City of Spokane Fire Department

Washington

Level of Service Study

2017

Emergency Services Consulting International

Introduction

The following report evaluates the resources, risks served, and current capability of the Spokane Fire Department. Much of the study follows closely the Center for Fire Public Safety Excellence (CPSE) Standards of Coverage model that develops written procedures to determine the distribution and concentration of a fire and emergency service agency's fixed and mobile resources. The purpose for completing such a document is to assist the agency in ensuring a safe and effective response force for fire suppression, emergency medical services, and specialty response situations.

Creating this document required that a number of areas be researched, studied, and evaluated. This report will begin with an overview of both the community and the agency. Following this overview, the plan will discuss topics such as community risk assessment, critical task analysis, agency service level objectives, and distribution and concentration measures. The report will provide analysis of historical performance and will conclude with policy and operational recommendations.

ESCI extends its appreciation to the elected and appointed officials of the City of Spokane, the Spokane Fire Department, and all others who contributed to this study.

Table of Contents

Table of Figures

Executive Summary

This document describes Spokane Fire Department's community risks, response resources, deployment strategies, and service levels. It uses response time goals and standards to measure the effectiveness of fire department services and the deployment of its resources. The document is segregated into components generally based on the format recommended by the *Center for Public Safety Excellence Standards of Coverage and Deployment Plan* (5th edition).

The Spokane Fire Department (SFD) is a direct operating department of City of Spokane and provides fire protection, rescue, and advanced life support (ALS) emergency medical services to the community. The department's service area encompasses all of the area within the governmental boundaries of the City of Spokane.

The City of Spokane has a resident population of 214,500.[1] It is estimated that employment brings an additional 30,271[2] people into the city, raising the SFD's daytime service population to approximately 244,771.

The department serves an area of approximately 69.5 square miles. The department operates 16 fire stations and 46 apparatus. The SFD provides regional emergency call receipt and dispatch service.

The Washington Survey and Rating Bureau (WS&RB) reviews the fire protection resources within communities and provides a Community Fire Protection Rating system from which insurance rates are often based. The rating system evaluates four primary areas: the emergency communication and dispatch system, the fire department, community risk mitigation, and the community's pressurized hydrant or tanker-based water supply. The overall rating is then expressed as a number between 1 and 10, with 1 being the highest level of protection and 10 being unprotected or nearly so. As of the latest rating, WS&RB gave the service area a rating of Class 3 for properties within 1,000 feet of a fire hydrant or other recognized water supply and five road miles of a fire station.

The analysis completed during this study revealed a number of important findings. These include:

- Total response workload has increased 73 percent over the past 13 years.
- 71.9 percent of all responses are requests for emergency medical service.
- Response workload is greatest in the city's central core and in the area of Fire Station 18.
- Eight SFD fire engines exceed 10 percent unit hour utilization.
- The current fire department services utilization rate is 189 incidents per 1,000 population. This is higher than typical for similar sized communities.
- The amount of time CCC takes to dispatch fire department response units is faster than SFD's performance goal.
- Fire department turnout times are significantly longer that its performance goals

[1] Washington State Office of Financial Management
[2] City-Data.com

- Although nearly the entire city is within 4 travel minutes of a fire station, the amount of time response units spend traveling to an incident significantly exceeds SFD's performance goal.
- 66 percent of priority EMS incidents within the SFD service area met its five-minute response time goal. Only 47 percent of priority fire and special operations incidents within the SFD service area met its 5 minute 20 second response time goal.
- Response times to deliver the full effective response force exceed the SFD performance goal by 4 minutes 49 seconds for moderate risk buildings and by 7 minutes 52 seconds for commercial properties
- Significant portions of the SFD service area cannot be provided with the effective response force within the time specified in the SFD performance goal.
- SFD arrived at an emergency medical incident first ahead of the ambulance 76 percent of the time.

An analysis of the City of Spokane's population density reveals that it is primarily of two classifications: urban and suburban. The Spokane City Council, however, has determined that its response performance objectives should be uniform across the entire city; thus the city will be evaluated as one designation--urban.

A Performance Statement and Standards for the services provided by the Spokane Fire Department to the City of Spokane have been developed. These further define the quality and quantity of service expected by the community and consistently pursued by the Spokane Fire Department.

Overall Performance Statement

For the purpose of analysis, the following performance statement and response performance standards will be used. The performance statement is the SFD Mission Statement describing its major programs and efforts. The response performance standards are based on *National Fire Protection Association Standard 1710 (Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments)* and by the City of Spokane.

Performance Statement (Mission Statement)

We enhance your quality of life, always earning your trust, by saving lives, preventing harm and protecting property with compassion and integrity.

In addition to the overall performance statement, the following response-specific performance standards have been used to evaluate current capability and recommend deployment and service delivery improvements.

1. **Turnout time** – the period of time from initial dispatch to initiation of travel toward the incident.
    - Fire and special operations incidents – Within 80 seconds, 90 percent of the time
    - All other incidents – Within 60 seconds, 90 percent of the time
2. **Response time for the first arriving response unit** – the period from notification of fire department response personnel of the incident to the arrival of the first unit at the scene of the incident.
    - Fire and special operations incidents – Within 5 minutes 20 seconds, 90 percent of the time
    - All other incidents – Within 5 minutes, 90 percent of the time
3. **Response time for the first fire department advanced life support medical unit at a priority emergency medical (EMS) incident** – the period from notification of fire department response personnel of the EMS incident to the arrival of the first fire department advanced life support unit at the scene of the incident.
    - Within 9 minutes, 90 percent of the time
4. **Response time for full first alarm assignment at a structure fire incident** – the period of time from notification of fire department response personnel of the incident to the arrival of all of the first alarm units at the scene of the incident.
    - Within 9 minutes 20 seconds, 90 percent of the time
5. **Response time for arrival of the first fire department unit at a technical rescue incident** – the period from notification of fire department response personnel of the technical rescue incident to the arrival of the first fire department unit.
    - Within 8 minutes 30 seconds, 90 percent of the time
6. **Response time for arrival of the first fire department unit at a marine technical rescue incident** – the period from notification of fire department response personnel of the marine rescue incident to the arrival of the first fire department unit.
    - Within 8 minutes 30 seconds, 90 percent% of the time
7. **Response time for arrival of first fire department unit at a hazardous materials incident** – the period from notification of fire department response personnel of the hazardous materials incident to the arrival of the first fire department unit.
    - Within 9 minutes, 90 percent of the time

The analysis conducted during the evaluation phase of this process identified a number of opportunities to improve service (improvement recommendations). The following improvement goals are offered for consideration. These goals and specific recommendations for each are described in more detail at the end of this report (Component G).

RECOMMENDATIONS

A. *Reduce turnout time and improve the accuracy of enroute time reporting* – The analysis indicates that turnout time well exceeds SFD's goal. Improvement will reduce overall turnout times. Technology should also be implemented to ensure enroute time is accurately reported to the dispatch center.

B. *Develop the ability to audit CAD closest unit recommendations* – SFD's computer-aided dispatch system calculates the closest unit to an incident based on travel time. This data should be captured and used to improve system performance.

C. *Install emergency vehicle pre-emption equipment on all controlled intersections* – Giving response units the ability to turn traffic signals green in their direction and red in all others will improve both incident travel times and motorist safety.

D. *Implement dynamic redeployment practices* – Procedures should be developed to move response units within the system to cover areas vacated due to non-response related resource movements (i.e. training) and during times of high incident activity.

E. *Increase the number of alternative response units (ARU) in the system and increase ARU hours of service* – Analysis demonstrated that additional ARUs can provide a lower cost alternative for improving first-due response time.

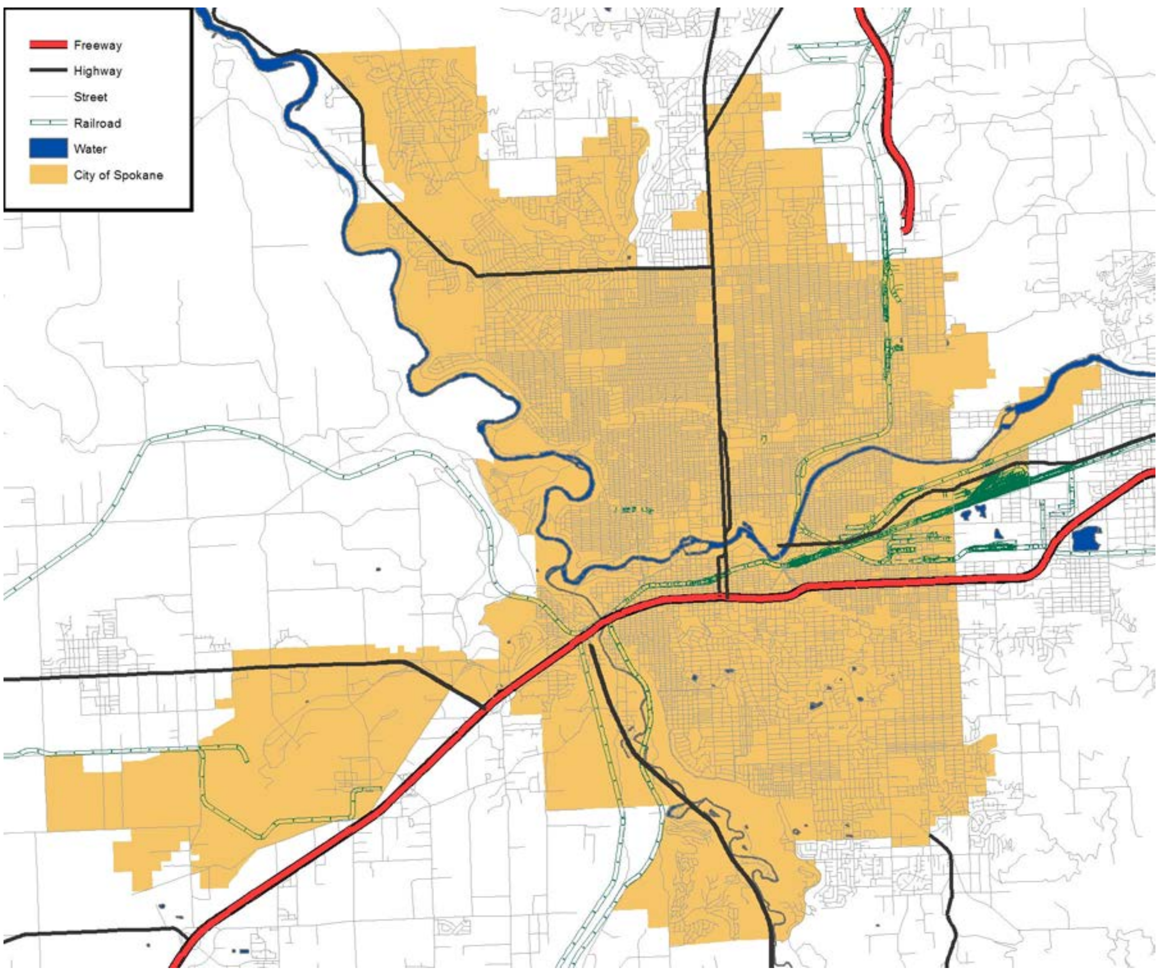
F. *Add stations, apparatus, and firefighters to improve delivery of an effective response force* – Several areas of the city cannot be provided sufficient apparatus and personnel for multiple unit responses such as structure fires. Additional resources are recommended to improve effective response force coverage.

Component A – Description of Community Served

Background

The City of Spokane is located in the northeast corner of the state of Washington and is the state's second largest city. The city covers an area of 69.5 square miles. The City of Spokane has a resident population of 214,500.[3] It is estimated that employment brings an additional 30,271[4] people into the city, raising the SFD's daytime service population to approximately 244,771.

Figure 1: City of Spokane



[3] Washington State Office of Financial Management
[4] City-Data.com

The City of Spokane has a rich history shaped originally by 18th century pioneers. The city was incorporated as "Spokan Falls" in 1881. The city's official name became Spokane in 1891. A major fire destroyed portions of the city in August 1889. During its rebuilding, Spokane replaced old wood buildings with structures of stone and brick.

Spokane experienced periods of rapid growth and periods of population decline during the next century. Its early years saw Spokane's population grow from 350 in 1880 to over 100,000 by 1910. Spokane's commercial and industrial strength blossomed during the World War II years. The community's growth has continued to its current population of 214,500.

Governance and Lines of Authority

The City of Spokane is a municipal corporation and operates as a charter city that is provided the authority to levy taxes for operating a fire protection system. The city operates under a strong mayor form of governance and the Mayor and City Council are provided with necessary power and authority to govern the provision of fire protection and emergency services. The City Council maintains strictly policy-level involvement, avoiding direct management and hands-on task assignment, an arrangement established within the city charter.

Organizational Finance

Financial oversight of Spokane Fire Department is the responsibility of the Mayor and City Council. The Fire Chief is appointed by the Mayor (subject to approval by the City Council) and is tasked with responsibility for fire and life safety services within the city.

The city uses a one-year budget cycle to prepare the annual operating budget and capital improvement plan based on a January through December fiscal year. The total fire department budget for fiscal year 2013 is $46,275,263, including the General Fund, Combined Communications Center Fund, Combined Communications Building Fund, and Emergency Medical Services Fund.

Revenue for the fire department is received through the general revenue of the city and through SFD service fees and charges. A large segment of municipal revenue is property tax receipts and, to a lesser degree, fees for service and other revenues. The total revenue generated by the fire department for fiscal year 2017 is expected to be $57,022,696.

The following figure lists the sources and amount of revenue for Spokane Fire Department for the current and previous four fiscal years.

Figure 2: Revenue

Revenue	Actual FY 2013	Actual FY 2104	Actual FY 2015	Actual FY 2016	Budget FY 2017
Taxes	7,295,251	7,431,462	7,651,464	7,713,012	8,265,000
Fire Safety Permits	306,733	367,170	350,036	368,240	350,000
Intergovernmental Revenue	11,208	26,641	2,623,199	1,274,564	8,821,816
Services	817,228	1,060,487	1,341,100	893,807	884,000
Ambulance Contract - Fines	105,540	168,780	234,600	248,700	132,000
Miscellaneous Revenue	(17,808)	39,977	61,964	110,476	69,880
Disposal of Fixed Assets		12,005	11,713	1,780	
General Fund	34,041,999	34,900,000	36,295,000	37,200,000	38,500,000
TOTAL	**42,560,151**	**44,006,522**	**48,569,076**	**47,810,579**	**57,022,696**

The next figure shows the expenditure history for the previous four fiscal years and the current year. Four major divisions of the budget are shown.

Figure 3: Budget/Expenditures by Year and Category

Expenditures	Actual FY 2013	Actual FY 2014	Actual FY 2015	Actual FY 2016	Budget FY 2017
Fire Prevention	1,996,534	1,480,576	1,924,711	2,023,051	2,078,457
Fire Suppression/EMS	37,997,093	34,877,519	37,355,793	37,424,825	37,577,631
Administration	1,346,430	7,795,412	5,003,500	4,406,374	4,626,584
Apparatus and Equipment	587,525		965,946	876,418	821,765
Facilities	532,300	186,205	697,416	682,106	652,053
Training	560,325	120,238	1,158,329	1,024,317	1,131,883
Grant Expenditures	1,288	19,101	1,680,813	1,175,318	4,788,930
Total	**43,021,495**	**44,479,050**	**48,786,508**	**47,612,410**	**51,677,303**

During the five-year period, the department's overall budget increased 20.1 percent.

SERVICE AREA OVERVIEW

The Spokane Fire Department is a direct operating department of City of Spokane and provides fire protection, rescue, and emergency medical services to the community. The department's jurisdiction encompasses all of the governmental boundaries of the city.

The department serves an area of approximately 69.5 square miles. The department's services are provided from 16 fire stations.

The department maintains a fleet of 46 apparatus, including engines, ladder trucks, brush engines, and specialty vehicles. SFD provides regional emergency call receipt and dispatch service.

There are 313 individuals involved in delivering services to the jurisdiction. Staffing coverage for emergency response is through the use of career firefighters on 24-hour shifts. For immediate response and at full staffing, no less than 61 personnel would be on duty at all times.

The Washington Survey and Rating Bureau (WS&RB) reviews the fire protection resources within communities and provides a Community Fire Protection Rating system from which insurance rates are often based. The rating system evaluates four primary areas: the emergency communication and dispatch system, the fire department, community risk mitigation, and the community's pressurized hydrant or tanker-based water supply. The overall rating is then expressed as a number between 1 and 10, with 1 being the highest level of protection and 10 being unprotected or nearly so. As of the latest rating, WS&RB gave the service area a rating of Class 3 for properties within 1,000 feet of a fire hydrant or other recognized water supply and five road miles of a fire station.

Component B – Review of Services Provided

SERVICES PROVIDED

The Spokane Fire Department provides a variety of services, including fire suppression, advanced level emergency medical service, entrapment extrication, high-angle rescue, trench, confined space, and hazardous materials emergency response (Level A).

The following chart provides basic information on each of the department's core services, its general resource capability for that service, and information regarding staff resources for that service. Additional detail on service capabilities will also be provided throughout this document.

Figure 4: Core Services Summary

Service	General Resource/Asset Capability	Basic Staffing Capability per Shift
Fire Suppression	14 staffed engines 3 staffed truck companies 2 Quint Apparatus 2 command response units Additional automatic and mutual aid engines, aerials, and support units available	61 suppression-trained personnel Additional automatic and mutual aid firefighters available
Emergency Medical Services	13 Engines - ALS equipped 1 Engine BLS equipped 2 Ladder trucks - BLS equipped 2 ARUs – ALS equipped	232 certified emergency medical technicians 81 paramedics
Vehicle Extrication	3 Ladder Companies and one cross-staffed rescue equipped with hydraulic rescue tools, hand tools, air bags, cutting torch, stabilization cribbing, and combination cutter-spreader hydraulic rescue tool	All firefighters vehicle rescue trained
High-Angle Rescue	2 cross-staffed specialty rescue vehicles equipped with rescue-rated rope and all associated hardware	All personnel trained to the operations level. Ten personnel per shift trained to the technician level in high-angle rope rescue.
Trench and Collapse Rescue)	1 cross-staffed heavy rescue equipped with pneumatic shoring jacks, cribbing, limited lumber and hand tools for initial stabilization	All personnel trained to the operations level. Ten personnel per shift trained to the technician level in trench and collapse rescue.
Swift-Water Rescue	All engines and trucks equipped with throw bags, PFDs, and helmets. 2 cross-staffed water rescue vehicles with light boats and one rescue boat	All personnel trained to the operations level. Ten personnel per shift trained to the technician level in swift-water rescue.

Service	General Resource/Asset Capability	Basic Staffing Capability per Shift
Confined Space Rescue	1 cross-staffed heavy rescue equipped with tripod, cribbing, pneumatic shores, air monitoring equipment, basket stretchers, rescue-rated rope	All personnel trained to the operations level. Ten personnel per shift trained to the technician level in confined space rescue.
Hazardous Materials Response	1 Hazardous Materials response vehicle equipped with personal protective equipment, gas and radiation monitoring equipment, containment supplies, and non-sparking tools	All personnel trained to the operations level. Thirteen personnel per shift trained to the technician level in hazardous materials.

ASSETS AND RESOURCES

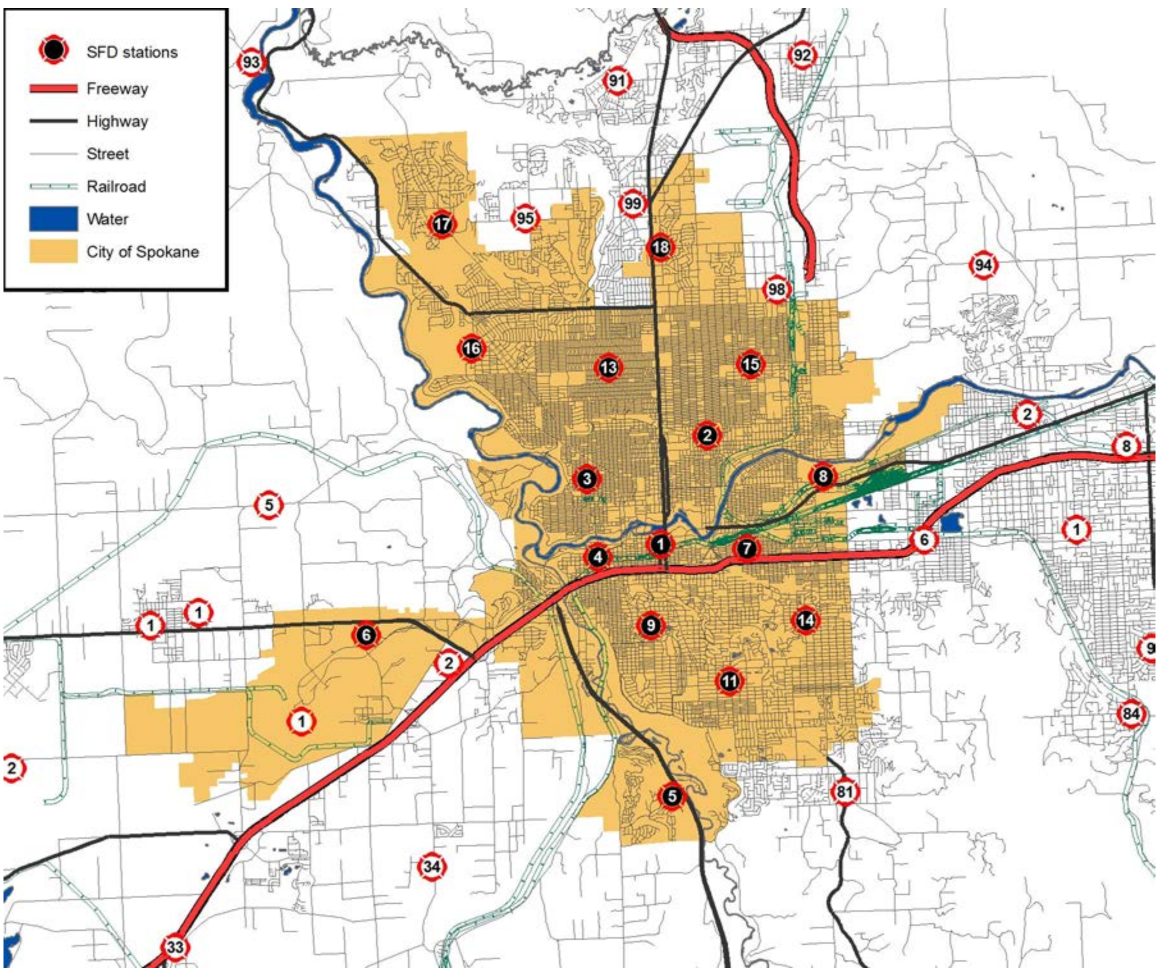
Fire Stations

Fire stations play an integral role in the delivery of emergency services for a number of reasons. A station's location will dictate, to a large degree, response times to emergencies. Fire stations also need to be designed to adequately house equipment and apparatus, as well as the firefighters and other personnel assigned to the station.

Station Location and Deployment

The SFD delivers fire, emergency medical service (EMS), and other emergency response from 16 fire stations located throughout the city. The following map shows the city boundaries and the locations of SFD and all adjacent agency fire stations.

Figure 5: Current Facility Deployment



Apparatus

Response vehicles are an important resource of the emergency response system. If emergency personnel cannot arrive quickly due to unreliable transport, or if the equipment does not function properly, then the delivery of emergency service is likely compromised. Fire apparatus are unique and expensive pieces of equipment, customized to operate efficiently for a specifically defined mission. The following figure lists apparatus assigned to each of the 16 SFD fire stations.

Figure 6: SFD Fire Stations and Apparatus

Station	Year	Apparatus	Unit #	Class
1	2009	Pierce	E1	Structural Engine
	2016	Pierce	L1	Ladder
	2001	Kenworth	Haz Mat 1	Haz Mat Unit
	1999	Ford F350	SU1	Support Unit - Rehab
	2005	Ford Explorer	ARU1	Alternative Response Unit
	2013	Chev K2500	S20	Battalion Chief
2	2005	Pierce	T2	Ladder
	2016	Pierce	E2	Pumper
	1991	Ford F350 4X4	R2	Rescue
	2012	Ford F350 4xX4	W2	Water Rescue
3	2009	Pierce	E3	Pumper
4	2009	Pierce	E4	Structural Engine
	2004	Pierce	L4	Ladder
	2000	International	SUSAR	USAR
	1993	Ford F350 4X4	R4	Rescue
5	2015	Ford 550	A5	Attack Engine
6	1990	Pierce	E6	Structural Engine
	2004	Ford F550 4X4	B6	Brush Engine
7	2016	Pierce	E7	Structural Engine
	2004	Ford F550	Haz Mat 7	Haz Mat Unit
	2004	Ford F550 4X4	B7	Brush Engine
8	2000	Pierce	E8	Pumper
	2000	Pierce	E54	Pumper
	2009	Dodge 5500 4X4	B8	Brush Engine
9	2000	Pierce	E9	Structural Engine
	2001	Pierce	R9	Rescue
	2002	Ford F350	Haz Mat 9	Haz Mat Unit
11	1992	Pierce	Q11	Ladder-Structural Engine
	2003	Ford F550 4X4	B11	Brush Engine
13	1992	Pierce	Q13	Ladder-Structure Engine
	2009	Chevrolet PU	S21	Battalion Chief
	2007	Chevrolet PU	S23	Battalion Chief
14	2000	Pierce	E14	Structural Engine
	2004	Ford F550 4X4	B14	Brush Engine
15	2009	Pierce	E15	Structural Engine
	2003	Ford F550 4X4	B15	Brush Engine
	2005	Ford Explorer	ARU15	ARU
16	2000	Pierce	E16	Pumper
	2002	Ford F350 4X4	R16	Rescue
	2003	Ford F550 4X4	B16	Brush
		Boat	W16	Rescue Boat

Station	Year	Apparatus	Unit #	Class
17	2000	Pierce	E17	Pumper
	2004	Ford F550	B17	Brush Engine
18	2016	Pierce	E18	Structural Engine
	1978	Van Pelt	L51	Reserve Ladder
	1991	Central States	E52	Reserve Pumper

SFD uses several types of apparatus as shown in the previous table. Some are further described as follows:

- Engine – Primary response unit from each station for most types of service requests. Each is equipped with a 1,500-gallon-per-minute pump and carries between 500 and 750 gallons of water.
- Ladder Truck – A specialized apparatus equipped with long ladders, salvage and overhaul equipment, and rescue tools. Used for structure fires, rescues, and other service requests.
- Brush Engine – Smaller fire engine with a 100 gallon-per-minute pump and 250 gallons of water. Used for wildland fires and for protecting structures from an approaching wildland fire.
- HazMat – Specialized response unit for containment and control of hazardous materials releases. It is accompanied by the Decon unit, which specializes in cleanup of contaminated persons and equipment.
- Rescue – Smaller unit primarily used for emergency medical response.
- ARU – Smaller unit used primarily for emergency medical response

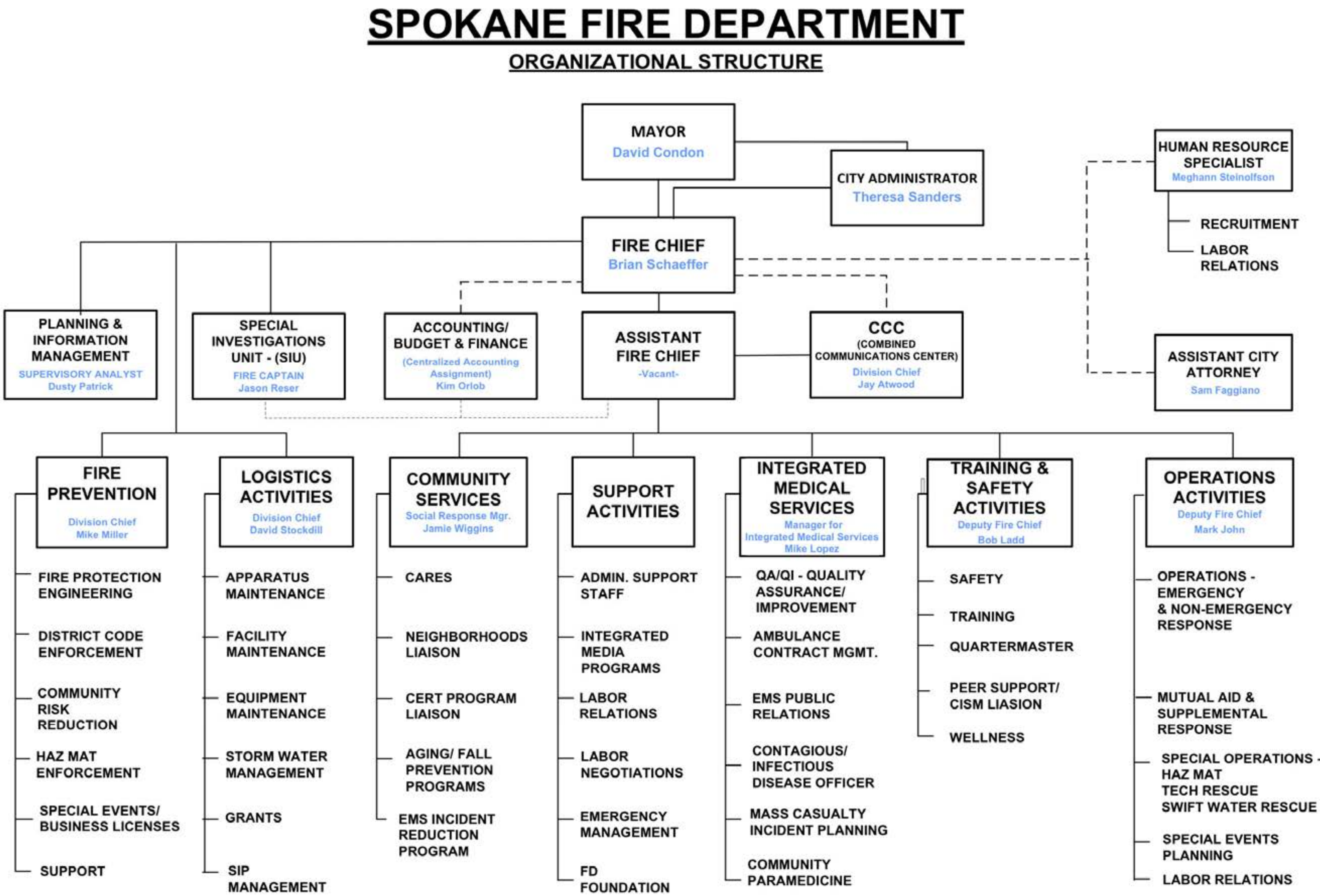
STAFFING INFORMATION

SFD provides staffing in four key areas: emergency services, risk mitigation (prevention), administration, and support.

Organizational Structure

SFD is organized in the typical top-down hierarchy. The chain of command is identified with common roles for a fire department of this size. The department's multiple facilities and its three-shift, 24-hour-per-day, seven-day-per-week operational schedule create numerous internal communications and management challenges. The SFD organizational chart is functional and primary roles are well identified.

Figure 7: Organizational Structure



Administration and Support Staff

One of the primary responsibilities of a department's administration and support staff is to ensure that the operational entities of the organization have the ability and means to accomplish their service delivery responsibilities to the public. Without sufficient oversight, planning, documentation, training, and maintenance, the operational entities of a department will struggle to perform their duties well. Like any other part of a fire department, administration and support require appropriate resources to function properly.

There are 313 individuals involved in delivering services to the City of Spokane. The department's primary management team includes a Chief, an Assistant Chief, two Deputy Chiefs, a Division Chief and Fire Marshal. Additional support personnel include office staff, training captain, mechanics and deputy fire marshals. SFD has 38 total administration and support staff.

Figure 8: Management, Administration, and Support Personnel by Position

Position	Employees
Fire chief	1
Assistant fire chief	1
Deputy fire chief	2
Logistics division chief	1
Fire marshal	1
Assistant fire marshal	1
Fire protection engineer	1
Deputy fire marshal	5
Community Risk Reduction Manager	1
Captain—Training	1
Office manager	1
Supervisory analyst	1
Senior analyst	2
Administrative secretary	1
Clerk III	2
Fire apparatus maintenance foreperson	1
Heavy equipment mechanic	3
Equipment servicer	1
Clerk II	1
Social Response Manager	1
Desktop Computer Specialist	1
Audio/Video Technician	1
Integrated Medical Services Manager	1
Lieutenant – Training	1
MSO	2
Investigator	3

Emergency Services Staff

It takes an adequate and well-trained staff of emergency responders to put the community's emergency apparatus and equipment to its best use in mitigating incidents. Insufficient staffing at an emergency decreases the effectiveness of the response and potentially increases damage and injury.

SFD uses career personnel to carry out emergency response functions. The following figure shows the distribution of emergency personnel by rank.

Figure 9: Emergency Response Personnel by Rank

Position	Employees
Battalion chief	9
Fire captain	20
Fire lieutenant	57
Fire equipment operator	84
Firefighter	105

SFD employs 275 emergency response personnel for EMS, rescue, and fire suppression activities. No less than 61 personnel are on duty at all times with an additional 6 during portions of the day. The resident population of the SFD service area is 214,500. SFD provides its community with 1.28 career firefighters per 1,000 population and 0.28 firefighters per 1,000 population on duty at all times. When employment population is included, the total personnel ratio drops to 1.12 and the on-duty personnel ratio drops to 0.25.

Methodology for Incident Staffing

This document will provide an analysis of how well SFD is doing at providing personnel and other resources for incidents within its primary service area. This data is important and can be an indicator of the effectiveness of its staffing efforts.

For larger incidents, SFD commonly acts together with one or more neighboring fire departments in providing fire and life protection through a coordinated regional response system of mutual and automatic aid agreements. This is particularly true for large structure fires, other high-risk incidents where staffing needs are great, and during periods of significant incident activity. This document will provide an overall view of aggregate staffing provided by SFD and neighboring agencies.

The prompt arrival of at least four personnel is critical for structure fires. Federal regulations (CFR 1910.120) require that personnel entering a building involved in fire must be in groups of two. Further, before personnel can enter a building to extinguish a fire, at least two personnel must be on scene and assigned to conduct search and rescue in case the fire attack crew becomes trapped. This is referred to as the two-in, two-out rule.

There are, however, some exceptions to this regulation. If it is *known* that victims are trapped inside the building, a rescue attempt can be performed without additional personnel ready to intervene outside the structure. Further, there is no requirement that all four arrive on the same response vehicle. Many fire departments rely on more than one unit arriving to initiate interior fire attack. SFD staffs fire engines with three firefighters, thus it must wait for a second unit to arrive before it can initiate interior fire attack operations in a non-rescue incident.

Some incidents (such as structure fires) require more than one response unit. The ability of SFD and its automatic aid neighbors to assemble an effective response force for a multiple unit incident within the specific period of time, also known as *resource concentration*, will be analyzed in a later section of this document.

The following figure lists each station, staffed unit, and the staffing assigned to each at minimum staffing.

Figure 10: Staffing Complement

Station	Year	Apparatus	Unit #	Class	Staffing
1	2009	Pierce	E1	Structural Engine	3
	2016	Pierce	L1	Ladder	4
	2001	Kenworth	Haz Mat 1	Haz Mat Unit	
	1999	Ford F350	SU1	Support Unit - Rehab	
	2005	Ford Explorer	ARU1	Alternative Response Unit	2 part-time
	2013	Chev K2500	S20	Battalion Chief	1
2	2005	Pierce	T2	Ladder	4
	2016	Pierce	E2	Pumper	3
	1991	Ford F350 4X4	R2	Rescue	
	2012	Ford F350 4X4	W2	Rescue	
3	2009	Pierce	E3	Pumper	3
4	2009	Pierce	E4	Structural Engine	3
	2004	Pierce	L4	Ladder	4
	2000	International	SUSAR	USAR	
	1993	Ford F350 4X4	R4	Rescue	
5	2015	Ford 550	A5	Attack Engine	2
6	1990	Pierce	E6	Structural Engine	3
	2004	Ford F550 4X4	B6	Brush Engine	
7	2016	Pierce	E7	Structural Engine	3
	2004	Ford F550	Haz Mat 7	Haz Mat Unit	
	2004	Ford F550 4X4	B7	Brush Engine	
8	2000	Pierce	E8	Pumper	3
	2000	Pierce	E54	Pumper	
	2009	Dodge 5500 4X4	B8	Brush Engine	
9	2000	Pierce	E9	Structural Engine	3
	2001	Pierce	R9	Rescue	
	2002	Ford F350	Haz Mat 9	Haz Mat Unit	
11	1992	Pierce	Q11	Ladder-Structural Engine	3
	2003	Ford F550 4X4	B11	Brush Engine	
13	1992	Pierce	Q13	Ladder-Structure Engine	3
	2009	Chevrolet PU	S21	Battalion Chief	1
	2007	Chevrolet PU	S23	Battalion Chief	
14	2000	Pierce	E14	Structural Engine	3
	2004	Ford F550 4X4	B14	Brush Engine	
15	2009	Pierce	E15	Structural Engine	3

Station	Year	Apparatus	Unit #	Class	Staffing
	2003	Ford F550 4X4	B15	Brush Engine	
	2005	Ford Explorer	ARU15	ARU	2 part-time
16	2000	Pierce	E16	Pumper	3
	2002	Ford F350 4X4	R16	Rescue	
	2003	Ford F550 4X4	B16	Brush	
		Boat	W16	Boat	
17	2000	Pierce	E17	Pumper	3
	2004	Ford F550	B17	Brush Engine	
18	2016	Pierce	18	Structural Engine	3
	1978	Van Pelt	L51	Reserve Ladder	
	1991	Central States	E52	Reserve Pumper	
				TOTAL ON-DUTYSTAFFING	**61 plus 4 part-time**

Spokane and other fire agencies in the area have developed a very comprehensive system for sharing resources. Regional fire agencies rely on the regional mutual and automatic aid agreements for major structure fires, other higher risk incidents, and during periods of high incident activity. Though this system is not a substitute for locally delivered services, it provides significant depth of coverage for unusual circumstances.

