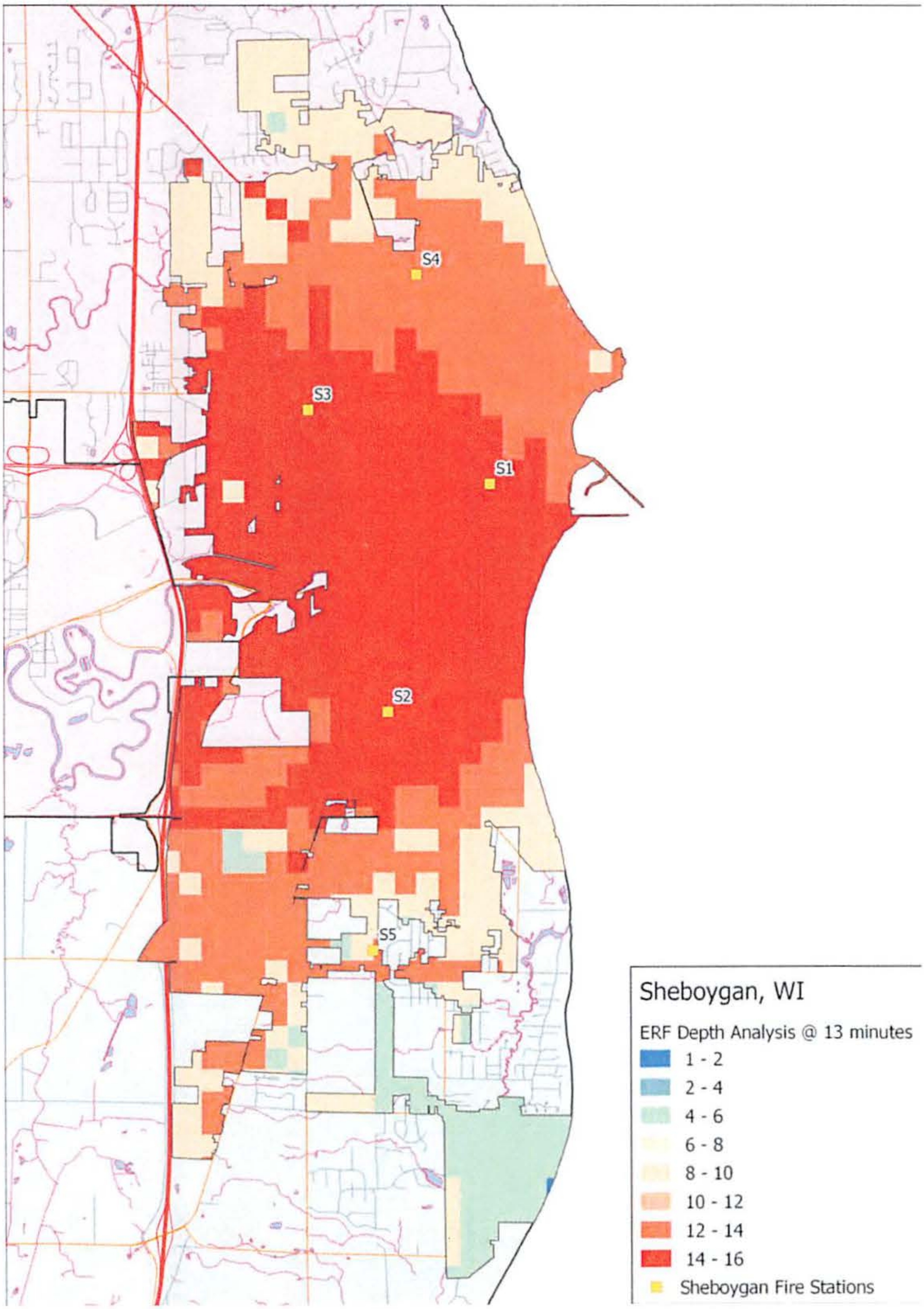


Figure 66: 13-Minute ERF from All Current Stations – Current Staffing


S4
S3
S1
S2
S5
Sheboygan, WI
ERF Depth Analysis @ 13 minutes
1 - 2
2 - 4
4 - 6
6 - 8
8 - 10
10 - 12
12 - 14
14 - 16
Sheboygan Fire Stations

Distribution of Risk Across the Jurisdiction

Distribution of Demand by Program Areas

Heat maps were created to identify the concentration of the historic demand for services by program area. Therefore, the following mapping will present the relative concentration of service demands by fire, EMS, and HAZMAT, respectively. The Blue areas have the least demand and the dark red areas have the highest concentration of demand.

When reviewing the heat maps, it is clear that the greatest relative density of service demands is generally located near the downtown area, with little variation over the program areas.

