I. Executive Summary

In April 2018 the City of Belleville engaged Pomax Consulting Inc. to complete a Core Services Review of the City of Belleville Fire and Emergency Services for the purpose of reviewing the current fire and emergency services delivery model, examining operational efficiencies, and recommending approaches and activity to optimize existing and future service delivery. Pomax analyzed more than five years of Belleville Fire and Emergency Service computer-based response and location data, comprising 19,665 incident records. Consultation was held with city staff, firefighters, association representatives, and others, and weekly conferences were held between Belleville Fire and Emergency Service administration and the Pomax team. Fire department and city documents, applicable to the study, were also reviewed.

The number of events and performance outcomes were determined for each incident type by year, response zone, day of week, time of day, and station from which the apparatus responded. The pattern, frequency, and geographic distribution of incidents were ascertained for each year from 2013 to 2017, and structure fire responses were plotted both by individual year and cumulatively to identify patterns and the appropriate placement of fire stations to support effective and efficient response. Future resource requirements were estimated by applying historical patterns to expected growth, demographic change, settlement type, and land use as laid out in the city’s 2018 Official Plan Review.

If this document is being read electronically and readers utilize the links to cross references, using Alt plus Left Arrow will return you to the original location.

A. Primary Areas for Consideration

The existing station 2 at 72 Moira Street West is aging and will soon require replacement or renovation. Station 2 should be relocated northwest of its current location, which will improve emergency response and coverage.

• Belleville Fire and Emergency Services is a combined fire department (page 13 for a definition) comprising career firefighters in the urban area and volunteer firefighters in rural areas, but it operates more as two fire departments under one administration. The purpose of a combined fire department is to leverage both volunteer and career firefighters to be mutually supporting and augment depth of response. However, in Belleville, both the career and volunteer firefighters as well as association representatives express ownership of traditional response areas, referring to “their response areas” rather than protection of the city as a whole. Additionally, the urban area has a prevention and public education division and a training officer, while the volunteer stations have volunteer prevention and public education officers as well as volunteer training officers. The estimated cost of those volunteer prevention, education, and training positions is $50,000–$60,000 a year. We suggest the volunteer duties can be accommodated within the career prevention and training complement.

• The current complement of career firefighters is sufficient for the foreseeable future. Adding to the complement is not required.

• The fire department response protocols are now generally divided, with career firefighters responding to the urban areas of the city and volunteers responding to the rural areas.
Response configuration should be adjusted as recommended in our report, which will improve efficiency and effectiveness.

- The fire department can operate effectively with four fire stations rather than five. Consideration should be given to decommissioning station 4 at 516 Harmony Road since it is in a poor state of repair, will be costly to upgrade or replace, and other fire stations can respond to almost all of station 4’s area within the same time and effectiveness.

- Fire administration should pay particular attention to developing and fostering the fire protection and public education division. The division requires a strong strategic plan for protecting and educating the public and, currently, is not providing value for money. Redirection and reorganization are necessary.

- The frequency of fires is plateauing or declining in most locations across Canada, and Belleville’s experience is similar. Most fortunately, changes to the building code and public awareness have reduced the frequency of fires. That is not to say that the danger of fire no longer exists, but Belleville’s fire service would benefit from a culture change that emphasizes prevention and education rather than response.

- Probationary firefighters are employed as fire dispatchers until a vacancy in the suppression division becomes available, at which point one of the probationary firefighters is moved to suppression. Another probationary firefighter is then hired and assigned to dispatch while awaiting a vacancy in the suppression division. The duties of call takers and dispatchers, and the associated aptitudes and skills, are significantly different than those required by firefighters. The assignment of junior firefighters to dispatch causes frequent turnover and can be significantly less effective than having career civilian dispatchers on duty.

- In addition, dispatchers work 24-hour shifts and are relieved by on-duty firefighters for rest and meals. The 24-hour shifts are attractive because they mean workers are on-site only about 8 days a month. Firefighters working 24-hour shifts have the opportunity to rest when calls are not occurring, but dispatchers’ roles are dissimilar in that dispatchers must stay alert at all times. Belleville should evaluate the efficacy of dispatchers working 24-hour shifts and the practicality of replacing future dispatch vacancies with career civilian dispatchers.

- Dispatchers are also responsible for answering administrative telephone calls for items such as permit applications and other non-emergency inquiries. When emergency calls are in progress, administrative lines remain unanswered. As in other fire departments, an automated or self-serve telephone system or online portal could accommodate almost all administrative inquiries, thereby relieving dispatchers of many non-emergency telephone activities.

- Dispatch call handling and turnout time is protracted. There can be many reasons for this, including dispatch staffing and station design. Process mapping the call taking and turnout activities should identify efficiencies.

- The fire administration does not have a confidential administrative assistant, which reduces the efficiency of the executive fire staff. Responsibilities and activities that could be assigned to a confidential assistant have to be performed by the chief and deputies.
B. Recommendations

Pomax’s recommendations are as follows.

Operations

- The volunteer and career sections of the fire department be combined in fact as well as name so that in one or two generations Belleville Fire and Emergency Services will be able to operate as one department.
- As a critical part of setting the stage for delivery of core services, Belleville Fire and Emergency Services must develop new vision and mission statements that establish prevention and education, rather than suppression, as the primary purpose of the fire service.

Fire Prevention and Public Education

- Revamp prevention and public education based on the comments provided in that section (section 3.2).
- Implement a time management program for division personnel.
- Senior department management and personnel in the division should develop a fire prevention policy that identifies priorities and schedules for prevention and public education.
- Develop a fire prevention policy intended to move the department from a reactive to a proactive fire prevention stance that addresses the needs and circumstances of Belleville.
- Develop the administrative skills and knowledge of personnel responsible for the operation of the division.
- Fire prevention officers who wish to return to the fire suppression division should be considered for a change in role when vacancies occur.
- Vacant fire prevention positions should be filled by educators rather than firefighters. Prevention and education candidates do not need to be firefighters to fulfill the role because the skills and aptitudes of firefighters are very different to those of educators or inspectors.
- Fire administration should designate separate prevention and educator positions within the existing complement of five. We suggest three prevention officers and two public educators. Please see the community risk profile in section 4. Conducting a community risk assessment will assist with determining the complement of prevention officers and educators within the existing division allocation.
- If the individual currently filling the senior prevention officer’s role is one of the staff members who wish to return to the suppression division, the senior prevention officer’s role should thereafter be filled by someone with the administrative aptitude, skills, and background to oversee education and prevention functions and staff, or the position should be eliminated and prevention and education staff should report to a deputy.
Internal Training