WASHINGTON SURVEY AND RATING BUREAU PUBLIC PROTECTION CLASSIFICATION

The Washington Survey and Rating Bureau (WS&RB) reviews the fire protection resources within communities and provides a Community Fire Protection Rating from which insurance rates are often based. The rating evaluates four primary areas: the emergency communication and dispatch system, the fire department, the community's fire safety and control efforts, and the community's pressurized hydrant or tanker-based water supply. The overall rating is then expressed as a number between 1 and 10, with 1 being the highest level of protection and 10 being unprotected or nearly so. As of the latest survey (2016) WS&RB gave SFD a rating of Class 3.

The emergency communications function includes the capabilities of the call receipt and dispatch system along with the quality and redundancy of communications systems between dispatchers and response units. WSRB gave 81 percent for this element. Deficiencies were noted in the facility's fire protection systems, security, and an insufficient number of telephones lines.

The fire department is evaluated on its ability to provide needed apparatus within specified distances of developed property, the pump capacity and equipment carried on those apparatus, and the number of personnel staffing each. In addition, the fire department is evaluated on its training programs and facilities. The fire department received 71 percent for this element. Deficiencies included insufficient numbers of firefighters on duty, insufficient company training, insufficient officer training, and inadequate pre-fire planning.

The water system is evaluated on the amount of storage, size of water mains, distribution and condition of fire hydrants, and the ability of the system to deliver needed quantities of water based on specific risks within the service area. The water system received 86 percent credit. Minor deficiencies were noted in the water supply system (when needed water flow from fire hydrants is compared to available water flow) and in the fire hydrant inspection and maintenance program.

The fire safety control function is evaluated on the city's fire code enforcement, public education, fire investigation, and building code enforcement efforts. The fire safety control function received 42 percent credit. Deficiencies were noted in the qualifications of the fire marshal, too infrequent fire code inspections of existing occupancies, insufficient public education in schools, and fire investigator qualifications.

CURRENT SERVICE DELIVERY STANDARDS

For the purpose of analysis, the following performance statement and response performance standards will be used. The performance statement is the SFD Mission Statement describing its major programs and efforts. The response performance standards are based on *National Fire Protection Association Standard 1710 (Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments)* and by the City of Spokane.

Performance Statement (Mission Statement)

We enhance your quality of life, always earning your trust, by saving lives, preventing harm and protecting property with compassion and integrity

In addition to the overall performance statement, the following response-specific performance standards have been used to evaluate current capability and recommend deployment and service delivery improvements.

1. **Turnout time** – the period of time from initial dispatch to initiation of travel toward the incident.
    - Fire and special operations incidents – Within 80 seconds, 90 percent of the time
    - All other incidents – Within 60 seconds, 90 percent of the time
2. **Response time for the first arriving response unit** – the period from notification of fire department response personnel of the incident to the arrival of the first unit at the scene of the incident.
    - Fire and special operations incidents – Within 5 minutes 20 seconds, 90 percent of the time
    - All other incidents – Within 5 minutes, 90 percent of the time
3. **Response time for the first fire department advanced life support medical unit at a priority emergency medical (EMS) incident** – the period from notification of fire department response personnel of the EMS incident to the arrival of the first fire department advanced life support unit at the scene of the incident.
    - Within 9 minutes, 90 percent of the time
4. **Response time for full first alarm assignment at a structure fire incident** – the period of time from notification of fire department response personnel of the incident to the arrival of all of the first alarm units at the scene of the incident.
    - Within 9 minutes 20 seconds, 90 percent of the time
5. **Response time for arrival of the first fire department unit at a technical rescue incident** – the period from notification of fire department response personnel of the technical rescue incident to the arrival of the first fire department unit.
    - Within 8 minutes 30 seconds, 90 percent of the time
6. **Response time for arrival of the first fire department unit at a marine technical rescue incident** – the period from notification of fire department response personnel of the marine rescue incident to the arrival of the first fire department unit.
    - Within 8 minutes 30 seconds, 90 percent of the time
7. **Response time for arrival of first fire department unit at a hazardous materials incident** – the period from notification of fire department response personnel of the hazardous materials incident to the arrival of the first fire department unit.
    - Within 9 minutes, 90 percent of the time

The SFD is not currently achieving most of these standards as will be demonstrated in a later section of this report.

Component C – Community Risk Assessment

This section analyzes certain categorical risks present within the SFD service area that potentially threaten the people and property within the community and that can create response workload for the SFD. These risks are examined to assist the SFD in identifying where to locate response resources in the types and numbers needed to effectively respond to likely emergencies.

Another very good reference describing community risks is the Spokane County Hazard Mitigation Plan. This document contains a great deal of information regarding risks within the region, including Spokane.

Although there are numerous fire stations operated by other agencies around Spokane, only some provide timely support to incidents within the city via automatic aid agreements. For purposes of illustration, only those stations and SFD stations are shown.

OVERALL GEOSPATIAL CHARACTERISTICS

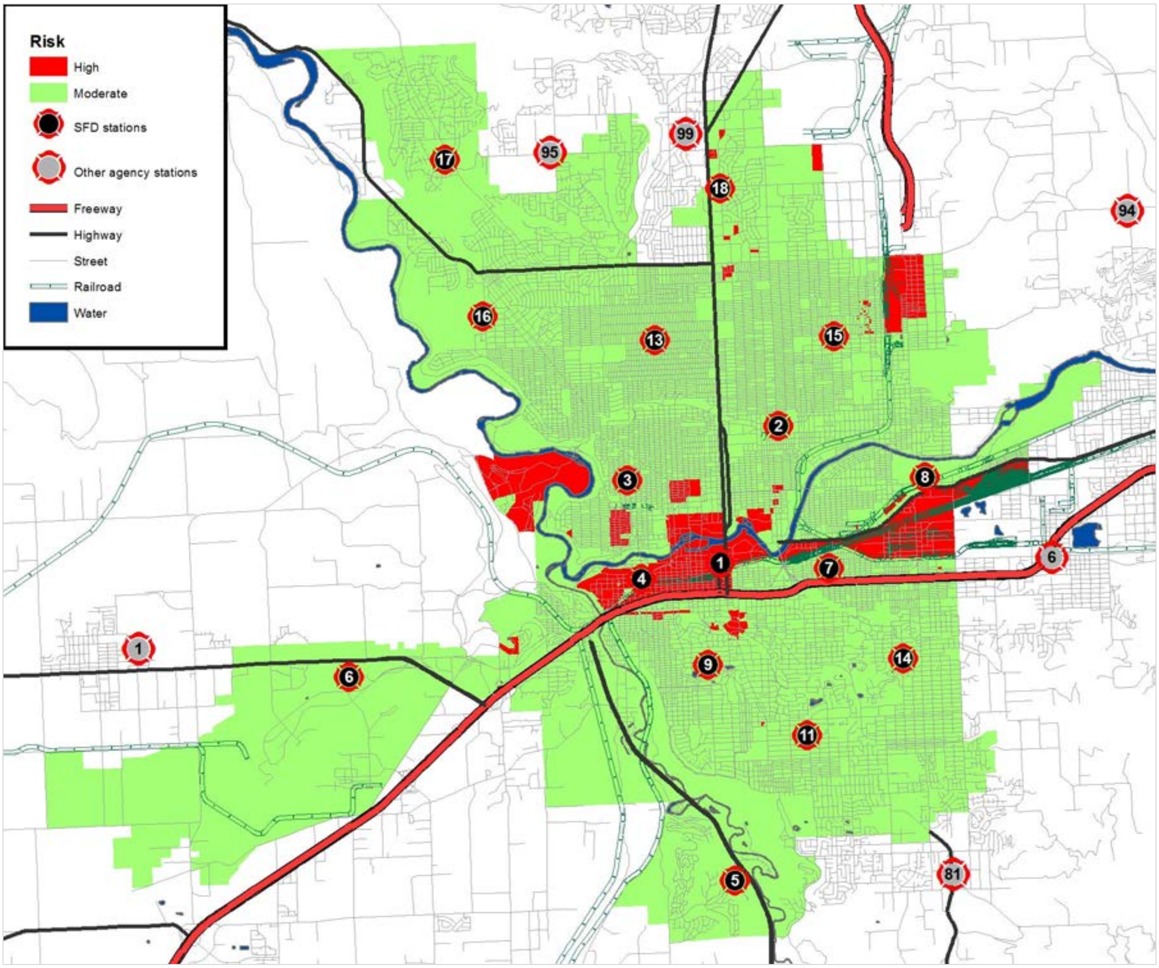
The fire service assesses the relative risk of properties based on a number of factors. Properties with high fire and life risk often require greater numbers of personnel and apparatus to effectively mitigate a fire emergency. Staffing and deployment decisions should be made with consideration to the level of risk within geographic sub-areas of a community.

The following community risk assessment has been developed based on intended land uses as described in the City of Spokane zoning designations. The following figure translates zoning to categories of relative fire and life safety risk.

- Low risk – Areas zoned and used for agricultural purposes, open space, and very low-density residential and uses.
- Moderate risk – Areas zoned for medium-density single family properties, small commercial and office uses, low-intensity retail sales, and equivalently sized business activities.
- High risk – Higher-intensity business districts, mixed use areas, high-density residential, industrial, warehousing, and large mercantile centers.

Most of the SFD service area is moderate risk. There are pockets of high risk mainly in the downtown area.

Figure 11: Fire and Life Safety Risk Based on Zoning



GEOGRAPHIC AND WEATHER-RELATED RISKS

Weather Risk

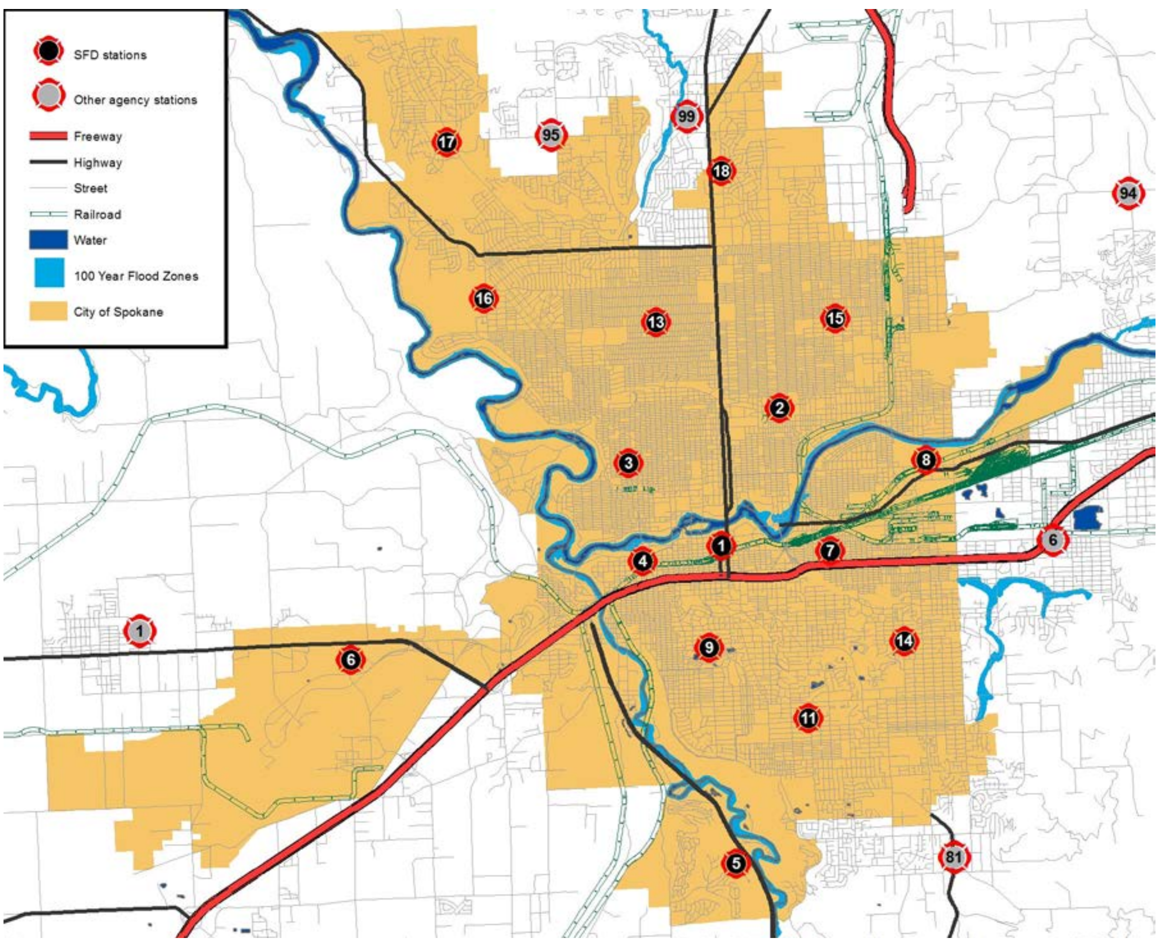
Spokane's location between the Cascade and Rocky Mountain ranges protects it from the normally moist climate experienced by much of the Pacific Northwest. Rainfall averages about 17 inches per year. In the winter, Spokane can get moderate to heavy snowfall averaging about 46 inches per year.

Mean high temperatures range from the low 80s in the summer to about 23° F in the winter. Extreme temperatures are rare. 90° F or more temperatures occur only 19 times per year on average. Temperatures below 0° F occur only 3.5 days per year on average.

Flood Risk

Waterway flooding is a risk within the community. During heavy rains, local streams overfill causing local area flooding. The following figure illustrates the area designated by FEMA as 100 year flood zones represented by the blue hashed shading on the map.

Figure 12: FEMA 100 Year Flood Zones

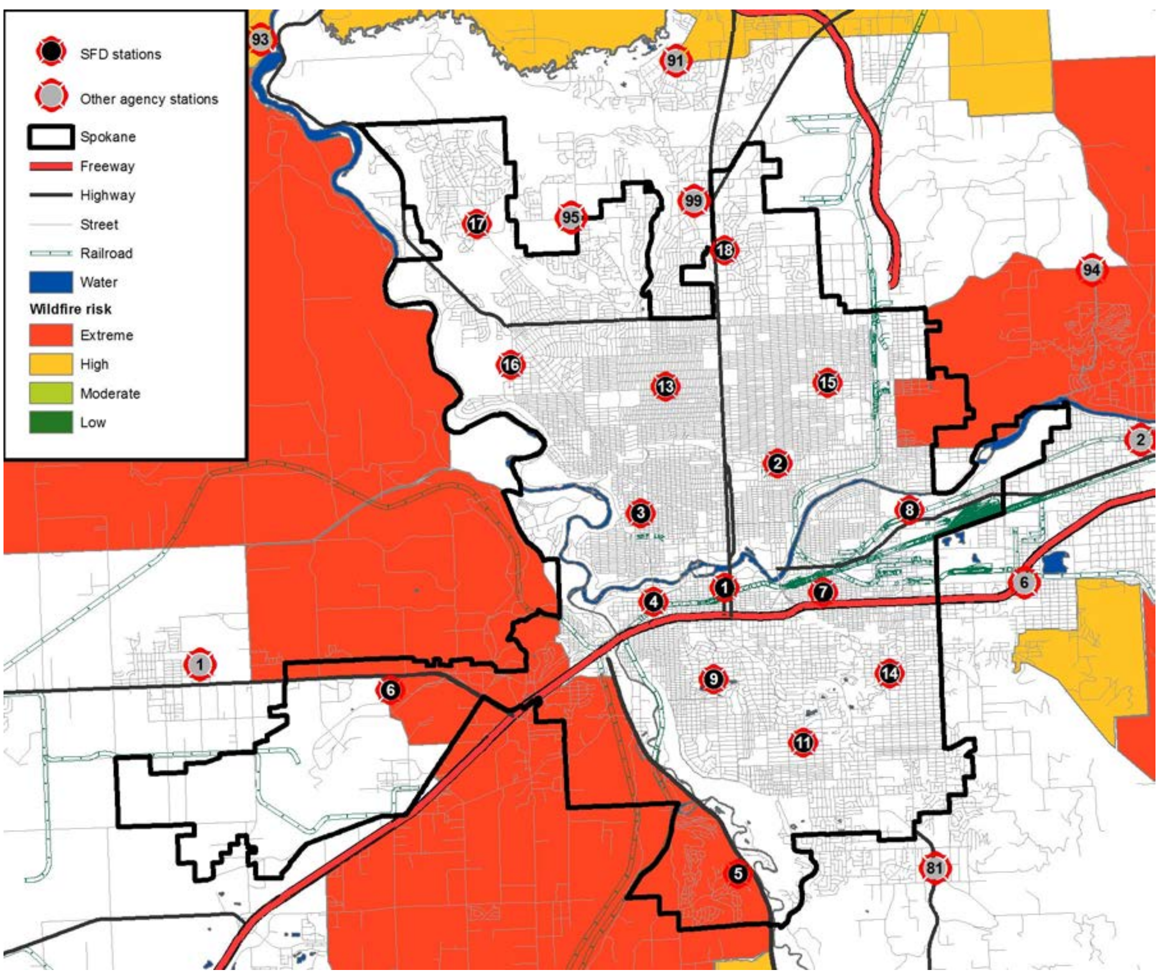


Wildfire Risk

Spokane's climate, vegetation, and topography make wildland fire a real risk to the community. Parts of the city have homes interspersed with large areas of natural vegetation. Many of these homes are located at the top of moderate to steep slopes, increasing the risk.

Historically, Spokane experiences rapidly moving wildland fires on a regular basis. Warm summer temperatures and strong winds can carry wildland fires into homes. Fuel types found in this region can support aggressive fire behavior. The following map illustrates higher risk areas in and near the city. This information was developed from the Washington Department of Natural Resources wildfire risk classification data.

Figure 13: Wildfire Threat



Geographic/Geological Risk

Certain geographic and geologic risks create situations that threaten the community or are physical barriers to street connectivity for emergency service response. Steep slopes, water barriers such as rivers, and other geographic features can impede rapid response.

Most of Spokane's urban area is relatively flat and does not present unusual risk. However, areas in the city's southwest do have moderate grades that can slow fire apparatus. The Spokane River traverses the city's center and follows the city boundary to the north.

The Spokane area has experienced earthquake activity in the past. Though not known as a seismically active area there is some risk to the community. The Spokane County Multi-Jurisdictional Hazard Mitigation Plan identifies this risk and recommended mitigation objectives.

The United States Geological Survey is conducting a seismic study of the Spokane area. They report,

> *In the summer and fall of 2001, a notable sequence of small earthquakes occurred at shallow depths beneath the Spokane urban area. This earthquake sequence has remained a mystery, with an unknown geological origin and uncertain implications for future damaging earthquakes. Some of these earthquakes were felt by thousands of people, and they had magnitudes of 4 or less. Residents of some neighborhoods in Spokane reported feeling brisk shaking or hearing explosion-like sounds accompanying the earthquakes. The depths of the earthquakes estimated from the seismic network and the explosion-like sounds indicate that the earthquakes were shallow – likely within the upper mile of the surface.*

TRANSPORTATION RISKS

Transportation corridors provide necessary access and egress for the department. The configuration of transportation systems can also affect the response capability of emergency services. Limited access freeways and rail lines can interrupt street connectivity, forcing apparatus to negotiate a circuitous route to reach an emergency scene.

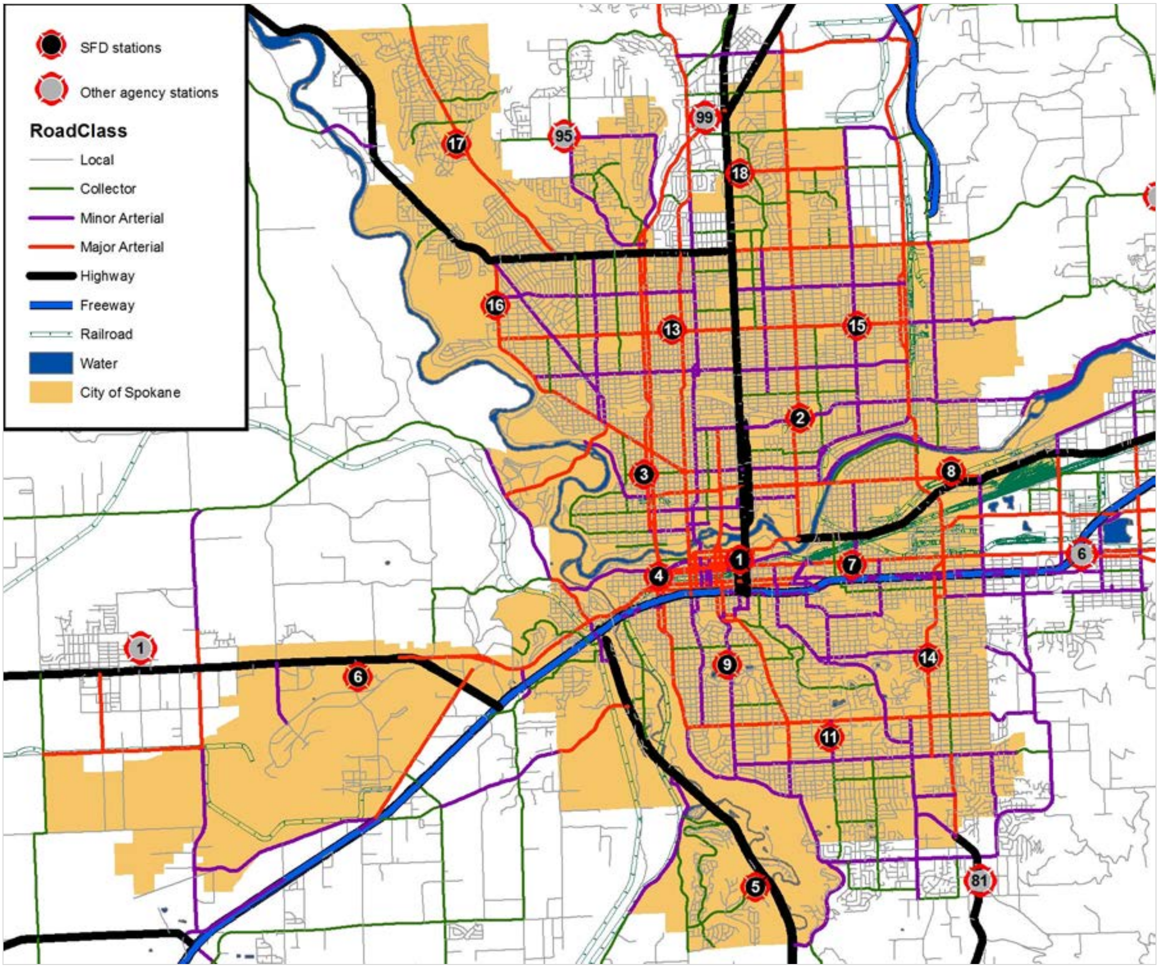
Roads

Spokane enjoys a well connected system of local, arterial, and limited access highways. Most areas are easily accessible from multiple pathways. Access to the city's southwestern region is limited by the Spokane River. Few crossings exist to allow response units from east of the river to serve the area to the west. The city's northwest area also has topography that limits street connectivity.

Interstate 90 is the major east-west corridor through northeast Washington. Numerous commercial vehicles carrying a variety of commodities transit this route. Trucks carrying hazardous materials transit the city frequently presenting a risk of release in highly populated areas in the event of an accident.

Roadways in the downtown and periphery can become quite congested during morning and evening commuting hours. This can slow the response to an emergency.

Figure 14: Street System



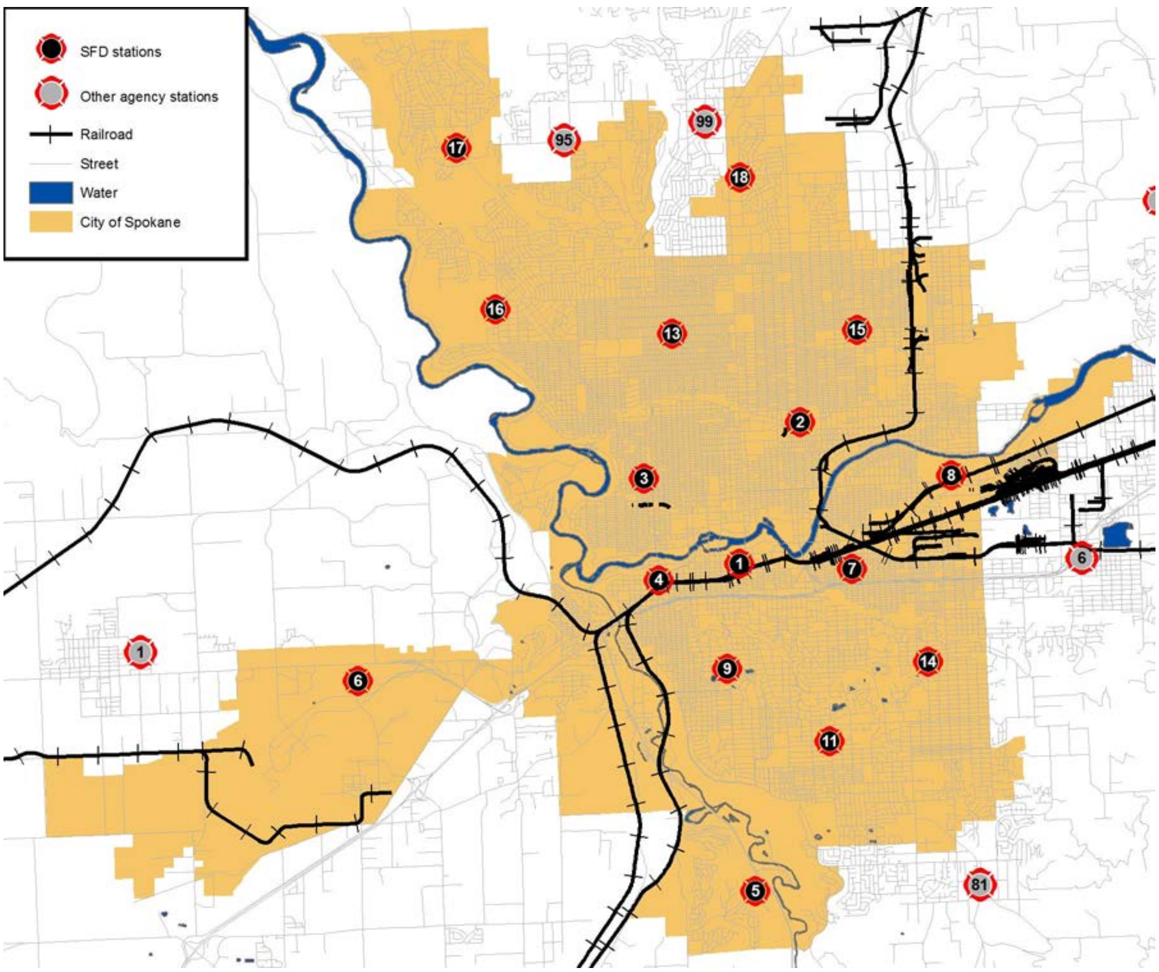
Some traffic signals within the service area are equipped with signal pre-emption equipment. This provides a significant response time performance advantage as well as improved safety to motorists.

Railroads

Burlington Northern and Santa Fe Railroad operates most of the rail lines that traverse the city. Union Pacific Railroad operates on the city's east-central area. All can cause delays in emergency vehicle response when trains are passing through. Some, but not all, of street crossings are grade-separated.

Also of concern with active rail lines is the amount of hazardous cargo carried by freight trains. Both Burlington Northern and Santa Fe (BNSF) and Union Pacific (UP) railroads transport thousands of railcars of hazardous materials through the city each year. Though rare, railroad accidents involving the release of hazardous materials can occur.

Figure 15: Railroads



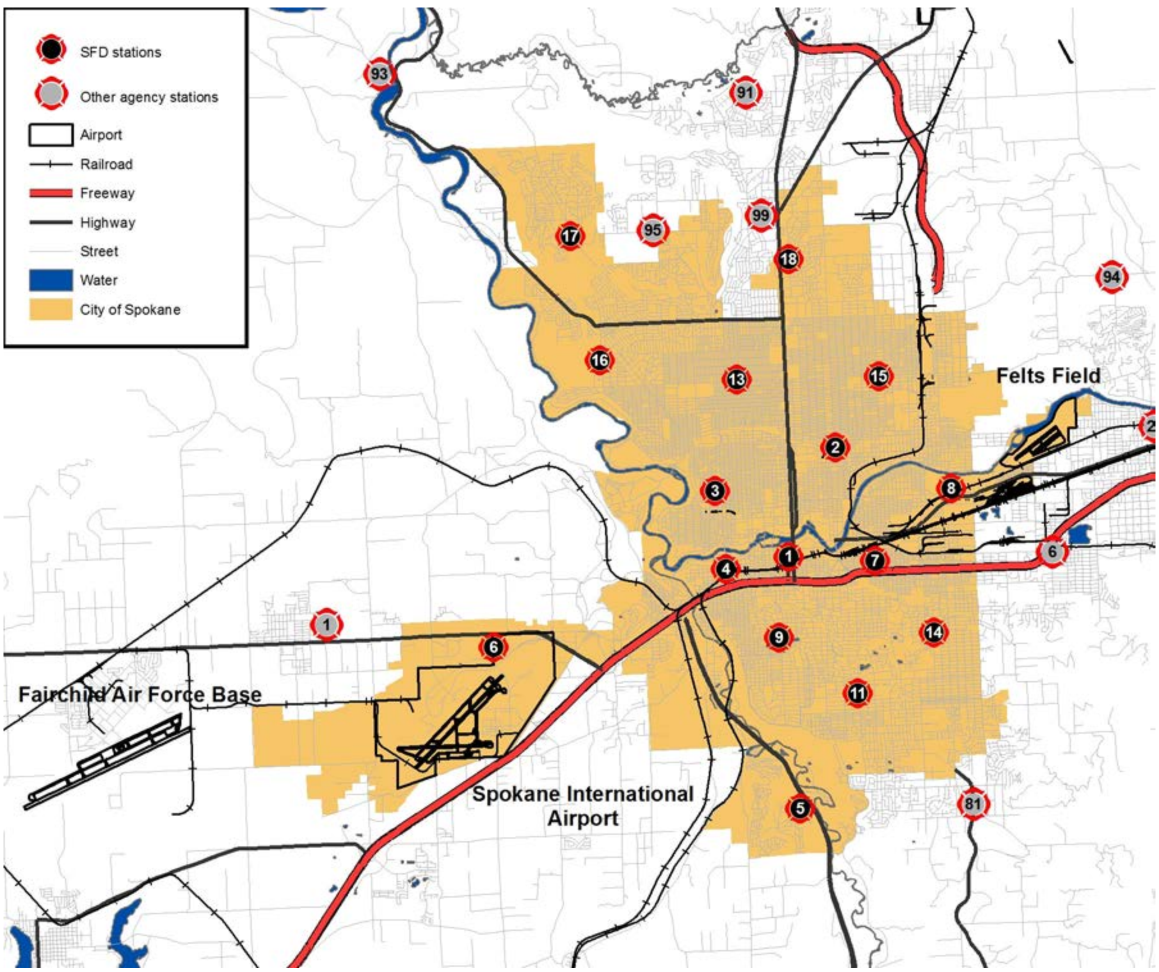
Airport

Spokane has two airports within the city and one military air base in close proximity.

Felts Field is a commercial and general aviation airport. It does not host scheduled service flight operations. Spokane International Airport serves scheduled service airline traffic and air freight operations. During 2012 the airport served over 67,000 flight operations (take-offs and landings) and over three million passengers. The airport provides its own aircraft crash rescue and firefighting (ARFF) services.

Just to the west of Spokane is the Fairchild Air Force Base. The base supports a number of military air missions including aerial refueling, training, and search and rescue.

Figure 16: Spokane Area Airports



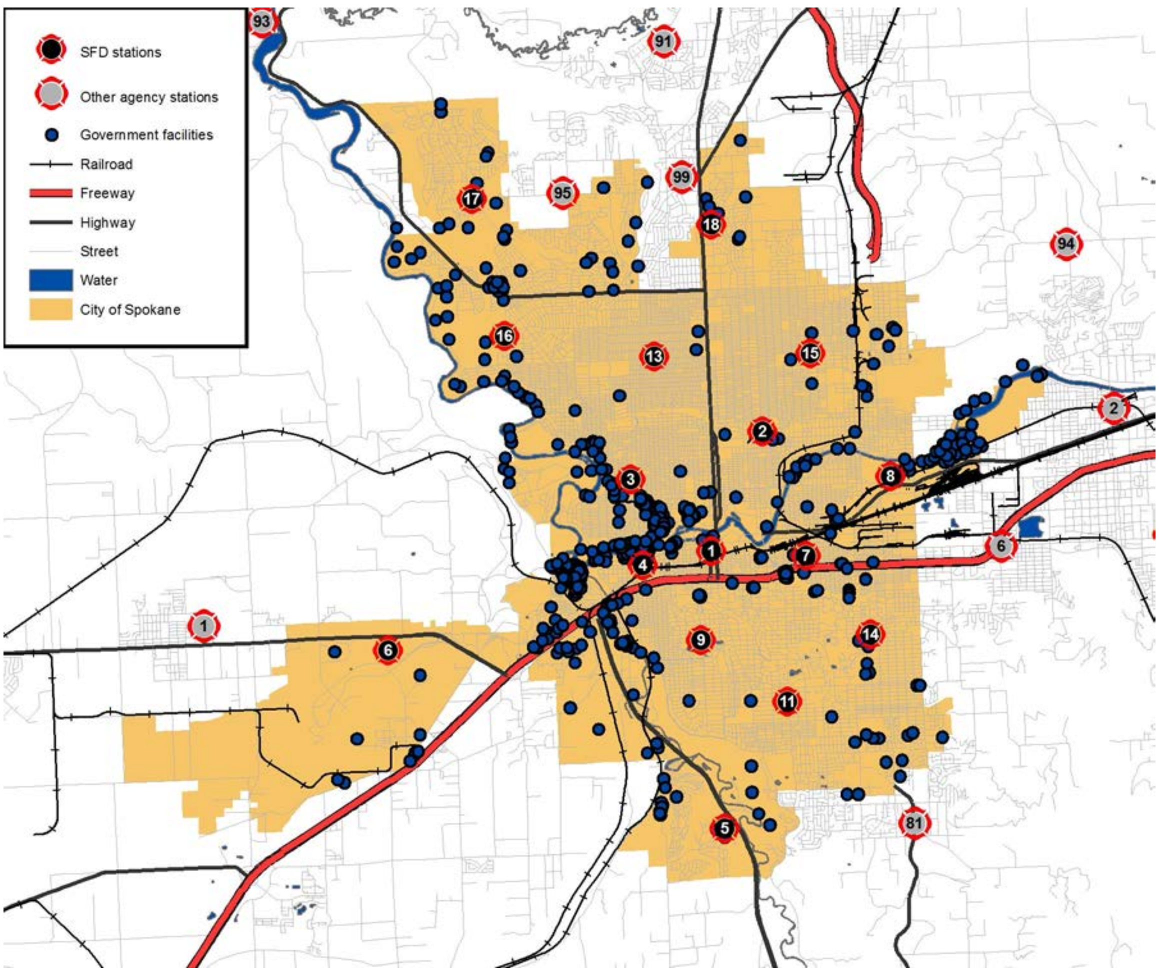
PHYSICAL ASSETS PROTECTED

Many buildings in the city are used for purposes that create more significant risk than others. High occupancy buildings, facilities providing care to vulnerable populations, and others may require greater numbers of emergency response resources during an emergency. This section draws on information from SFD records and other sources.

Government Properties

There are a variety of government buildings and properties in Spokane considered important to providing critical services to the community in times of disaster. Buildings such as city hall, fire stations, federal, state, and county offices, police stations, and the like provide important services to the community. The following map shows the locations of government buildings within the city.