Figure 67: Heat Map for Fire Related Incidents

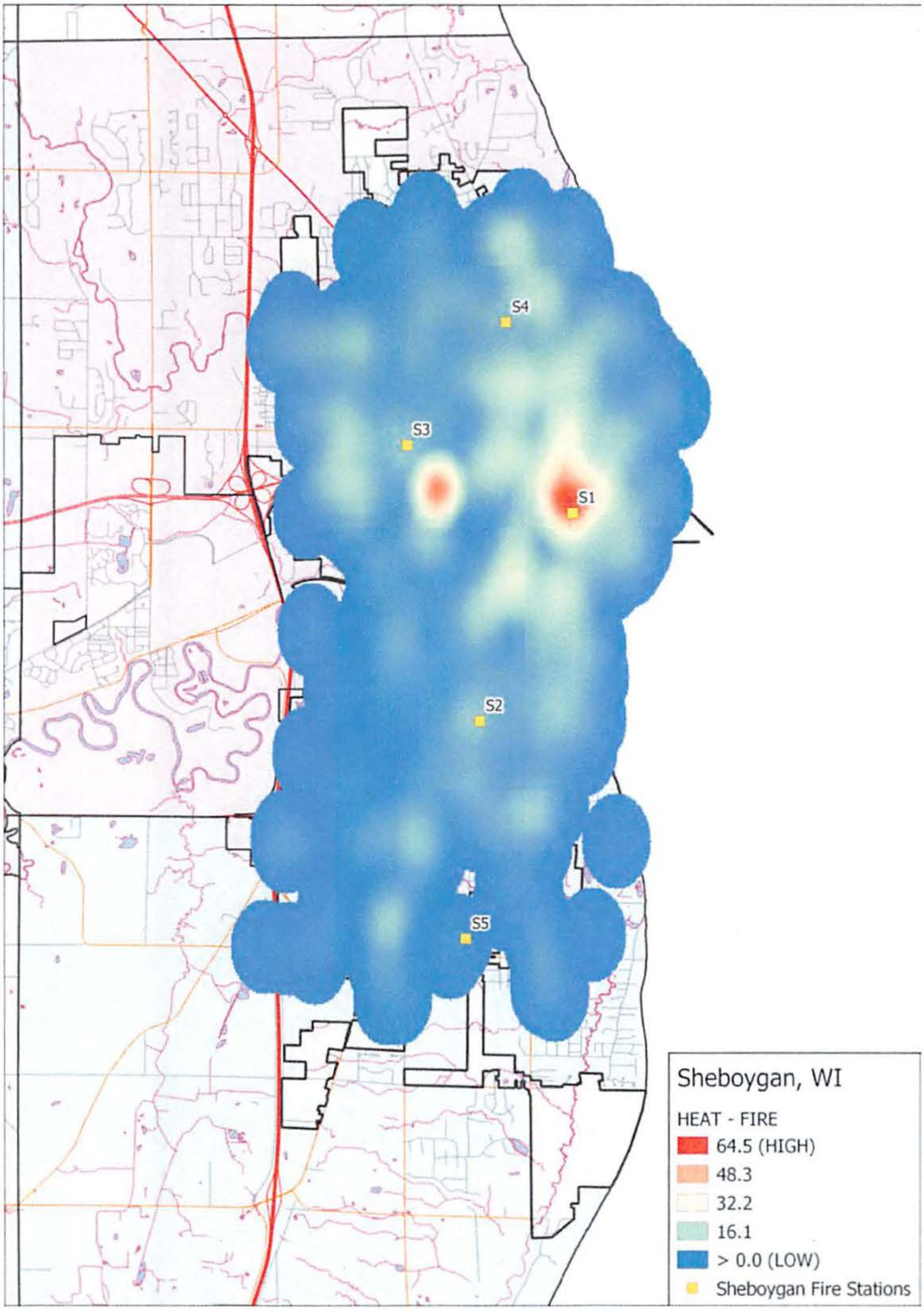


Figure 68: Heat Map for EMS Related Incidents

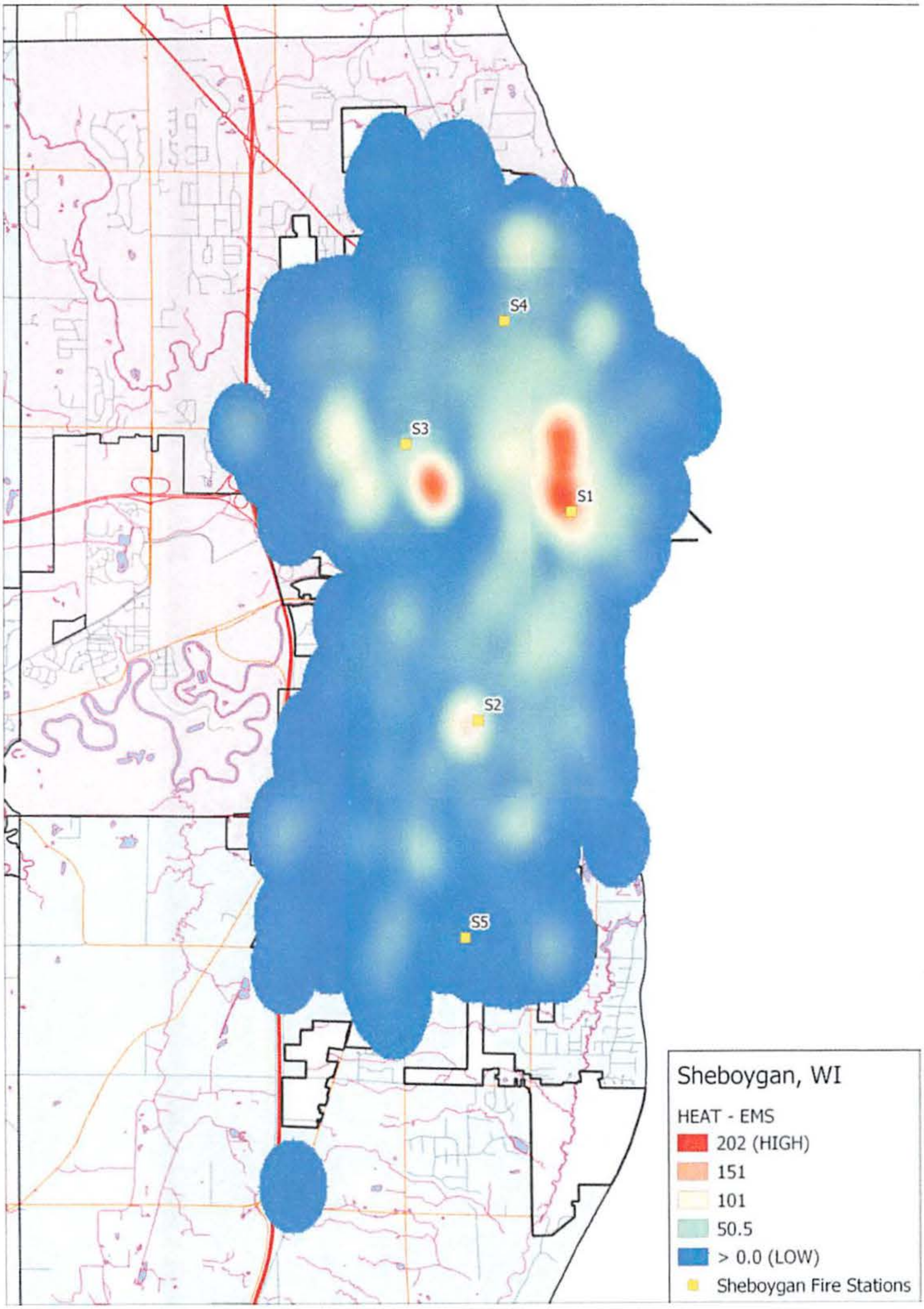
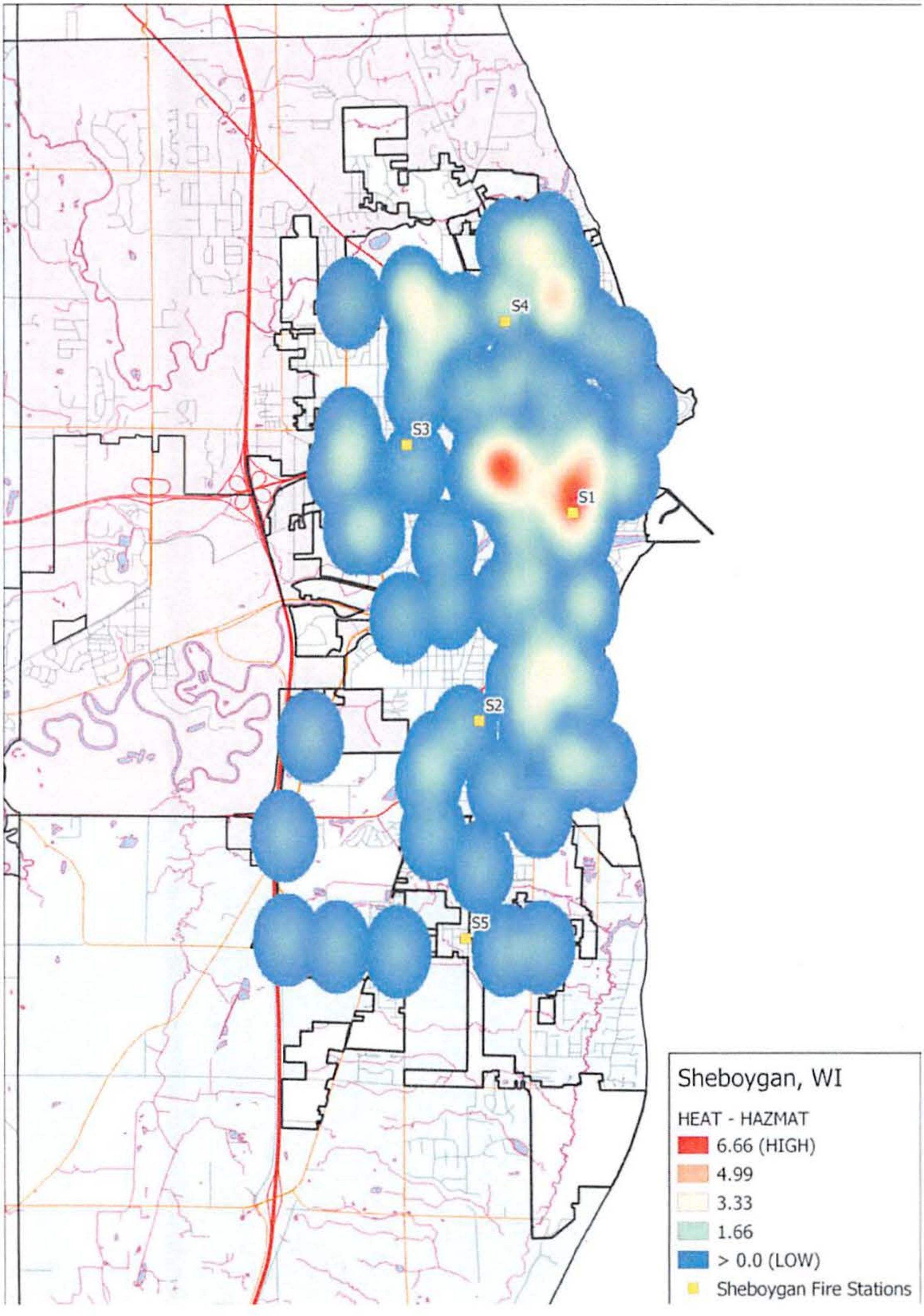
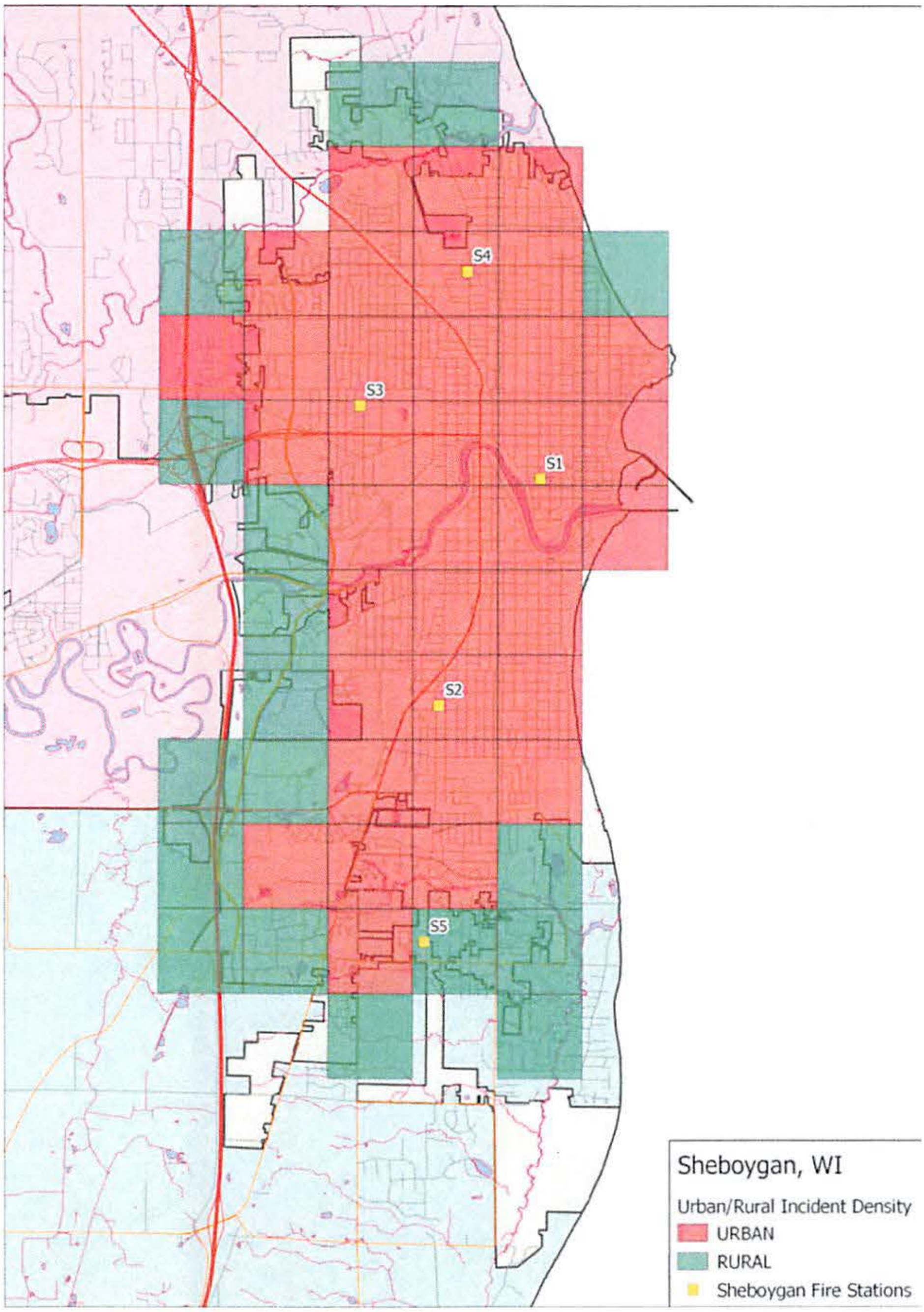