- Create a formal training curriculum.
- Implement a local or commercial record-keeping system for training programs for both volunteer and career firefighters.
  - Our understanding is that training activity can be documented in Belleville Fire and Emergency Services’ record management system but that some staff are reluctant to use that feature. That feature should be used to ensure accurate tracking of training completion.
- Consider a second full-time training position, possibly by reassigning a complement from a fire prevention officer’s position, thereby providing consistent training officer support to both the career and volunteer sections of the combined fire service. This does not mean an additional position should be put into place to compensate for a reassigned position.
- Although firefighter training requires specific knowledge about firefighting and rescue techniques, candidates for the position(s) should also have formal training in adult education techniques.
- Implement continuing education.
- We are pleased that $200,000 has been allocated to the fire service capital fund for land acquisition for a training facility although it was deferred, during city budget discussions, to 2020. In any event, Belleville Fire and Emergency Services and the city should move as quickly as possible to find a site to build a training facility, considering the length of time it will take to commission a building.

Emergency Response

- Greater efficiency and public protection can be accomplished by realigning emergency response areas as recommended in section 2.3.
- Plans to relocate station 2 to northwest of the current location should be initiated. Relocating station 2 will maintain or improve coverage into areas of Belleville north of Highway 401 and improve first vehicle response to southwest Belleville. Second vehicle coverage to south and southeast Belleville may take an additional 60 seconds but will still be within standards for second-on-scene apparatus. Efforts to reduce call handling and turnout time may mitigate the additional time for second vehicle arrival into the south and southeast (please see Dispatching recommendations below).

Dispatching

- Evaluate, through observation and job shadowing, whether 24-hour shifts are detrimental to dispatch staff, clients, and public safety.
- Evaluate the logistics and opportunities to replace probationary firefighters, as they move from dispatch to the suppression division, with civilian professional full-time radio operators / dispatchers.
  - Concurrent with this recommendation, to accommodate circadian rhythm, new hires should work no more than a 12-hour shift.
• Process map call taking and turnout activity to determine the causes of protracted times.

**Organization and Administration**

• The City of Belleville should update its Establishing and Enabling Bylaw as soon as possible observing the content of the Office of the Ontario Fire Marshal’s communiqué referenced [here](#).

• Job descriptions and expectations for all positions should be drafted as soon as possible and should include critical objectives for fulfilling roles and responsibilities.

• Implement a chief business officer position in the fire department, for a minimum of two years, to assist the chief and deputies with refocusing and reorganization.

• Make all efforts to exempt the administrative assistant’s position from the bargaining unit.

**Protective Services Advisory Committee**

We notice that there are a number of departmental advisory committees within the city’s organization such as the planning advisory committee, transit advisory committee, and others. Our experience is that most fire services that we have had as clients work through an advisory committee composed of council and public representatives. Indications from these clients are that process and changes are expedited when an advisory committee is in place rather than bringing all issues directly to council. Further, it is reported that council time is sometimes avoided since some matters are brought from the advisory committee to council as recommendations within resolutions.

• The city should strongly consider implementing a Protective Services (fire) and Emergency Operations Advisory Committee.
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1. Introduction

In late December of 2017 the City of Belleville issued a request for proposals for a consultant to conduct a comprehensive core service review of the city’s fire and emergency services department. The project was awarded to Pomax Consulting in late April 2018.

1.1 Project Intent

The City of Belleville intends that the core service review will

- review the current fire and emergency services delivery model and confirm operational efficiencies;
- discover useful best practices;
- identify opportunities for improvement;
- provide a comprehensive needs assessment report;
- provide a strategic framework and recommendations to assist council to determine optimal fire protection services that are efficient, affordable, and sustainable;
- establish options for council respecting immediate, mid-range, and long-term planning of emergency services traditionally provided by the fire service;
- ensure that the right service is provided to the public in the best yet most affordable manner.

Elements of the fire and emergency services to be reviewed encompass

- fire administration;
- emergency planning;
- fire prevention;
- community risk profiles;
- public education;
- fire suppression;
- technical rescue and operations;
- training and professional development; and
- communications.

1.2 What Is a Core Services Review?

The intent of a core services review differs slightly depending on client objectives, but — generally — it compiles facts about the current state of a municipal department’s services and programs, delineates those things that have changed over a given period, and determines options that are available to overcome existing and expected challenges.

A core review

- compiles clear, objective information about the service being provided (in this case, the fire department) and may review and suggest a redesign of the service mix;
- evaluates how the service has changed over time;
- determines whether it meets community needs;
- identifies potential service delivery improvements;
- defines how to close the gap — if one exists — between community needs and services provided;
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- outlines expected change over a specified period;
- determines which programs or services delivered may, or may not, be required currently or in future and improves an organization’s efficiency and effectiveness;
- includes a report outlining options and charting how challenges may be met and opportunities achieved; and
- addresses financial sustainability by recommending improvements to performance and costs.

1.2.1 What a Core Services Review Isn’t
It isn’t a fire master plan.
- A master plan
  - might define an organization’s mission, vision, and values, whereas a core services review might recommend changes to, or creating, mission, vision, and values statements;
  - outlines a vision to guide organizational or operational change and development;
  - sets out objectives and strategies to manage change;
  - is designed to be amended as time goes on.

1.3 The Core Services of a Fire Department
The core services of a fire department are
- education;
- prevention;
- suppression;
- rescue;
- public assistance.

These core services are accomplished through
- rapid response when required;
- continuous training;
- awareness of community need;
- risk assessment;
- community engagement;
- information gathering and data analysis;
- firefighter and staff engagement;
- legislation and bylaws that support the core services.

1.4 About Belleville Fire and Emergency Services
Belleville Fire and Emergency Services is housed in five fire stations and a sixth substation. Stations 3, 4, and 5 are located in Ward 2, and stations 1 and 2 are in Ward 1. Station 1 is the headquarters station, built in 2015; stations 3 and 5 were commissioned in 2016 and 2017 respectively. Stations 2 (commissioned 1949) and 4 are older facilities that should be planned for renovation or, preferably,
replacement. Station 4 is attached to the Thurlow Community Centre and is a former cheese factory. Additional information with respect to stations 2 and 4 is provided in section 3.4.3. Stations 1, 3, and 5 are new and will remain in service for several generations.