Figure 17: Government Facilities and Properties

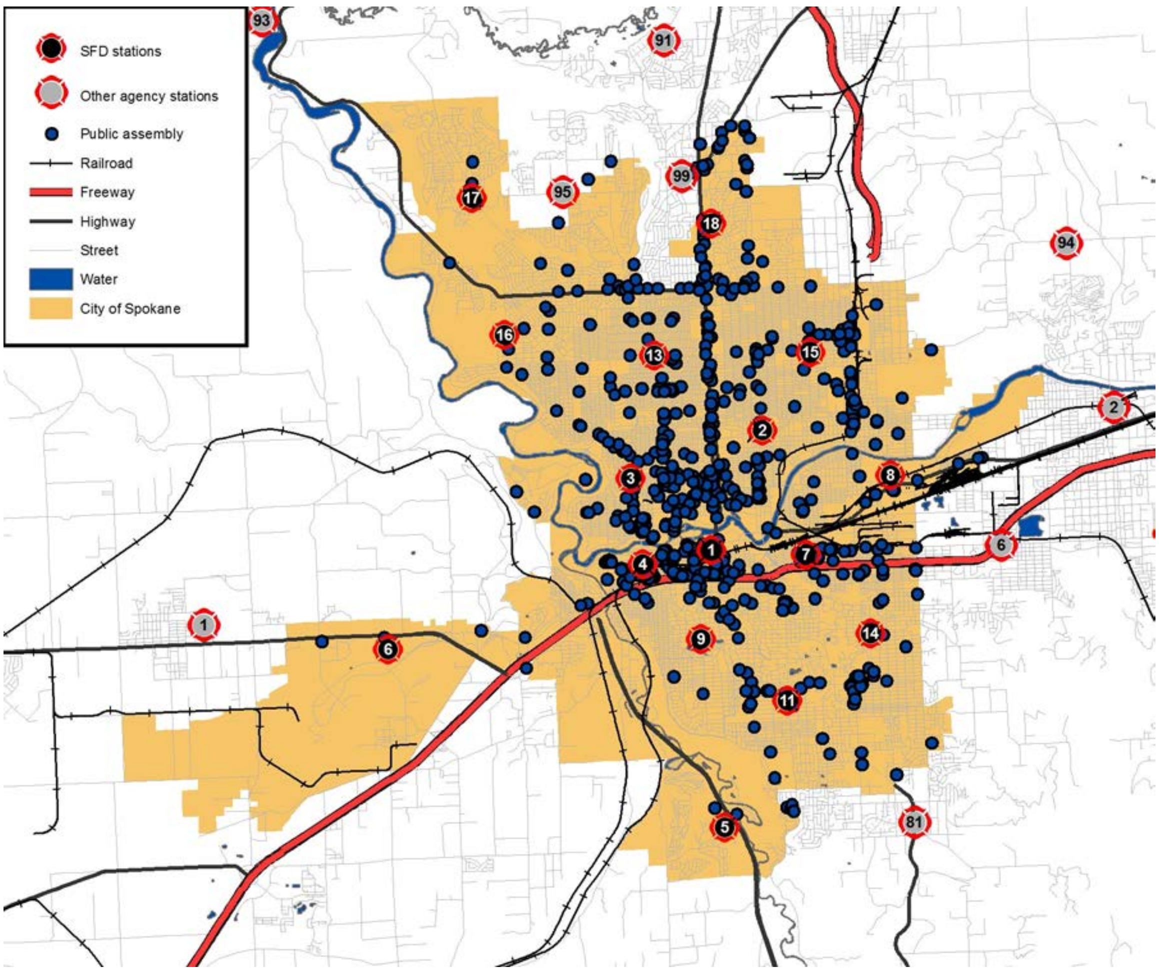


Public Assembly

Numerous buildings lie within the city in which large numbers of people gather for entertainment, worship, dining, and such. A variety of nightclubs, theaters, and other entertainment venues exist.

These facilities present additional risk, primarily for mass casualty incidents. Fire, criminal mischief, and potentially terrorism could cause a major medical emergency requiring significant emergency service resources. The following figure shows the locations of buildings identified as public assembly facilities within the city.

Figure 18: Public Assembly Facilities

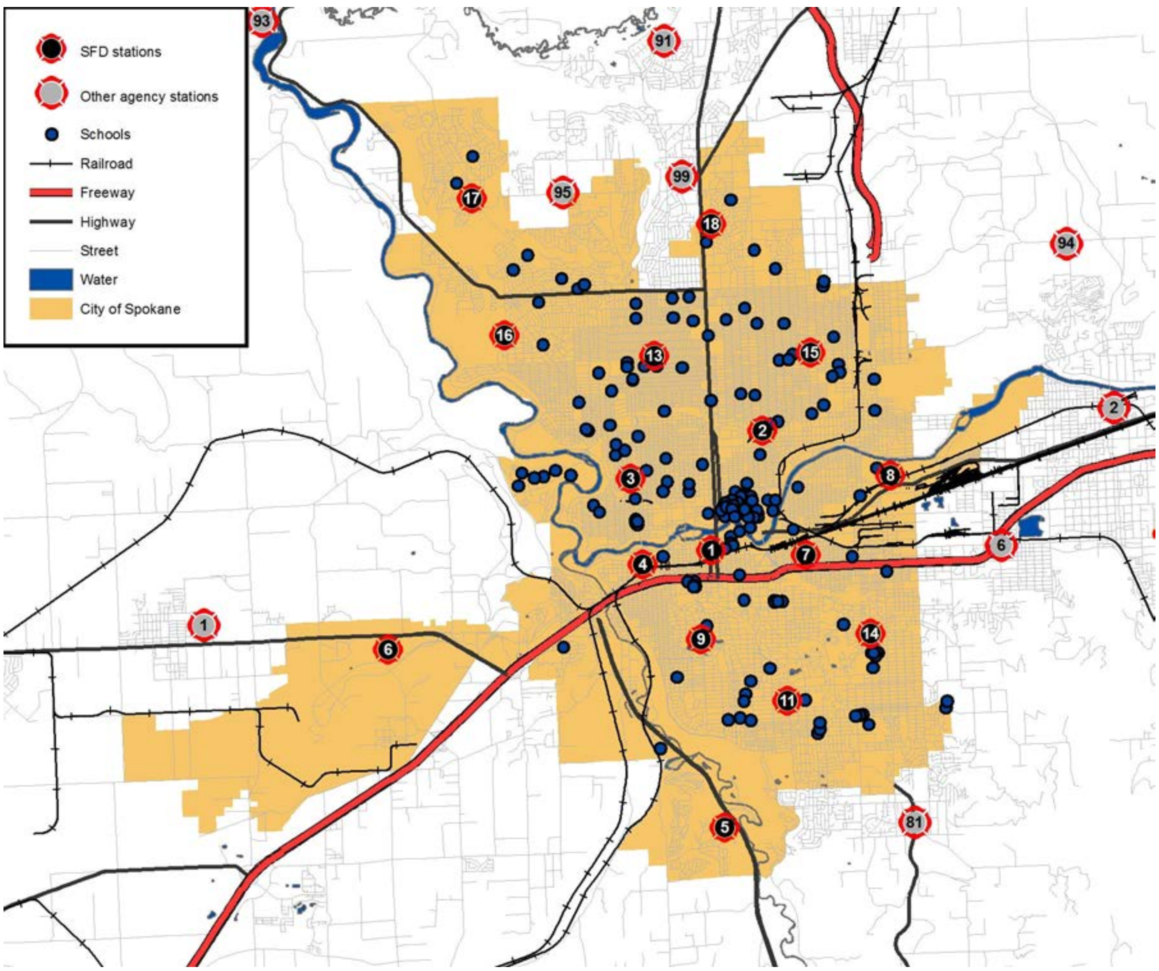


Schools/Day Care

The Spokane Public School District is the largest school district in eastern Washington. It operates 34 elementary schools, 6 middle schools, 5 high schools, 4 alternative schools, and a number of support facilities within the district. Forty of these schools are within the City of Spokane. Total enrollment is 29,275.

Gonzaga University and Whitworth College have campuses in the City of Spokane. A number of other colleges and universities have satellite campuses in Spokane as well. The following map shows the locations of most public schools and colleges in the SFD service area.

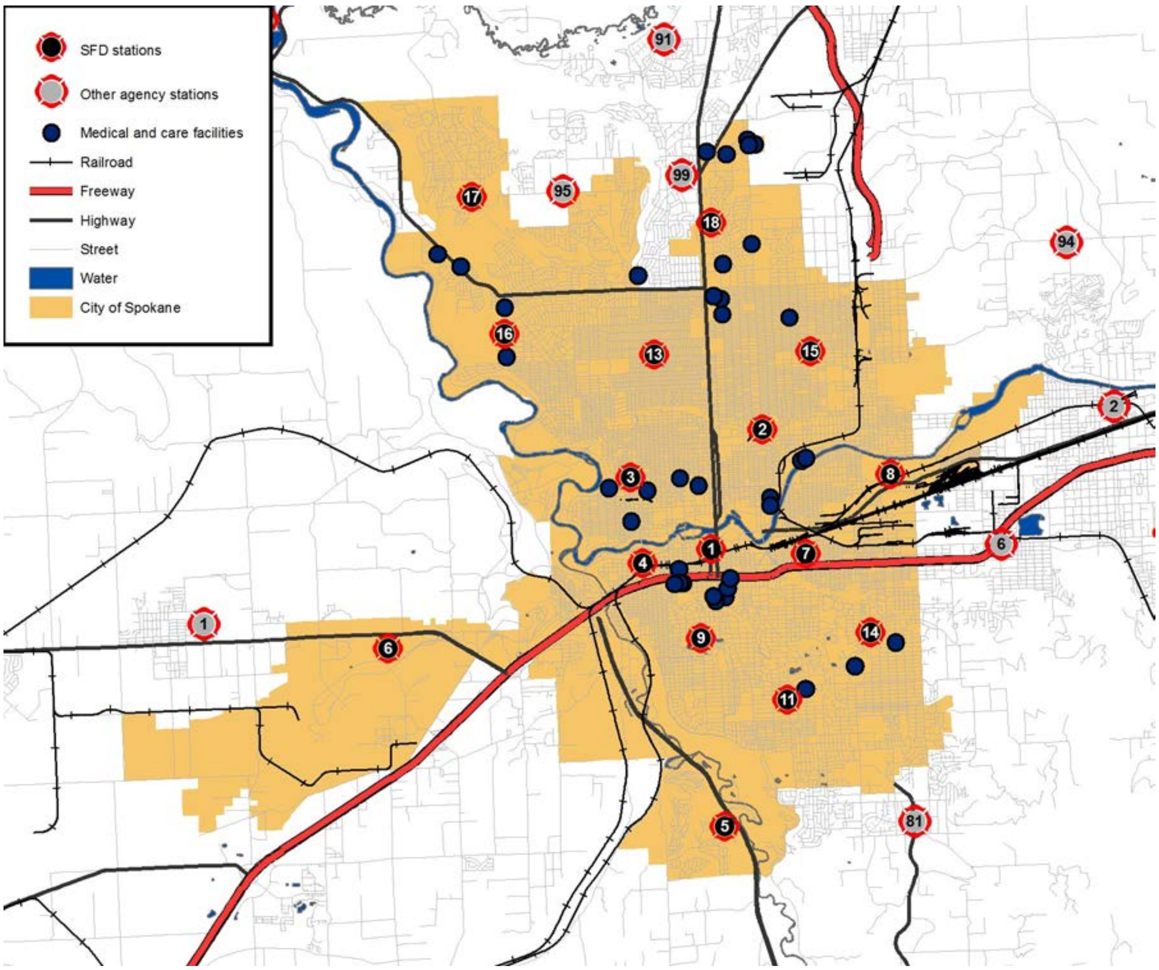
Figure 19: Public and Private School Facilities



Medical Facilities

The city is home to a number of important medical care facilities, including Holy Family Hospital, Sacred Heart, Mann-Grandstaff VA Medical Center, Shriner's Hospital, Deaconess Medical Center, and The Providence Spokane Heart Institute Additional facilities include skilled nursing facilities and other in-patient care facilities. The following map shows the location of the hospitals and other in-patient care facilities.

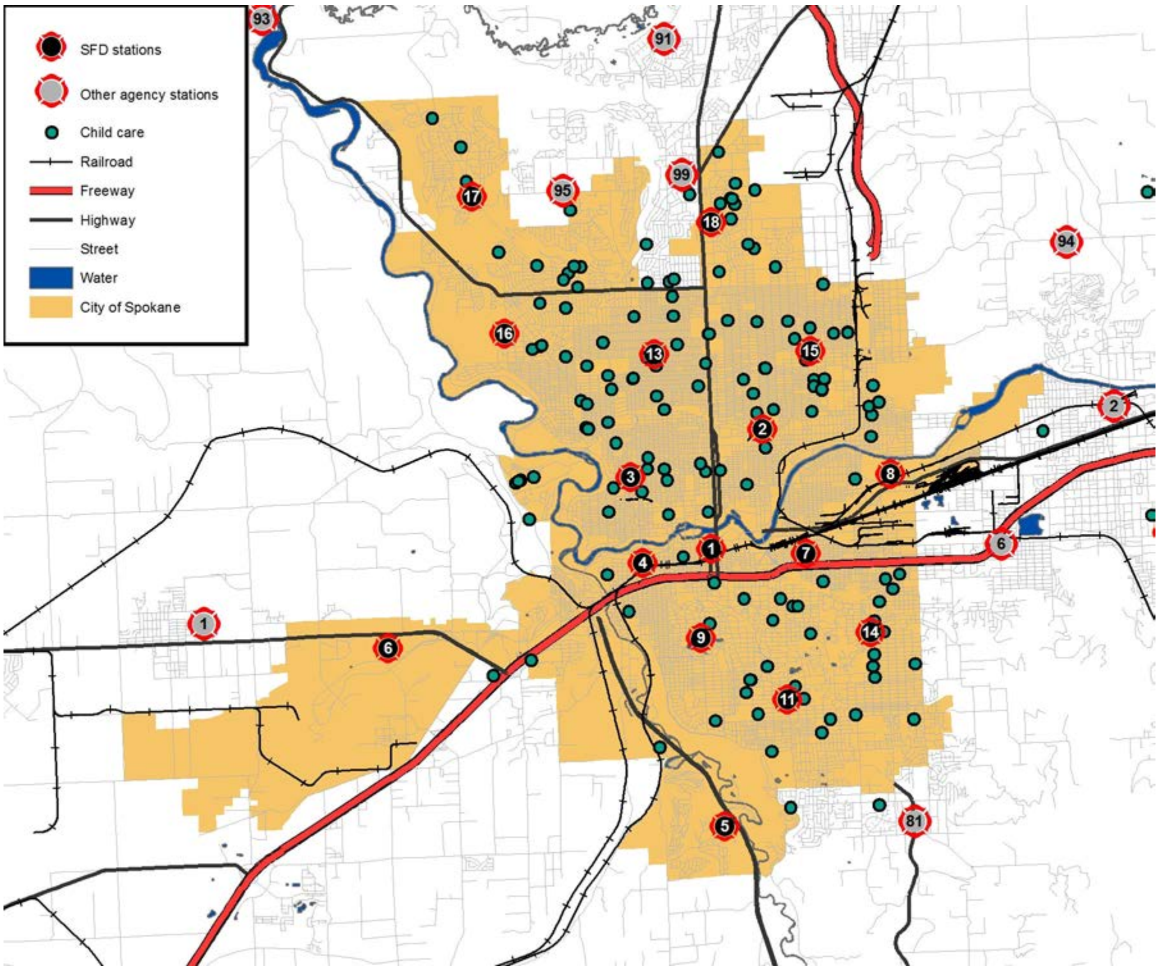
Figure 20: Hospitals and Care Facilities



Child Care Facilities

There are numerous facilities that provide day care for children. These are either in commercial buildings or operate from homes. These facilities care for vulnerable populations. Child care facilities can be found throughout the city.

Figure 21: Child Care Facilities



Other Critical Infrastructure

In this section, other types of infrastructure critical to a community are discussed in general terms. Though SFD does not have any unusual critical community infrastructure, it is important the fire department plan for emergencies at any of these facilities.

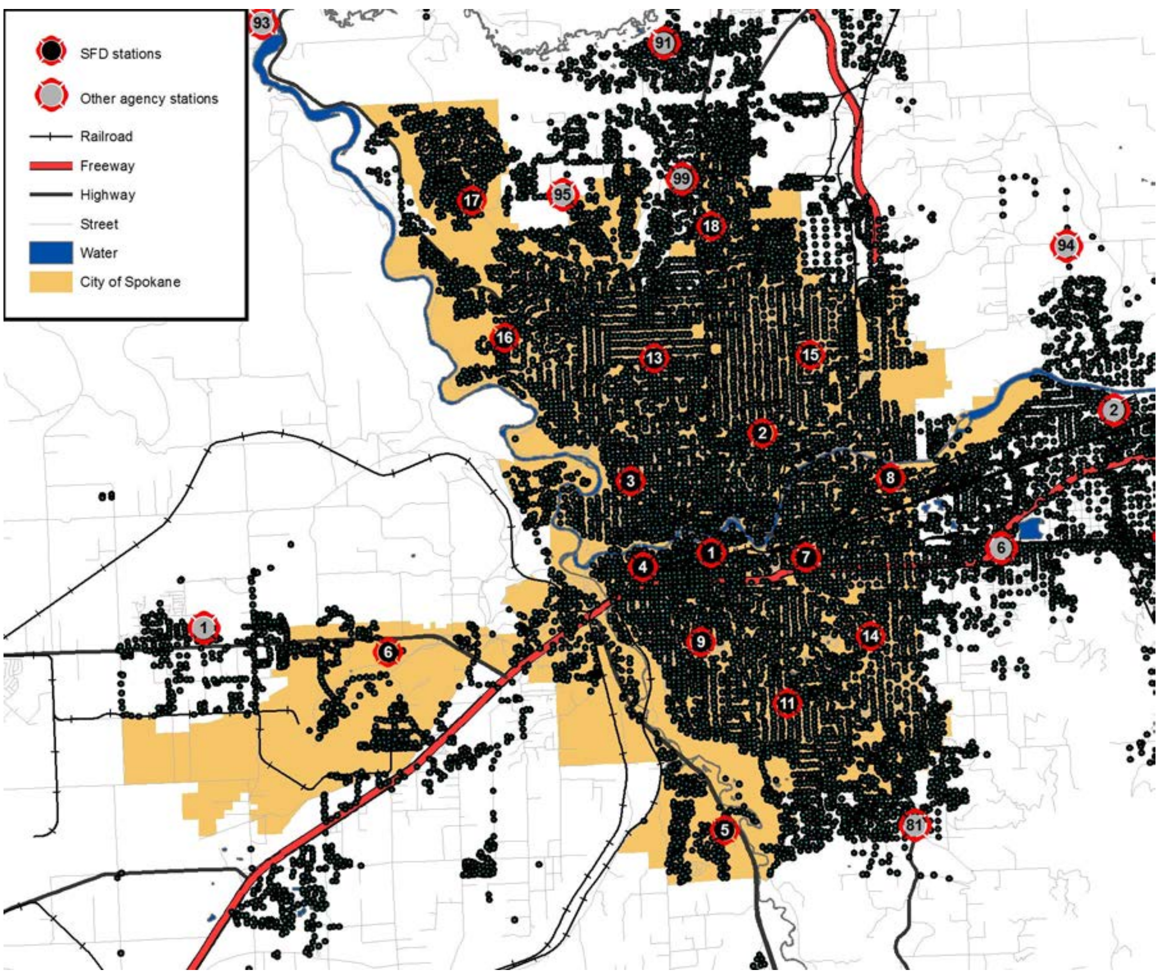
Water Distribution

The most obvious element of this infrastructure of concern to the fire department is the reservoir, water main, and fire hydrant system. Providing sufficient storage, distribution, and access to this valuable firefighting resource through well-distributed fire hydrants is very important.

Firefighting water service from fire hydrants is available to nearly every developed property within the city. Fire flows are generally acceptable for risks protected.

The city's primary water source is the Spokane Valley-Rathdrum Prairie Aquifer. Water treatment plants clean and distribute water through large mains to the city. Water is pumped into water reservoirs at a number of locations. Water service to distribution mains is nearly exclusively gravity fed. The city uses a hydro-electric dam to produce electricity for pumping water.

Figure 22: Fire Hydrant Distribution



Communications

Emergency communication centers and the associated transmitting and receiving equipment are essential facilities for emergency response. A number of agencies provide emergency 9-1-1 call receipt. Redwood Empire Communications Authority provides dispatch service to a number of regional fire agencies. This center provides for the interrogation of 9-1-1 calls for help, dispatching of fire and other emergency responders, and important support to the incident management function.

There are other communication facilities and equipment that are equally important to the community and government operations. These are the telephone company central offices and the transmission lines of local telephone service providers. Internet service providers, along with wireless cellular communication providers, provide essential communication capabilities for the community as well as emergency personnel through their facilities and equipment.

Energy

Previously discussed community services, from communications to traffic signals to normal operations, require the use of energy. Whether it is electricity generation and transmission systems, fuel distribution and storage tanks, or natural gas pipelines and regulator stations, the community is dependent upon energy sources.

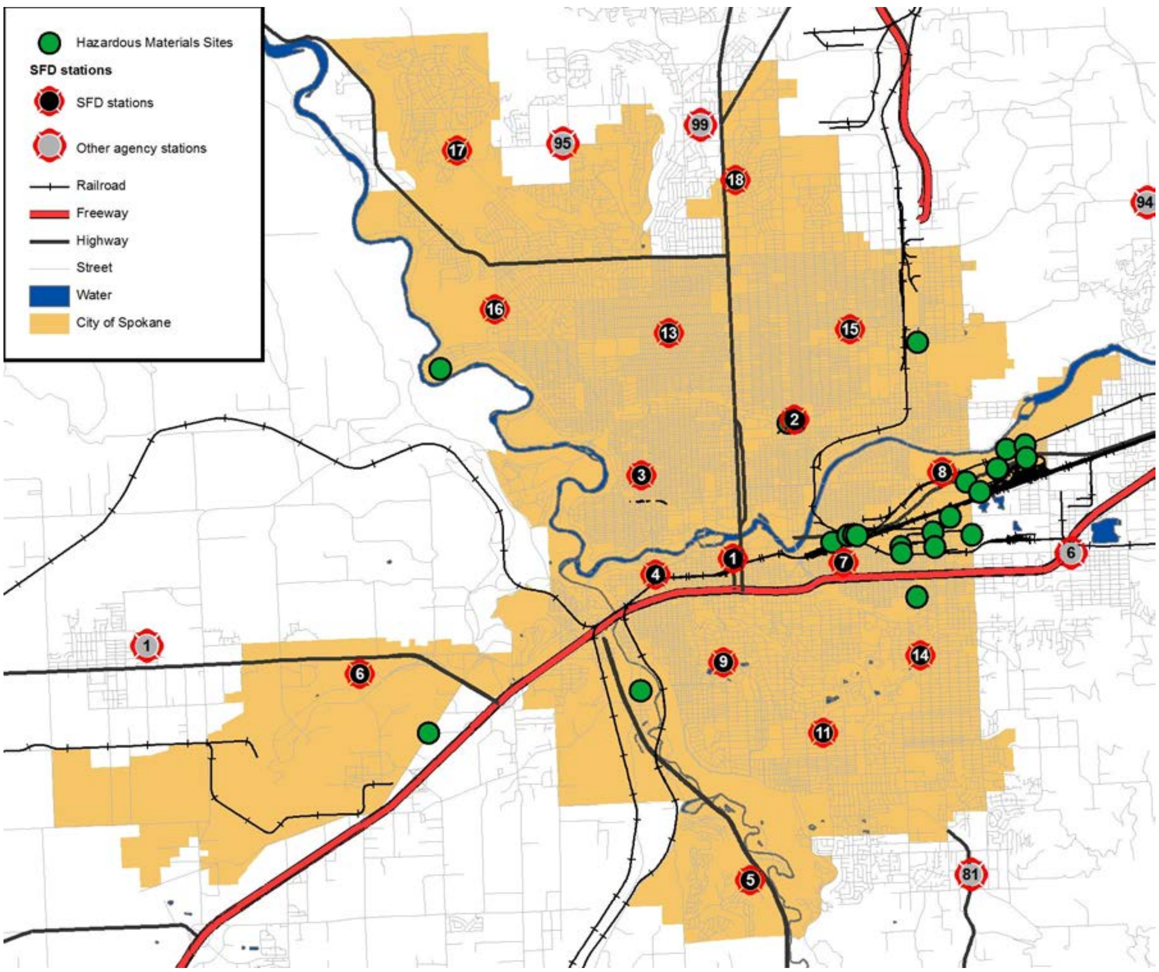
Structural Risks

Certain buildings, their contents, functions, and size present a greater firefighting challenge and require special equipment, operations, and training. Information for this section has been drawn from SFD records.

Hazardous Materials

Buildings that have been identified as containing hazardous materials can create a dangerous environment to the community as well as the firefighters during a spill or fire. Special equipment such as protective clothing and sensors, along with specialized training, is necessary to successfully mitigate a hazardous materials incident. The following figure shows the locations of the facilities classified as using more than small quantities of hazardous materials.

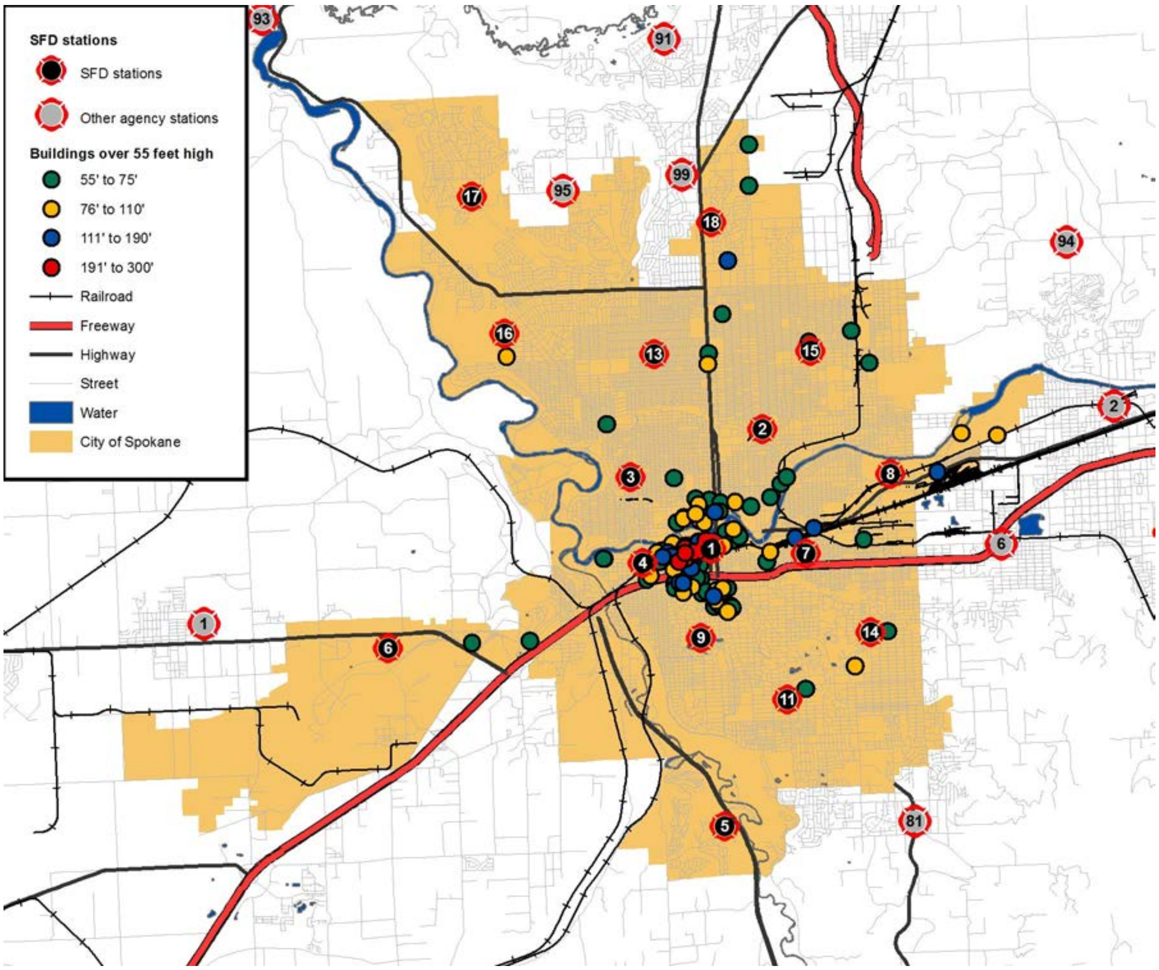
Figure 23: Hazardous Material Use Locations



Multi-Story Buildings

Multi-story buildings present a unique challenge to fire departments. Additional personnel are required to move hose and equipment to upper floors of these buildings. The following figure shows the locations of buildings 55 feet or more in height.

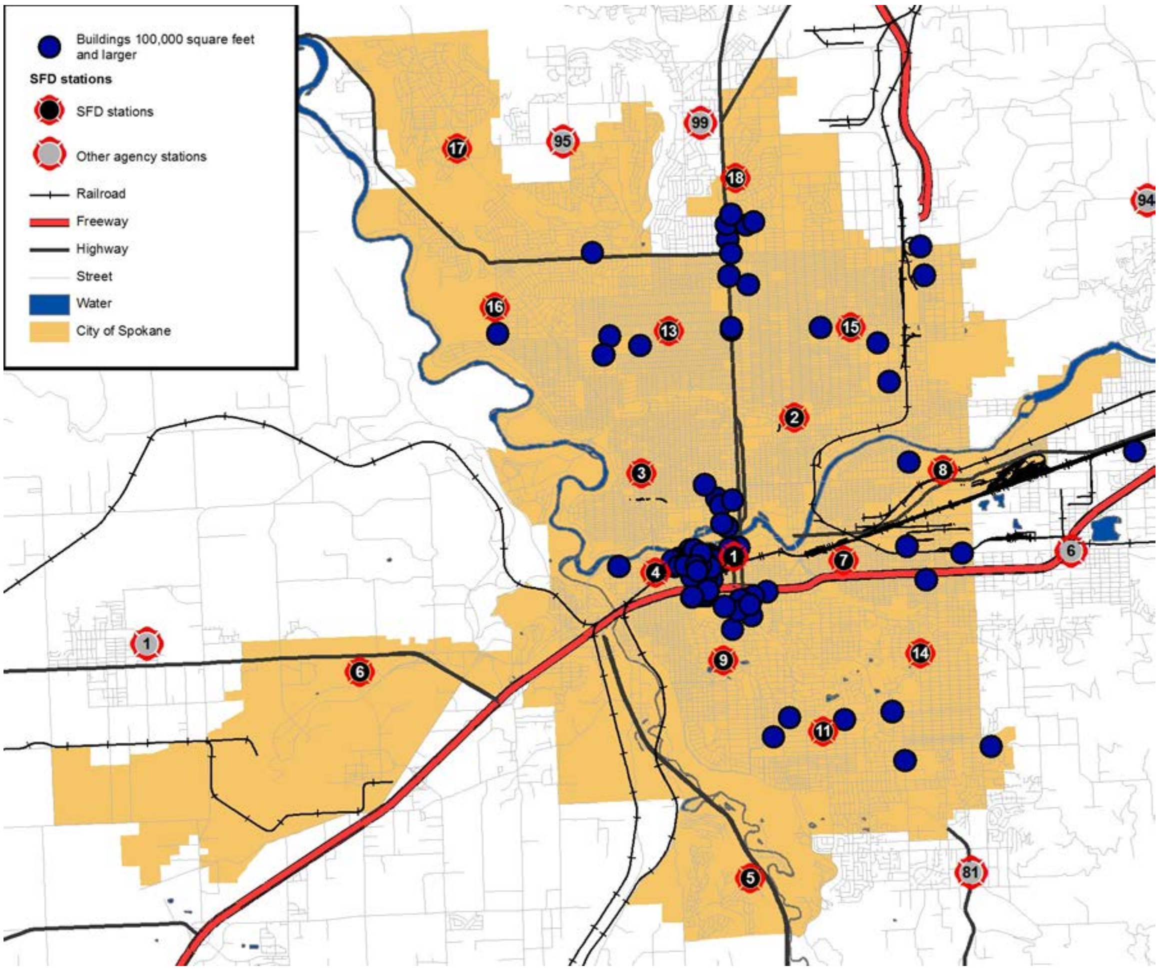
Figure 24: High Rise Buildings



Large Square Footage Buildings

Large buildings, such as warehouses, malls, and large "box" stores require greater volumes of water for firefighting and require more firefighters to advance hose lines long distances into the building. The following figure shows the locations for buildings 100,000 square feet and larger.

Figure 25: Buildings – 100,000 Square Feet and Larger



Terrorism

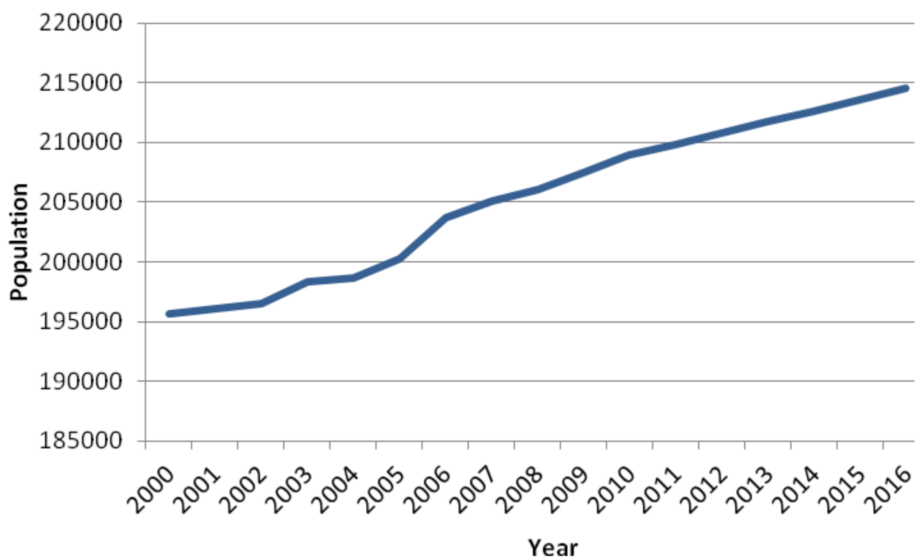
Spokane is a potential target for terrorism. Most of the previously categorized risks in the community are targets for such activity. In addition, the city hosts numerous large public gathering events during the year all of which can be terrorism targets.

DEVELOPMENT AND POPULATION GROWTH

Current Population Information

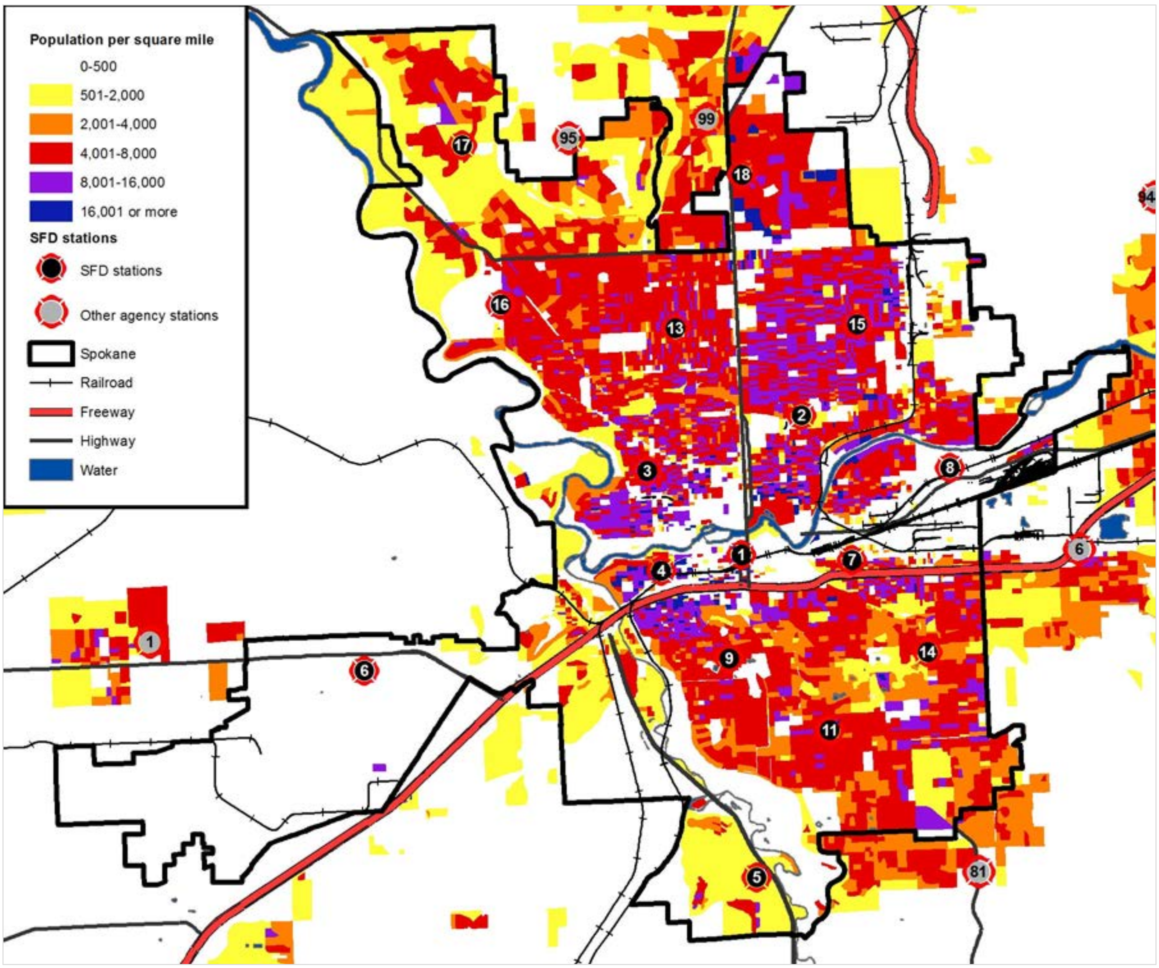
SFD's population has grown moderately, with an average annual growth rate of less than 1 percent between 2000 and 2016. At the time of this study, the current service area population is estimated at 214,500. The following figure illustrates resident population growth over the past 17 years.