Figure 69: Heat Map for HazMat Related Incidents


S4
S3
S1
S2
S5
Sheboygan, WI
HEAT - HAZMAT
6.66 (HIGH)
4.99
3.33
1.66
> 0.0 (LOW)
Sheboygan Fire Stations

Finally, we calculate call density based on the relative concentration of incidents based on approximately 0.5-mile geographic areas as well as the adjacent 0.5-mile areas. The results demonstrate an urban and rural designation based on call density for services and not based on population. The red areas are designated as urban service areas and the green areas are designated as rural service areas. Any area that is not colored has less than one call every six months in the 0.5-mile area and the adjacent areas.

Figure 70: Urban and Rural Call Density Map with Current Stations



Long-Term Sustainability of the Models Presented

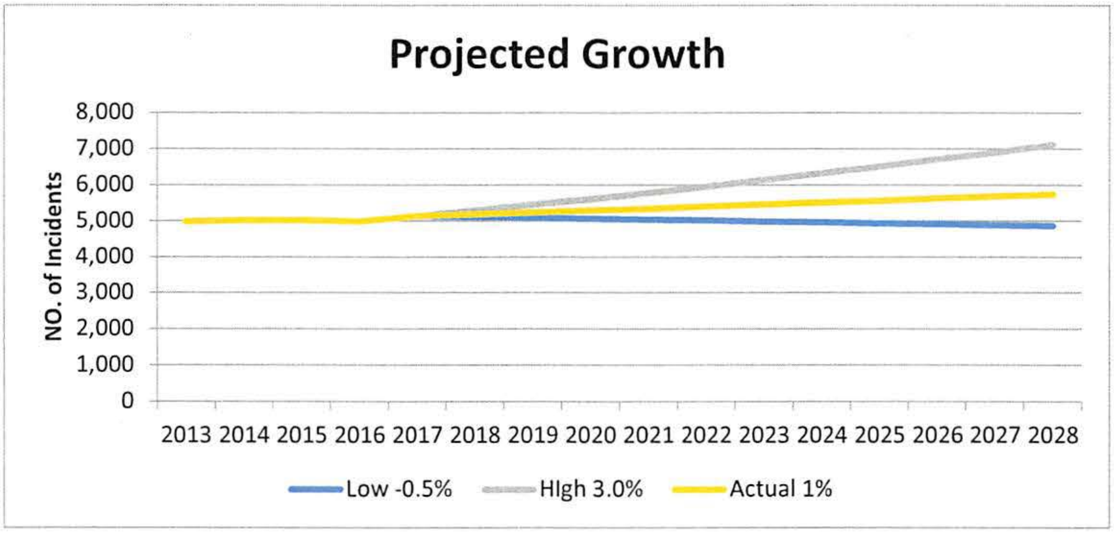
It is important to understand that the distribution models are restrictive to the geographic limitations of the jurisdiction and the historical demand for services. Therefore, the number of stations is descriptive of the number of fixed facilities required from which to deploy resources. These analyses do not specifically describe the concentration of resources required at each fire station facility to adequately handle the demand for services. For example, some stations may require two or more units in order to handle the demand for services.

With respect to the long-term sustainability of the deployment models presented here, the models will remain accurate for as long as the jurisdictions' overall coverage area has not expanded. In other words, if the City's square mileage remains, then the deployment strategy will be sustainable indefinitely with respect to the coverage area. As other variables such as population density or changes in socioeconomic status change over time, there may be a need for a higher concentration of resources necessary to meet the growing demand for services, but not additional stations. The most prominent reason that the geographic distribution model would need to be updated is for changes in traffic impedance that significantly limit the historical average travel speed. Monitoring travel time performance, system reliability, and call concurrency will provide timely feedback for changes in the environment that could impact the distribution model.

Projected Growth

The available data set was restricted to 5 years with an annualized growth of 2.98%. The following straight-line projection should be used with caution due to the variability across years. However, in all cases, data must be reviewed annually to ensure timely updates to projections. The overall year over year growth between 2013 and 2017 data includes a -0.5% drop in incidents between 2015 and 2016 as well as a 0.0% change between 2014 and 2015. The highest rate of growth was 3.0% that occurred between 2016 and 2017.

Figure 71: Projected Growth of 1%

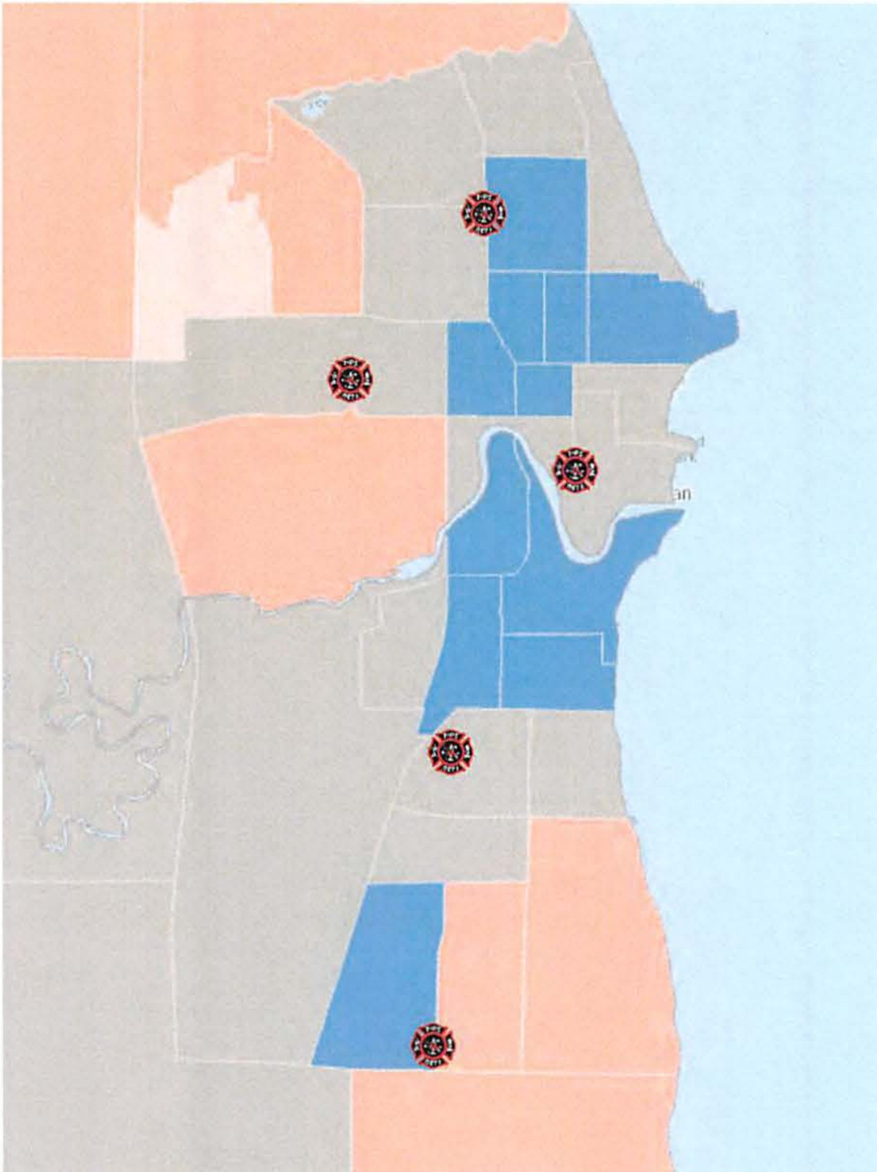


Assuming that future demands may not be reasonably distributed across the various stations in the system, the system will require a redistribution of workload and ultimately reinvestment in resources to meet the growing demand. While the system should be evaluated continuously for performance and desired outcomes, the department should specifically re-evaluate workload and performance indicators for every 1,000-call increase to ensure system stability.

Population Characteristics

Generally, older populations and very young populations are considered to be most vulnerable to the frequency and incidents of fire. In addition, older populations historically utilize EMS services with greater frequency. It is important to understand, what field crews often recognize intuitively, is that the distribution of population risks are not uniform across the jurisdiction. The median age is provided below.