The substation is located south of the railway tracks that divide the city, and a second-line fire truck is housed there in case a train blocks access to an incident south of the tracks. No firefighters are housed at the substation, but firefighters from Ward 1 stations can reach the substation by using a pickup truck via a small rail underpass and can thereby respond to incidents.

Photographs of the fire stations can be viewed in Appendix A of the report. If the link provided is used to view the fire station information, Alt plus Left Arrow will bring you back to this location.

Belleville Fire and Emergency Services is a combined fire department, which means that both full-time career firefighters and volunteers are available to respond to emergency incidents and public assistance. However, in practice, Belleville Fire and Emergency Services is two departments operated by the same administration team. Career staff are represented by the Belleville Professional Fire Fighters’ Association, which has a collective agreement with the city, whereas volunteers have a separate association and collective agreement and are affiliated with the Christian Labour Association of Canada. Different collective agreements are not unusual in a municipality, but our interviews with volunteers, career staff, and association representatives revealed that the two organizations consider themselves separate, even to the point of talking about “their response areas” rather than protection of the city as a whole.

There are several implications to this organizational design, the most important of which is the negative effect it has on protecting the city and the cost to efficiency and effectiveness. Additionally, the fire department and city have the responsibility of negotiating two firefighter contracts and trying to balance the interests of the city against two labour associations that have the responsibility of protecting their members and the viability of the associations.

Even though we understand the onerous nature of the task, our recommendation is that the volunteer and career sections of the fire department be combined in fact as well as name so that in one or two generations Belleville Fire and Emergency Services will be able to operate as one department.

Organizational topics are addressed in sections 3.4 and 3.4.3.

Minimum firefighter staffing at career stations 1 and 2 is 11 firefighters, although 14 staff are assigned to each shift. The variance between the minimum staff on duty (11) and staff assigned (14) accounts for approved absences due to vacation, illness, training, or other paid absences.

- Station 1 has one captain and a minimum of three firefighters assigned to the pumper, and one firefighter assigned to the heavy rescue truck.
- When staffing levels and equipment permit, the additional firefighter assigned to station 1 will be assigned, at the captain’s discretion, to ride the pump, rescue, or ladder depending on the incident. One radio operatordispatcher is on duty at station 1, resulting in a minimum of six staff.
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- Staffing at station 2 is a minimum of a captain and four firefighters. The captain and three firefighters (total four) are assigned to the pump and the remaining firefighter to the aerial/ladder.

Exhibit 1: Minimum Station Staffing Urban Area

<table>
<thead>
<tr>
<th>Station</th>
<th>Apparatus</th>
<th>Number of Firefighters</th>
<th>Total Firefighters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pumper</td>
<td>Captain + 3 firefighters</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>Heavy Rescue</td>
<td>1 firefighter</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>Dispatch</td>
<td>Radio operator (probationary firefighter)</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Pumper</td>
<td>Captain + 3 firefighters</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Aerial/ladder</td>
<td>1 firefighter</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>11</strong></td>
</tr>
</tbody>
</table>

Staff are routinely transferred between stations to ensure minimum staffing is maintained. Overtime is used to ensure minimum staffing of apparatus.

Rural stations (stations 3, 4, and 5) are staffed by volunteers who are called in when an incident occurs. Rural stations operate on a converging response model, which means that the first available staff respond to the fire station to pick up the required apparatus, while other firefighters respond directly to the incident in private cars. Radio information or smartphone applications keep volunteer responders informed as to whether they should respond to the station or the incident. The efficacy of responding directly to a scene in private vehicles versus all firefighters assembling at a fire station and travelling to an incident in a fire truck or trucks is a subject of discussion within fire services across Canada. However, the response configuration that best serves a community has to be decided by each individual fire service.

Administratively, Belleville Fire and Emergency Services is operated by a chief and two deputies, supported by an administrative staff member.

Additionally, for the urban area, the fire department has positions allocated for a training officer, a senior fire prevention officer, and four fire prevention officers, who work Monday to Friday during business hours. However, the days actually worked, and the number of prevention and training staff on duty at any time, varies depending on the hours and days assigned to work, as well as vacation and other approved absences.

There are also two fire prevention officers and two training officers assigned to the volunteer section of the fire service. Fire service administration estimates that the annual cost associated with the volunteer fire prevention and training positions is $50,000. **Even though collective bargaining issues may impede the following proposal, we recommend that the fire service administration evaluate the operational value of having the career training and fire protection officers assume the roles for the volunteer cadre.** The annual savings of $50,000 could be directed elsewhere and the volunteer positions currently allocated to prevention and public education could be assigned to suppression services.

A fire and emergency services responsibility chart is shown in Exhibit 2.
Exhibit 2: Fire and Emergency Services Responsibility Chart
2. Fire and Emergency Services Data

Data analysis is an important part of any emergency services study, but both the merits and limitations of data must be recognized, as the following examples illustrate.

- Data analysis is helpful in determining quantity and patterns of activity or behaviour.
- Data don’t reveal the “why”: data provide information, but conclusions and recommendations are proposed by the individual or team interpreting data. Data components that are missing, misinterpretation by the team, or a disregard of qualitative information that could influence conclusions could result in data, by themselves, being an unreliable basis for determining the best solution to a problem.
- Data are important in arriving at conclusions and recommendations but should be influenced by a qualitative approach that includes interviews, possibly focus groups, and observation.
- Data should be used in concert with temporal and other factors. For example, historically, population change or urban spread have been influencers of emergency services resources. Fire stations or the number of firefighters might have increased along with population growth or spread. But other factors such as improvements in construction materials and code standards, and fire safety education awareness and prevention efforts, mean that using delineators such as fires per capita or number of firefighters per capita is no longer a reliable method of measuring the need for resources.
- Data must be combined with the effort of rigorous testing to determine if conclusions and recommendations derived from data can be effectively incorporated into an emergency services system. “Effort” is defined as the force required to test a hypothesis even in the face of possible resistance to assessing the premise; “rigorous” is defined as precision to ensure decisions resulting from a combination of data and qualitative analysis have the greatest chance of success.

We’ll reference some of these bullets as we examine several conclusions and recommendations throughout this report.

2.1 Historical Data

As part of the core services review Pomax evaluated urban and rural data inclusive of the years 2013–2017 provided by Belleville Fire and Emergency Services from the computer aided dispatch system (CAD). CAD data were used as they indicate performance and response data based on the type of incident determined at the time a call for assistance was received from the public or another emergency service.