Figure 26: Population History, 2000 - 2016



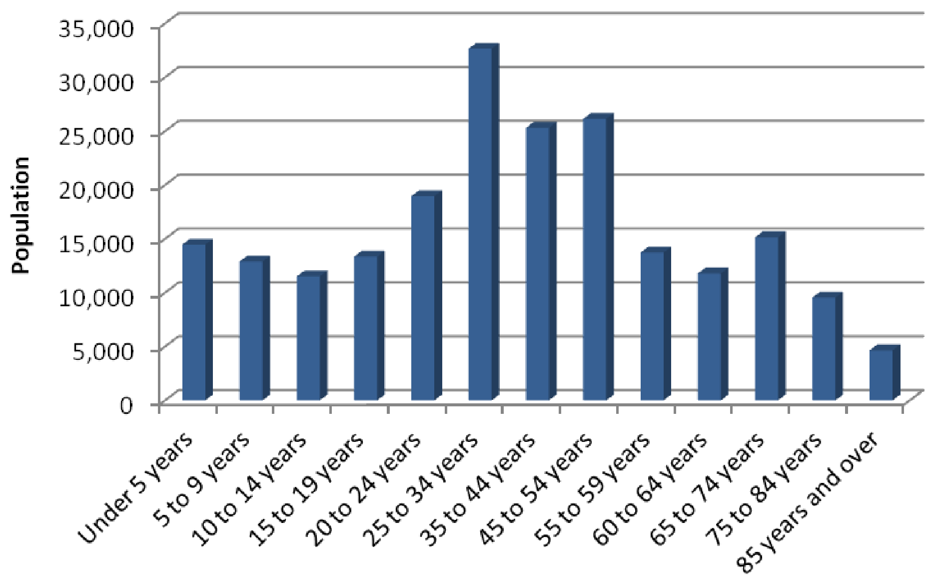
There is a direct correlation between population density and service demand. The following figure displays the population density of the SFD service area based on 2010 Census data. Census data only includes people who live full-time in the community. It does not include people who visit or reside temporarily in a community.

Figure 27: Population Density, 2010



One of the factors that can influence emergency service demand, particularly emergency medical services, is the population's age. The following figure examines Spokane's population segmented by age groups. This data is based on 2014 American Community Survey estimates.

Figure 28: Estimated Population by Age

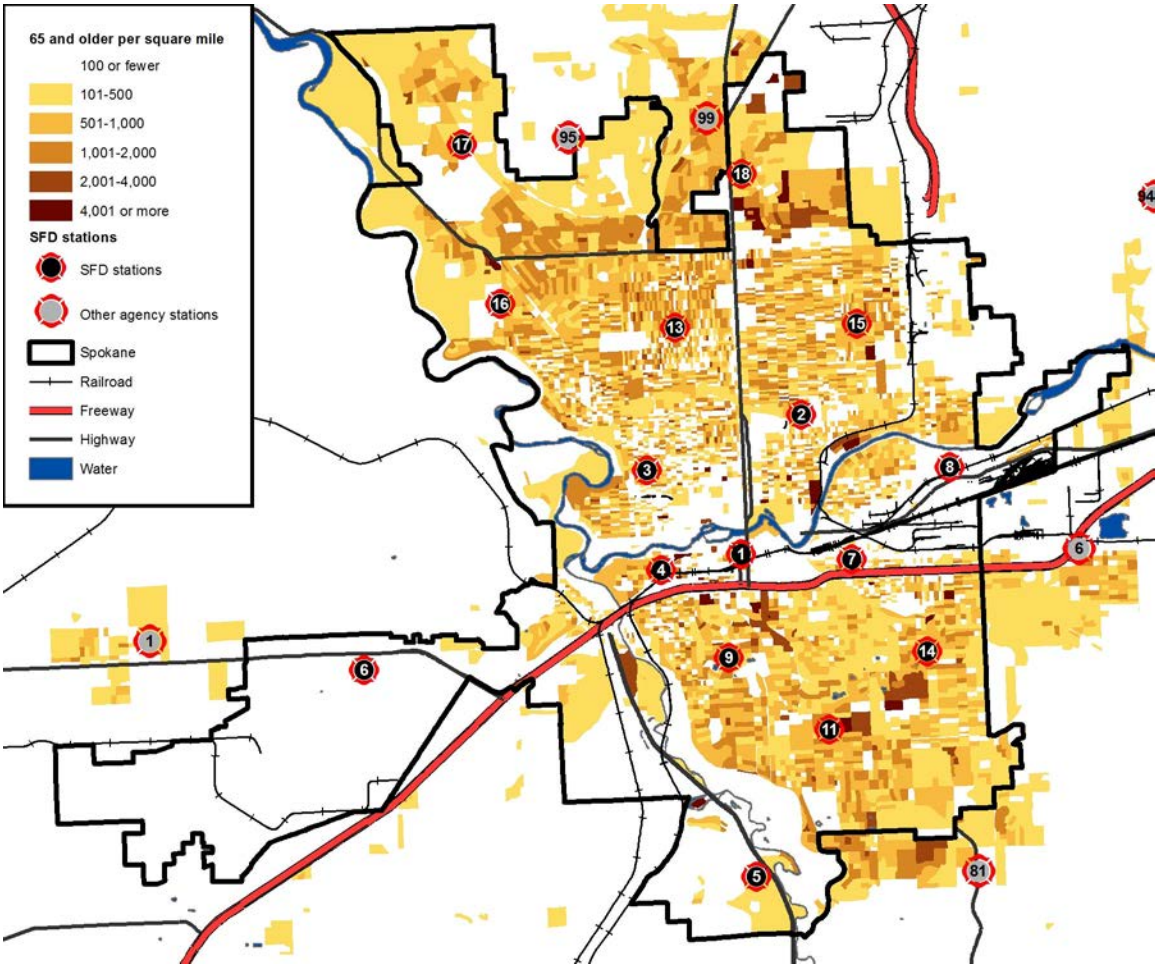


Based on the preceding figure, 13.9 percent of the population is 65 years of age or older and 6.9 percent of the population is under five years of age. This places a total of 20.8 percent of the area's population within the age groups that are at highest risk in residential fire incidents and account for some of the highest use of emergency medical services. Senior citizens can have difficulty escaping from fire due to physical limitations. Seniors also tend to use emergency medical services more frequently than younger persons. As the population ages, this will create an increase in service demand for emergency medical services.

The very young also represent a vulnerable population, both in regard to their ability to escape a structure fire as well as their susceptibility to serious medical ailments such as asthma, traumatic events, choking, or injury from vehicular accidents.

The following figure illustrates the population per square mile of those 65 years or older by census block. There are areas of the city that have higher concentrations of senior citizens.

Figure 29: 65 years and Older per Square Mile by Census Block



RISK CLASSIFICATION

Areas of higher fire and life risk require greater numbers of personnel and apparatus to effectively mitigate emergencies. Areas with a higher incident activity require additional response units to ensure reliable response. Staffing and deployment decisions for different regions of the city should be made in consideration of the level of risk in each.

Most communities contain areas with different population densities and property risk allowing the community's policy makers to specify different response performance objectives by geographic area. The classifications are identified as:[5]

- **Metropolitan**—Geography with populations of over 200,000 people in total and a population density predominately over 3,000 people per square mile. These areas are distinguished by inner city neighborhoods, numerous mid-rise and high-rise buildings, often interspersed with smaller structures.
- **Urban**—Geography with a population of over 30,000 people and/or a population density predominately over 2,000 people per square mile. These areas are characterized by significant commercial and industrial development, dense neighborhoods, and some mid-rise or high-rise buildings.
- **Suburban**—Geography with a population of 10,000 to 29,999 and/or a population density predominately between 1,000 and 2,000 people per square mile. These areas are characterized by single and multifamily neighborhoods and smaller commercial developments
- **Rural**—Geography with a total population of less than 10,000 people or with a population density of less than 1,000 people per square mile. These areas are characterized by low density residential, little commercial development, and significant farm or open space uses.
- **Wilderness/Frontier/Undeveloped**—Geography that is both rural and not readily accessible by a publicly or privately maintained road.

SFD's service area, based on population density, is of two classifications: urban and suburban. The community's risk classifications should influence how response resources are distributed now and in the future. Since suburban areas are anticipated to grow in population densities, response performance objectives have been established that are uniform across the entire developable service area.

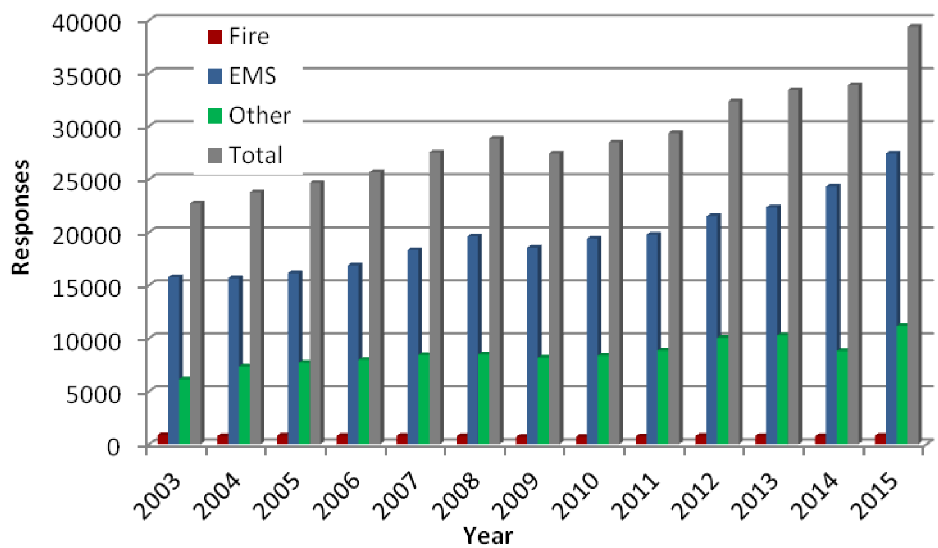
[5] CFAI *Standards of Cover, 5th edition*

HISTORIC SYSTEM RESPONSE WORKLOAD

Before a full response time analysis is conducted, it is important to first examine the level of workload (service demand) that a fire department experiences. Higher service demands can strain the resources of a department and may result in a negative effect on response time performance.

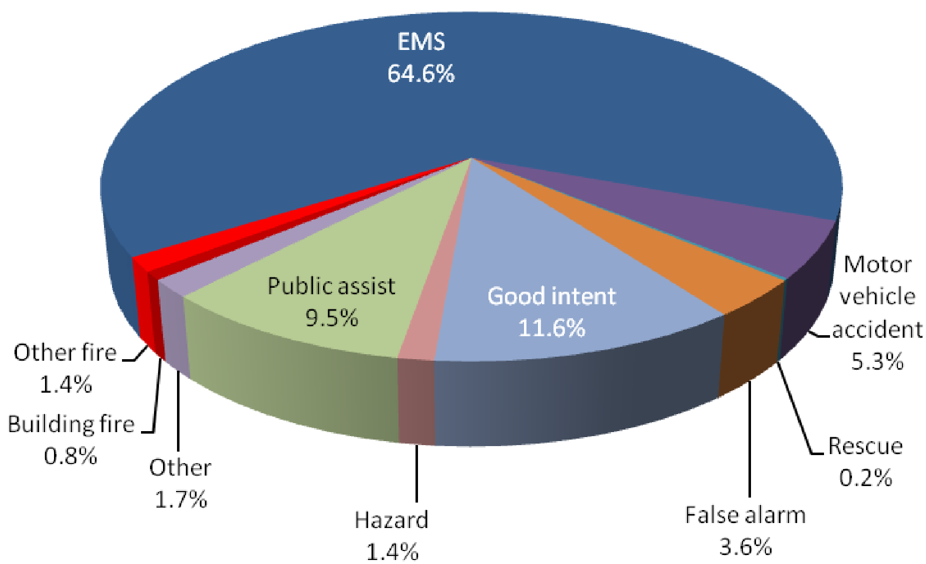
The following figure shows response workload for 13 years. Total response workload has increased 73 percent over the 13 years, primarily driven by the increase in emergency medical responses.

Figure 30: Response Workload History, 2003 – 2015



Incident data used for the evaluation of current performance was all responses made between September 1, 2015, and August 31, 2016 (study period). During the study period SFD responded to 39,419 incidents. The next figure shows responses by final type of incident for the study period. Emergency medical type responses (EMS and motor vehicle accidents) are the most common at 69.9 percent of total responses.

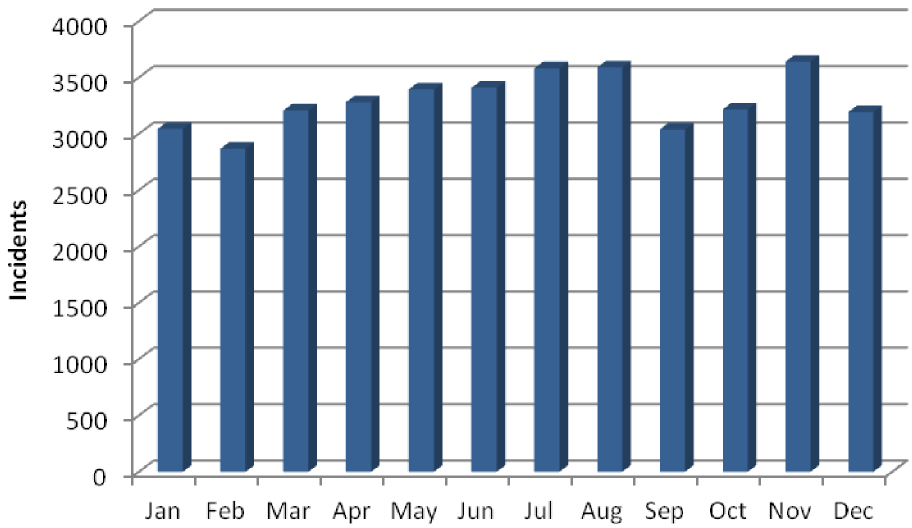
Figure 31: Responses by Type of Incident



Temporal Analysis

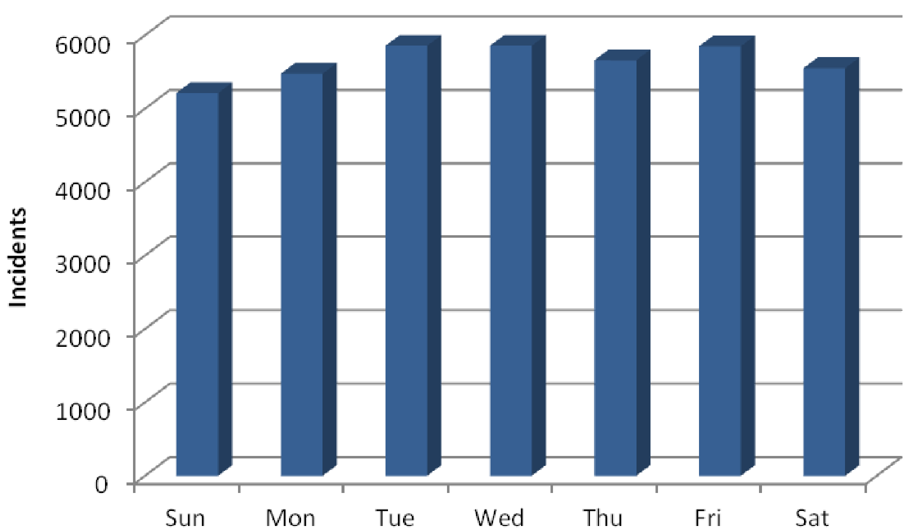
A review of incidents by time of occurrence also reveals when the greatest response demand is occurring. The following figures show how activity and demand changes for SFD based on various measures of time. The following figure shows response activity during the study period by month. There is little variation by month.

Figure 32: Monthly Response Workload



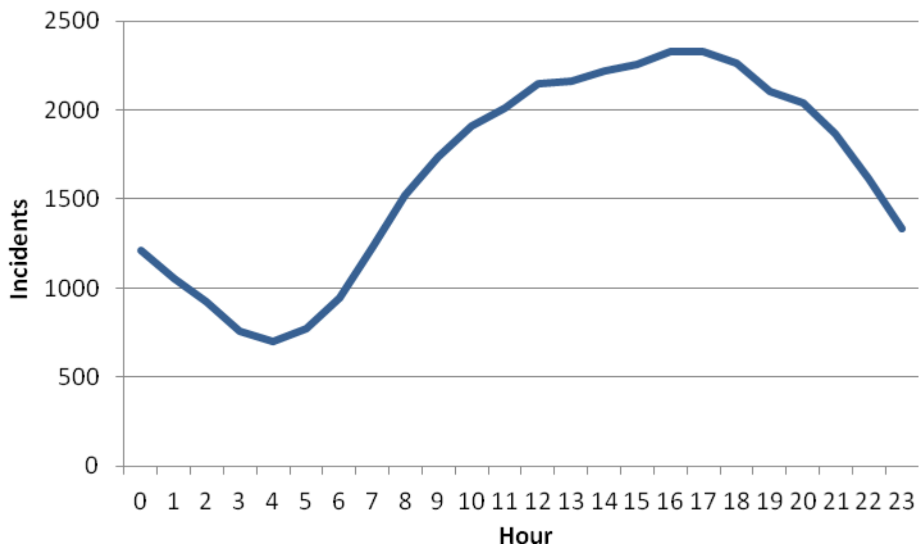
Next, response workload is compared by day of week. Again, there is little variation in response workload by weekday.

Figure 33: Daily Response Workload



The time analysis that always shows significant variation is response activity by hour of day. Response workload directly correlates with the activity of people, with workload increasing during daytime hours and decreasing during nighttime hours as shown in the following figure. Incident activity is at its highest between 11:00 AM and 9:00 PM.

Figure 34: Hourly Response Workload

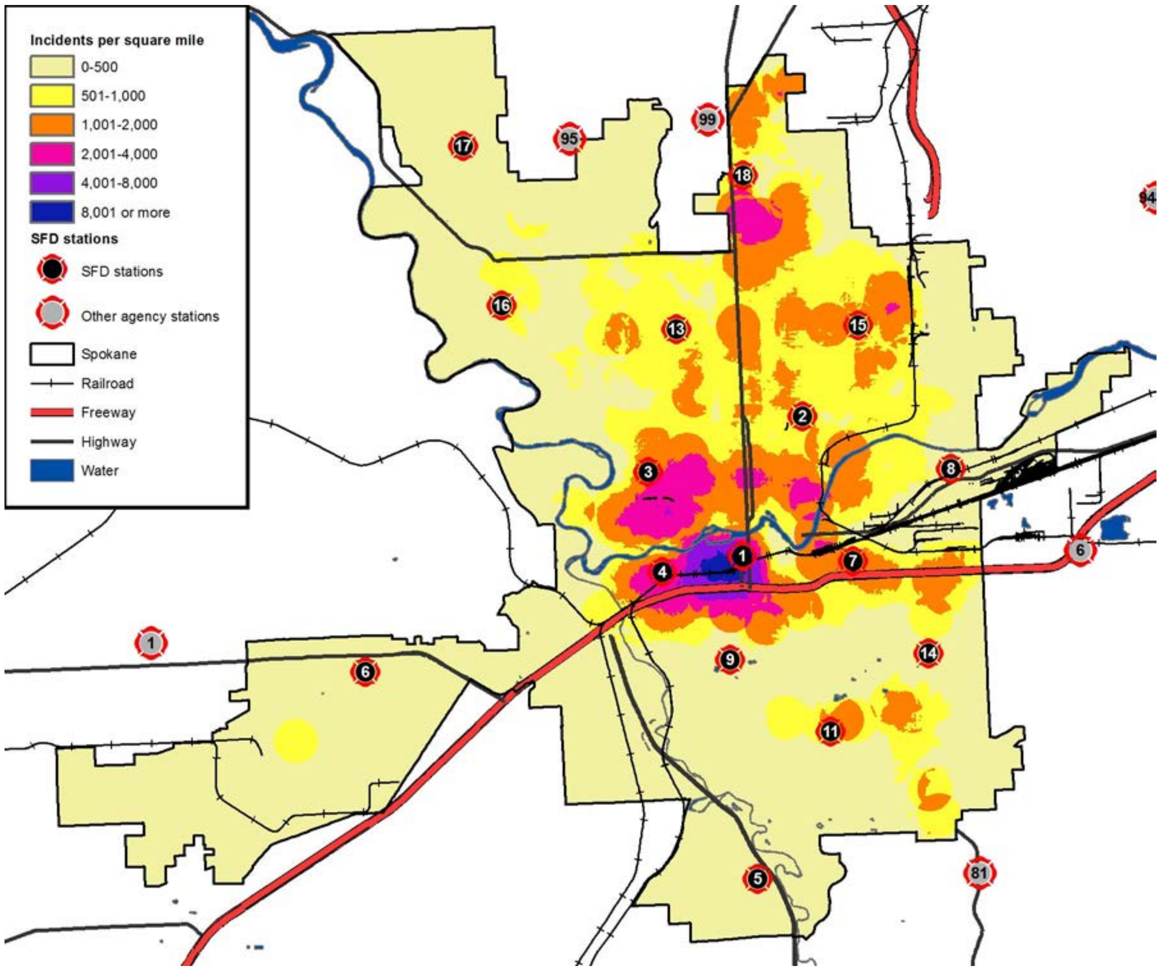


Spatial Analysis

In addition to the temporal analysis of the current service demand, it is useful to examine geographic distribution of service demand. The following figures indicate the distribution of emergency incidents in SFD during the study period.

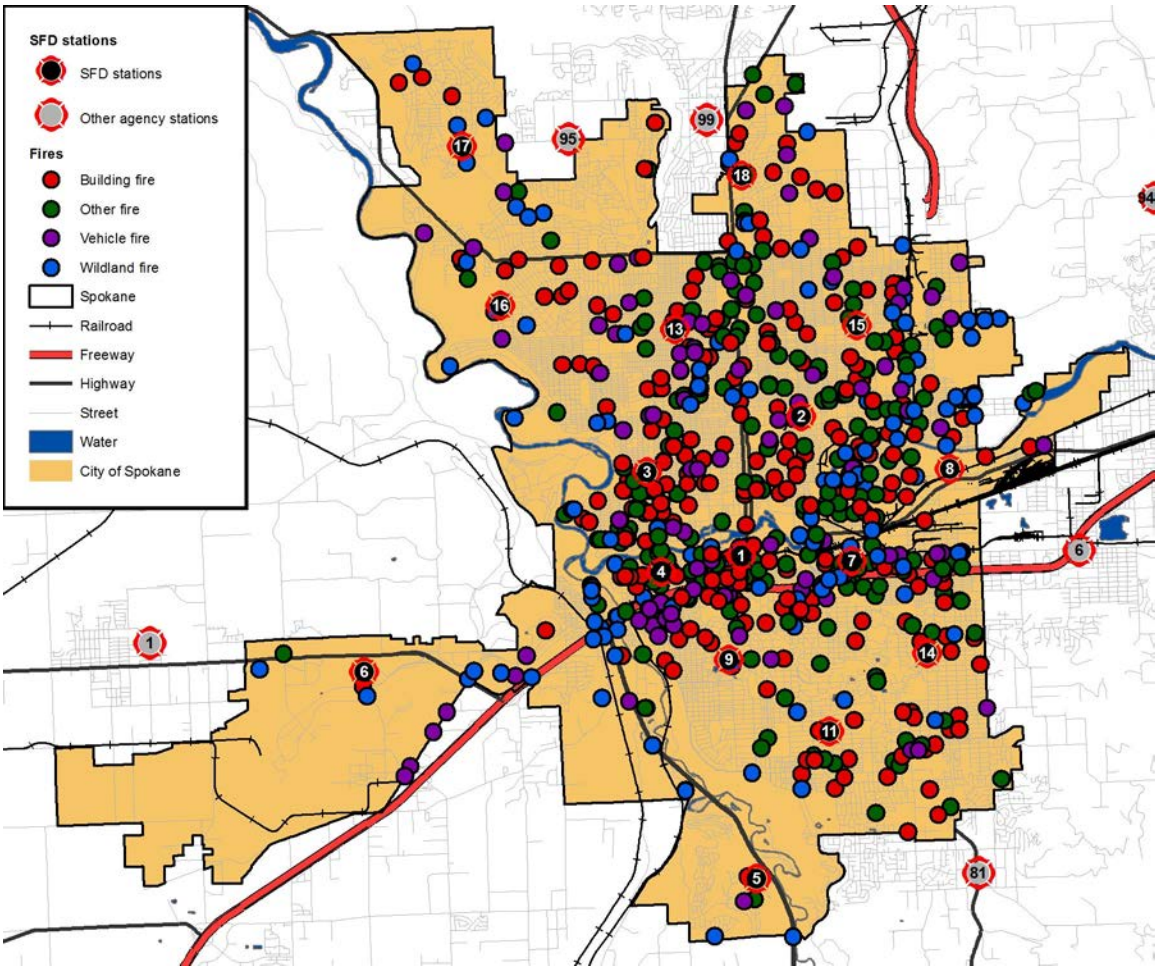
The first figure displays the number of incidents per square mile within various parts of the city. The areas of greatest service demand are the city's central core and in the Station 18 area to the north east.

Figure 35: Service Demand Density



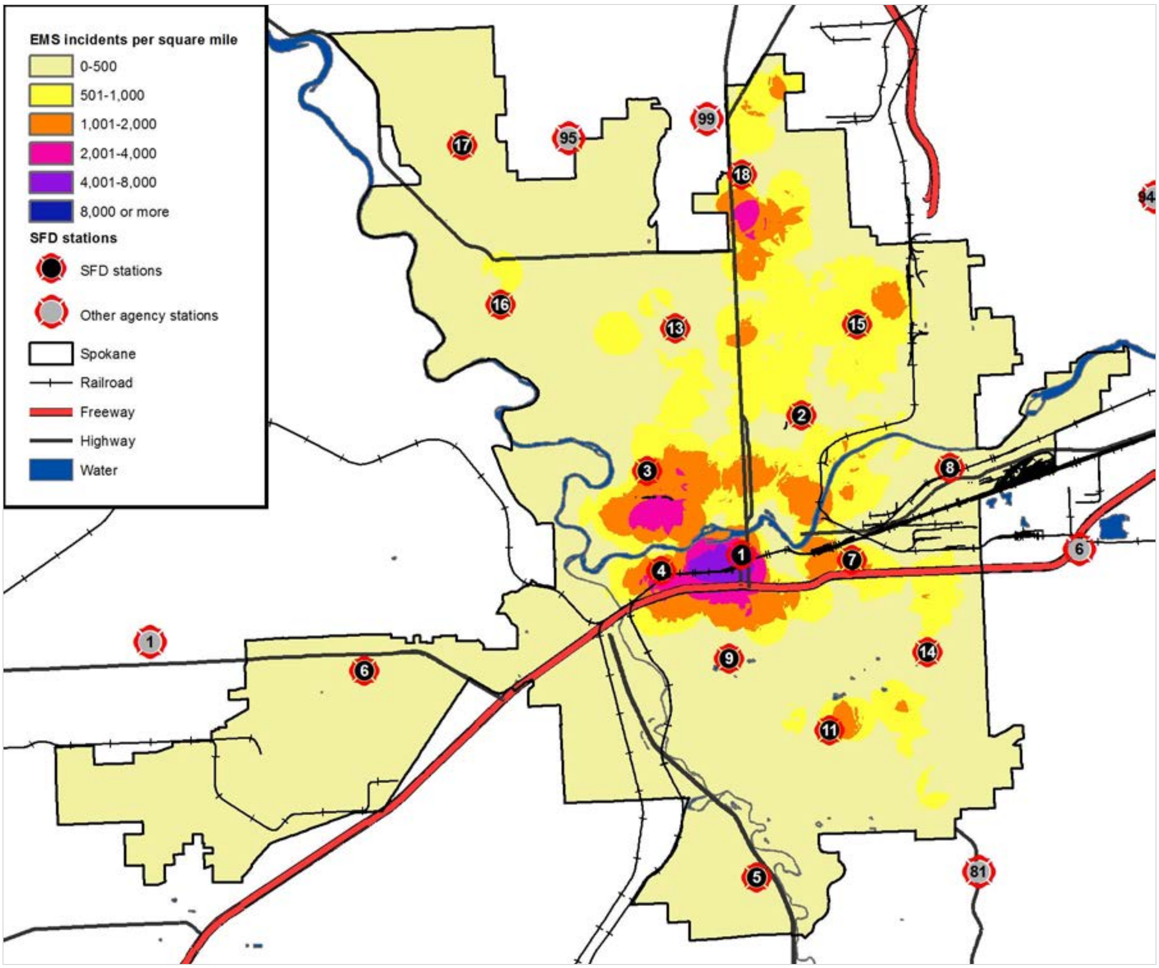
The preceding figure reflects all calls served by SFD. Service demand can vary by area based on incident type. The following figure displays the location of fires occurring within the SFD service area during the study period. This illustrates that fire incidents are distributed mostly in the city's central and northern areas.

Figure 36: Fires



Similarly, emergency medical incidents also occur in greater concentration in areas of higher population density. The following figure displays emergency medical incidents per square mile during the study period.

Figure 37: Emergency Medical Incidents per Square Mile



EMS incidents are classified as either priority (potentially life-threatening) or non-priority (not life-threatening). During the study period SFD responded to 12,675 priority EMS incidents and 19,521 non-priority EMS incidents.

The following figures illustrate the number of priority and non-priority incidents per square mile. There is little difference between the distribution of priority and non-priority EMS incidents across the city.

Figure 38: Priority EMS Incidents per Square Mile

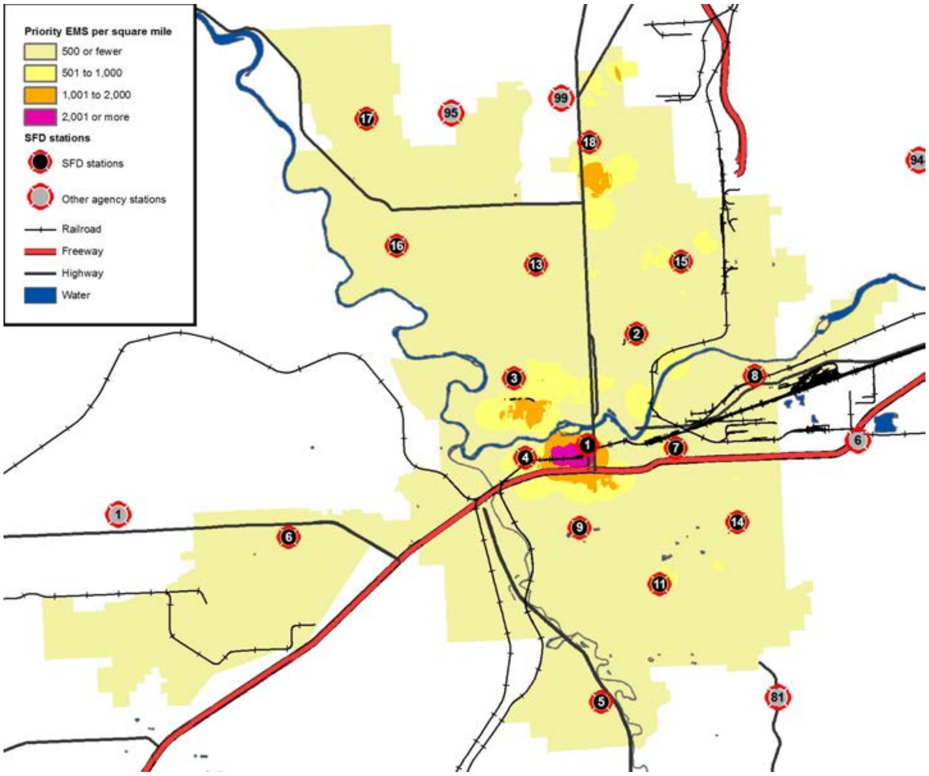
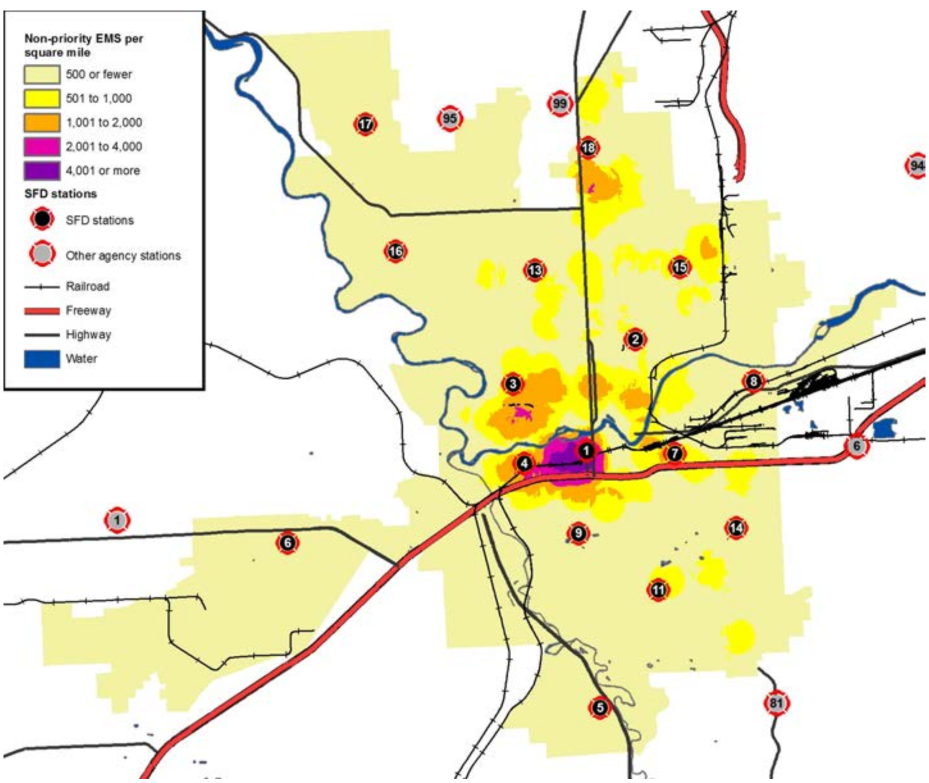


Figure 39: Non-Priority EMS Incidents per Square Mile



The number of priority and non-priority EMS incidents by hour is also fairly comparable as shown in the following charts. Non-priority EMS incidents occur with somewhat greater frequency in the late-afternoon, early evening hours.