Figure 72: Median Age - 2018



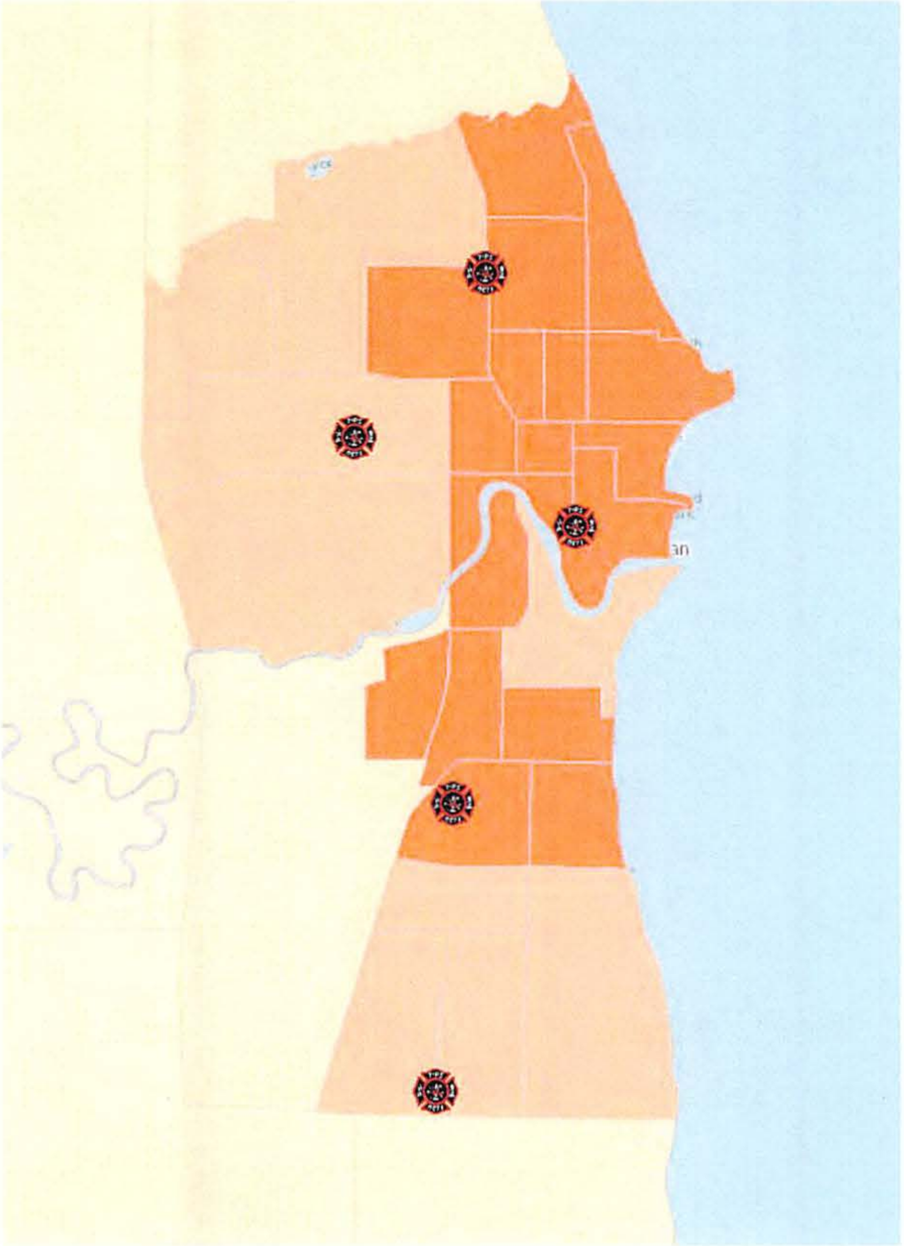
2018 USA Median Age

Block Group

- 53 - 86 years of age
- 45 - 53 years of age
- 36 - 45 years of age
- 28 - 36 years of age
- 0 - 28 years of age

For the majority of the jurisdiction, the population density is urban or suburban.

Figure 73: Population Density by Census Block - 2018



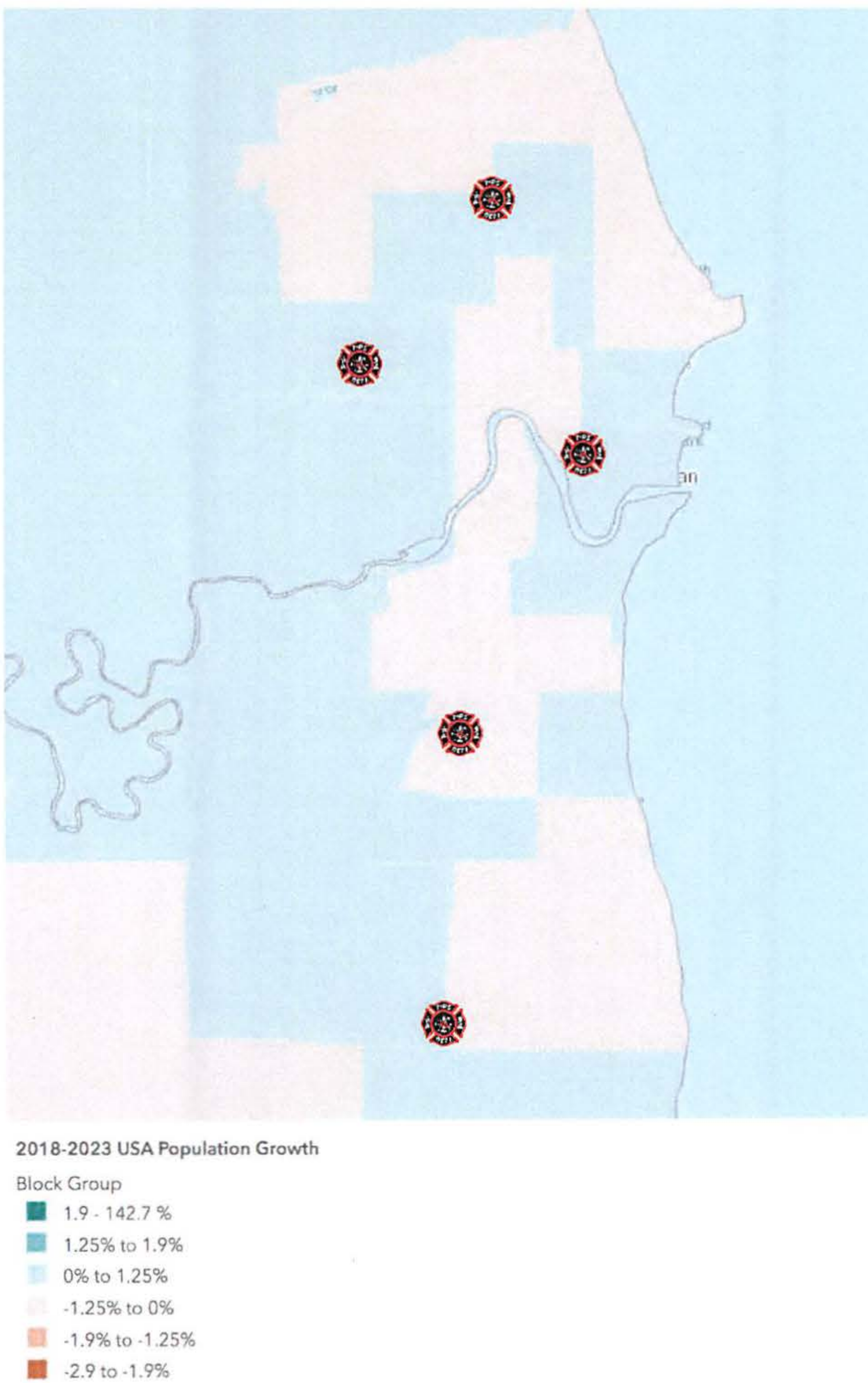
2018 USA Population Density

Block Group

- 116,000 - 618,125 people per sq mi
- 22,000 - 116,000 people per sq mi
- 4,000 - 22,000 people per sq mi
- 1,000 - 4,000 people per sq mi
- 0 - 1,000 people per sq mi

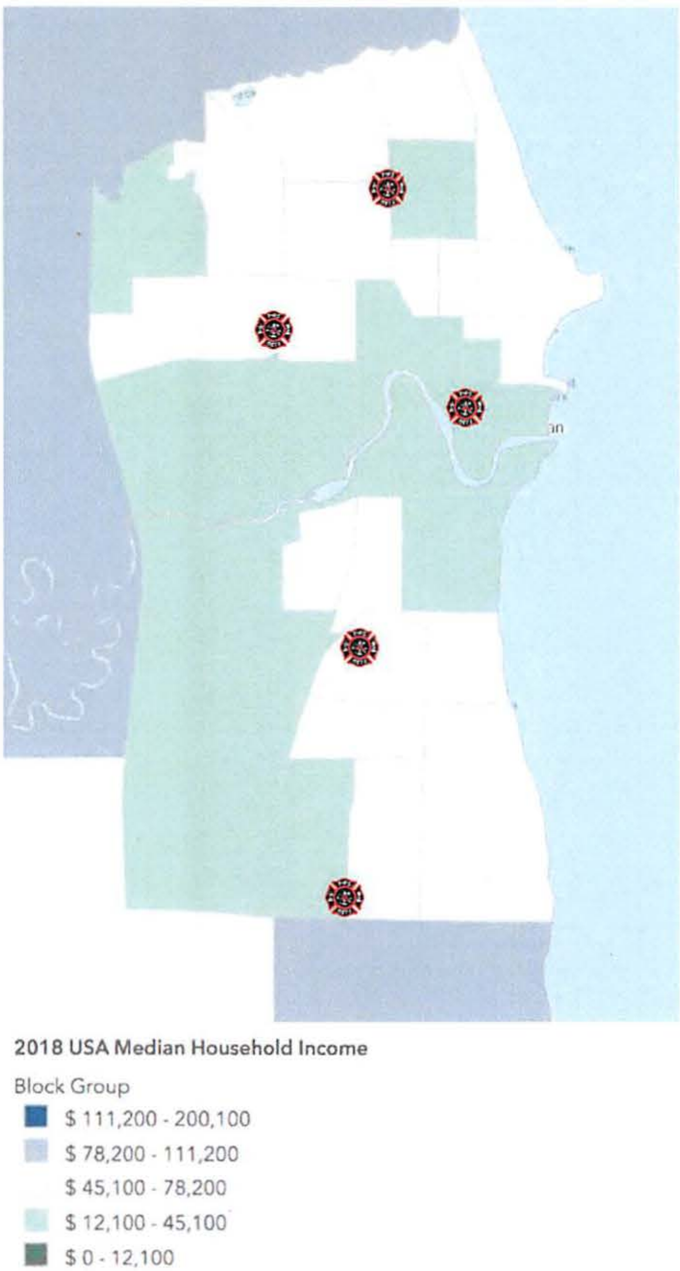
The population change is either holding static or reducing by 1.25% or growing slowly between 0 and 1.25%. Overall, the projected changes to population should be relatively stable.