- The original data included 19,665 records for the 2013–2017 period.
- Records that had blanks in some of the time fields (for example, a blank in the “On Location” time field) were removed from the analysis.
- Apparatus that are not normally front-line response apparatus, such as pickup trucks, command units, boats, and four-wheelers, were not included in the analysis.
- Belleville receives calls and dispatches fire departments in municipalities surrounding the city. Those incidents were not included in the analysis.
- Public service or public assist incidents and other non-life-threatening responses such as elevator rescues (without occupant illness or injury) were not included in the analysis.
• The data were then filtered to arrive at information for the first responding vehicles only, so information for the earliest responding and arriving trucks could be used for performance analysis.
• The resulting 6,343 incident records were used to determine Belleville Fire and Emergency Services’ performance during the five-year period.

Data provide important context to the core services discussion later in this report.

Exhibit 3: Incident Type in Order of Frequency 2013–2017

<table>
<thead>
<tr>
<th>Incident Type</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical: Assistance</td>
<td>353</td>
<td>239</td>
<td>271</td>
<td>280</td>
<td>316</td>
</tr>
<tr>
<td>Medical: Emergency</td>
<td>88</td>
<td>143</td>
<td>178</td>
<td>228</td>
<td>162</td>
</tr>
<tr>
<td>Alarm: Residential</td>
<td>167</td>
<td>127</td>
<td>136</td>
<td>142</td>
<td>138</td>
</tr>
<tr>
<td>Alarm: Commercial/Industrial</td>
<td>122</td>
<td>144</td>
<td>114</td>
<td>113</td>
<td>136</td>
</tr>
<tr>
<td>Public Service: CO Detector</td>
<td>130</td>
<td>129</td>
<td>121</td>
<td>104</td>
<td>108</td>
</tr>
<tr>
<td>Vehicle Accident: Extrication</td>
<td>77</td>
<td>96</td>
<td>102</td>
<td>103</td>
<td>89</td>
</tr>
<tr>
<td>Fire/Smoke: Structural: Residential</td>
<td>77</td>
<td>75</td>
<td>93</td>
<td>75</td>
<td>61</td>
</tr>
<tr>
<td>Alarm: Hospital/Institution</td>
<td>49</td>
<td>96</td>
<td>49</td>
<td>61</td>
<td>45</td>
</tr>
<tr>
<td>Leak/Spill: Natural Gas/Propane</td>
<td>40</td>
<td>33</td>
<td>23</td>
<td>41</td>
<td>49</td>
</tr>
<tr>
<td>Fire/Smoke: Non-Structural: Vehicle</td>
<td>17</td>
<td>29</td>
<td>25</td>
<td>27</td>
<td>29</td>
</tr>
<tr>
<td>Vehicle Accident: Fuel Leak</td>
<td>37</td>
<td>28</td>
<td>18</td>
<td>23</td>
<td>21</td>
</tr>
<tr>
<td>Fire/Smoke: Non-Structural: Grass/Brush</td>
<td>18</td>
<td>20</td>
<td>17</td>
<td>27</td>
<td>25</td>
</tr>
<tr>
<td>Electrical: Wires Down</td>
<td>44</td>
<td>14</td>
<td>11</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>Fire/Smoke: Structural: Commercial/Industrial</td>
<td>12</td>
<td>15</td>
<td>14</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Fire/Smoke: Non-Structural: Other</td>
<td>15</td>
<td>9</td>
<td>9</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>Rescue: Ice/Water</td>
<td>11</td>
<td>8</td>
<td>14</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Fire/Smoke: Non-Structural: Rubbish</td>
<td>9</td>
<td>13</td>
<td>6</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Electrical: Wiring Overhead</td>
<td>11</td>
<td>8</td>
<td>5</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Electrical: Transformer</td>
<td>10</td>
<td>6</td>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Leak/Spill: Gasoline/Diesel/Oil</td>
<td>3</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Fire/Smoke: Electrical: Utility Pole</td>
<td>2</td>
<td>5</td>
<td>8</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Leak/Spill: Other</td>
<td>4</td>
<td>7</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Fire/Smoke: Structural: Hospital/Institution</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Rescue: Entrapment</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire/Smoke: Structural: School</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical: Defib</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Fire/Smoke: Electrical: Transformer</td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Fire/Smoke: Structural: Church</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Fire/Smoke: Structural: Retirement Home</td>
<td></td>
<td></td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Explosion: Structural: Residential</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Fire/Smoke: Electrical: Substation</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical: Substation</td>
<td></td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Default</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leak/Spill: Hazmat: Minor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Totals</td>
<td>1302</td>
<td>1257</td>
<td>1234</td>
<td>1289</td>
<td>1261</td>
</tr>
</tbody>
</table>
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The following major-category charts and accompanying tables indicate trends in incident frequency from 2013 to 2017. Exhibit 3: Incident Type in Order of Frequency 2013–2017 is the table associated with Exhibit 5. Other than medical responses, all incident types trend down, even though Belleville’s population increased by 2.6% from the 2011 Statistics Canada census to that of 2016 and private dwellings increased by 591.

Exhibit 4: StatCan Population and Dwellings, Belleville City

<table>
<thead>
<tr>
<th>Statistics Canada Data</th>
<th>Population</th>
<th>% Change</th>
<th>Total Private Dwellings</th>
<th>Population Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>50,716</td>
<td>2.6</td>
<td>22,744</td>
<td>205.1</td>
</tr>
<tr>
<td>2011</td>
<td>49,454</td>
<td>1.3</td>
<td>22,153</td>
<td>200.0</td>
</tr>
<tr>
<td>2006</td>
<td>48,821</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In Exhibit 4 Population Density relates to city-wide density (urban and rural areas).

In Exhibits 5 through 10, dotted orange lines indicate trend.