Figure 40: Priority EMS Incidents by Hour

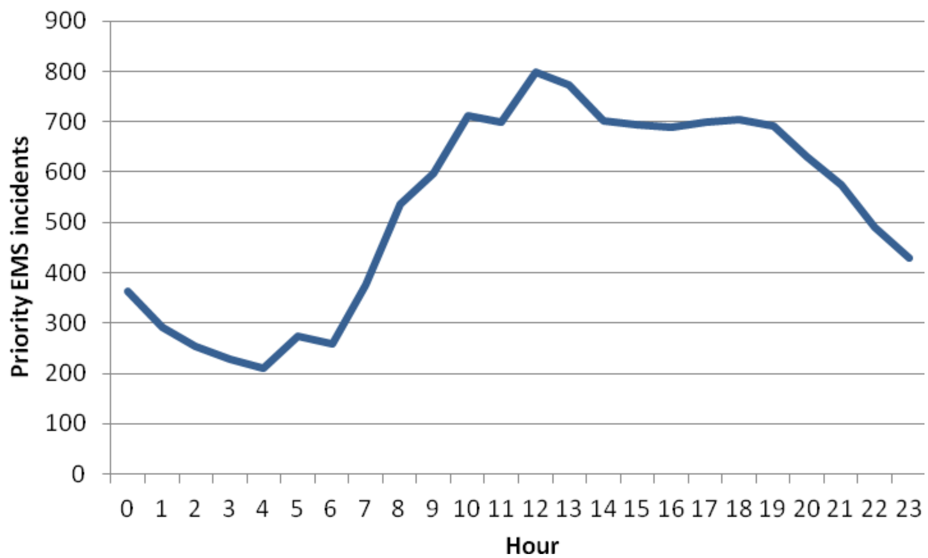
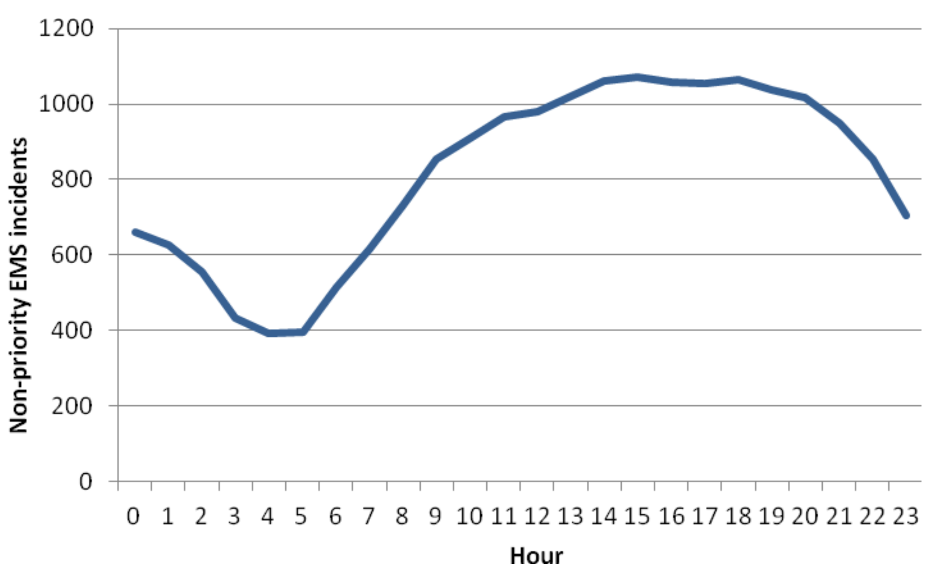


Figure 41: Non-Priority EMS Incidents by Hour



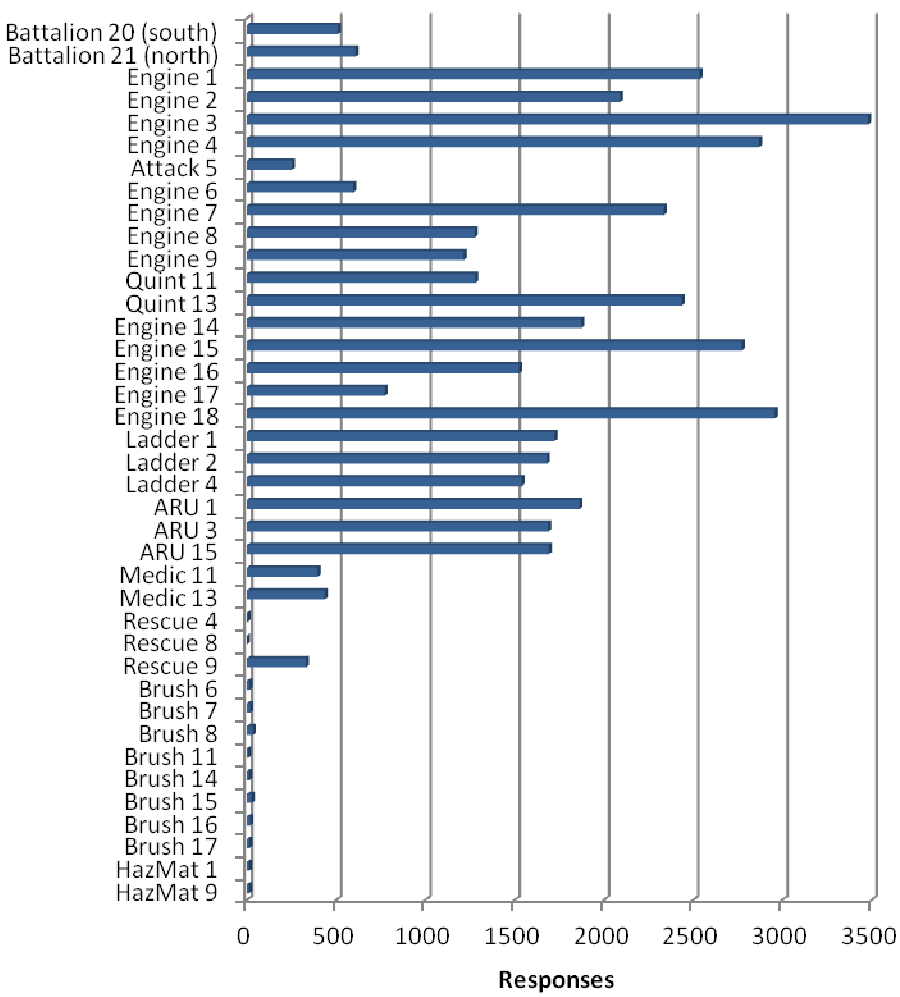
UNIT WORKLOAD ANALYSIS

A review of workload by response unit can reveal much about response time performance. Although fire stations and response units may be distributed in a manner to provide quick response, that level of performance can only be obtained when the response unit is available in its primary service area. If a response unit is already on an incident and a concurrent request for service is received, a more distant response unit will need to be dispatched. This will increase response times.

Response Unit Workload

The workload on individual response units during the study period is shown in the following figures.[6] Individual response unit workload can be greater than the workload in its home station area. Many incidents, such as structure fires, require more than one response unit.

Figure 42: Response Unit Workload



[6] Note that ARU 3 was placed out of service starting at the end of 2016

The amount of time a given unit is committed to an incident is also an important workload factor. The following table illustrates the average time each unit was committed to an incident, from initial dispatch until it was available for another incident.

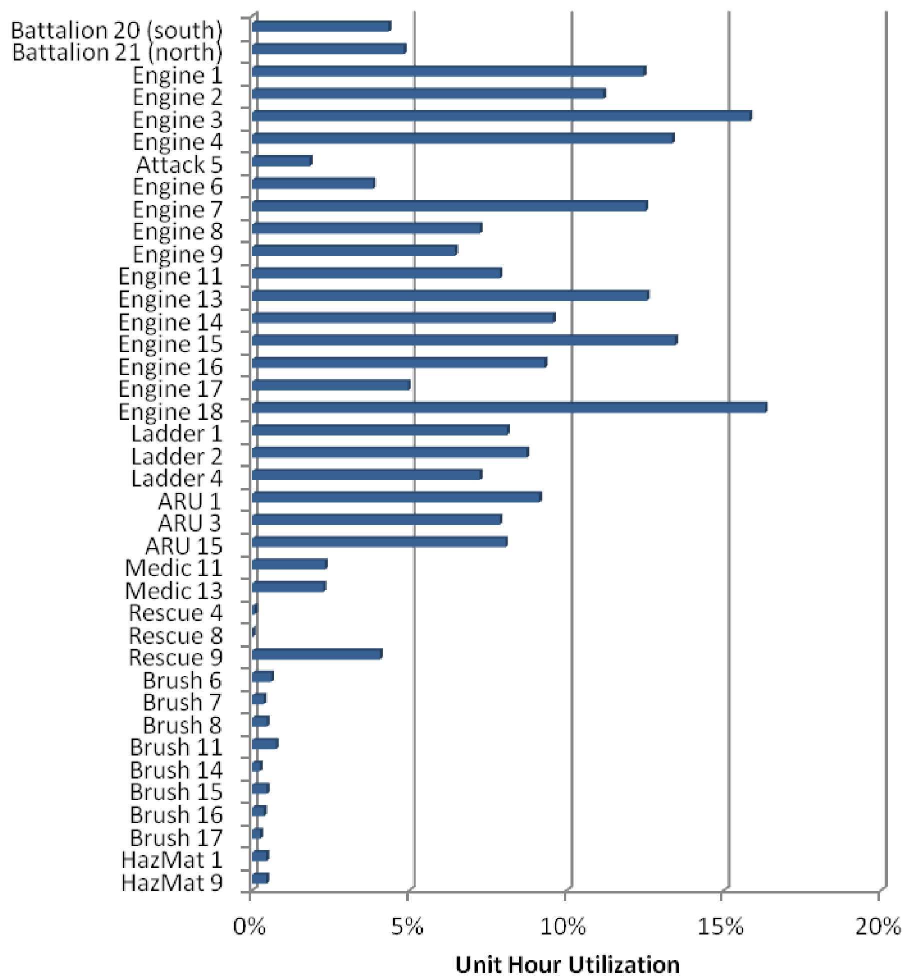
Figure 43: Average Time Committed to an Incident by Unit

Unit	Average minutes per call
Battalion 20 (south)	44.6
Battalion 21 (north)	41.6
Engine 1	25.8
Engine 2	28.1
Engine 3	23.9
Engine 4	24.4
Attack 5	38.0
Engine 6	33.7
Engine 7	28.1
Engine 8	29.8
Engine 9	27.9
Quint 11	32.3
Quint 13	27.1
Engine 14	26.8
Engine 15	25.5
Engine 16	32.0
Engine 17	33.7
Engine 18	29.0
Ladder 1	24.7
Ladder 2	27.3
Ladder 4	24.7
ARU 1	25.7
ARU 3	24.5
ARU 15	25.0
Medic 11	30.6
Medic 13	27.2
Rescue 4	89.7
Rescue 8	97.6
Rescue 9	64.4
Brush 6	197.8
Brush 7	96.3
Brush 8	72.8
Brush 11	440.2
Brush 14	94.8
Brush 15	87.7
Brush 16	98.5
Brush 17	88.1
HazMat 1	183.3
HazMat 9	183.0

Unit hour utilization is an important workload indicator. It is calculated by dividing the total time a unit is committed to all incidents during a year divided by the total time in a year. Expressed as a percentage, it describes the amount of time a unit is not available for response since it is already committed to an incident. The larger the percentage, the greater a unit's utilization and the less available it is for assignment to an incident. Unit hour utilization is an important statistic to monitor for those fire agencies using percentile-based performance standards, as does SFD. In SFD's case, where performance is measured at the 90th percentile, unit hour utilization greater than 10 percent means that the response unit will not be able to provide on-time response to its 90 percent target even if response is its only activity.

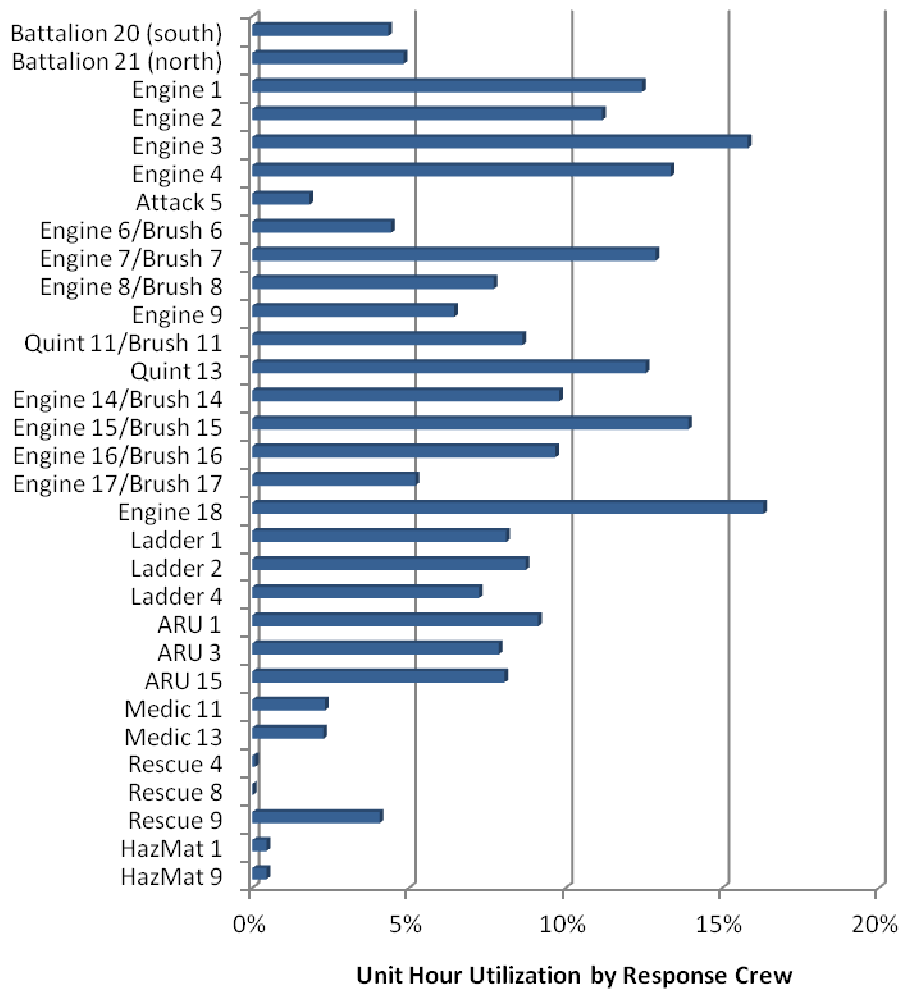
Eight SFD engines exceed 10 percent unit hour utilization.

Figure 44: Unit Hour Utilization



A number of response crews staff more than one unit. Eight crews staff an engine and cross-staff a brush unit. When the workload of both units are combined, the unit hour utilization of the response crew increases but only moderately. The following figure illustrates crew utilization.

Figure 45: Unit Hour Utilization by Response Crew



POPULATION FORECAST

A population forecast was provided by the city, produced by the Planning Technical Advisory Committee, November 2015. Population growth for Spokane is forecast to average 0.5 percent per year through 2037. Using this estimate, the city's population could reach 236,698 by 2037.

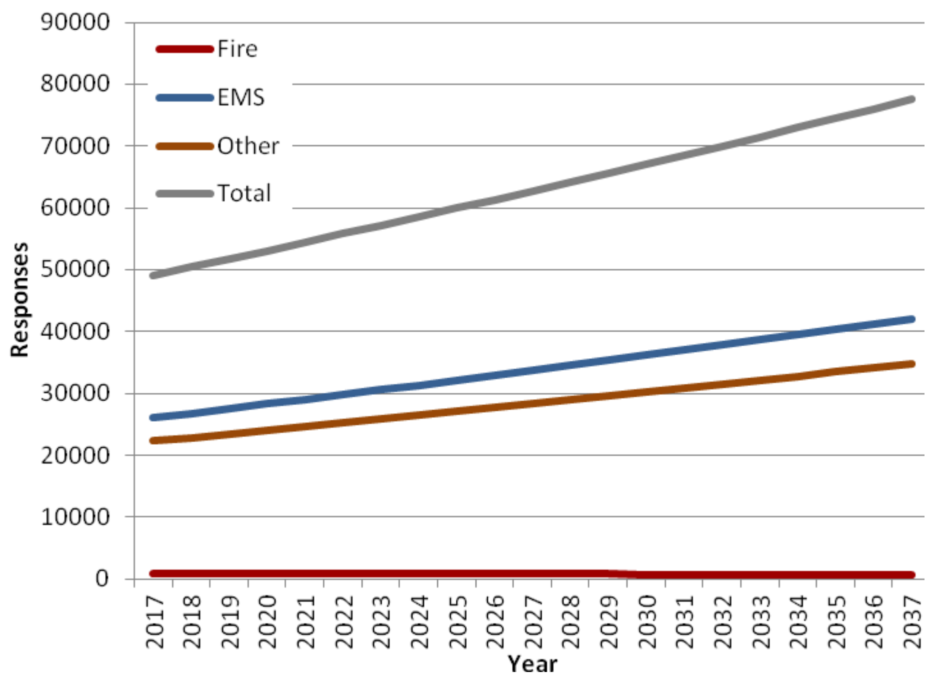
INCIDENT WORKLOAD PROJECTION

The most significant predictor of future incident workload is population; 100 percent of requests for emergency medical service are people-driven. The National Fire Protection Association reports that approximately 70 percent of all fires are the result of people either doing something they should not have (i.e., misuse of ignition source) or not doing something they should have (i.e., failure to maintain equipment). It is reasonable to use forecast population growth to predict future fire department response workload.

The current fire department services utilization rate is 189 incidents per 1,000 population. This is higher than typical for similar sized communities.

The utilization of fire department services is expected to grow modestly over time at a rate of about 2 percent per year. This, plus expected population growth, will increase the SFD's workload as shown in the following figure. Response workload could reach 77,508 responses per year by 2037 driven primarily by requests for emergency medical care.

Figure 46: Response Forecast 2017 – 2037



Component D – Critical Tasking and Alarm Assignments

The SFD service area has a densely populated urban environment and, as such, contains an elevated number, density, and distribution of risk. Further, its suburban and rural areas present unique challenges such as wildland fires. The fire department should have the resources needed to effectively mitigate the incidents that have the highest potential to negatively impact the community. As the actual or potential risk increases, the need for higher numbers of personnel and apparatus also increases. With each type of incident and corresponding risk, specific critical tasks need to be accomplished and certain numbers and types of apparatus should be dispatched. This section considers the community's identified risks and illustrates the number of personnel that are necessary to accomplish the critical tasks at an emergency.

Tasks that must be performed at a fire can be broken down into two key components: life safety and fire flow. Life safety tasks are based on the number of building occupants, and their location, status, and ability to take self-preservation action. Life safety-related tasks involve the search, rescue, and evacuation of victims. The fire flow component involves delivering sufficient water to extinguish the fire and create an environment within the building that allows entry by firefighters.

The number and types of tasks needing simultaneous action will dictate the minimum number of firefighters required to combat different types of fires. In the absence of adequate personnel to perform concurrent action, the command officer must prioritize the tasks and complete some in chronological order, rather than concurrently. These tasks include:

- Command
- Scene safety
- Search and rescue
- Fire attack
- Water supply
- Pump operation
- Ventilation
- Backup/rapid intervention

Critical task analysis also applies to non-fire type emergencies including medical, technical rescue, and hazardous materials emergencies. Numerous simultaneous tasks must be completed to effectively control an emergency. The department's ability to muster needed numbers of trained personnel quickly enough to make a difference is critical to successful incident outcomes.

The following figure illustrates the minimum emergency incident staffing recommendations of the Commission on Fire Accreditation, International. The following definitions apply to the figure:

> **Low Risk**—Minor incidents involving small fires (fire flow less than 250 gallons per minute), single patient non-life threatening medical incidents, minor rescues, small fuel spills, and small wildland fires without unusual weather or fire behavior.
>
> **Moderate Risk**—Moderate risk incidents involving fires in single-family dwellings and equivalently sized commercial office properties (fire flow between 250 gallons per minute to 1,000 gallons per minute), life threatening medical emergencies, hazardous materials emergencies requiring specialized skills and equipment, rescues involving specialized skills and equipment, and larger wildland fires.

High Risk—High risk incidents involving fires in larger commercial properties with sustained attack (fire flows more than 1,000 gallons per minute), multiple patient medical incidents, major releases of hazardous materials, high risk rescues, and wildland fires with extreme weather or fire behavior.

Figure 47: Staffing Recommendations Based on Risk

Incident Type	High Risk	Moderate Risk	Low Risk
Structure Fire	29	15	6
Emergency Medical Service	12	4	2
Rescue	15	8	3
Hazardous Materials	39	20	3
Wildland Fire	41 (Red Flag level)	20	7

The SFD has developed the following Critical Task analyses using the risk matrices included in the Critical Task section for various incident types. Further, it has defined, based on current unit staffing levels, the number and type of apparatus needed to deliver sufficient numbers of personnel to meet the critical tasking identified. ESCI's review of the Critical Task analysis concludes that all are generally in keeping with industry standards and provide the minimum number of personnel needed for effective incident operations.

Establishing resource levels needed for various types of emergencies is a uniquely local decision. Factors influencing local decisions for incident staffing include the type of equipment operated, training levels of responders, operating procedures, geography, traffic, and the nature of building and other risks being protected.

CRITICAL TASKING

Critical tasks are those activities that must be conducted early on and in a timely manner by firefighters at emergency incidents in order to control the situation, stop loss, and to perform necessary tasks required for a medical emergency. SFD is responsible for assuring that responding companies are capable of performing all of the described tasks in a prompt, efficient, and safe manner. These are the minimum number of personnel needed by incident type. More personnel will be needed for incidents of increased complexity or size.

Low Rise Structure Fire

Task	Number of Personnel
Command/Safety	2
Pump Operations	1
Attack Line	2
Search and Rescue	2
Ventilation	2
RIC	3
Other (Hydrant, backup line)	2
Total	**14**

High Rise Structure Fire (55+ feet in height)

Task	Number of Personnel
Command/Safety	3
Pump Operations	2
Attack Line	4
Search and Rescue	4
Ventilation	4
RIC	4
Other (Hydrant, backup line)	4
Total	**25**

Moderate Risk Commercial Structure Fire

Task	Number of Personnel
Command/Safety	3
Pump Operations	2
Attack Line	4
Search and Rescue	4
Ventilation	4
RIC	2
Other (Hydrant, backup line)	4
Total	**23**

High Risk Commercial Structure Fire

Task	Number of Personnel
Command/Safety	3
Pump Operations	2
Attack Line	4
Search and Rescue	4
Ventilation	4
RIC	4
Other (Hydrant, backup line)	4
Total	**25**

Wildland Fire – Low Risk

Task	Number of Personnel
Command/Safety	1
Attack Line	2
Total	**3**

Wildland Fire – High Risk

Task	Number of Personnel
Command/Safety	2
Pump Operations/Lookout	1
Attack Line	3
Structure Protection	4
Water Supply	1
Total	**11**

Aircraft Emergency

Task	Number of Personnel
Command/Safety	2
Aircraft Fire Suppression	4
Pump Operations	1
Attack Line	3
Back-up Line	2
Rescue	2
Emergency Medical Care	2
Water Supply	1
Total	**17**

Hazardous Materials – Low Risk

Task	Number of Personnel
Command	2
Liaison	1
Decontamination	4
Research/Support	2
Entry Team, and Backup Team	6
Total	**15**

Hazardous Materials – High Risk

Task	Number of Personnel
Command	2
Liaison	1
Decontamination	4
Research Support	2
Team Leader, Safety, Entry Team, and Backup Team	12
Total	**21**

Emergency Medical Aid (Life-Threatening)

Task	Number of Personnel
Patient Management	1
Patient Care	1
Documentation	1
Total	**3**

Major Medical Response (10+ Patients)

Task	Number of Personnel
Incident Command/Safety	1
Triage	5
Treatment Manager	1
Patient Care/Transport	12
Transportation Manager	1
Total	**20**

Motor Vehicle Accident (Non-Trapped)

Task	Number of Personnel
Scene Management/Documentation	1
Patient Care/Extrication	2
Total	**3**

Motor Vehicle Accident (Trapped)

Task	Number of Personnel
Command/Safety	2
Scene Management	1
Patient Care	4
Extrication	7
Pump Operator/Suppression Line	3
Extrication/Vehicle Stabilization	3
Total	**20**

Technical Rescue – Water

Task	Number of Personnel
Command/Safety	2
Rescue Team	3
Backup Team	3
Patient Care	4
Rope Tender	3
Upstream Spotter	3
Downstream Safety	3
Total	**21**

Technical Rescue – Rope

Task	Number of Personnel
Command/Safety	2
Rescue Team	3
Backup/Support Team	3
Patient Care	4
Rigger	2
Attendant	2
Ground Support	4
Edge Person	1
Total	**21**

Technical Rescue – Confined Space

Task	Number of Personnel
Command/Safety	2
Rescue Team	3
Backup/Support Team	3
Patient Care	4
Attendant	2
Rigger	3
Ground Support	4
Total	**21**

Technical Rescue – Trench

Task	Number of Personnel
Command/Safety	2
Rescue Team	3
Backup/Support Team	4
Patient Care	4
Shoring	8
Total	**21**

ALARM ASSIGNMENTS

In order to ensure sufficient personnel and apparatus are dispatched to an emergency event the following first alarm response assignments have been established. "Total Staffing Needed" is the number identified in the Critical Tasking analysis above. The number of personnel and apparatus required to mitigate an active and complex working incident will require additional resources above and beyond the numbers listed below.

Low Rise Structure Fire

Unit Type	Number of Units	Total Personnel
Engine	3	9
Truck	1	4
Battalion Chief	2	1
Total Staffing Provided		**14**
Total Staffing Needed		**14**

High Rise Structure Fire (55+ feet)

Unit Type	Number of Units	Total Personnel
Engine	7	21
Truck	3	12
Battalion Chief	2	2
Total Staffing Provided		**35**
Total Staffing Needed		**25**

Moderate Risk Commercial Structure Fire

Unit Type	Number of Units	Total Personnel
Engine	5	15
Truck	2	8
Battalion Chief	2	2
Total Staffing Provided		**25**
Total Staffing Needed		**23**

High Risk Commercial Structure Fire

Unit Type	Number of Units	Total Personnel
Engine	5	15
Truck	2	8
Battalion Chief	2	2
Total Staffing Provided		**25**
Total Staffing Needed		**25**

Wildland Fire – Low Risk

Unit Type	Number of Units	Total Personnel
Engine	1	3
Battalion Chief	0	0
Total Staffing Provided		**3**
Total Staffing Needed		**3**

Wildland Fire – High Risk

Unit Type	Number of Units	Total Personnel
Engine	1	3
Brush Engine	2	6
Battalion Chief	2	2
Total Staffing Provided		**11**
Total Staffing Needed		**11**

Aircraft Emergency

Unit Type	Number of Units	Total Personnel
Engine	1	3
Truck	2	8
ARRF	0	0
Rescue/Extrication	1	3
Paramedic	1	2-3
Battalion Chief	2	2
Total Staffing Provided		**18-19**
Total Staffing Needed		**17**

Hazardous Materials – Low Risk

Unit Type	Number of Units	Total Personnel
Engine	3	9
Truck	1	4
Battalion Chief	2	2
Total Staffing Provided		**15**
Total Staffing Needed		**15**

Hazardous Materials – High Risk

Unit Type	Number of Units	Total Personnel
Engine	4	12
Truck	1	4
Rescue	1	3
Battalion Chief	2	2
Hazardous Materials Unit	4	Cross-staffed with above
Total Staffing Provided		**21**
Total Staffing Needed		**21**

Emergency Medical Aid (Life threatening)

Unit Type	Number of Units	Total Personnel
Engine or Truck	1	3-4
Total Staffing Provided		**3-4**
Total Staffing Needed		**3**

Major Medical Response (10+ Patients)

Unit Type	Number of Units	Total Personnel
Engine/Paramedic	2	6
Engine/Truck – BLS	2	6-8
Rescue	1	3
Battalion Chief	2	2
Total Staffing Provided		**17-19**
Total Staffing Needed		**20**

Motor Vehicle Accident (Non-Trapped)

Unit Type	Number of Units	Total Personnel
Engine or Truck	1	3-4
Total Staffing Provided		**3-4**
Total Staffing Needed		**3**

Motor Vehicle Accident (Trapped)

Unit Type	Number of Units	Total Personnel
Engine	1	3
Truck	2	8
Paramedic	1	2-3
Rescue/Extrication	1	3
Battalion Chief	2	2
Total Staffing Provided		**18-19**
Total Staffing Needed		**20**

Technical Rescue – Water

Unit Type	Number of Units	Total Personnel
Engine	2	6
Water Rescue Unit	2	7-8
Tech Rescue Unit	1	3-4
Rescue/Extrication	1	3
Battalion Chief	2	2
Valley Fire Swift Water Auto Aid	Unknown	Unknown
Total Staffing Provided		**21-23**
Total Staffing Needed		**21**

Technical Rescue – Rope

Unit Type	Number of Units	Total Personnel
Engine	2	6
Truck	1	4
Rescue/Extrication	1	3
Tech Rescue Unit	2	6-8
Battalion Chief	2	2
Total Staffing Provided		**21-23**
Total Staffing Needed		**21**

Technical Rescue – Confined Space

Unit Type	Number of Units	Total Personnel
Engine	2	6
Truck	1	4
Rescue/Extrication	1	3
Tech Rescue Unit	2	6-8
Battalion Chief	2	2
Total Staffing Provided		**21-23**
Total Staffing Needed		**21**

Technical Rescue – Trench

Unit Type	Number of Units	Total Personnel
Engine	2	6
Truck	1	4
Rescue/Extrication	1	3
Tech Rescue Unit	2	6-8
Battalion Chief	2	2
Total Staffing Provided		**21-23**
Total Staffing Needed		**21**

Component E – Review of Historical System Performance

Incident data for the period between September 1, 2015, and August 31, 2016 (study period), was evaluated in detail to determine SFD's current performance. Data was obtained from SFD incident reports and the dispatch center's computer-aided dispatch system.

Only incidents occurring within the SFD service area that were dispatched as a "priority" are included in the analysis. Priority incidents involve emergencies to which the fire department initiated a "code 3" (using warning lights and sirens) response (16,425 incidents during the study period). Incidents initially dispatched as non-emergency responses were excluded. Performance is reported based on the type of incident units were dispatched to rather than the final incident type.

Each phase of the incident response sequence was evaluated to determine current performance. This allows an analysis of each individual phase to determine where opportunities might exist for improvement.

The total incident response time continuum consists of several steps, beginning with initiation of the incident and concluding with the appropriate mitigation of the incident. The time required for each of the components varies. The policies and practices of the fire department directly influence some of the steps.

SFD's response performance was compared to its performance standards. In most cases these standards compare to the national consensus standard for response performance found in the *National Fire Protection Association Standard 1710 – Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*, 2010 Edition. The Combined Communications Center's (CCC) performance were compared to the standards found in *National Fire Protection Association Standard 1221 – Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*, 2013 Edition.

The following figure summarizes SFD's performance standards.

Figure 48: Summary of SFD Performance Standards

Incident Interval	Performance Standard
Call process time (time from receipt at the dispatch center until notification of response units)	Within 90 seconds, 90 percent of the time for EMS incidents when triage process is used Within 60 seconds, 80 percent of the time for all other incidents
Turnout time (time from notification of response personnel until the initiation of movement towards the incident)	Within 80 seconds, 90 percent of the time for fire and special operations incidents Within 60 seconds, 90 percent of the time for all other incidents
First unit travel time (time from initiation of response until arrival of the first unit at the incident)	Within 4 minutes, 90 percent of the time
First unit response time (time from dispatch until arrival of the first unit at the incident)	Within 5 minutes 20 seconds, 90 percent of the time for fire and special operations incidents Within 5 minutes, 90 percent of the time for all other incidents
Response time for the first advance life support unit	Within 9 minutes, 90 percent of the time
Full effective response force time (Time from dispatch until all units initially dispatched arrive at the incident)	Within 9 minutes 20 seconds, 90percent of the time
Response time for the first arriving unit at a technical rescue incident	Within 8 minutes 30 seconds, 90 percent of the time
Response time for the first arriving unit at a marine rescue incident	Within 8 minutes 30 seconds, 90 percent of the time
Response time for the first arriving unit at a hazardous materials incident	Within 9 minutes, 90 percent of the time

In keeping with *NFPA Standards 1710* and *1221* along with SFD's performance standards, all response time elements are reported at a given percentile. Percentile reporting is a methodology by which response times are sorted from least to greatest, and a "line" is drawn at a certain percentage of the calls to determine the percentile. The point at which the "line" crosses the 90th percentile, for example, is the percentile time performance. Thus, 90 percent of times were at or less than the result. Only 10 percent were longer.

Percentile differs greatly from average. Averaging calculates response times by adding all response times together and then dividing the total number of minutes by the total number of responses (mean average). Measuring and reporting average response times is not recommended. Using averages does not give a clear picture of response performance because it does not clearly identify the number and extent of events with times beyond the stated performance goal.

What follows is a detailed description and review of each phase of the response time continuum. All phases will be compared to SFD's performance standards.

Detection

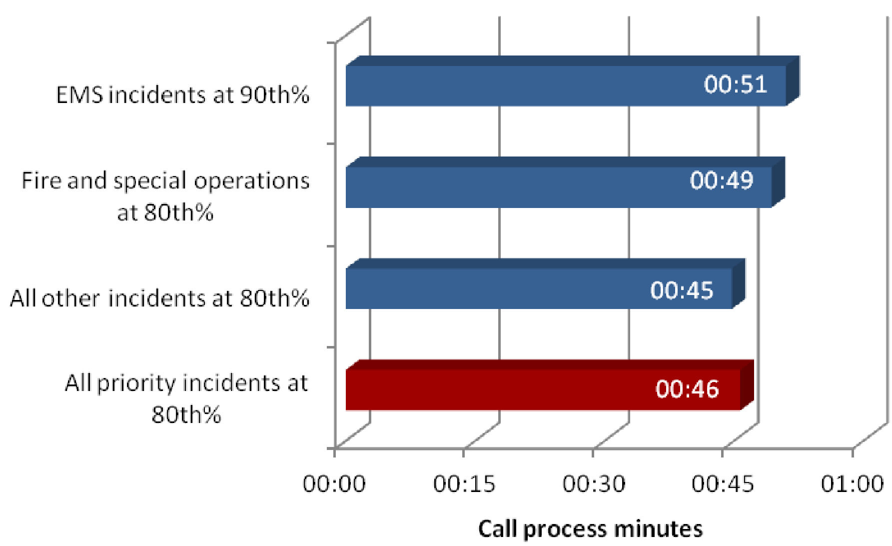
The detection of a fire (or medical incident) may occur immediately if someone happens to be present or if an automatic system is functioning. Otherwise, detection may be delayed, sometimes for a considerable period. The time period for this phase begins with the inception of the emergency and ends when the emergency is detected. It is largely outside the control of the fire department and not a part of the event sequence that is reliably measurable.

Call Processing

Most emergency incidents are reported by telephone to the 9-1-1 center. Call takers must quickly elicit accurate information about the nature and location of the incident from persons who are apt to be excited. A citizen well trained in how to report emergencies can reduce the time required for this phase. The dispatcher must identify the correct units based on incident type and location, dispatch them to the emergency, and continue to update information about the emergency while the units respond. This phase begins when the 9-1-1 call is answered at the primary public safety answer point (PSAP) and ends when response personnel are notified of the emergency. This phase is labeled "call processing time."

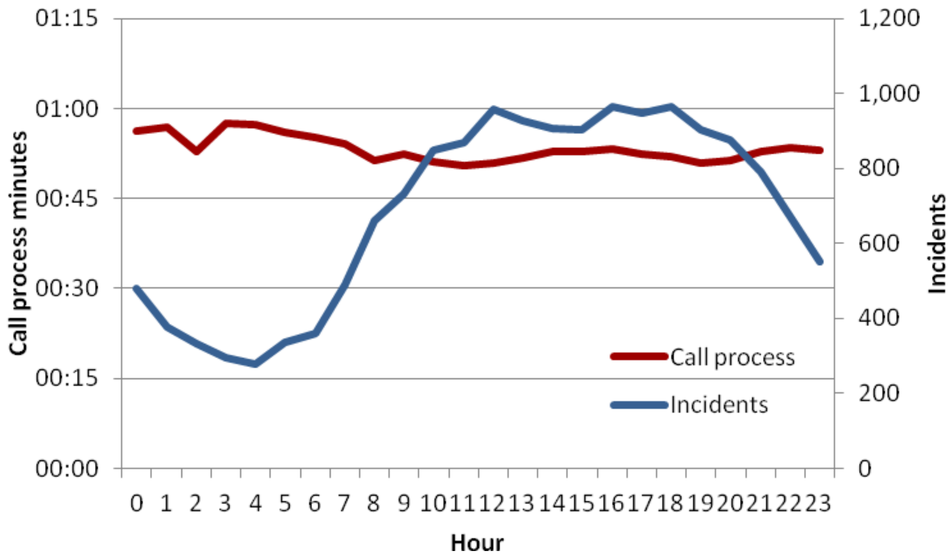
The Combined Communication Center (CCC) is both the primary answer point and dispatch center. The following figure illustrates performance by CCC from the time it receives the call until it notifies response units. Overall performance was within 46 seconds, 80 percent of the time and within 53 seconds 90 percent of the time.

Figure 49: Call Processing Time Performance



System workload can affect performance. The following figure shows CCC's performance at the 90th percentile by hour of day. Workload does not appear to affect call processing performance.