Figure 74: Annual Population Change 2018-2023



Finally, population alone is not the sole variable that influences the demand for services as socioeconomic and demographic factors have greater influence over demand. The median household income was evaluated to determine the degree to which the community had underprivileged populations. The majority of census blocks were at or below the national median household income. The national median household income is reported at $58,100.

Figure 75: Median Household Income -2018



Risk analyses

Occupancy Level Risk

Occupancy risk was evaluated across the jurisdiction utilizing the most recent ISO batch reports. The ISO Batch report provided specific building occupancy information for the needed fire flow, the number of stories, location, and square footage. Ultimately, a quantifiable risk-rating matrix was developed that categorized 940 occupancies within the jurisdiction into high, moderate, and low risks. The risk matrix is presented in Table 8 below.

Due to the relatively higher demands for personnel and apparatus required for fire events that have a large square footage, higher elevation (stories), and greater water demands, the risks garnished the highest numeric values. The results of the risk assessment process categorized the 940 occupancies into 21 high-risk structures, 566 moderate structures, and 353 low risk structures.

Geospatial analyses were completed to map the locations of each of the commercial occupancies included in the risk matrix process and specifically overlaid within each of the fire station locations. This analysis lends validity to the risk assessment matrix and the process utilized by the Department as the concentration of risks is correlated with the historical demand for fire related services. The results of the geospatial analyses of all, high, moderate, and low risk structures are presented below as Figures 28 - 30, respectively. From a broad perspective, this provides validation to the risk assessment process developed with the Department as well as the necessary deployment strategy to cover the historical demand for services.

Table 31: Summary of Occupancy Risk Matrix

Risk Class	Fire Flow		Number of Stories		Square Footage		Total Risk Score
	Value	Scale	Value	Scale	Value	Scale	Scale
High	5	≥ 1500 gpm	5	≥ 4	5	>=100k Sq. Ft.	≥ 13
Moderate	3	> 499 and < 1500 gpm	3	> 1 and < 4	3	> 10k < 100k Sq. Ft.	>6 and <12
Low	1	≤ 499 gpm	1	1	1	< 10k Sq. Ft.	≤ 5