Exhibit 5: All Incidents

All Incidents
Exhibit 6: Medical Responses

<table>
<thead>
<tr>
<th>Year</th>
<th>Medical: Assistance</th>
<th>Medical: Emergency</th>
<th>All Medical</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>353</td>
<td>88</td>
<td>441</td>
</tr>
<tr>
<td>2014</td>
<td>239</td>
<td>143</td>
<td>382</td>
</tr>
<tr>
<td>2015</td>
<td>271</td>
<td>178</td>
<td>449</td>
</tr>
<tr>
<td>2016</td>
<td>280</td>
<td>228</td>
<td>508</td>
</tr>
<tr>
<td>2017</td>
<td>316</td>
<td>162</td>
<td>478</td>
</tr>
</tbody>
</table>

Exhibit 7: Alarms

<table>
<thead>
<tr>
<th>Year</th>
<th>Alarm: Residential</th>
<th>Alarm: Commercial/Industrial</th>
<th>Public Service: CO Detector</th>
<th>Alarm: Hospital/Institution</th>
<th>All Alarms</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>167</td>
<td>122</td>
<td>130</td>
<td>49</td>
<td>468</td>
</tr>
<tr>
<td>2014</td>
<td>127</td>
<td>144</td>
<td>129</td>
<td>96</td>
<td>496</td>
</tr>
<tr>
<td>2015</td>
<td>136</td>
<td>114</td>
<td>121</td>
<td>49</td>
<td>420</td>
</tr>
<tr>
<td>2016</td>
<td>142</td>
<td>113</td>
<td>104</td>
<td>61</td>
<td>420</td>
</tr>
<tr>
<td>2017</td>
<td>138</td>
<td>136</td>
<td>108</td>
<td>45</td>
<td>427</td>
</tr>
</tbody>
</table>
### Exhibit 8: Vehicle Accidents

#### Vehicle Incidents

<table>
<thead>
<tr>
<th>Year</th>
<th>Extrication</th>
<th>Fuel Leak</th>
<th>All Vehicle Accidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>77</td>
<td>37</td>
<td>114</td>
</tr>
<tr>
<td>2014</td>
<td>96</td>
<td>28</td>
<td>124</td>
</tr>
<tr>
<td>2015</td>
<td>102</td>
<td>18</td>
<td>120</td>
</tr>
<tr>
<td>2016</td>
<td>103</td>
<td>23</td>
<td>126</td>
</tr>
<tr>
<td>2017</td>
<td>89</td>
<td>21</td>
<td>110</td>
</tr>
</tbody>
</table>

### Exhibit 9: Fire/Smoke

#### All Fire/Smoke

<table>
<thead>
<tr>
<th>Year</th>
<th>Structural: Residential</th>
<th>Non-Structural: Grass/Brush</th>
<th>Structural: Commercial/Industrial</th>
<th>Non-Structural: Other</th>
<th>Non-Structural: Rubbish</th>
<th>Electrical: Utility Pole</th>
<th>Structural: Hospital/Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>77</td>
<td>18</td>
<td>12</td>
<td>15</td>
<td>9</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2014</td>
<td>75</td>
<td>20</td>
<td>15</td>
<td>9</td>
<td>13</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>2015</td>
<td>93</td>
<td>17</td>
<td>14</td>
<td>9</td>
<td>6</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>2016</td>
<td>75</td>
<td>27</td>
<td>7</td>
<td>13</td>
<td>9</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>2017</td>
<td>61</td>
<td>25</td>
<td>10</td>
<td>7</td>
<td>6</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
Comprehensive Core Services Review
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<table>
<thead>
<tr>
<th>All Fire Smoke</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire/Smoke: Structural: School</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire/Smoke: Electrical: Transformer</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire/Smoke: Structural: Church</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire/Smoke: Structural: Retirement Home</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explosion: Structural: Residential</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire/Smoke: Electrical: Substation</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>All Fire/Smoke</td>
<td>139</td>
<td>139</td>
<td>155</td>
<td>139</td>
<td>119</td>
</tr>
</tbody>
</table>

Exhibit 10: Electrical

<table>
<thead>
<tr>
<th>All Electrical</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical: Wires Down</td>
<td>44</td>
<td>14</td>
<td>11</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>Electrical: Wiring Overhead</td>
<td>11</td>
<td>8</td>
<td>5</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Electrical: Transformer</td>
<td>10</td>
<td>6</td>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Electrical: Substation</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Electrical</td>
<td>65</td>
<td>29</td>
<td>16</td>
<td>14</td>
<td>31</td>
</tr>
</tbody>
</table>
2.2 Emergency Response

The National Fire Protection Association (NFPA) includes in its standards a Cascade of Events chart, which outlines the stages of an emergency response from what is referred to as a state of normalcy, preceding an emergency event, to the state of normalcy after an event (Exhibit 11).

Exhibit 11: Cascade of Events Chart

This section of the report addresses the following three areas of the cascade of events:

- **Alarm answering time and alarm processing** time are referred to collectively as call handling. Call handling includes the time period from when the phone is answered and an emergency event is created in the CAD, to when firefighters are notified to respond via paging, radio, or other means. Dispatchers may continue to gather information from callers even after firefighters are notified to respond. Therefore, the amount of time dispatchers are occupied with alarm processing is likely to be greater than the times indicated in the call handling exhibits below.

- **Turnout time** is measured from the time firefighters are notified to respond until they report that they are departing the station or wherever they are located at the time of notification. Most responses occur from a station although occasionally firefighters may be mobile.

- **Travel time** can be defined as the time firefighters depart the station, or location when notified, to the time the trucks stop at the incident. Travel time does not include the time it may take to set up equipment or reach an incident — for example, inside a large building such as a school or arena, or a multi-story building.
Issues related to setup time and resource requirements are addressed in section 3.4.

Exhibit 12 and Exhibit 13 indicate Belleville Fire and Emergency Services’ elapsed time, in 2017, for call handling, turnout and travel time at the 90th percentile for each phase, and by urban and rural stations. The 90th percentile mark indicates that 90% of all incidents were responded to or handled within the times noted. The 90th percentile is a common measurement standard within emergency services.

NFPA standards 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 1720 (Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Volunteer Fire Departments) recommend turnout and travel time performance benchmarks for career and volunteer fire departments respectively. However, Belleville Fire and Emergency Services is defined as a Combination Department within section 3.3.15.1 of NFPA 1720:

3.3.15.1 Combination Fire Department. A fire department having emergency service personnel comprising less than 85 percent majority of either volunteer or career membership.

NFPA 1221 Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems sets out standards for communications including call handling. The three NFPA standards referred to above include some variances depending upon the nature of an incident, but for the purpose of comparison to Belleville Fire and Emergency Services’ performance the relevant points are as follows:

Career Departments:
- Call Handling: 90% of alarm processing (call handling) will be completed in 64 seconds (one minute, four seconds) (NFPA 1221; 7.4.2).
- Turnout Time, career departments: 80 seconds turnout time (NFPA 4.1.2.1 (2)).
- Travel Time, career departments: 240 seconds (four minutes) or less travel time for the arrival of the first arriving engine company at a fire suppression incident (NFPA 4.1.2.1 (4)).