Figure 50: Call Processing Time by Hour of Day

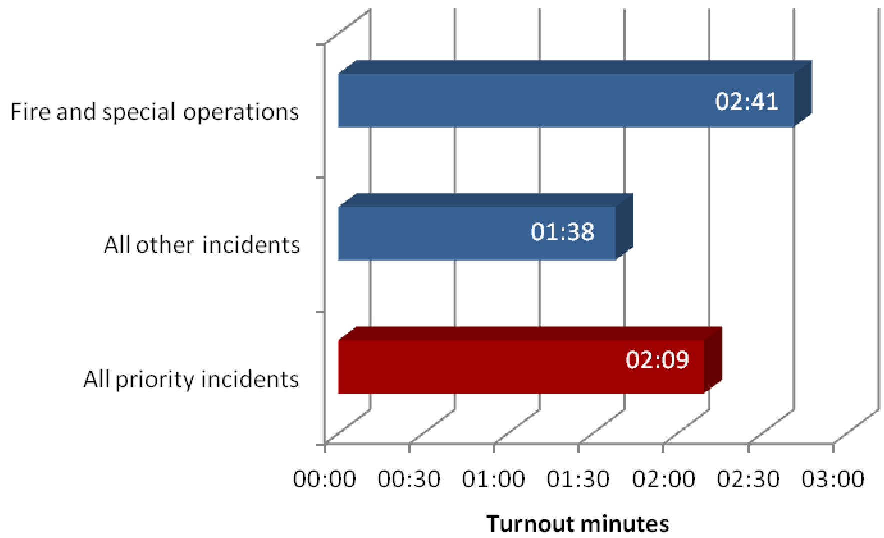


Turnout Time

Turnout time is a response phase controllable by the fire department. This phase begins at notification of an emergency in progress by the dispatch center and ends when personnel and apparatus begin movement towards the incident location. Personnel must don appropriate equipment, assemble on the response vehicle, and begin travel to the incident. Good training and proper fire station design can minimize the time required for this step.

The SFD performance goal for turnout time is within 80 seconds 90 percent of the time for fire and special operations incidents and within 60 seconds 90 percent of the time for all other incidents. The following figure lists turnout time performance during the study period. Note that this data includes both SFD units and ambulances operated by American Medical Response (AMR).

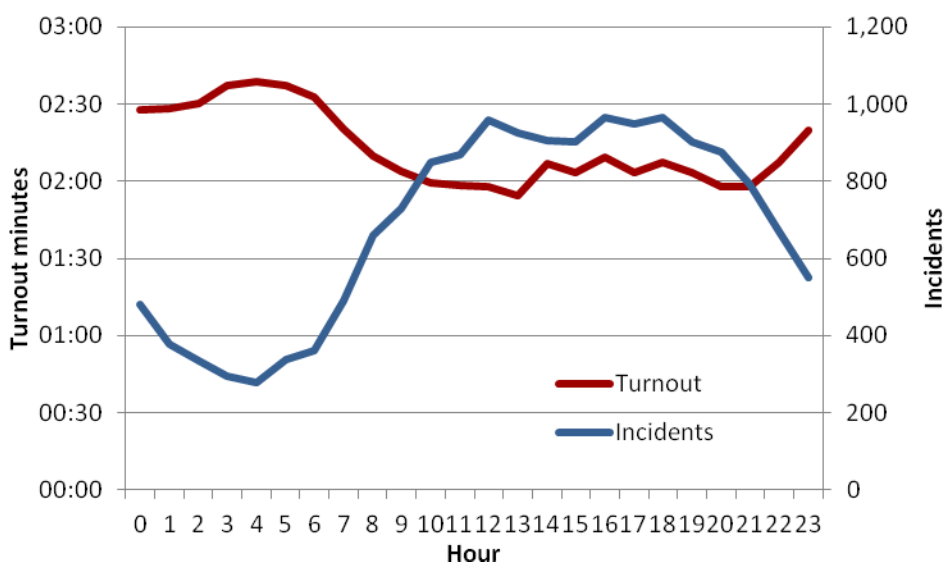
Figure 51: Turnout Time Performance



The above reflects the first unit enroute to incidents. AMR tends to have faster turnout times than fire apparatus since their crews are typically in the vehicle waiting for the next call. Overall, AMR turnout times are within 51 seconds, 90 percent of the time. SFD unit turnout times are within 2 minutes 39 seconds, 90 percent of the time.

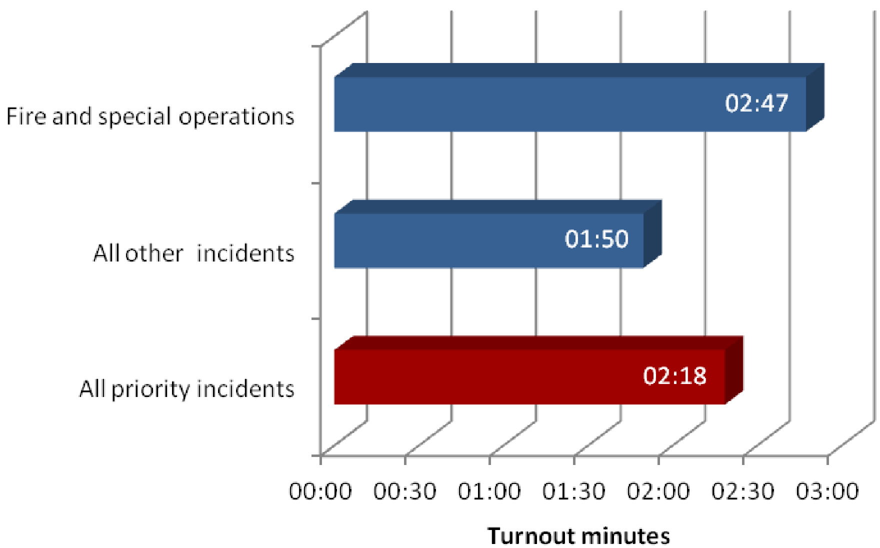
Turnout time can vary by hour of day. In this case turnout time varies by 44 seconds between the early morning hours and daytime hours.

Figure 52: Turnout Time by Hour of Day



During the development of this report a concern was raised that the configuration of the computer-aided dispatch system and mobile data computers was artifically extending turnout time. It was reported that a fix had been implemented January 1, 2017. Data for the month of January 2017 was evaluted to determine if turnout time had improved as a result of this change. It has not. The figure below illustrates turnout time for priority incidents during the month of January.

Figure 53: Turnout Time Performance – January 2017



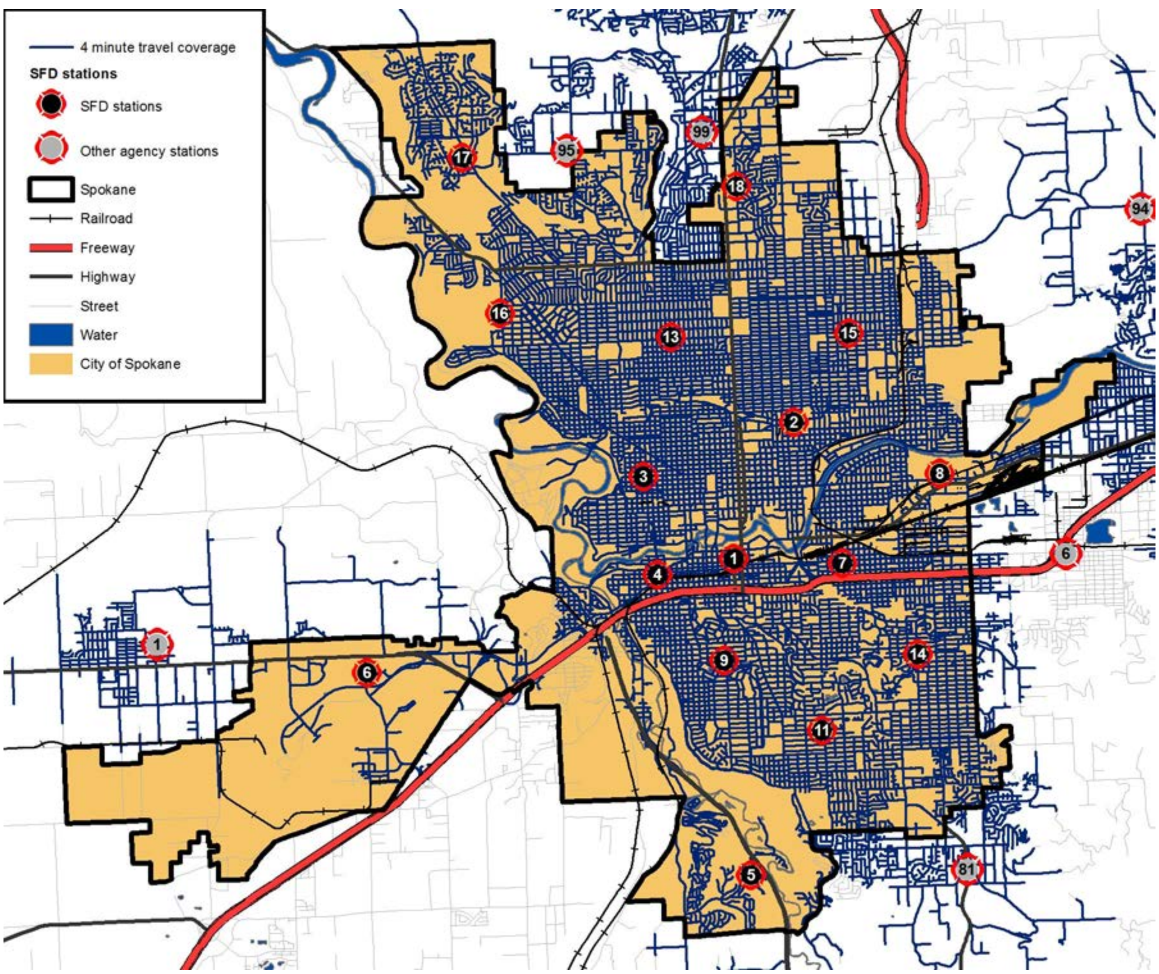
Distribution and Initial Arriving Unit Travel Time

Travel time is potentially the longest of the response phases. The distance between the fire station and the location of the emergency influences response time the most. The quality and connectivity of streets, traffic, driver training, geography, and environmental conditions are also factors. This phase begins with initial apparatus movement towards the incident location and ends when response personnel and apparatus arrive at the emergency's location. Within the SFD standard, four minutes is allowed for the first response unit to arrive at an incident.

SFD units are selected for response to an incident based on a calculation by the dispatch computer system to determine the unit that will have the shortest travel time. This method ensures the shortest possible travel times. Since response units are in their home stations most of the time, SFD's coverage is described in the following discussion based on fire station location.

The following figure illustrates the street sections that can be reached from all SFD fire stations and adjacent agency stations providing automatic aid in four minutes of travel time. It is based on posted road speeds modified to account for turning, stops, and acceleration.

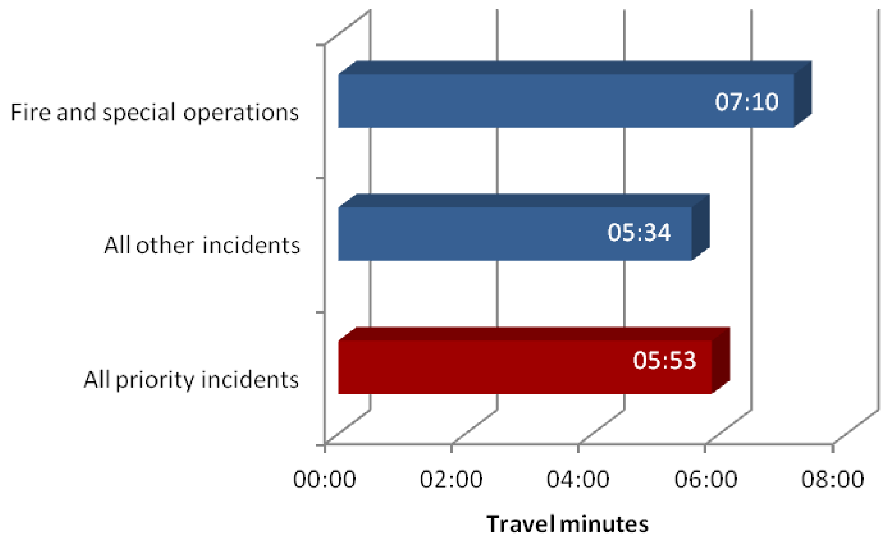
Figure 54: Initial Unit Travel Time Capability – SFD and Automatic Aid Resources



Nearly all of Spokane is within four travel minutes of a fire station. Automatic aid agencies provide limited four-minute travel coverage within the city.

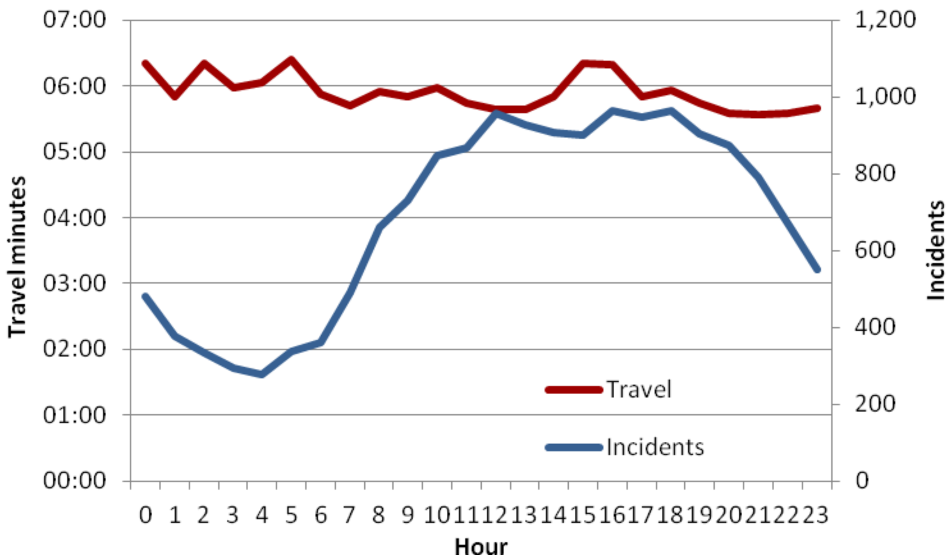
The following figure lists travel time for all priority incidents as well as specific incident types. Overall, travel time for all priority incidents within the city is within 5 minutes 53 seconds, 90 percent of the time. SFD met its four-minute goal 70 percent of the time.

Figure 55: Travel Time Performance – First Arriving Unit



Travel time can vary considerably by time of day. Heavy traffic at morning and evening rush hours can slow fire department response. Concurrent incidents can also increase travel time since units from more distant stations would need to respond. Only the afternoon rush hour (3:00 pm to 5:00 pm) appears to impact travel times.

Figure 56: Overall Travel Time and Incidents by Hour of Day – First Arriving Unit



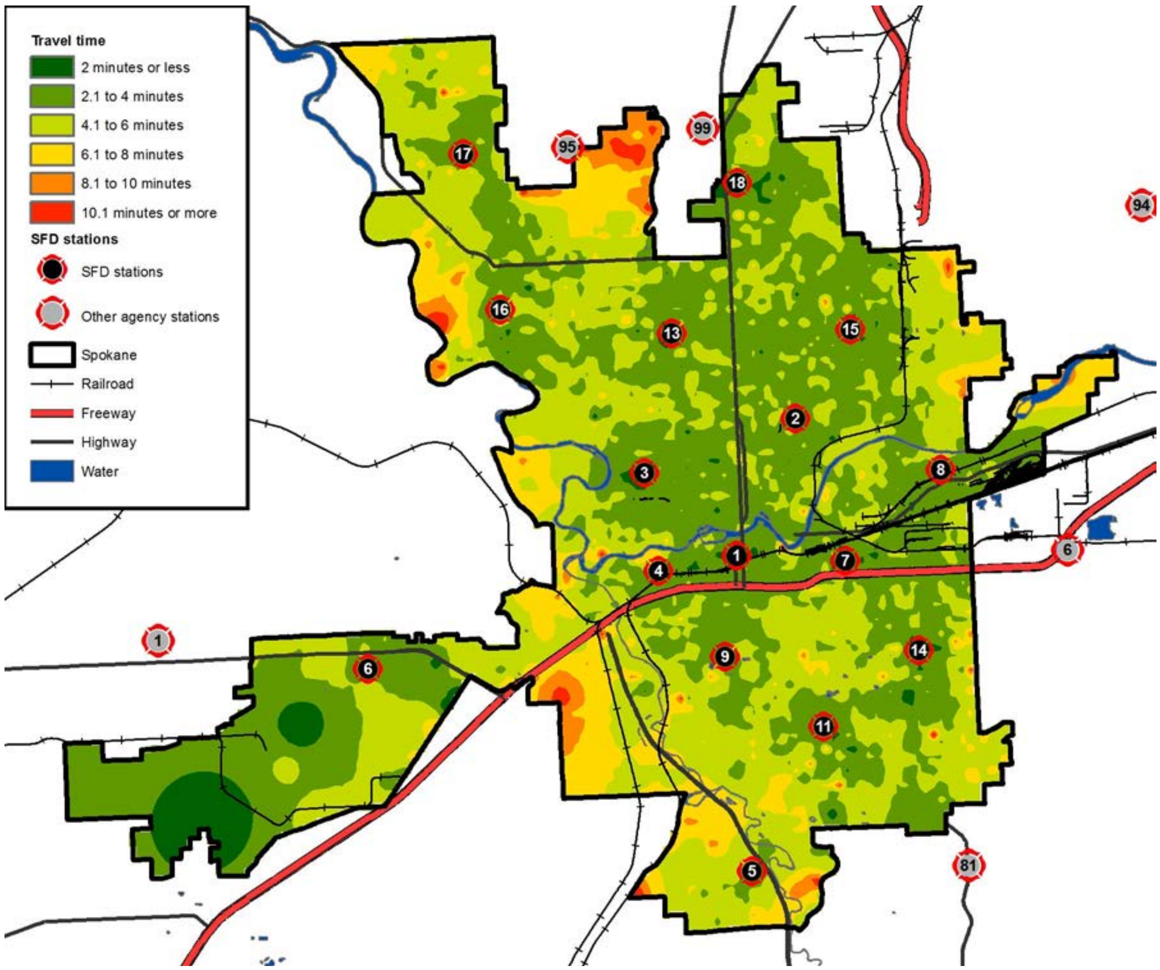
In order to provide on-time response, a response unit must be within four travel minutes of the incident. Incidents were reviewed to identify how many priority incidents were within four travel minutes of a fire station. During the study period 16,119 of the 16,425 priority incidents (98.1 percent) occurred within four travel minutes of a fire station.

Travel Time Performance by Region

Travel time performance by region is variable and influenced by a number of factors including individual station area workload and the number of times a station must cover another station's area. Additional factors include the size of the station area and the street system serving it. More highly connected, grid patterned, street systems contribute to faster response times than do areas with meandering streets with numerous dead-ends.

The following figure evaluates travel time performance by sub-area using inverse distance weighting analysis (IDW). This process uses travel time for known points (actual incidents) to predict travel time for the area surrounding the actual incident. Better performance is generally noted near fire stations with progressively longer response times for those incidents more distant from the stations.

Figure 57: Travel Time Performance by Region

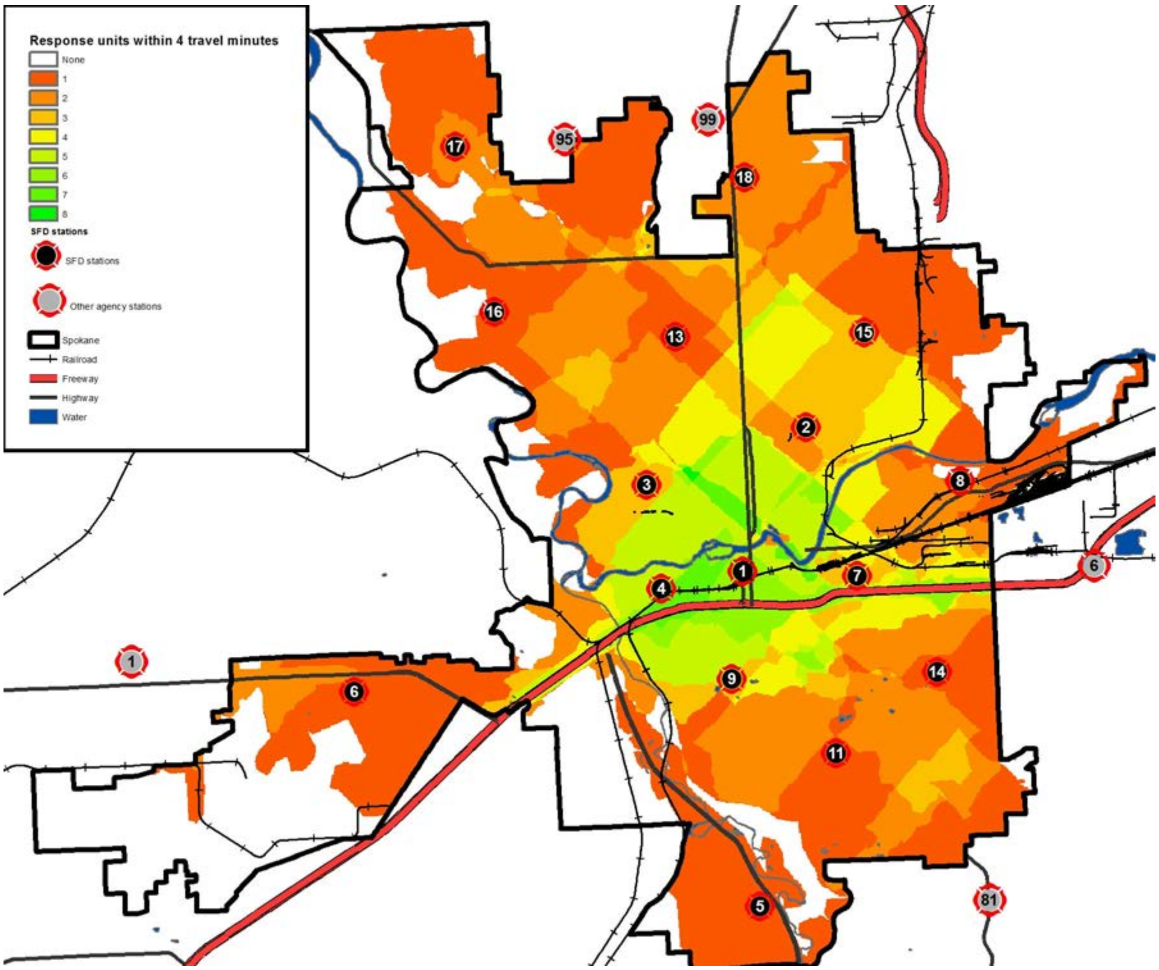


Redundancy

In busy systems such as SFD, a certain amount of redundancy, or overlapping first-due coverage, can be beneficial. The following figure illustrates the number of response units within four minutes travel by area.

There is a substantial amount of redundancy in the city's central core with as many as eight response units within four minutes of travel.

Figure 58: Number of Response Units Within Four Minutes Travel

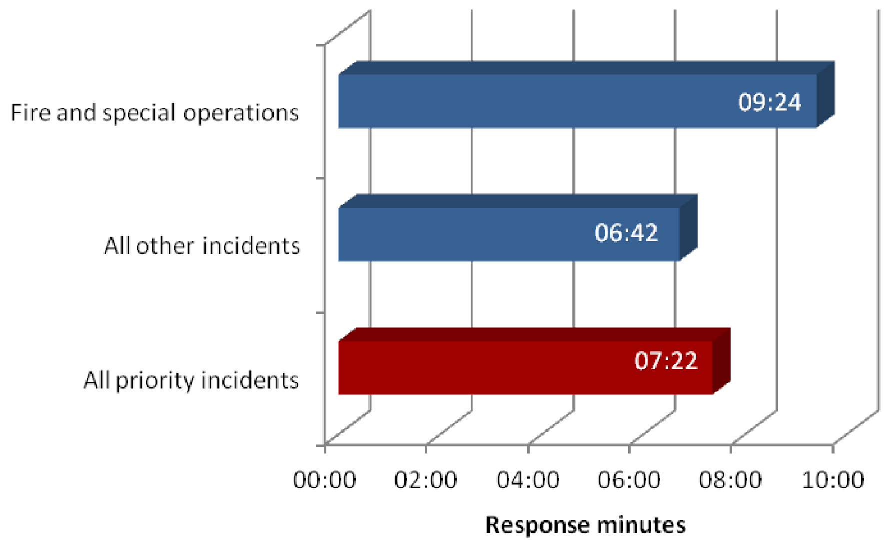


First Arriving Unit Response Time

Response time is defined as that period between the notifications to response personnel by the dispatch center that an emergency is in progress until arrival of the first fire department response unit at the emergency. When turnout time and travel time are combined, the SFD performance goal for response time is within 5 minutes 20 seconds, 90 percent of the time for fire and special operations incidents and within 5 minutes, 90 percent of the time for all other incidents.

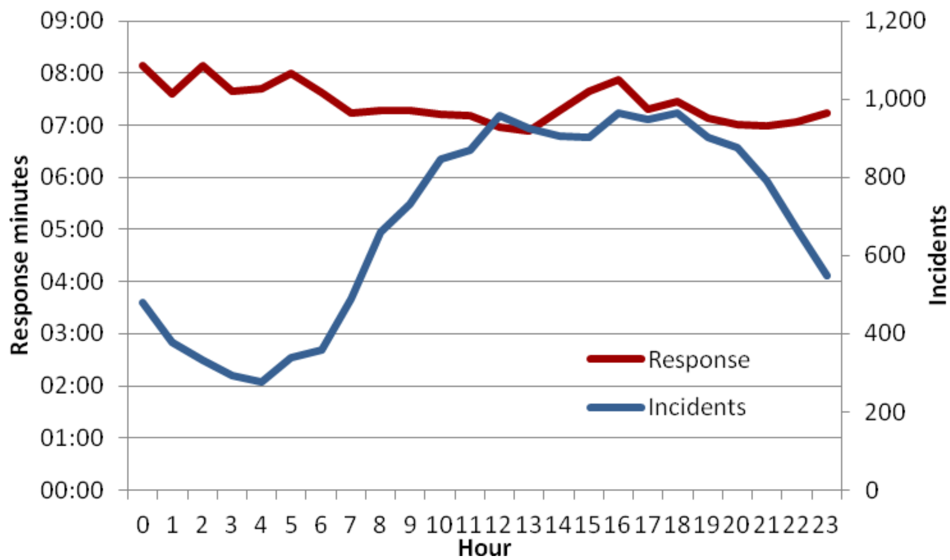
The following figure illustrates response time for all priority incidents as well as specific incident types during the study period. Overall, response time for all priority incidents was within 7 minutes 22 seconds, 90 percent of the time.

Figure 59: Response Time Performance – First Arriving Unit



The next figure shows response time and number of incidents by hour of day for all incidents. Response time is slowest during the nighttime hours and fastest during the day. Generally, SFD's best response times occur during the period of the day when response activity is at its highest.

Figure 60: Hourly Response Time Performance

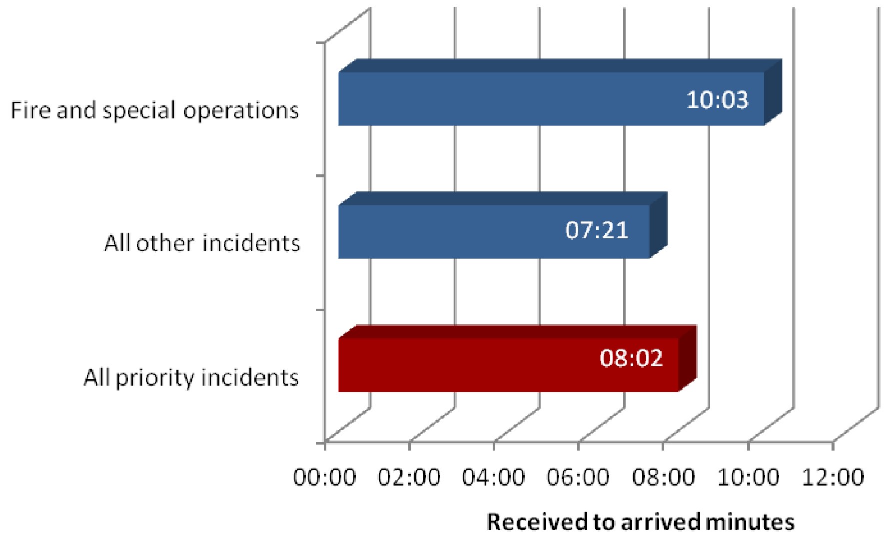


First Arriving Unit Received to Arrival Time

From the customer's standpoint, response time begins when the emergency occurs. Their first contact with emergency services is when they call for help, usually by dialing 9-1-1. Received to arrival time combines call processing, turnout, and travel time. When the SFD performance standards are combined, received to arrival time should be within 6 minutes 20 seconds, 90 percent of the time for fire and special operations incidents and within 6 minutes, 90 percent of the time for all other incidents.

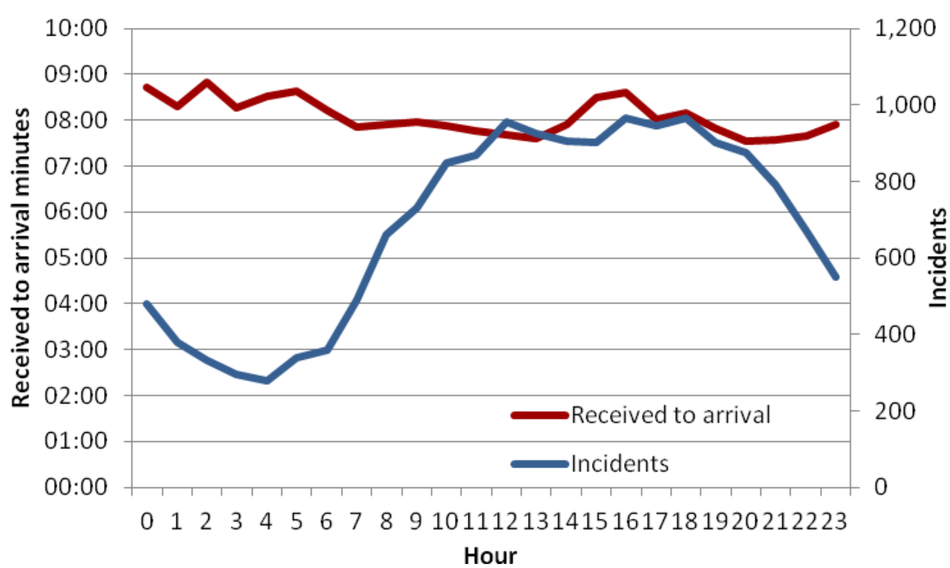
The next figure shows received to arrival performance during the study period at the 90th percentile for priority incidents within the SFD service area. Overall, received to arrival time is within 8 minutes 2 seconds, 90 percent of the time. SFD met the combined goal of 6 minutes 75 percent of the time.

Figure 61: Received to Arrival Time – First Arriving Unit



The next figure shows received to arrival performance by time of day also compared to incident activity by time of day. Received to arrival, from the customer's standpoint, is quickest during the day and slowest during the early morning hours except during the afternoon rush hour period.

Figure 62: Hourly Received to Arrival Performance



Concentration and Effective Response Force Capability Analysis

Effective Response Force (ERF) is the number of personnel and apparatus required to be present on the scene of an emergency incident to perform the critical tasks in such a manner to effectively mitigate the incident without unnecessary loss of life and/or property. The ERF is specific to each individual type of incident, and is based on the critical tasks that must be performed. In accordance with *NFPA 1710*, a moderate risk building fire is modeled for this analysis.

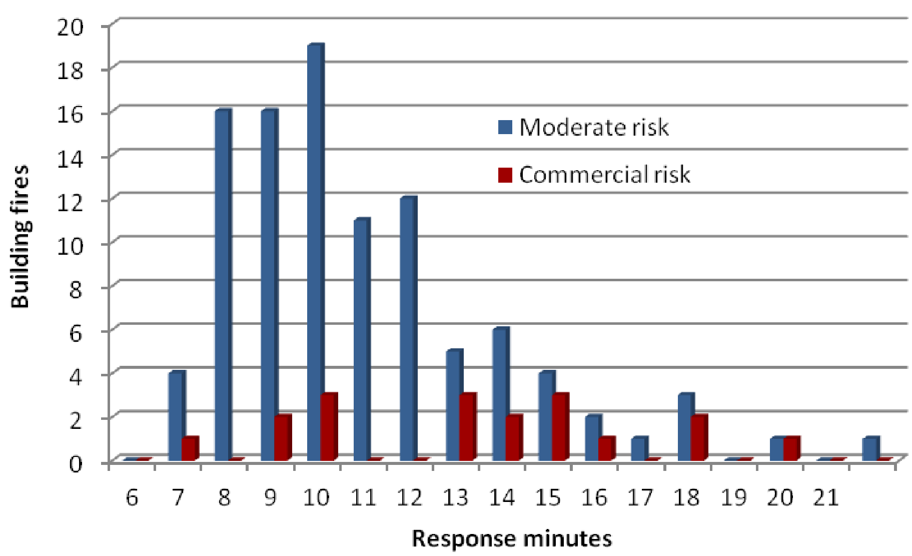
The SFD response time goal for the delivery of the full ERF to a building fire is within 9 minutes 20 seconds, 90 percent of the time. SFD has defined the minimum full effective response force for low rise building fires as three fire engines, one truck, and one battalion chief. For commercial building fires this increases to five engines, two ladder trucks, and two battalion chiefs. For a high rise building (55 feet or more in height), the minimum effective response force is seven engines, three ladder trucks, and two battalion chiefs.

The minimum full effective response force arrived at 120 building fires during the study period. Nineteen of these were in commercial properties and the remaining 101 in moderate risk properties. High rise incidents are not defined in the SFD incident data.

SFD delivered the minimum effective response force to moderate risk properties within 14 minutes 9 seconds, 90 percent of the time. SFD delivered the minimum effective response force to commercial risk properties within 17 minutes 12 seconds, 90 percent of the time.

The following figure illustrates the frequency distribution of the travel times experienced during the study period.

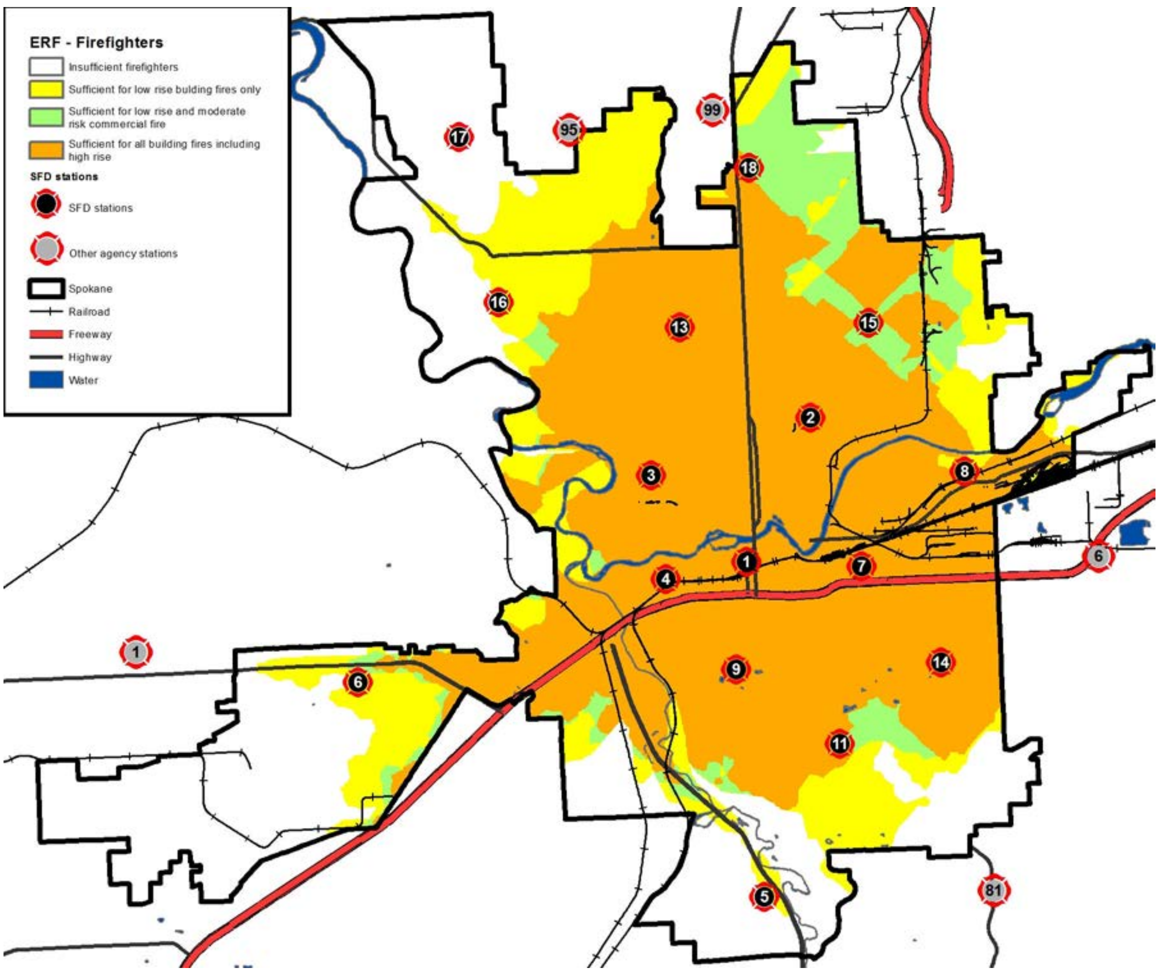
Figure 63: Frequency Distribution of Travel Time for Full ERF Arrival



Concentration analysis reviews the physical capability of SFD's resources to achieve its target ERF travel time to its service area. The following figures depict the physical capability of SFD to assemble apparatus and firefighters by area within eight minutes travel time. The modeled analysis shown assumes that all response units are available.