Figure 76: High Risk Occupancies by Station Demand Zone

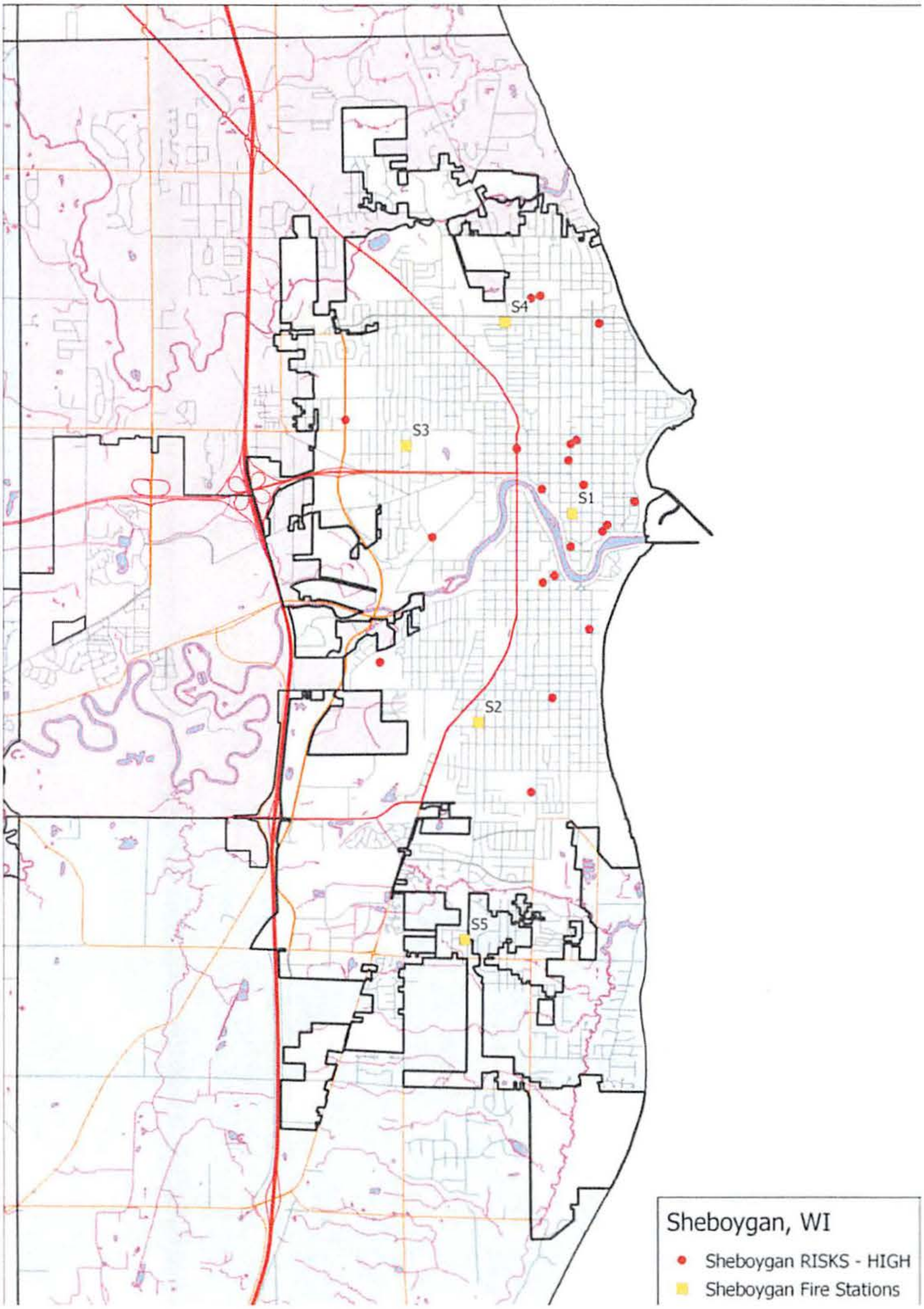


Figure 77: Moderate Risk Occupancies by Station Demand Zone

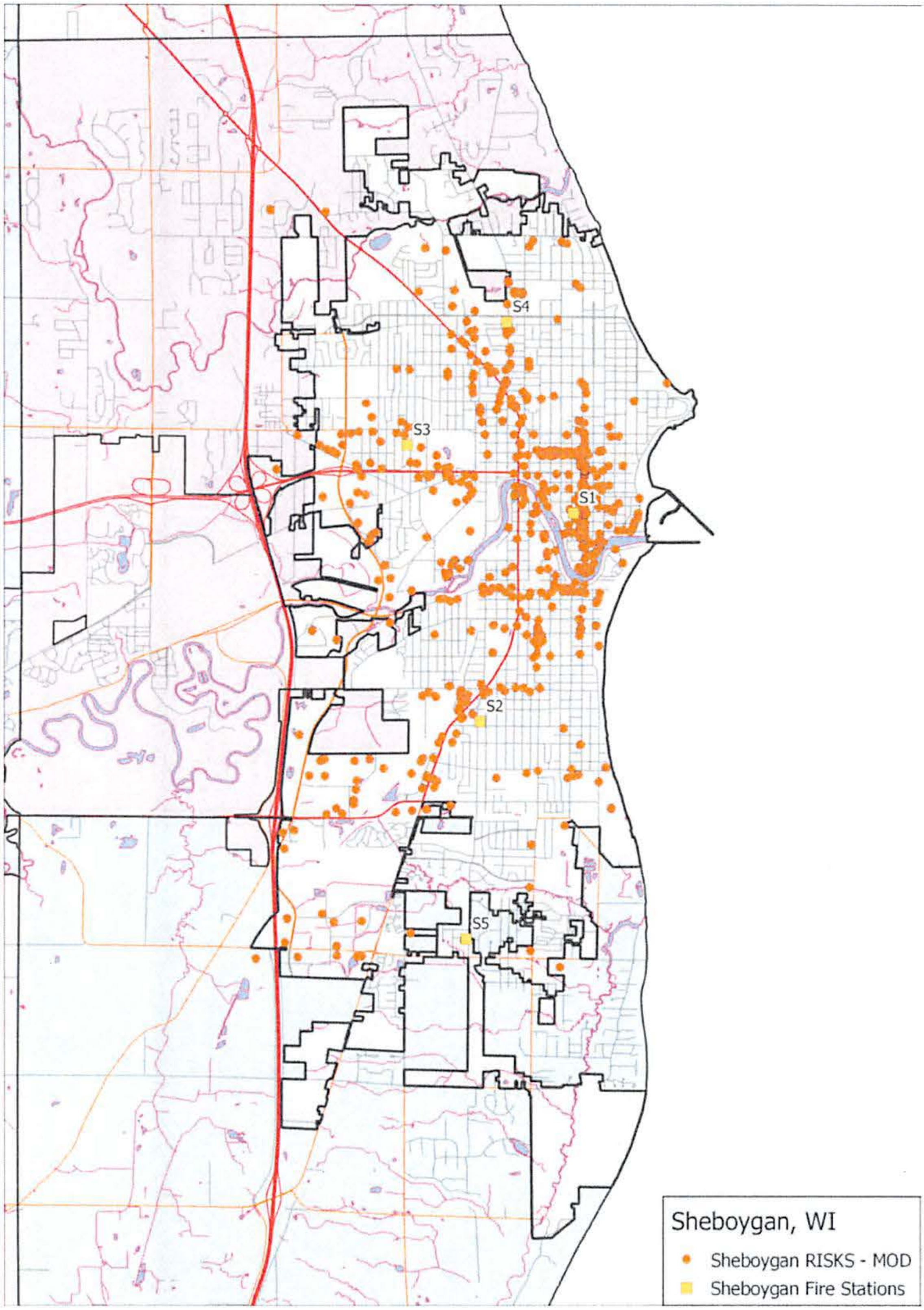
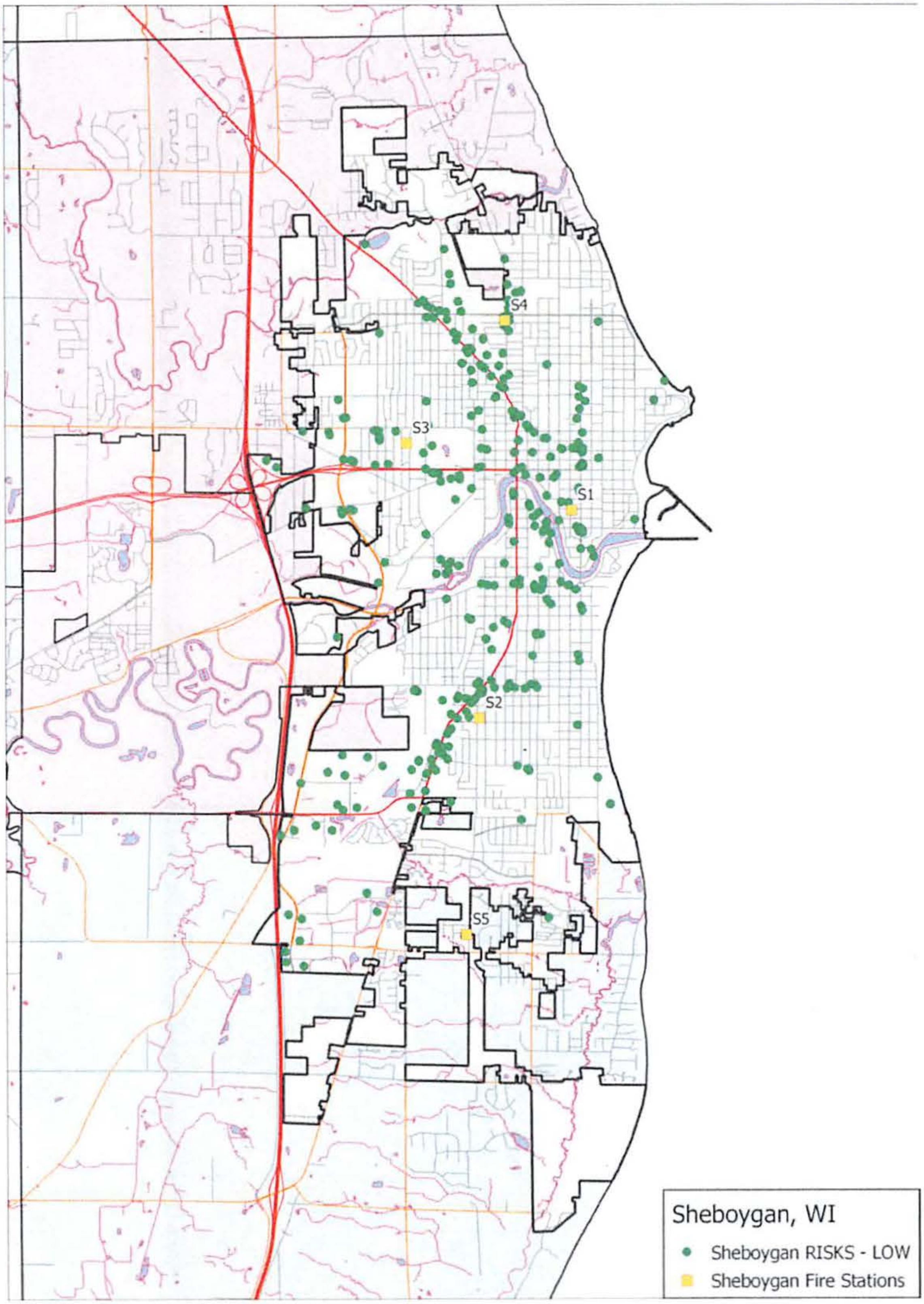


Figure 78: Low Risk Occupancies by Station Demand Zone



Concentration of Risks by Demand Zone

Analyses were conducted to describe and measure the relative concentration of risks in each of the fire station demand zones. Therefore, a station demand zone risk matrix was developed to quantitatively evaluate the relative risk by including measures for the frequency of moderate and high risk occupancies in each fire demand zone that are directly correlated to the necessity of higher concentrations of resources. In addition, several measures that both serves the distribution aspect of the risk evaluation, but also contributes to the need for higher concentrations of resources. For example, a higher call volume may serve to drive the need for additional resources to cover the community's demand.

The variables included in the risk matrix are the demand for services for each station demand zone, the number of high and moderate-risk occupancies, and the impact of simultaneous events in each station demand zone. All measures were weighted equally, however, two variables have surrogate relationships with historical community demands and one variable is dedicated to prospective occupancy risk. Community demands were rated more heavily in an effort to provide a realistic balance between the risk potential with historical experience. The risk tool and the scoring template are provided below.

Table 32: Station Demand Zone Risk Concentration Matrix

Station FDZ	Community Demand	Call Concurrency	High/Moderate Risk Occupancies	Total risk Score	Risk Rating
1	8	5	6	49.01	High
2	6	3	3	19.09	Moderate
3	7	4	3	26.16	Moderate
4	2	3	2	6.63	Low
5	2	3	1	4.95	Low

Overall, the risk assessment identified that Stations 1 is a high-risk station and Stations 2 and 3 are moderate risk stations. The remaining stations was categorized as lower risk. This would indicate that Station 1 should have a higher concentration of resources than the lower risk stations.

Table 33: Summary of Station Fire Demand Zone Risk Concentration Matrix

Risk Class	Community Demand (D)		Call Concurrency (C)		High/Moderate Risk Occupancies (R)		Total Risk Score
	Value	Scale (Calls)	Value	Scale (%)	Value	Scale (Occupancies)	$\sqrt{\frac{(CD)^2 + (CR)^2 + (RD)^2)}{2}}$
Maximum	≥10	≥4,050	≥10	≥ 27	≥10	≥500	≥72
High	7 – 9	≥ 2,700 and < 4,049	7	≥ 18 and < 27	7 to 9	≥ 300 and <449	≥ 39.35 and < 72
Moderate	4 to 6	≥ 1,350 and < 2,700	5	≥ 9 and < 18	4 to 6	≥ 150 and < 300	≥ 16.49 and < 39.35
Low	1 to 3	< 1,350	1	<9	1 to 3	< 150	< 16.49

** Definitions for Occupancy Risk Type were provided as part of the full risk assessment previously.*

These analyses result in a three-dimensional model that illustrates the representativeness of each of the variables as they contribute to each station's risk profile. For example, one station may score heavily in potential risk and have moderate or low demand for services and another station may have little potential risk but have high demand and call concurrency that drives the necessity for a greater concentration of resources.

Graphic representations of the three axis risk matrices are provided below. When reviewing these radar figures, the larger the shaded area, the greater the risk. In addition, each axis is labeled so that the reader can determine the relationship between the risk drivers for each station area.