Volunteer Departments:
- NFPA 1720 sets standards based on population density urban, suburban, rural, remote, and special risk circumstances. In Belleville, the NFPA rural target is most applicable to the volunteer fire stations.
- The time target is based on turnout time plus travel time, and in the case of rural response to a low-hazard occupancy such as a two-story, single-family home without a basement and adjacent buildings it is 14 minutes with a minimum staffing of six firefighters.
  - It is important to note that some commercial or more heavily populated areas of Belleville that are traditionally responded to from station 4, such as those north of Highway 401 adjacent to North Front Street and Sidney Street, might fall into the suburban or urban
recommended standards of NFPA 1720, which require a greater assembly of resources in a shorter period of time.

### 2.2.1 Belleville Response Performance

Information shown in Exhibit 12 and Exhibit 13 is based on 2017 structure fire incidents because they are most urgent and response will occur in the shortest possible time. Also, the NFPA standards noted above relate to fire suppression incidents.

**Exhibit 12: Urban Fire Station Performance Compared to NFPA 1710**

<table>
<thead>
<tr>
<th>Urban Performance Stations 1 and 2</th>
<th>NFPA 1710 Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Call Handling 90&lt;sup&gt;th&lt;/sup&gt; Percentile</td>
<td>Minutes</td>
</tr>
<tr>
<td>Turnout 90&lt;sup&gt;th&lt;/sup&gt; Percentile</td>
<td>02:00</td>
</tr>
<tr>
<td>Wheels start rolling 4 minutes 37 seconds after dispatcher answers the telephone</td>
<td></td>
</tr>
<tr>
<td>Travel time 90&lt;sup&gt;th&lt;/sup&gt; Percentile</td>
<td>0:04:15</td>
</tr>
<tr>
<td>Total Time</td>
<td>08:52</td>
</tr>
</tbody>
</table>

The urban stations’ travel time performance is similar to the NFPA travel time recommendation; in our experience, Belleville is one of the few fire departments that is able to come close to attaining that standard. Belleville’s call handling and turnout time are well off the NFPA 1710 standard, but again, in our experience, this is not unusual in many fire departments. That is not to suggest that Belleville shouldn’t strive for improvement in those two areas.

**Exhibit 13: Rural Fire Station Performance Compared to NFPA 1720**

<table>
<thead>
<tr>
<th>Rural Performance Stations 3, 4, and 5</th>
<th>NFPA 1720 Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Call Handling 90&lt;sup&gt;th&lt;/sup&gt; Percentile</td>
<td>Minutes</td>
</tr>
<tr>
<td>Turnout 90&lt;sup&gt;th&lt;/sup&gt; Percentile</td>
<td>06:35</td>
</tr>
<tr>
<td>Wheels start rolling 9 minutes 32 seconds after dispatcher answers the telephone</td>
<td></td>
</tr>
<tr>
<td>Travel time 90&lt;sup&gt;th&lt;/sup&gt; Percentile</td>
<td>07:49</td>
</tr>
<tr>
<td>Total Time</td>
<td>17:28</td>
</tr>
</tbody>
</table>

The rural station turnout and travel time performance is 14 minutes and 24 seconds at the 90<sup>th</sup> percentile, which likely would achieve the NFPA 1720 recommendation of 14 minutes at the 80<sup>th</sup> percentile. The call handling performance of 177 seconds, compared to the NFPA recommended standard of 64 seconds, is the factor that slows down overall response. We note that it is difficult to achieve the NFPA recommended 64-second standard, but Belleville Fire and Emergency Services should determine causes for this elongated call taking time. Mapping the call taking process (auditing end-to-end activity to find performance and customer value improvements) may assist in determining negative factors.
2.3 The Application of Performance Data to Response Areas

Now that we have identified Belleville Fire and Emergency Services’ response ability in the urban and rural areas, the concentration of incidents and distribution of fire incidents need to be identified. Thereafter, we can coordinate resource response and the sites of current and future recommended stations with the location of incidents.

Exhibit 14 indicates the distribution of emergency incidents throughout Belleville. The exhibit shows all emergency incidents, not just fires, and, as can be expected, occurrence is greater where population is concentrated. A larger map can be found in Appendix B.

Exhibit 14: Heat Map: Concentration of Incidents in Wards 1 and 2

Exhibit 15 indicates the location of each structure fire event to which Belleville Fire and Emergency Services were dispatched in 2017. Some incidents were severe, whereas others had not progressed to the point of being serious. The map does not indicate severity.
A larger map, as well as fire dispatches in years 2013–2016, can be found in Appendix C.

Exhibit 15: Structure Fire Locations 2017

The frequency and location of structure fires are also known to be associated with building type and age, income (related to the ability to maintain property), and demographics; the very young and elderly are more susceptible to toxic atmospheres or fractional effective dose (Appendix E NIST).
Exhibit 16 and Exhibit 17, starting on page 18, demonstrate the location of fires in Belleville, in 2017, with relational information about population, average household income, and demographics by StatCan census tract. Exhibit 17 is an inset of the downtown area, where most fires occur.

Other information relevant to this subject can be found at the following links:

  “... the research is clear that residential fires disproportionately affect those of low socioeconomic status (SES). Studies conducted in the United Kingdom (UK) and United States (US) have consistently shown that stepwise increases in residential fire risk correspond to diminishing levels of SES. Although sparse, reports from BC describe similar trends among the adult population.”

- [https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1525262/](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1525262/) Income, Housing, and Fire Injuries: A Census Tract Analysis
  “Multiple regression analysis indicates that older housing (prior to 1940), low income, the prevalence of vacant houses, and the ability to speak English have significant independent effects on fire injury rates in Philadelphia. In addition, the results show a significant interaction between older housing and low income.”

  Canadian Mortgage and Housing Corp (1991) reports
  “In 1987, 277 people died in fires in one- and two-family dwellings across the country – the vast majority of them in homes built before 1980 ... New homes, which have been required by building codes to have mandatory wired in smoke alarms since early in the 1980s, are much safer (estimated 1.4 deaths per 100,000) than the general housing stock.”