The first figure shows the area that can be reached by the number of firefighters that make up the target ERF for three classes of building fires based on the SFD performance goal. Eight minutes of travel time is allowed to assemble the defined full effective response force on scene. This figure includes the resources of adjacent automatic aid stations.

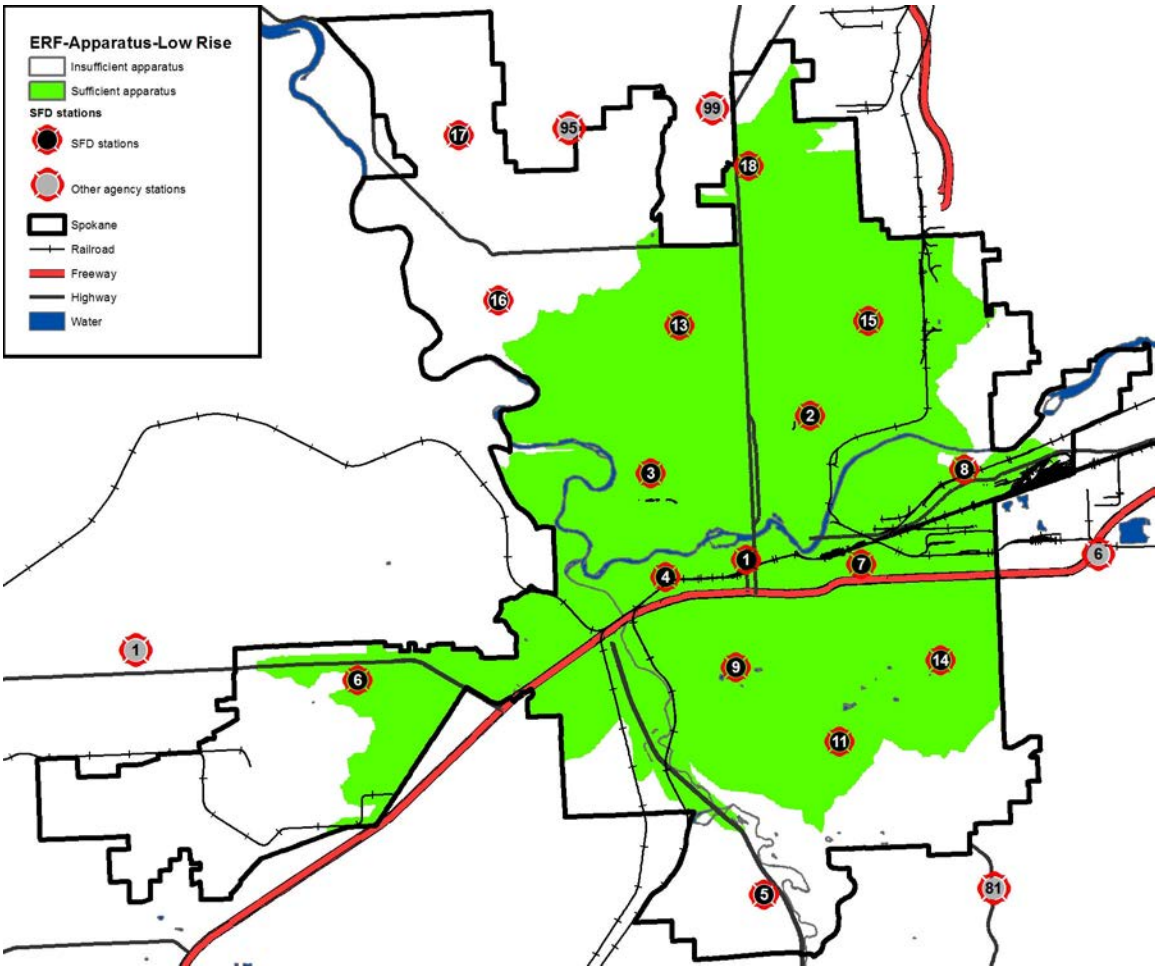
Figure 64: Effective Response Force – Firefighters



Much of the SFD service area can be served with the minimum 14 firefighters needed for a low rise building fire within the target response time. A substantial portion of the city can be provided with the staffing required for a high rise building fire. Areas to the northwest, south, and the Station 6 area lie outside sufficient effective response force staffing.

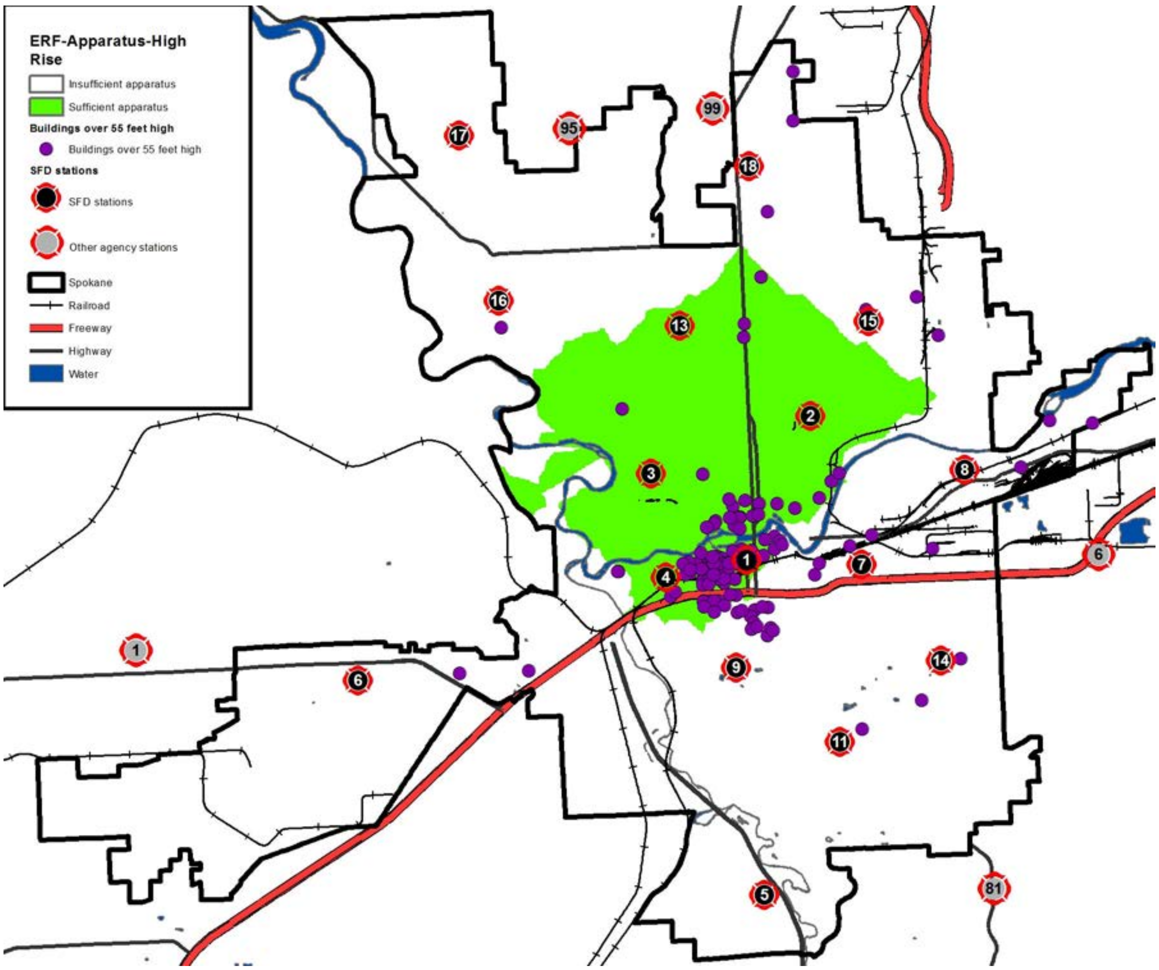
The next figure shows the area to which three fire engines, one ladder truck, and one battalion chief can respond within the eight minutes travel time allowed by the SFD performance goal. This is the apparatus complement needed for a low rise building fire. The model indicates these resources can be delivered within eight minutes travel time to much of the service area.

Figure 65: Effective Response Force – Apparatus – Low Rise Building Fire



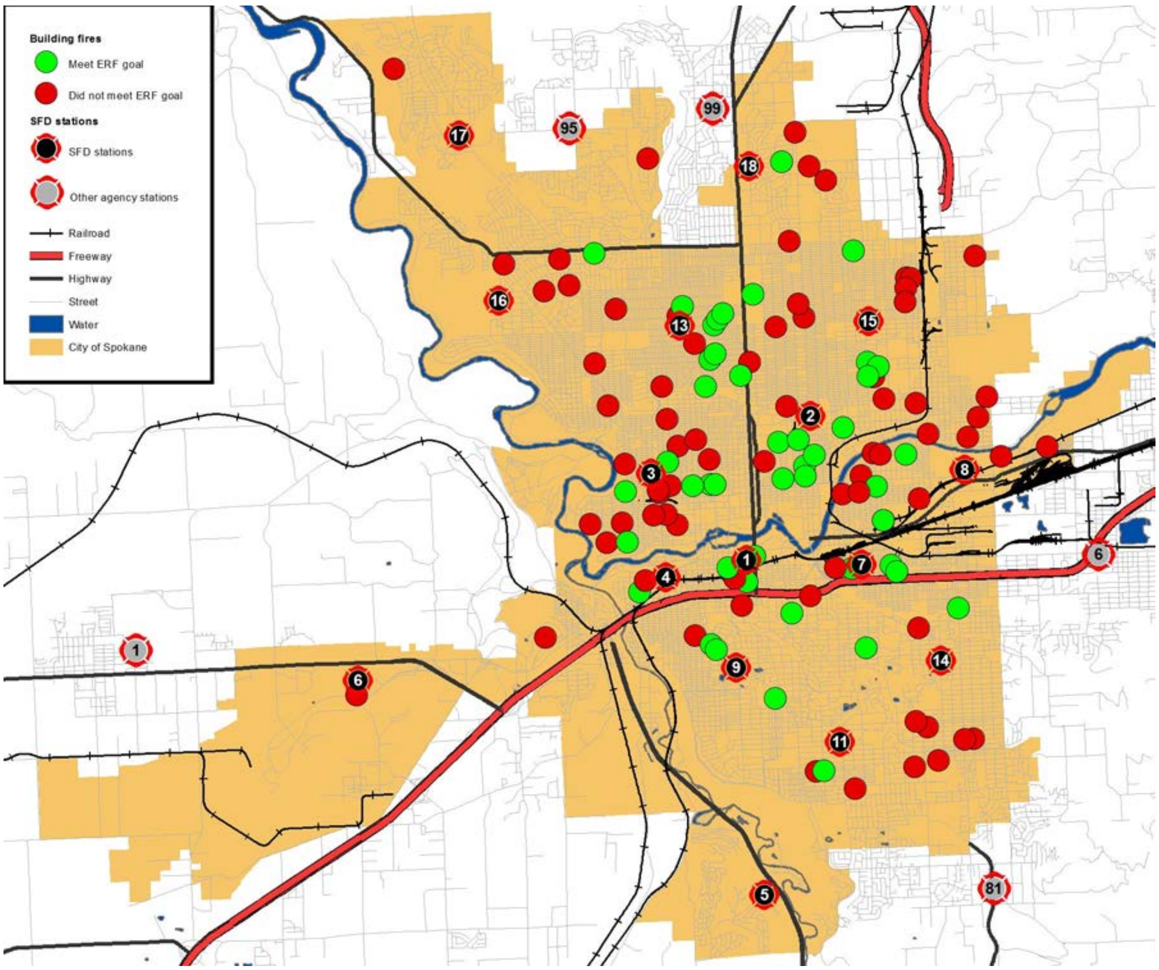
The next figure illustrates SFD's capability to deliver the apparatus required for a high rise fire (seven engines, three ladder trucks, and two battalion chiefs). Though a much smaller area can be served, it does include most of the buildings over 55 feet tall in the city.

Figure 66: Effective Response Force – Apparatus - High Rise Building Fire



The following figure illustrates the location of those building fires to which ERF was provided within 9 minutes 20 seconds response time and those for which response time was longer. During the study period only 49 of the 120 building fires that received the full ERF had response times of 9 minutes 20 seconds or less.

Figure 67: Building Fires Meeting and Not Meeting the ERF Goal



Second Unit Arrival Time

SFD fire engines are staffed with three personnel. Ladder trucks are staffed with four personnel. Safety regulations require that at least four firefighters be on scene before firefighters can enter a burning building. The only exception is if it is known that a person is inside the building and needs rescue. Current staffing levels on engines require the arrival of a second response unit before non-rescue interior firefighting activities can be initiated.

Incident data for building fires during the study period was reviewed to determine the time the second response unit arrived on the scene. According to the data the second unit arrived on scene of a structure fire within 3 minutes 13 seconds, 90 percent of the time after the arrival of the first unit (1 minute 29 seconds on average).

Emergency Medical Services

SFD provides first response emergency medical service normally at the advanced life support level. Private ambulance companies provide patient transportation and enroute care to a medical facility. All SFD engine, ladders, and ARUs are advanced life support capable.

SFD units arrive at an emergency medical incident within 8 minutes 22 seconds, 90 percent of the time from time of dispatch. The private ambulance arrives within 11 minutes 23 seconds, 90 percent of the time from the time of dispatch.

A review of EMS incidents was conducted to determine the number of times each entity arrived first at an EMS incident. SFD arrived first 76 percent of the time and the ambulance arrived first 24 percent of the time.

Incident Concurrency and Reliability

When evaluating the effectiveness of any resource deployment plan, it is necessary to evaluate the workload of the individual response units to determine to what extent their availability for dispatch is affecting the response time performance. In simplest terms, a response unit cannot make it to an incident across the street from its own station in four minutes if it is unavailable to be dispatched to that incident because it is committed to another call.

Concurrency

One way to look at resource workload is to examine the number of times multiple incidents happen within the same time frame in each station area. Incidents during the study period were examined to determine the frequency of concurrent incidents. This is important because concurrent incidents can stretch available resources and extend response times.

The following figure shows the number times during the study period that one or more incidents occurred concurrently. It shows that much of the time (18,948), three or fewer incident were in progress at a time.

Figure 68: Incident Concurrency

Concurrent incidents	Count
1	3374
2	7003
3	8571
4	7731
5	5653
6	3531
7	1889
8	910
9	413
10	185
11	101
12	42
13	37
14	23
15	6

It is also useful to review the number of times one or more response units are committed to incidents at the same time. The following figure shows the number of times one or more SFD response units were committed to incidents. It is more common than not for multiple response units to be simultaneously committed to incidents.

Figure 69: Response Unit Concurrency

Concurrent Units	Count
1	5984
2	9344
3	9117
4	6923
5	4593
6	2878
7	1688
8	1059
9	830
10	578
11	463
12	368
13	265
14	216
15	301

Reliability

The ability of a fire station's first-due unit(s) to respond to an incident within its assigned response area is known as unit *reliability*. The reliability analysis is normally done by measuring the number of times response units assigned to a given fire station were available to respond to a request for service within that fire station's primary service area.

SFD does not dispatch response units based on a particular geographic service area. Instead, the computer-aided dispatch system assigns the closest unit to an incident based on calculated travel time. This is a far superior way to select response units for an incident.

To determine reliability under this system, data should be collected to determine the number of times any response unit was available for an incident within the target travel time, in this case four minutes. Data is not currently available to make that calculation.

Component F – Performance Objectives and Performance Measures

DYNAMICS OF FIRE IN BUILDINGS

Most fires within buildings develop in a predictable fashion unless influenced by highly flammable material. Ignition, or the beginning of a fire, starts the sequence of events. It may take several minutes or even hours from the time of ignition until a flame is visible. This smoldering stage is very dangerous, especially during times when people are sleeping, since large amounts of highly toxic smoke may be generated during this phase.

Once flames do appear, the sequence continues rapidly. Combustible material adjacent to the flame heat and ignite, which in turn heats and ignites other adjacent materials if sufficient oxygen is present. As the objects burn, heated gases accumulate at the ceiling of the room. Some of the gases are flammable and highly toxic.

The spread of the fire from this point continues quickly. Soon the flammable gases at the ceiling as well as other combustible material in the room of origin reach ignition temperature. At that point, an event termed "flashover" occurs; the gases and other material ignite, which in turn ignites everything in the room. Once flashover occurs, damage caused by the fire is significant and the environment within the room can no longer support human life.

Flashover usually occurs about five to eight minutes from the appearance of flame in typically furnished and ventilated buildings. Since flashover has such a dramatic influence on the outcome of a fire event, the goal of any fire agency is to apply water to a fire before flashover occurs.

Although modern codes tend to make fires in newer structures more infrequent, today's energy-efficient construction (designed to hold heat during the winter) also tends to confine the heat of a hostile fire. In addition, research has shown that modern furnishings generally ignite more quickly and burn hotter (due to synthetics).

In the 1970s, scientists at the National Institute of Standards and Technology found that after a fire broke out, building occupants had about 17 minutes to escape before being overcome by heat and smoke. Today, that estimate is as short as three minutes.[7] The necessity of effective early warning (smoke alarms), early suppression (fire sprinklers), and firefighters arriving on the scene of a fire in the shortest span of time is more critical now than ever.

Perhaps as important as preventing flashover is the need to control a fire before it does damage to the structural framing of a building. Materials used to construct buildings today are often less fire resistive than the heavy structural skeletons of older frame buildings. Roof trusses and floor joists are commonly made with lighter materials that are more easily weakened by the effects of fire. "Light weight" roof

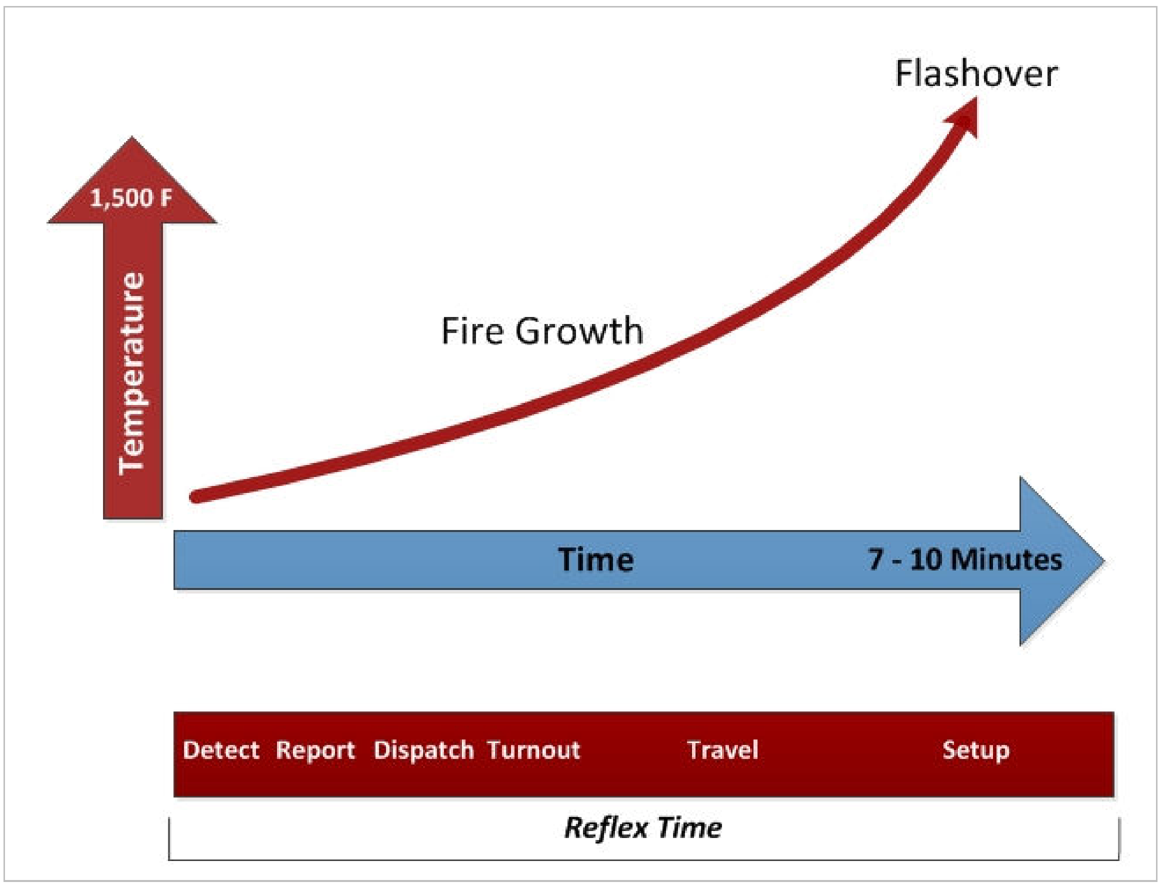
[7] National Institute of Standards and Technology, *Performance of Home Smoke Alarms, Analysis of the Response of Several Available Technologies in Residential Fire Settings,* Bukowski, Richard, et al.

trusses fail after five to seven minutes of direct flame impingement. Plywood I-beam joists can fail after as little as three minutes of flame contact. This creates a dangerous environment for firefighters.

In addition, the contents of buildings today have a much greater potential for heat production than in the past. The widespread use of plastics in furnishings and other building contents rapidly accelerate fire spread and increase the amount of water needed to effectively control a fire. All of these factors make the need for early application of water essential to a successful fire outcome.

A number of events must take place quickly to make it possible to achieve fire suppression prior to flashover. Figure 70 illustrates the sequence of events.

Figure 70: Fire Growth vs. Reflex Time



As is apparent by this description of the sequence of events, application of water in time to prevent flashover is a serious challenge for any fire department. It is critical, though, as studies of historical fire losses can demonstrate.

The National Fire Protection Association found that fires contained to the room of origin (typically extinguished prior to or immediately following flashover) had significantly lower rates of death, injury, and property loss when compared to fires that had an opportunity to spread beyond the room of origin (typically extinguished post-flashover). As evidenced in the following figure, fire losses, casualties, and deaths rise significantly as the extent of fire damage increases.

Figure 71: Fire Extension in Residential Structures – United States

Consequence of Fire Extension In Residential Structures 2003 – 2007			
Extension	Rates per 1,000 Fires		
	Civilian Deaths	Civilian Injuries	Average Dollar Loss Per Fire
Confined to room of origin or smaller	2.44	25.67	$5,317
Confined to floor of origin	16.18	72.79	$34,852
Confined to building of origin or larger	27.54	54.26	$60,064

Source: National Fire Protection Association "Home Structure Fires," March 2010

EMERGENCY MEDICAL EVENT SEQUENCE

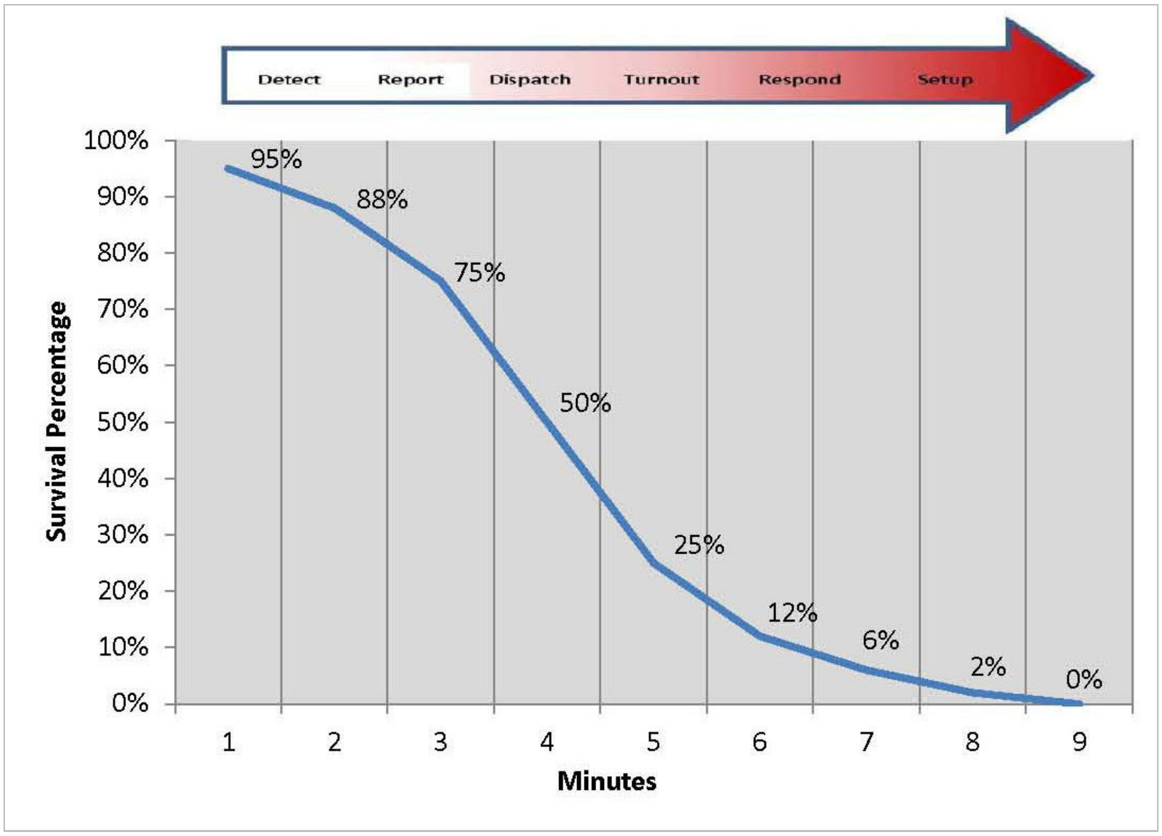
Cardiac arrest is the most significant life-threatening medical event in emergency medicine today. A victim of cardiac arrest has mere minutes in which to receive lifesaving care if there is to be any hope for resuscitation.

The American Heart Association (AHA) issued a set of cardiopulmonary resuscitation guidelines designed to streamline emergency procedures for heart attack victims, and to increase the likelihood of survival. The AHA guidelines include goals for the application of cardiac defibrillation to cardiac arrest victims.

Cardiac arrest survival chances fall by 7 to 10 percent for every minute between collapse and defibrillation. Consequently, the AHA recommends cardiac defibrillation within five minutes of cardiac arrest.

As with fires, the sequence of events that lead to emergency cardiac care can be graphically illustrated, as in the following figure.

Figure 72: Cardiac Arrest Event Sequence



The percentage of opportunity for recovery from cardiac arrest drops quickly as time progresses. The stages of medical response are very similar to the components described for a fire response. Recent research stresses the importance of rapid cardiac defibrillation and administration of certain medications as a means of improving the opportunity for successful resuscitation and survival.

PEOPLE, TOOLS, AND TIME

Time matters a great deal in the achievement of an effective outcome to an emergency event. Time, however, is not the only factor. Delivering sufficient numbers of properly trained, appropriately equipped personnel within the critical time period completes the equation.

For medical emergencies this can vary based on the nature of the emergency. Many medical emergencies are not time critical. However, for serious trauma, cardiac arrest, or conditions that may lead to cardiac arrest, a rapid response is essential.

Equally critical is delivering enough personnel to the scene to perform all of the concurrent tasks required to deliver quality emergency care. For a cardiac arrest, this can be up to six personnel; two to perform CPR, two to set up and operate advanced medical equipment, one to record the actions taken by emergency care workers, and one to direct patient care.

Thus, for a medical emergency, the real test of performance is the time it takes to provide the personnel and equipment needed to deal effectively with the patient’s condition, not necessarily the time it takes for the first person to arrive.

Fire emergencies are even more resource critical. Again, the true test of performance is the time it takes to deliver sufficient personnel to initiate application of water to a fire. This is the only practical method to reverse the continuing internal temperature increases and ultimately prevent flashover. The arrival of one person with a portable radio does not provide fire intervention capability and should not be counted as “arrival” by the fire department.

Component G – Overall Evaluation, Conclusions, and Recommendations

OVERALL EVALUATION

This Level of Service study required the completion of an intensive analysis on all aspects of the SFD deployment policies. The analysis used various tools to review historical performance, evaluate risk, validate response coverage, and define critical tasking and alarm assignments. The analysis relied on the experience of staff officers and their historical perspective combined with historical incident data captured by both the dispatch center and SFD's in-house records management system.

The Description of Community Served section provided a general overview of the organization, including governance, lines of authority, finance, and capital and human resources, as well as an overview of the service area including population and geography served. The Review of Services Provided section detailed the core services the organization provides based on general resource/asset capability and basic staffing complements.

An overview of community risk was provided to identify the risks and challenges faced by the fire department. Geospatial characteristics, topographic and weather risks, transportation network risks, physical assets, and critical infrastructure were reviewed and which then identified medical incidents, structure fires, and rescues as the primary risks within the community. As a factor of risk, community populations and demographics are evaluated against historic and projected service demand. Population and service demand has increased over the past decade and will continue to increase in the future.

Evaluating risk using advanced geographic information systems (GIS) provided an increased understanding of community risk factors to support deployment recommendations.

During the analysis of service level objectives, critical tasking assignments were completed for incident types ranging from a basic medical emergency to a high rise structure fire. Critical tasking required a review of on-scene staffing requirements to mitigate the effects of an emergency. These tasks ultimately determine the resource allocation necessary to achieve a successful operation. The results of the analysis indicate that a low rise (moderate risk) structure fire required a minimum of 14 personnel.

The review of historical system performance evaluated each component of the emergency incident sequence. These included call processing, turnout, and travel time. Beyond the response time of the initial arriving units, the additional components of concentration and effective response force, reliability, and call concurrency were evaluated.

Based on the analysis and considering community expectations, recommendations are offered to improve the delivery of fire and emergency services to the community service by SFD. It is not expected that all will be implemented in the short-term. Some may wait until economic conditions allow their implementation. However, all the recommendations offered chart a course to improved capability and service.

RECOMMENDATIONS

During the course of this study a number of issues, concerns, and opportunities were identified. The following recommendations are intended to accomplish three primary objectives:

1. Improve the efficiency and effectiveness of the current system through modifications to operating practices, deployment of existing resources, use of technology, and system management.
2. Decrease the time from the first call for help until the arrival of the first capable response unit and personnel to meet response performance standards.
3. Decrease the time from the first call for help until the arrival of the entire first alarm assignment (effective response force) to meet response performance standards.

The recommendations are described as improvement recommendations. Each will improve SFD's ability to provide effective service to the community. It will be up to the City of Spokane's policy makers to determine the extent to which these recommendations are implemented based on the community's desired level of emergency services and the ability to fund improvements. Additional details for the costs of each recommendation can be found in the Appendix.

Improvement Recommendation A: Reduce turnout time and improve the accuracy of enroute time reporting

Turnout time is the time period between when dispatchers notify response personnel of the incident and when response crews begin travel towards the incident location. The adopted performance goal for turnout time is within 80 seconds, 90 percent of the time for fire and special operations incidents and within 60 seconds, 90 percent of the time for all other incidents. SFD's current turnout time performance significantly exceeds these goals.

Some believe there is a margin of error in SFD's actual recorded performance. Prior to January 2017, it was suspected there was a lag between the time the enroute button on the MDC was pushed and when CAD recorded the status change. A correction was implemented in January 2017 to route that information across a different radio system. The change did not improve turnout time. There is now a belief among some that radio warm-up time is also contributing to long turnout time being recorded.

This issue needs to be investigated thoroughly and a resolution implemented. But, even if the delay being reported by some is resolved, turnout times still exceed goals by a significant margin.

SFD should review fire station configuration to determine if there are obstacles to rapid turnout. Solutions could include adding doors between rooms, rearranging furnishings and adding dispatch alerting system speakers to improve audibility.

Improving the capability of in-cab computers (MDCs) should also help improve performance. At the time of dispatch the MDC should be able to display the incident location, details gathered by the call taker, and the best route to the incident. The MDC should also be able to display pre-incident plan information as available and other information useful to incident management.

Other technology should be considered including using the global positioning system (GPS) equipment already installed on fire apparatus. This equipment can be used to automatically record the vehicle's enroute time when it senses vehicle movement.

Fire department management should regularly prepare information that describes current turnout time performance by individual response crews. Performance expectations should be reinforced and periodic monitoring conducted to determine if improvements are being made and sustained.

Response personnel should avoid activities that extend turnout times. Response personnel must make serious efforts to improve their turnout time performance for the benefit of the community.

Estimated cost: Dependent on physical rearrangements required for each station. Automatic reporting of enroute time through GPS dependent on needed CAD programming.

Improvement Recommendation B: Develop the ability to audit CAD closest unit recommendations

In the historic response performance section of this report it was noted that actual travel times are longer than what the performance model would suggest is possible. There could be any number of reasons for this. High response unit workload leading to reduced unit reliability, traffic congestion, units out of position for administrative and training reasons, and others can all contribute to longer travel times.

SFD's computer-aided dispatch (CAD) system automatically identifies the unit closest to any incident. It does this through a computation that identifies the response unit that is closest to any incident by travel time.

The data produced by this computation presents a very good opportunity to better understand SFD's travel time performance. The data can be used to evaluate excessively long travel times, travel time patterns within a region, by time of day, and more. But first SFD will need to develop a way to capture this data, export it, and evaluate it.

SFD should create the ability to capture the CAD travel time calculations for each incident and to export them for further analysis. Creating this capability will require some reprogramming of the CAD system and establishing data storage capability so the data can be retrieved for analysis.

Closest unit calculation data should also be used to periodically audit unit recommendations to ensure CAD is accurately selecting the closest unit to the incident location.

Estimated cost: Dependent on needed CAD programming.

Improvement Recommendation C: Install emergency vehicle pre-emption equipment on all controlled intersections

Traffic signal pre-emption equipment allows responding fire personnel to control traffic signals, turning the signal green in their direction and red in all other directions. Utilization of this equipment helps to provide a clear path through a controlled intersection minimizing the delays these intersections can create. Further, it greatly improves safety for both responders and the motoring public.

This technology is not inexpensive. Each signal controlled intersection will cost $10,000 or more depending on the age of the controller. Each apparatus not already equipped will require equipment costing approximately $2,000. However, the benefits to response performance and safety far outweigh the cost.

Estimated cost: Dependent on the number and age of signals requiring the pre-emption equipment.

Improvement Recommendation D: Implement dynamic redeployment practices

Current workload, response practices, and deployment can impact response time performance. One factor that contributes to this is daily non-emergency response movements of units within the system. The majority of this type of movement is a result of crews being summoned from their station and first due area for training, meetings, and other scheduled or non-scheduled events.

SFD should review non-response crew movement to ensure that only mission critical movements are taking place. Web-based and in-station training should be incorporated into the training schedule whenever and wherever possible. For those times when it is necessary for a unit to move out of its first due area (such as mandatory multi-company training), stations should be back-filled strategically with other response units to ensure that the ability to meet response performance goals is being maintained.

During periods of high incident activity, dispatch personnel and SFD battalion chiefs should implement "move-up and cover" procedures to ensure available response units are positioned to provide the shortest possible response times. This would involve moving response resources to different stations based on both response time and where the next incidents are likely to occur.

Additional daytime response units should be considered and systematically incorporated into the delivery system. These units would be placed in service and used to refill stations vacated for non-response reasons. These units can be staffed by personnel on overtime, or if it is found that these are used often enough, with full-time personnel. The number of daytime response units that may be needed will vary on a day-to-day basis. SFD should review required non-response crew movements to determine the number of daytime units that may be needed.

ARUs provide additional dynamic deployment flexibility. These small units can be easily moved to different locations based on coverage needs and predictable incident activity.

Estimated Cost: None unless additional daytime response units are placed in service.

Improvement Recommendation E: Increase the number of alternative response units (ARU) in the system and increase ARU hours of service

Current use of ARUs

SFD's implementation of ARUs has made a positive difference in response performance. This state-of-the-art program places additional response units in areas of higher incident activity at a lower cost as compared to an engine or ladder truck. In addition, ARUs help keep engines and ladder trucks in service and available for responses requiring that type of resource such as building fires.