Figure 79: Station 1 Risk Profile

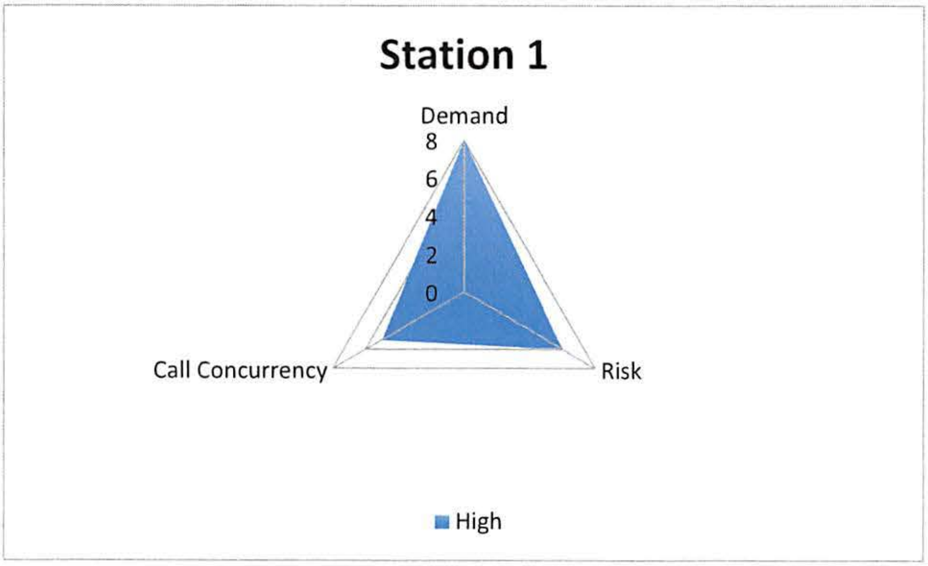


Figure 80: Station 2 Risk Profile

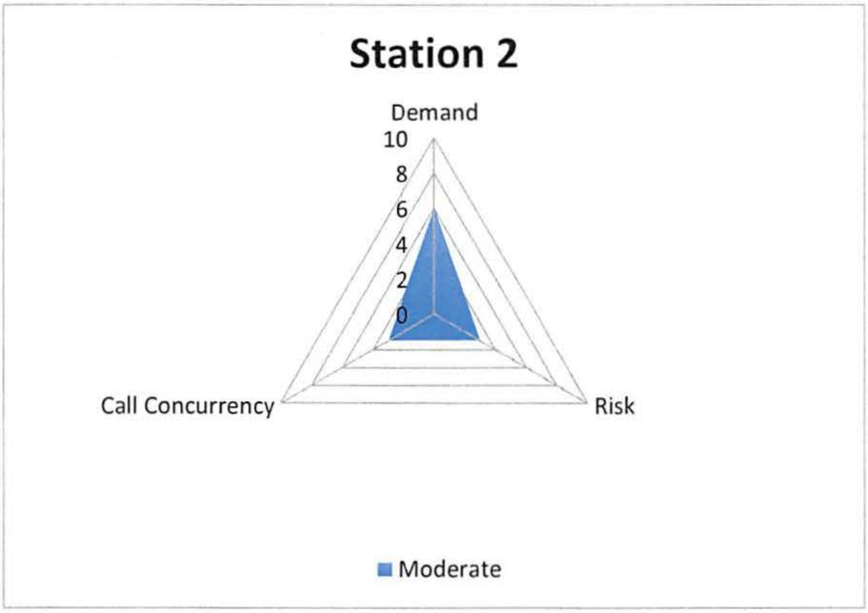


Figure 81: Station 3 Risk Profile

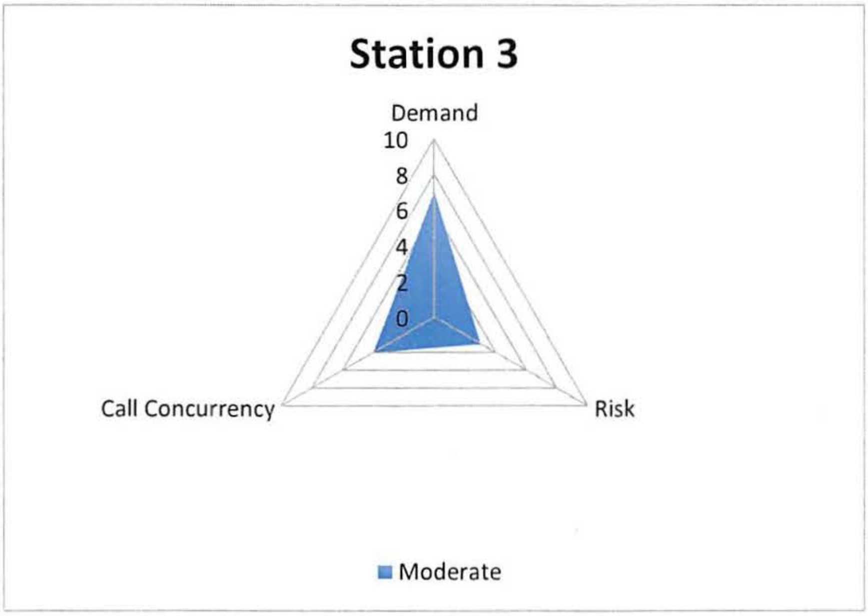


Figure 82: Station 4 Risk Profile

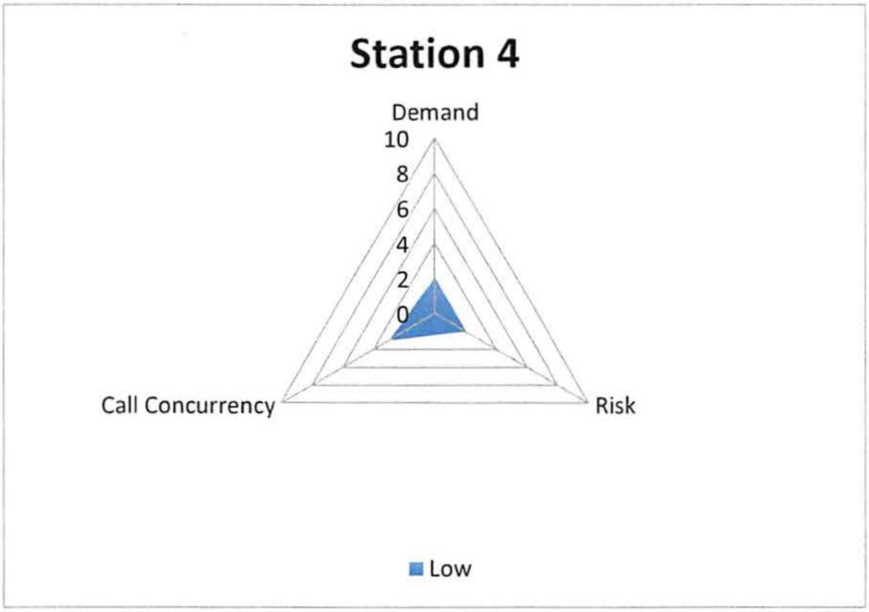
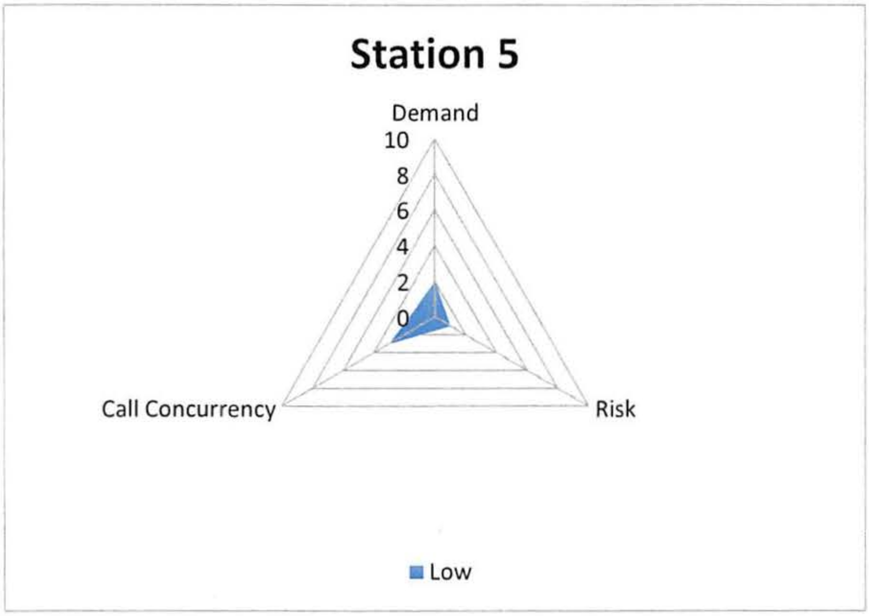


Figure 83: Station 5 Risk Profile



SECTION 5: Percentile Calculations & Purpose in Emergency Services

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Purpose

Various national groups endorse or mandate the use of percentile/fractile evaluations when assessing public safety departments. These include the National Fire Protection Association (NFPA) as outlined in NFPA 1221[24] and NFPA 1710[25], National Emergency Number Association's Standard NENA 56-005[26], as well as the Center for Public Safety Excellence's Standard of Cover document[27]. The use of 90th, 95th, or even 99th percentile evaluations in fire and EMS services is a best practice in the industry. While many organizations will report performance using 'average response time', the utility of this approach is quite limited. If one assumes a normal distribution of fire or EMS response times, which in reality they are not, then half of the time the response time performance is better than average and half the time the performance is worse. When asking policy makers to establish a performance goal for significant incidents within their community, doing so as a 50/50 proposition does little to reassure the citizen. When framing the performance goal at a 90th percentile, policy makers are ensuring that 9 out of 10 times the performance will be achieved. Because of the nature of public safety events, providing a 100% assurance of performance is both costly for almost all communities and essentially unrealistic.