  “There has been a steady change in the residential fire environment over the past several decades. These changes include larger homes, different home geometries, increased synthetic fuel loads, and changing construction materials. Several experiments were conducted to compare the impact of changing fuel loads in residential houses. These experiments show living room fires have flashover times of less than 5 min when they used to be on the order of 30 min. Other experiments demonstrate the failure time of wall linings, windows and interior doors have decreased over time which also impact fire growth and firefighter tactics. Each of these changes alone may not be significant but the all-encompassing effect of these components on residential fire behavior has changed the incidents that the fire service is responding to. This analysis examines this change in fire dynamics and the impact on firefighter response times and operational timeframes.”
Exhibit 17: Downtown Inset Fire Occurrences Relative to Census Tract Data

Information source: StatCan.
Avg Household Income is based on StatCan 2015 data.
Tables indicating
0-14 15-59 60+
% % %
represent age ranges.

0011.00
Population: 4,060
Avg. Household Income: $61,222
0-14 15-59 60+
19% 59% 25%

0007.00
Population: 6,479
Avg. Household Income: $71,189
0-14 15-59 60+
17% 52% 31%

0004.00
Population: 4,264
Avg. Household Income: $65,926
0-14 15-59 60+
17% 55% 32%

0005.00
Population: 1,042
Avg. Household Income: $38,624
0-14 15-59 60+
20% 57% 23%

0009.00
Population: 2,203
Avg. Household Income: $101,434
0-14 15-59 60+
17% 55% 31%

0006.00
Population: 5,604
Avg. Household Income: $51,302
0-14 15-59 60+
23% 63% 23%

0008.00
Population: 3,180
Avg. Household Income: $56,909
0-14 15-59 60+
21% 51% 19%

0003.00
Population: 2,308
Avg. Household Income: $80,9,598
0-14 15-59 60+
17% 55% 32%

0001.00
Population: 6,479
Avg. Household Income: $71,189
0-14 15-59 60+
17% 52% 31%

0002.00
Population: 4,060
Avg. Household Income: $61,222
0-14 15-59 60+
19% 59% 25%

0000.00
Population: 2,203
Avg. Household Income: $101,434
0-14 15-59 60+
17% 55% 31%

0001.00
Population: 6,479
Avg. Household Income: $71,189
0-14 15-59 60+
17% 52% 31%

0002.00
Population: 4,060
Avg. Household Income: $61,222
0-14 15-59 60+
19% 59% 25%

0000.00
Population: 2,203
Avg. Household Income: $101,434
0-14 15-59 60+
17% 55% 31%
The distribution of structure fire dispatches has remained consistent over the past five years. The majority occur in the more densely populated urban area, with few taking place in rural areas. The highest number of structure fires in the Ward 2 rural area was 15 in 2016; other years averaged one a month or fewer.

Exhibit 18 to Exhibit 21 indicate the elapsed time from the moment a call for help is answered at the fire dispatch to the time the first fire truck arrives at the incident. The elapsed time is based on the information provided in Exhibit 12 and Exhibit 13 and includes

- call handling time at the 90th percentile;
- turnout time at the 90th percentile (which is different for career and rural stations); and
- travel time history at the 90th percentile.

Each incident is different, which means that actual time will vary depending on the circumstance. Nevertheless, the response patterns shown in the following exhibits are based on accurate data from the fire department.

Exhibit 18 shows the area to which each station can likely respond, based on a 90th percentile historical experience, within 8 minutes of a call for assistance being received by the fire dispatcher. This means that, at the 90th percentile, 4 minutes and 37 seconds will be used to

- take call information;
- alert fire crews; and
- for fire crews to don protective equipment and depart the station.

The balance of the 8-minute period — 3 minutes and 23 seconds — is the travel time depicted in Exhibit 18.

Only stations 1 and 2 are depicted in Exhibit 18 and Exhibit 19 because the call handling and turnout time for rural stations takes 9 minutes and 32 seconds. Call handling time is about 2 minutes and 48 seconds, and the time it takes volunteers to respond from home, or wherever they may be at the time of receiving an alert, is about 6 minutes and 35 seconds. Volunteers will attest that they can turn out faster than 6:35, with some telling us it takes only a minute or two because a few volunteers live close to the stations. We won’t dispute that there could be occasions that volunteers may be able to turn out faster than 6:35, but 6:35 is admirable performance and better than we have seen in many fire services across Canada. Therefore, the 8-minute exhibit shows travel by the 8-minute elapsed time of an incident, and in many or most cases volunteers would not have left the station in a fire truck by that time. The same is applicable to the 10-minute depiction in Exhibit 19, since a volunteer station fire truck would have been on the road for 30 seconds or less by the 10-minute mark, which is too small a distance to show on a map of this scale.

The same premise is applicable to the 12- and 14-minute depictions, where volunteer stations will be on the road for 2 minutes and 28 seconds and 4 minutes and 28 seconds, respectively, and career stations 7 minutes and 23 seconds and 9 minutes and 23 seconds.
Exhibit 18: Area Covered, by Station, 8 Minutes After a Call for Help Is Received
Exhibit 19: Area Covered, by Station, 10 Minutes After a Call for Help Is Received
Exhibit 20: Area Covered, by Station, 12 Minutes After a Call for Help Is Received
Exhibit 21: Area Covered, by Station, 14 Minutes After a Call for Help Is Received

CITY OF BELLEVILLE FIRE RESPONSE
14-Minute Elapsed Time
(Travel Time: 9'23" Urban, 4'28" Rural)

Legend
- Fire Station
- Road
- Railway

Travel Time Contour
- Fire Station 1
- Fire Station 2
- Fire Station 3
- Fire Station 4
- Fire Station 5
- City Boundary
- Water Features
What can we observe from these exhibits?

- Exhibit 19 indicates that 10 minutes after a call for assistance the rural fire stations are likely to be responding from their stations but have been on the road for only 30 seconds or slightly more.
- Exhibit 20 indicates that at the 12-minute mark after a call for assistance, fire stations 1 and 2 will have reached near the intersections of Wiser Road and Highway 37, and Blessington Road and Ritz Road, and near Harmony Road and Ashley Street, which are all within three kilometres of station 4.
  - Those locations can then serve as the demarcation points where stations 1 and 2 can arrive at generally the same time as station 4. Incidents further south from those points should be responded to by stations 1 or 2.
- Exhibit 21 depicts that at the 14-minute mark after a call for assistance is received
  - the demarcation point between stations 4 and 5 is south of Sills Road on Highway 37 and about three to three and a half road kilometres from station 4;
  - the demarcation point between stations 1 and 2, and station 3, is approximately 800 metres east of Point Anne Road on Old Highway 2.
- Exhibit 21 also shows that past the intersection of Harmony Road and Ashley Street, station 2 can likely reach incidents to the north in the same time as station 4.