Two ARUs are currently in service from 8:30 am to 6:30 pm. This schedule misses much of the peak workload period identified in an earlier section of this report. ARUs should be in service from 9:00 am until 9:00 pm daily. Increasing ARU hours of service to this 12-hour period is recommended.

Expansion of the ARU program

Fire stations should be located, staffed, and equipped to provide response resources using two primary considerations:

1. Provide sufficient resources to effectively intervene in predictable requests for emergency service.
2. Provide sufficient resources to ensure a reliable response to any predictable emergency service request.

The first consideration suggests that there should be sufficient resources available 24 hours per day to effectively respond to an incident based on risk. For example, resources should be deployed so that the full effective response force can be provided to a building fire in any area at any time of the day. In most of Spokane that means a minimum of three fire engines, one ladder truck, and a battalion chief (14 firefighters total) should be available to respond and arrive within a set amount of time. In areas with much larger buildings, high-rise buildings, or other unusual risks, additional resources are needed 24 hours per day.

The second consideration suggests that during periods of higher incident activity, additional resources should be available to respond. The additional resources should be of the type necessary for predictable requests for service; in SFD's case, emergency medical incidents.

Dynamic deployment practices should be, and to a degree are now, used during unusual events such as predicted significant storms, special events with large gatherings of people, and the like. Since the likelihood of a response is greater during these events, additional resources are assigned and positioned where incidents are likely to occur.

This dynamic approach to deployment provides two benefits. First, additional response resources can be made available during times each are predictably needed. Second, since these resources are not needed or assigned during slower workload periods, the organization is maximizing its ability to match resources with system demand.

Peak workload periods occur every day of the week. The following figure illustrates workload by station and by time of day during the study period. Workload is based on responses made by each unit assigned to the station.

Figure 73: Incidents by Station and by Period of Day – 2016

Station	Incidents 9:00 am to 9:00 pm	Incidents 9:00 pm to 9:00 am	Incidents per hour 9:00 am to 9:00 pm	Incidents per hour 9:00 pm to 9:00 am
1	4078	2049	0.93	0.47
2	2237	1535	0.51	0.35
3	2788	1537	0.64	0.35
4	2667	1744	0.61	0.40
5	27	6	0.01	0.00
6	426	187	0.10	0.04
7	1451	906	0.33	0.21
8	854	457	0.19	0.10
9	712	504	0.16	0.12
11	866	423	0.20	0.10
13	1578	859	0.36	0.20
14	1255	633	0.29	0.14
15	3310	1185	0.76	0.27
16	1018	536	0.23	0.12
17	538	250	0.12	0.06
18	1798	1161	0.41	0.27

A process called "queuing analysis" has been used to determine the number of units needed in each station area by time of day. This process utilizes probability analysis to determine the number of units needed in each station area to reduce the likelihood that a response unit would not be available to serve an incident to 10 percent or less. It uses the variables incidents per hour, number of available response units, and average time committed per incident.

Though very useful to this effort, queuing analysis has some limitations. It assumes that customers (incidents) arrive at a constant rate. This is not always true in emergency services. It also assumes that each customer requires an equal amount of time from servers (response units). While the average time committed to an incident was used for service time, some incidents require less or substantially more than the average.

The following figure illustrates the current deployment and proposed deployment plan for both daytime (9:00 am to 8:59 pm) and night-time (9:00 pm to 8:59 am) based on current station locations. The figure includes individual station workload based on unit responses and the current and proposed probability of wait analysis based on the current number of stations. Six stations exceed 10 percent probability of wait during the day and four stations at night.

Figure 74: Current and Proposed Response Units

Station	Current Units Day	Current Units Night	Current Probability of Wait - Day	Current Probability of Wait - Night	Proposed Units Day	Proposed Units Night	Proposed Probability of Wait - Day	Proposed Probability of Wait - Night
1	3	2	1.2%	2.4%	2	2	8.8%	2.4%
2	2	2	2.9%	1.4%	2	2	2.9%	1.4%
3	1	1	31.8%	17.5%	2	2	4.4%	1.4%
4	2	2	4.0%	1.8%	2	2	4.0%	1.8%
5	1	1	0.3%	0.1%	1	1	0.3%	0.1%
6	1	1	4.9%	2.1%	1	1	4.9%	2.1%
7	1	1	16.6%	10.3%	2	2	1.3%	0.5%
8	1	1	9.7%	5.2%	1	1	9.7%	5.2%
9	1	1	8.1%	5.8%	1	1	8.1%	5.8%
11	1	1	9.9%	4.8%	1	1	9.9%	4.8%
13	1	1	18.0%	9.8%	2	1	1.5%	9.8%
14	1	1	14.3%	7.2%	2	1	1.0%	7.2%
15	2	1	6.0%	13.5%	2	2	6.0%	0.9%
16	1	1	11.6%	6.1%	2	1	0.6%	6.1%
17	1	1	6.1%	2.9%	1	1	6.1%	2.9%
18	1	1	20.5%	13.3%	2	2	1.9%	0.8%
Total	**21**	**19**		**Total**	**26**	**23**		

Five additional ARUs are proposed during the day located at Stations 3, 7, 13, 14, and 16. The ARU currently based at Station 1 should be relocated to Station 18. The ARU based at Station 15 should be maintained. At night, ARUs should be available at Stations 3, 7, 15, and 18. The following figures illustrate the locations of ARUs both current and proposed.

Figure 75: ARU Locations – Current

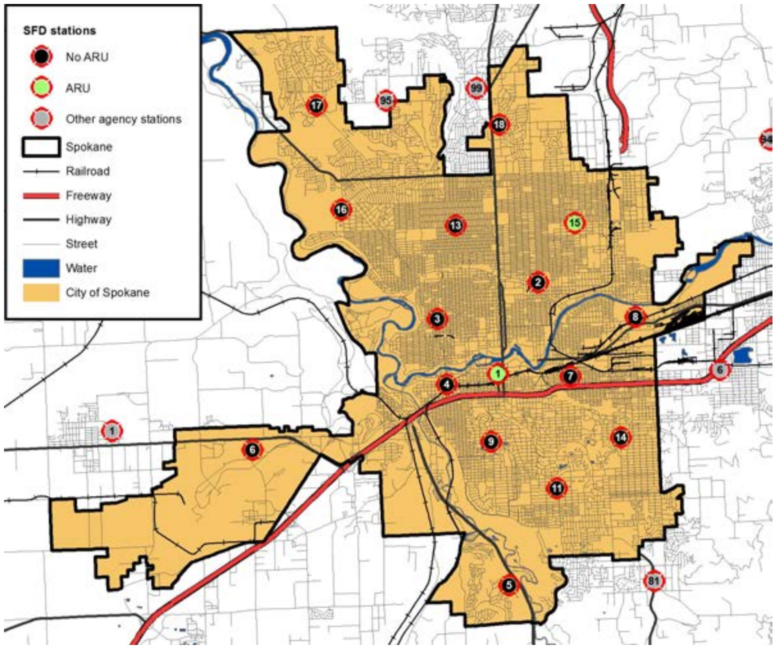


Figure 76: ARU Locations – Proposed Daytime

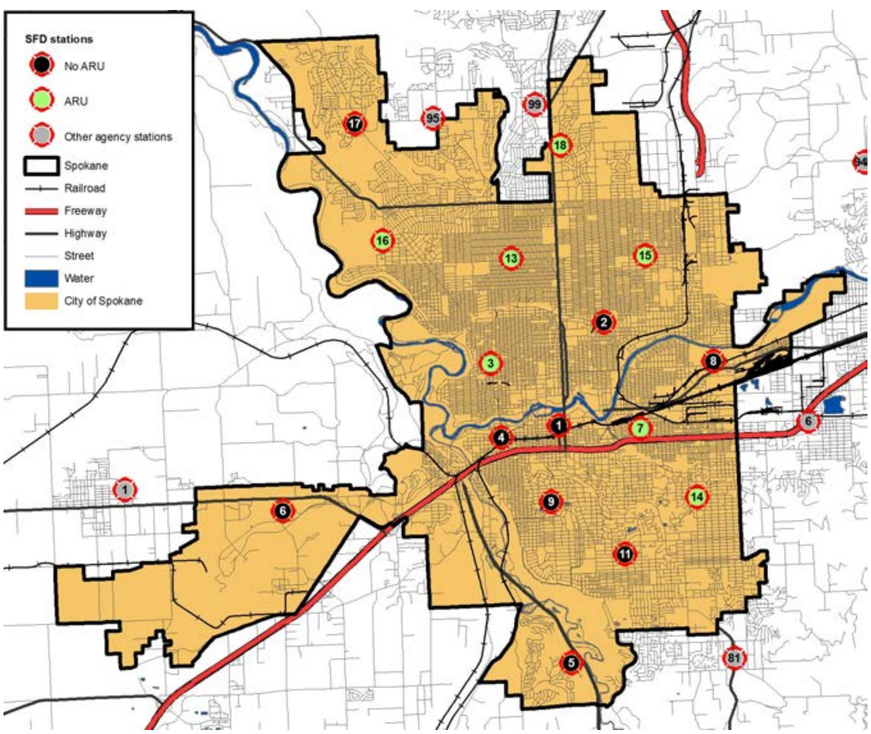
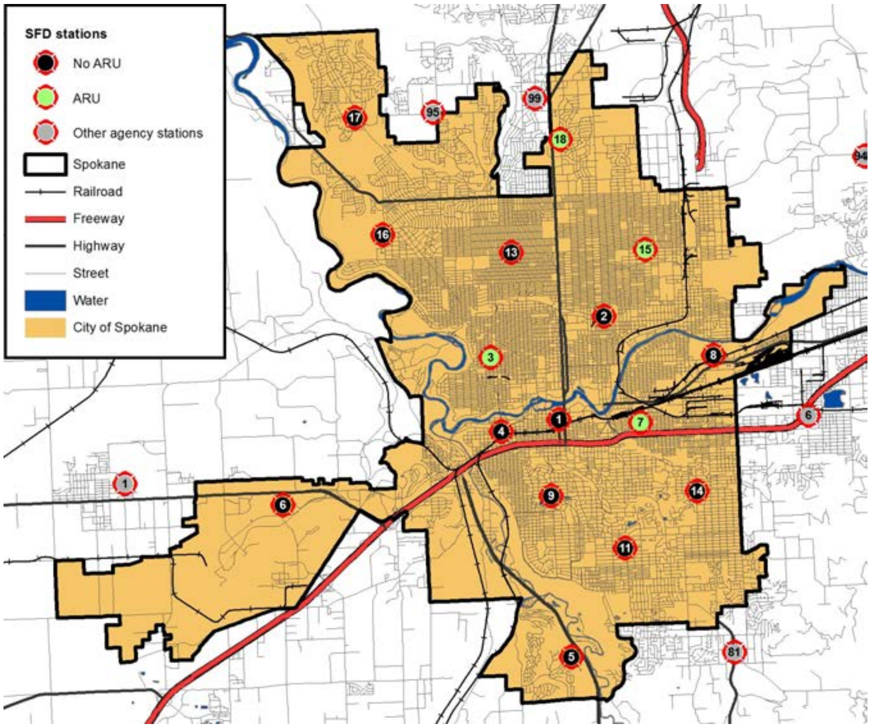


Figure 77: ARU Locations – Proposed Nighttime



This recommendation is a significant expansion of the ARU program in both the number of units in the system and the amount of time each is available for response. However, it provides much benefit to the response system through improved system reliability and increased availability of engines and ladder trucks.

Estimated Cost:
Total one-time costs (apparatus, equipment, initial training, uniforms, protective clothing) - $1,910,760.
Total ongoing expenses (personnel costs and vehicle and equipment maintenance) - $4,231,328.

Improvement Recommendation F: Add stations, apparatus, and firefighters to improve delivery of an effective response force

The previous recommendation dealt with improving response to incident workload by providing greater reliability that a response unit would be available within the target travel time. This recommendation addresses the need to provide an effective response force to those incidents requiring multiple response units, particularly building fires.

Earlier in this report it was noted that many areas of the city could not be provided an effective response force for building fires. Analysis was completed to determine what additional resources would be needed to improve effective response force coverage and where these resources should be located. The following describes the results of that analysis.

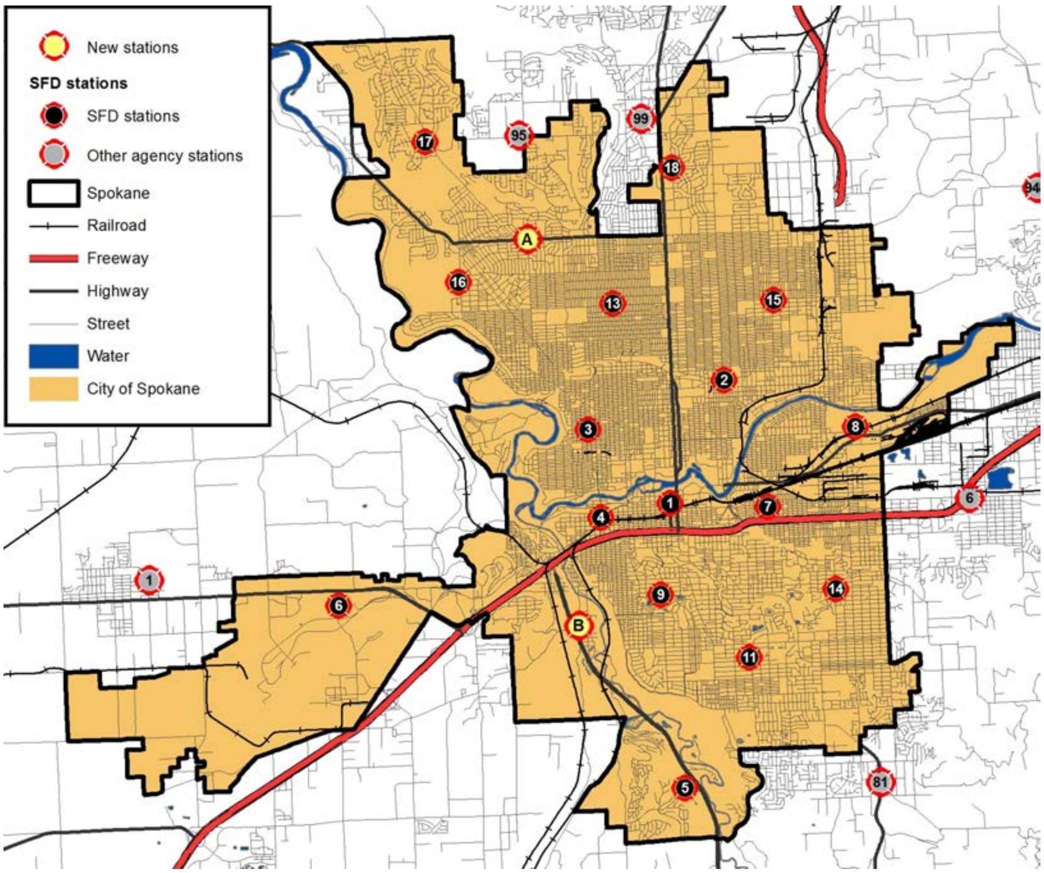
Two new fire stations are needed in order to provide the needed effective response force across the vast majority of the city.

Station A – Located in the vicinity of W. Francis Ave. and N. A St.

Station B – Located in the vicinity of W. Thorpe R. and S. Chestnut St.

The following figure illustrates the locations of these two new stations in relation to existing stations.

Figure 78: Proposed New Fire Stations



The following figure illustrates current deployment by fire station, the proposed deployment during the day, and the proposed deployment at night.

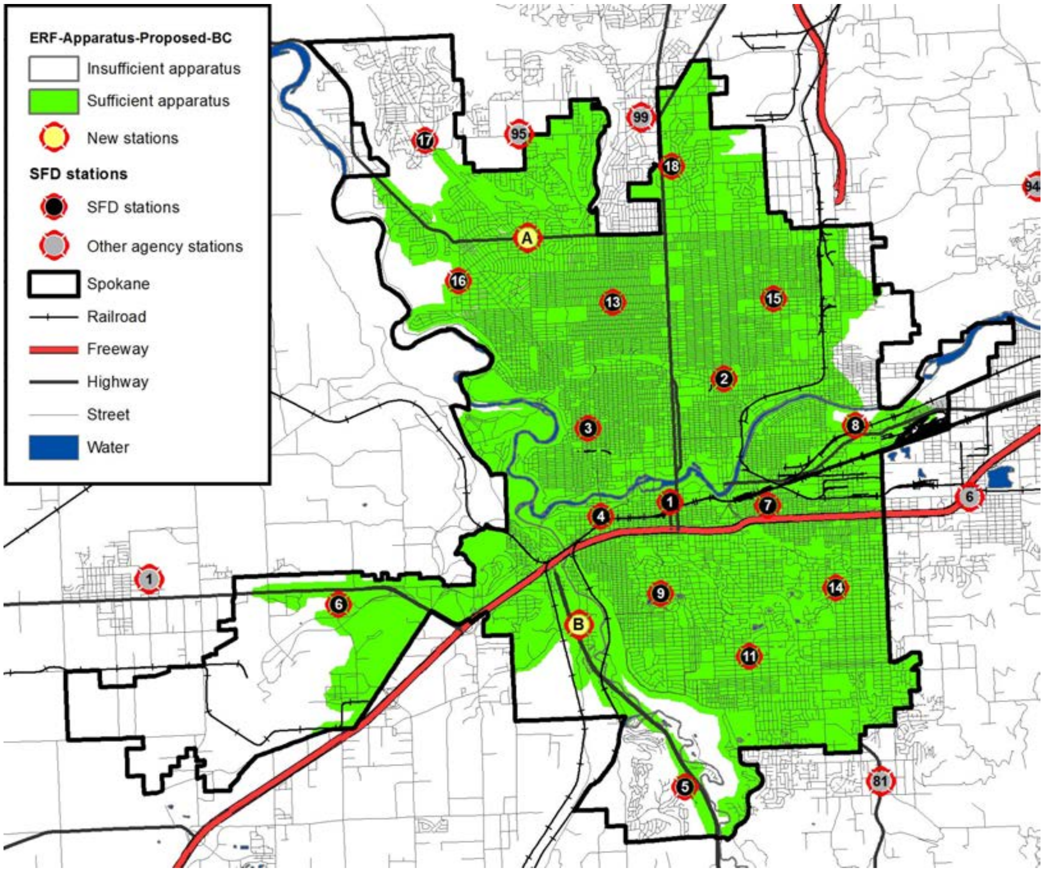
Figure 79: Current and Proposed Response Resource Deployment

Station	Current	Proposed Daytime	Proposed Nighttime
1	Engine, Ladder, ARU, BC	Engine, Ladder, BC	Engine, Ladder, BC
2	Engine, Ladder	Engine, Ladder	Engine, Ladder
3	Engine	Engine, ARU	Engine, ARU
4	Engine, Ladder	Engine, Ladder	Engine, Ladder
5	Attack Engine	Engine	Engine
6	Engine	Engine	Engine
7	Engine	Engine, ARU	Engine, ARU
8	Engine	Engine	Engine
9	Engine	Engine	Engine
11	Quint	Engine, Ladder	Engine, Ladder
13	Quint, BC	Quint, ARU, BC	Quint, BC
14	Engine	Engine, ARU	Engine
15	Engine, ARU	Engine, ARU	Engine, ARU
16	Engine	Engine, ARU	Engine
17	Engine	Engine	Engine
18	Engine	Engine, ARU	Engine, ARU
New A	NA	Engine, Ladder	Engine, Ladder
New B	NA	Engine	Engine
TOTAL PERSONNEL	**61 plus 4 daytime ARU staff**	**77 plus 14 ARU staff**	**77 plus 8 ARU staff**

Two additional fire engines, two additional ladder trucks, and one additional battalion chief are added 24 hours per day. The two-person attack engine at Station 5 is upgraded to a three-person fire engine. The quint at Station 11 is replaced with a fire engine. During daytime hours (9:00 am to 8:59 pm), five additional ARUs are in service for a total of seven. During nighttime hours (9:00 pm to 8:59 am) four ARUs are in service.

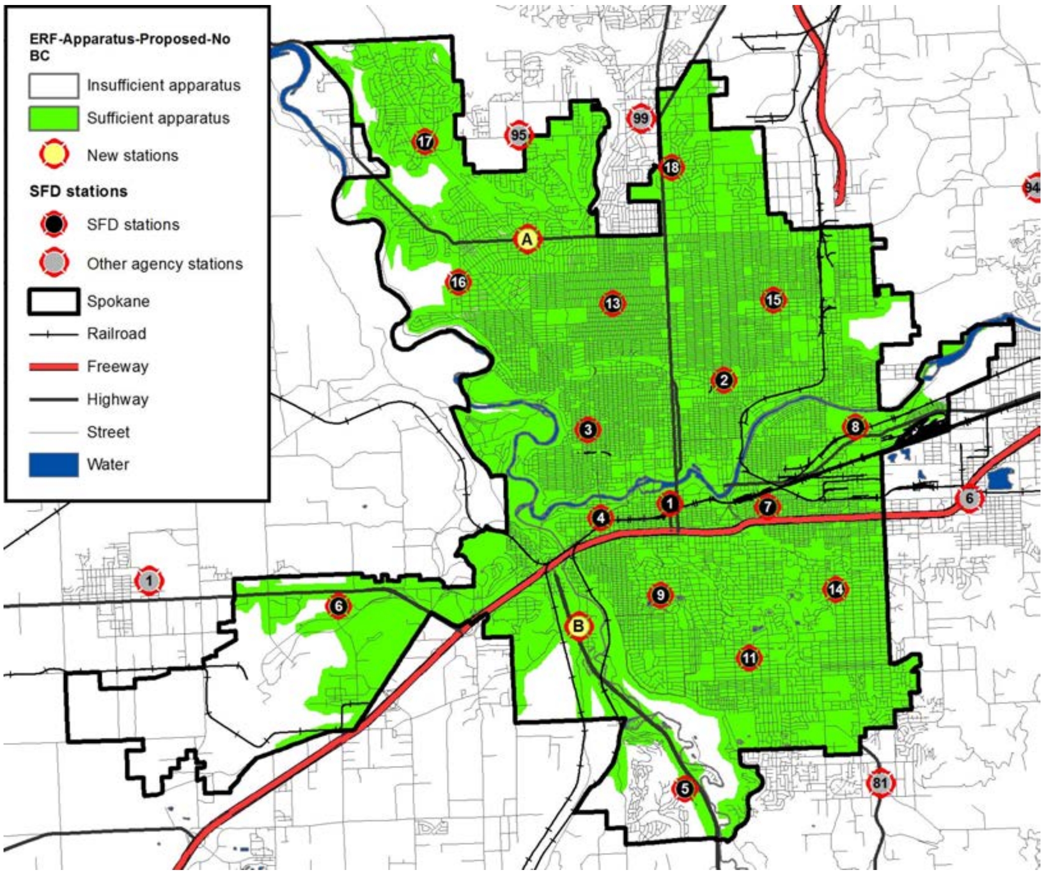
The following figures illustrate the improvement this proposed deployment plan provides in effective response force coverage. The first shows areas to which the required number of apparatus for a low rise building fire can be delivered within the target travel time assuming all response units are in quarters and available.

Figure 80: Effective Response Force – Apparatus – Low Rise Building Fire



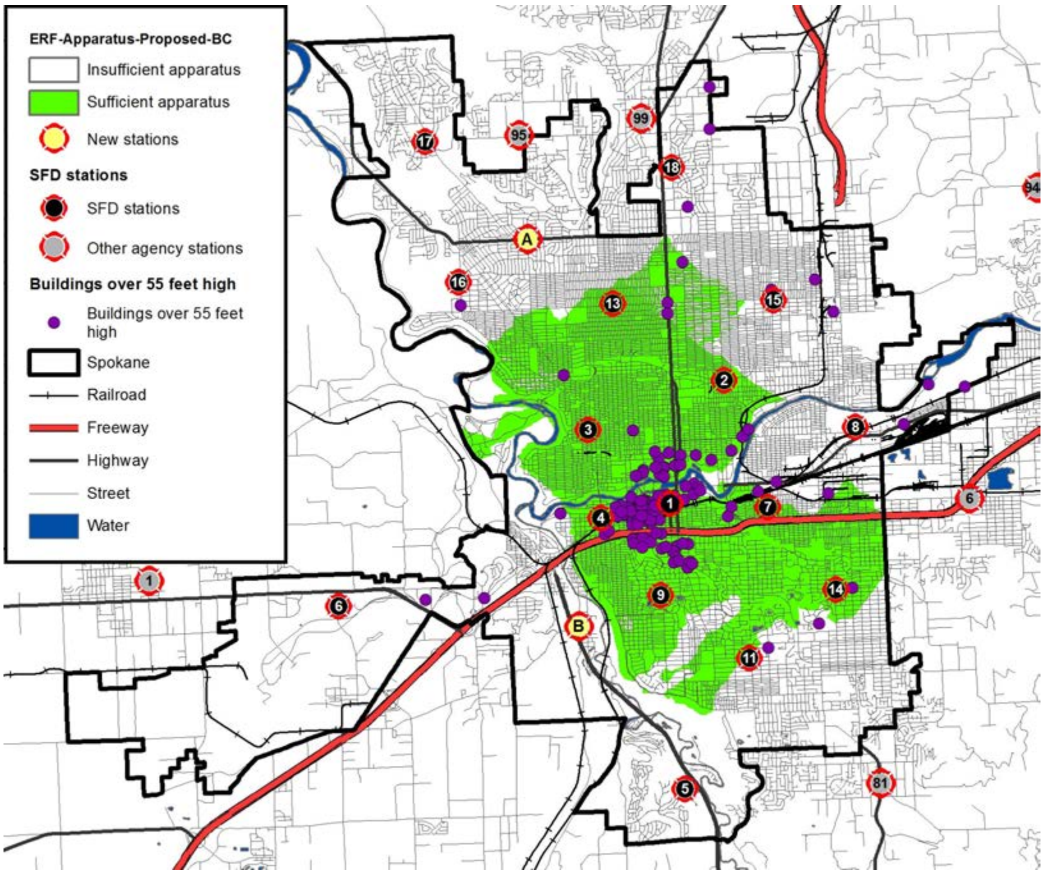
The previous map shows that there are still areas around Stations 5 and 17 that are underserved. However, the limiter in this analysis is the requirement for a battalion chief. The following figure shows effective response force coverage for low rise building fires without the battalion chief requirement. Without the battalion chief requirement, the city is nearly fully covered for low rise building fires. Only the area southwest of Station 5 remains underserved.

Figure 81: Effective Response Force – Apparatus – No Battalion Chief



The following figure illustrates areas of the city to which the required effective response force of apparatus, including the battalion chiefs, can be delivered for high rise building fires within the target travel time. The locations of buildings over 55 feet are included for reference. The required number of apparatus can be delivered to nearly all existing buildings over 55 feet.

Figure 82: Effective Response Force – Apparatus – High Rise Building Fires



The next figures illustrate areas of the city to which the required number of firefighters can be delivered within the target travel time for both low rise and high rise building fires. The city is well covered for both.

Figure 83: Effective Response Force – Firefighters – Daytime

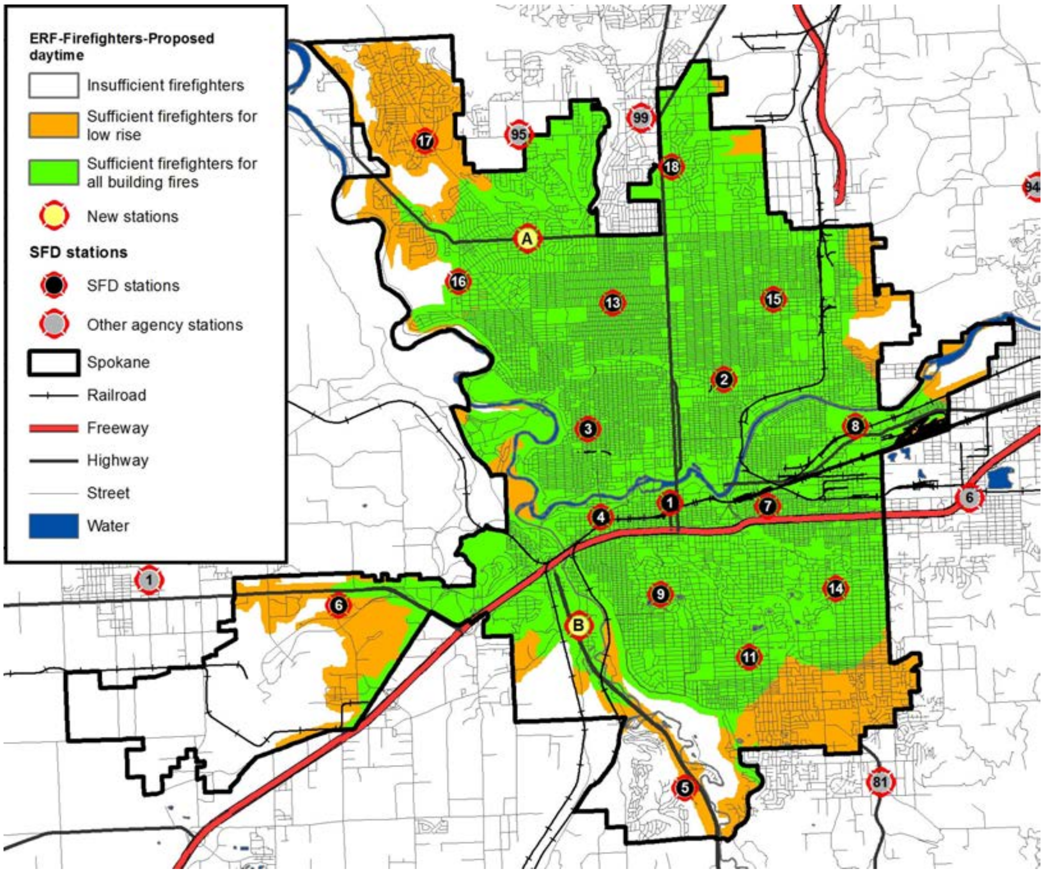
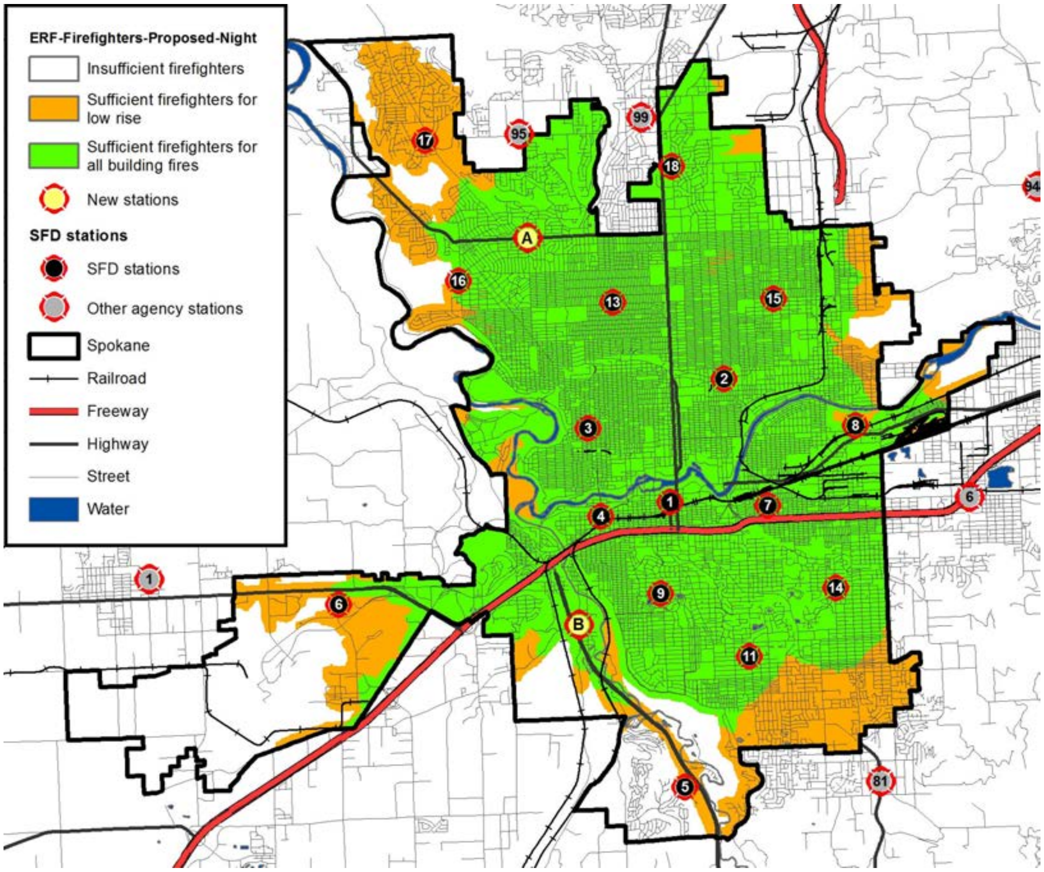


Figure 84: Effective Response Force – Firefighters – Nighttime



The city would be well served for low rise building fires and the vast majority of areas with commercial/industrial and high rise development are provided sufficient numbers of firefighters. Only the area southwest of Station 5 remains underserved.

Estimated costs:

- *One-time Costs*
  - *Two fire stations - $9 million*
  - *Two engine companies* - $1,777,080
  - *Two ladder companies - $3,027,440*
  - *One battalion chief - $50,000*
  - *Upgrade A5 to an engine - $20,090*
- *Ongoing Costs:*
  - *Two engine companies - $3,224,356*
  - *Two ladder companies - $3,931,628*
  - *One battalion chief - $510,641*
  - *Upgrade A5 to an engine - $302,178*

Appendix

The following cost assumptions were used in the development of the estimated costs for the improvement recommendations. Significant assistance was provided by the City of Spokane Finance Department.

Capital Resources

Item	Cost
Fire engine – equipped	$768,000
Ladder truck – equipped	$1,353,000
ARU – equipped	$125,000
Fire station – furnished	$4,500,000

Cost per Response Resource

Engine Company		
Personnel	$	1,602,178
Vehicle and equipment maintenance	$	10,000
Total ongoing cost	**$**	**1,612,178**
Personal protective equipment/initial training	$	120,540
Apparatus and equipment	$	768,000
Total one-time cost	**$**	**888,540**

Ladder Company		
Personnel	$	1,955,814
Vehicle and equipment maintenance	$	10,000
Total ongoing cost	**$**	**1,965,814**
Personal protective equipment/initial training	$	160,720
Apparatus and equipment	$	1,353,000
Total one-time cost	**$**	**1,513,720**

ARU -12 Hour		
Personnel	$	527,666
Vehicle and equipment maintenance	$	5,000
Total ongoing cost	**$**	**532,666**
Personal protective equipment/initial training	$	40,180
Apparatus and equipment	$	125,000
Total one-time cost	$	165,180

ARU -24 Hour		
Personnel	$	791,499
Vehicle and equipment maintenance	$	5,000
Total ongoing cost	**$**	**796,499**
Personal protective equipment/initial training	$	60,270
Apparatus and equipment	$	125,000
Total one-time cost	$	185,270

Battalion chief		
Personnel	$	168,547
Vehicle and equipment maintenance	$	5,000
Total ongoing cost	**$**	**173,547**
Personal protective equipment/initial training	$	-
Apparatus and equipment	$	50,000
Total one-time cost	**$**	**50,000**

Summary of Recommendations Costs

Recommendation	One-time Costs	Ongoing Costs	Total Cost
Recommendation A - Reduce turnout time and improve accuracy of enroute time reporting	None	Dependent on station remodel and CAD programming	Not known at this time
Recommendation B – Develop the ability to audit CAD closest unit recommendations	Dependent on CAD reprogramming costs	None	Not known at this time
Recommendation C – Install emergency vehicle pre-emption equipment on all controlled intersections	Approximately $10,000 per traffic signal		Not know at this time. Signal inventory needs to be developed
Recommendation D – Implement dynamic redeployment practices	None unless additional daytime units are placed in service	None unless additional daytime units are placed in service	None unless additional daytime units are placed in service
Recommendation E – Increase the number of ARUs in the system and increase ARU hours of service	Vehicles, equipment, PPE for 4 additional 24 hour units and 3 additional 12 hour units - $1,910,760	Personnel and related costs for 4 additional 24 hour units and 3 additional 12 hour units - $4,231,328	$6,142,088
Recommendation F – Add stations, apparatus, and firefighters to improve delivery of an effective response force	2 fire engines, equipped, 2 ladder trucks, equipped, 1 battalion chief vehicle, A5 upgrade to an engine, 2 fire stations, furnished - $13,874,520	Personnel and related costs for 2 additional engine companies, 2 additional ladder companies and 1 additional battalion chief, A5 upgrade to an engine- $7,968,803	$21,843,323