Performance measurement and benchmarking performance have been consistent themes in public administration for decades. Within fire and EMS services, the most often cited measure is that of response time.[28] Yet problems with "definitional ambiguity" often make comparisons between communities quite challenging.[29] Across the nation, agencies may utilize any number of response time definitions. In fact, the definition technically involves defining a time interval's two endpoints – when the response time clock starts and when it stops. The Figure below highlights the generally utilized timestamps along the response time continuum along with the associated time intervals most often evaluated.

[24] National Fire Protection Association. (2016). NFPA 1221: Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems. Quincy, MA: NFPA

[25] National Fire Protection Association. (2016). NFPA 1710: Standard for the Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments. Quincy, MA: NFPA

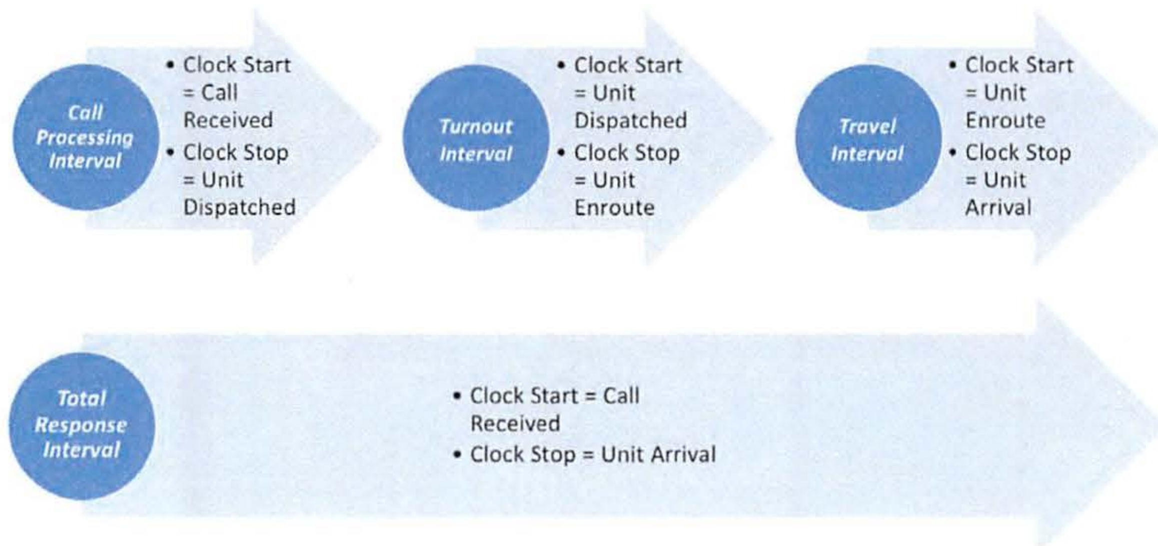
[26] National Emergency Number Association. (2006). NENA 56-005 Call Answering Standard/Model Recommendation.

[27] Center for Public Safety Excellence. (2016). Community Risk Assessment: Standards of Cover, 6th Edition. Chantilly, VA: CPSE.

[28] Flynn, J. D. (2009). *Fire Service Performance Measures*. National Fire Protection Association. Quincy, MA:

[29] Moeller, B. (2001). *Measuring performance in the public sector: An examination of benchmarking paramedic response times.* (Doctor of Philosophy PhD), Florida Atlantic University.

Figure 84: Response Time Components & Intervals



A comprehensive analysis of response time is best accomplished by assessing both the average and percentage performance for each component of response time. These intervals, and their associated timestamps are defined below.

Figure 85: Response Time Continuum & Associated Intervals with Timestamps

Interval Name	Clock Start Timestamp	Clock Stop Timestamp
Call Processing Interval	Call Received	Units Dispatched
Turnout Interval	Unit Dispatched	Unit Enroute
Travel Time Interval	Unit Enroute	Unit Arrived
Total Response Interval	Call Received	Unit Arrived

In practice, the ability to accurately evaluate any response time interval is dependent on a number of factors. The first timestamp within the computer-aided dispatch (CAD) system may reflect any number of discrete events – the time the 911 call was received, the first keystroke of a call-taker filling out the incident form, the geo-validation of the incident address, or other timestamps depending on the specific 911 phone system and/or CAD system in use. In addition, the failure of a dispatcher or first responder to accurately report or record their activity may also impact the timestamps available upon which to calculate a specific response time interval. Since each interval is calculated separately, as defined above, both the start and stop timestamps must be available. When a timestamp is missing, as is often the case in a small number of CAD records, then that specific record is not included in the assessment of the average or fractile (e.g. 90^{th}) percentile calculation. The failure to include these small number of records is not significant in most cases as it is assumed the missing timestamp was the result of random error.

Definition of Percentile

An important consideration in any significant data analysis involves the count and/or percentage of records you have available for analysis. As data sets grows larger, any differences in the following methods tend to disappear. For example, if you had 1,000 records to analyze, then the top ten percent would consist of 100 records. Therefore, the probability that values would be clustered around the 90th percentile would be quite high, and any differences in the output from various methods would be minor. If evaluating a data set of 10,000 records, any differences would be even smaller and likely irrelevant. There are several methods which can be used to calculate a percentile. The following discussion highlights a few of the commonly used approaches.

Rank Order:

The value under which 'X' percent of the data fall. If using a set of 100 records, the 90th percentile would be the value under which 90 percent of all the data fall. In the example of 100 records, it would be the 91st value when sorted in rank order. In a data set of 10, it would be the 9th value.

Interpolation:

This method is based on linear interpolation and is used when the percentile sought is not necessarily a whole number. For example, the 90th percentile in a set of 100 records sorted in rank order is 90. We know that because we multiply the desired percentile (e.g. 90th) by the number of records in the data set. However, if we needed to find the 90th percentile with a set of only 25 records sorted in rank order, then we would multiply 25 by 0.9, which would result in a value of 22.5. There may be no value of 22.5, so we would need to either round up or round down depending on the adjacent values to 22.5.

A more precise method is easily obtained through the use of Microsoft Excel or other statistical software. A more robust discussion for calculating interpolated percentiles can be found from a variety of sources should the reader desire. An expanded discussion can also be found from The Center for Public Safety Excellence.[30]

Regardless of the program you use, document the formula you use and, if possible, be prepared to explain its operation. However, the most important issue is to be consistent in the method utilized and document it's approach so that you can do it the same way each time and communicate these methods to your backup and successor.

Example

In the Figure below is a small set of 10 CAD records reflecting the calculated values for Call Processing, Turnout, Travel and Total Response Time Intervals.

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[30] Derived from The Center for Public Safety Excellence (2016). Community Risk Assessment: Standard of Cover, 6th Edition. Author: Chantilly, VA. pp. 85-87.

Figure 86: Example of 10 CAD Records & Response Time Intervals

Call #	Call-Processing Time	Turnout Time	Travel Time	Total Response Time
2018-0001	1	2	4	7
2018-0002	2	3	6	11
2018-0003	3	1	8	12
2018-0004	2	3	7	12
2018-0005	1	1	5	7
2018-0006	1	2	6	9
2018-0007	2	1	3	6
2018-0008	3	3	4	10
2018-0009	2	1	7	10
2018-0010	1	2	5	8

We then take these same time intervals – by each category – and sort them in rank order in ascending fashion, as reflected in the Figure below. The highlighted cells reflect the 9th out of 10 values for each response time interval. Of particular note is that when examining all the 90th rank order values below, the Total Response Time does not equal the sum of the sub-components within the same row, that is Call Processing, Turnout and Travel times. The reason for this unexpected finding is that as reflected in the full CAD records above, there are some incident times where there is a slow turnout time on the same call where there is a shorter travel time. In another incident, the opposite may be true. Since each response time interval is calculated separately based on the definition defined earlier, the 90th percentiles often will not sum exactly to the Total Response Time.

Figure 87: Response Time Intervals in Rank Order

Call-Processing Time	Turnout Time	Travel Time	Total Response Time
1	1	3	6
1	1	4	7
1	1	4	7
1	1	5	8
2	2	5	9
2	2	6	10
2	2	6	10
2	3	7	11
3	3	7	12
3	3	8	12

The Figure below reflects the results of Average and 90th percentile calculations for the CAD records above. Both the rank order and interpolated 90th percentile (calculated with Microsoft Excel) are shown. In this small data set, note the difference (highlighted) in Travel Time depending on the method used for the calculation.

Figure 88: Response Time Calculations on Small Data Set

Method	Call-Processing Time	Turnout Time	Travel Time	Total Response Time
Average (Mean)	1.8	1.9	5.5	9.2
90th Rank Order Percentile	3.0	3.0	7.0	12.0
90th Percentile.exc (Excel)	3.0	3.0	7.9	12.0

FITCH & ASSOCIATES

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Sheboygan Fire Department

Fitch Study Recommendations

Committee of the Whole Meeting 1/14/2019

Chief Michael Romas

Recommendations

1. Program Accounting Change

- A. This is up to Finance and I will follow their direction
- B. No reduction to budget or staff

Recommendations

2. Ambulance Replacement Schedule

- A. 2014 proposal to refurbish ambulance fleet.
- B. Future capital budget requests spreading out purchase of ambulance fleet.
    - 2022 - one
    - 2023 - two
    - 2024 - one

Recommendations

3. Additional Administration Resources

- A. Fire 2020 Plan
- B. Added Battalion Chief in July of 2017
- C. Ongoing department reorganization involving ACs and both civilian positions

Recommendations

4. Codify Performance Baseline

- A. Working on this 2014
- B. EMD Program start and updates have delayed this process