Our conclusion from this analysis is that there is an area of three to four road kilometres in any direction from station 4 that cannot be covered in the same time by any other station. Phrased another way, if Belleville was starting from a greenfield state, it would have to make a decision as to whether to establish a station at or near the current station 4 for the purpose of covering three to four kilometres of travel that can’t be covered by other stations.

Fewer than 10–12 incidents per year of all types, including medical and motor vehicle incidents, many of which turn out to be non-life-threatening and are not as time critical as fires, occur in those four kilometres. And, without diminishing the gravity, only one or two structure fires may occur within that area annually, which causes us to conclude that the risk to residents in that area is low (please see Exhibit 14: Heat Map: Concentration of Incidents in Wards 1 and 2 and Exhibit 15: Structure Fire Locations 2017).

Our conclusions are theoretical yet based on the best objective data available, but the hypothesis should be tested by observation. That is discussed in sections 3.4 and 3.4.3.
3. Core Services

3.1 A Review
After 22 pages of data and maps it is reasonable to briefly review what has been presented thus far, prior to addressing the core services.

- In section 1 we
  - presented the project intent;
  - listed the elements or areas of the fire and emergency services to be reviewed;
  - defined what a core services review is and isn’t;
  - indicated the core services of a fire department;
  - offered a brief description of Belleville Fire and Emergency Services; and
  - presented an organizational chart.
- In section 2 we
  - presented fire service data for the period 2013–2017 inclusive;
  - showed that, except for medical incidents, all other incident types have had a downwards trend in the past five years;¹
  - described the NFPA Cascade of Events and call handling, turnout, and travel time components of an emergency response;
  - indicated response performance for those three components for urban and rural stations and offered comparisons to NFPA standards;
  - showed the application of the performance data to response areas and provided heat maps, structure fire maps, and response area maps, by station, based on the three components of call handling, turnout, and travel time;
  - concluded that there is an approximately four-kilometre travel area around station 4 that cannot be covered by stations 1, 2, or 5.

In section 1.2.1 we identified the core services of a fire department and how they are accomplished. They are repeated below:

¹ At the time of this report Emergency Health Services and the Ministry of Health have an initiative underway to implement a commercial incident prioritization product called the Medical Priority Dispatch System (MPDS) at ambulance communications centres across the province. MPDS is a de facto standard across North America and many other countries, and has been shown in several studies to have greater sensitivity and specificity with respect to initial determination of medical priority and resource assignment. In other words, the initial assigned priority for incidents is sometimes lower than with other prioritization products such as the Dispatch Priority Index, which is in use in most ambulance dispatch centres in Ontario.

In locations such as Toronto, Niagara Region, British Columbia, and others where MPDS has been in use, the number of tiered responses to fire departments has been reduced. Therefore, as MPDS is deployed in the Belleville area, it can be expected that fire department medical response will also trend downwards by approximately 20% or more.

The implementation of MPDS across Ontario was on hold at the time of this report, while the province reviews government-wide funding.
The core services of a fire department are

- prevention;
- education;
- suppression;
- rescue;
- public assistance.

These core services are accomplished through

- rapid response when required;
- continuous training;
- awareness of community need;
- risk assessment;
- community engagement;
- information gathering and data analysis;
- firefighter and staff engagement;
- legislation and bylaws that support the core services.

### 3.2 Prevention and Education

The primary role of a fire department is — or should be — to prevent fires and injury. Stated another way, it should be to protect the public. Historically, “protecting the public” has taken the form of rapid response and fire suppression, both of which are important roles of a firefighter, but it is now commonly considered as a failure to protect when the need for response occurs.

Fire prevention happens through public education and inspection. Some interesting articles from FireRescue1, an online publication, with respect to prevention and education, are included in Appendix D. The Ontario Office of the Fire Marshal provides many online resources² to educate the public and assist fire departments, and fire departments across Ontario are willing to exchange prevention and education programs and techniques. Additionally, prevention and public education are stipulated within the Fire Protection and Prevention Act, 1997, S.O. 1997, c. 4 and associated regulations.³

The organization chart at the end of section 1 shows that the fire department has five positions for fire prevention in the urban area. Unfortunately, we have seen no evidence that the prevention section is providing value for money. Neither were we able to find a written strategy for fire prevention and public education, or a formal public education program or schedule of educational events. Simply having positions assigned to fire prevention and public education roles without a formal program and adequate record-keeping in place may not meet the municipality’s legislative responsibility of establishing a fire prevention program that must include public education.

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³ [https://www.ontario.ca/laws/statute/97f04?_ga=2.69848600.928223289.1546969583-146779870.1546969583#BK3]
Prevention (inspections) is more quantifiable than public education by virtue of being able to measure changes in loss or injuries over a defined period based on the implementation of a new prevention program or increased or decreased enforcement. Also, because inspections are based on local bylaw and provincial legislation and regulations, determining whether establishments are in compliance or not in compliance is relatively straightforward and more prescriptive than education programs and trying to associate those with changes in fire loss or injury.

It is also more difficult to establish the relationship of education to reduced fire incidents because education takes place over a period of time, and is therefore cumulative, and any decrease in fires or injury incidents is likely to take several years to manifest itself. Direct association between education and changes in incident frequency may also be attributable to other initiatives such as building code improvements. However, even though the relationship may not be immediate that doesn’t mean that education is not beneficial as part of an overall fire and injury mitigation effort.

Education can also be directed based on up-to-date data; for example, if candles, cooking, or smoking are indicated as recent causes of fire, those subjects should be targeted.

Following interviews with senior management and the senior fire prevention officer we found that the division requires attention in a number of areas. Although it complies with the provincial mandates to inspect vulnerable occupancies annually and responds to community concerns on a complaint basis in addition to conducting inspections for code compliance, we find that it operates in a reactive manner.

Recently, the department has turned extra effort to inspections of high-rises and service industries, although this was an internal initiative of individuals in the division. Public education efforts are limited to requests from the public (inspectors are directed on an ad hoc basis to conduct requested sessions); participation in annual school drills; and participation in the Belleville Safety Village Board of Directors.

There are no departmental policies regarding priority occupancies for inspections, frequency of inspections, community targets for public education efforts, or consistent messaging about fire safety in the community. Subsequently, the division is not able to optimize its resources to impact community fire safety.

Although that sounds like strong criticism it is really just a finding of fact.

Interviews with fire administration and career staff association representatives revealed that some prevention staff members wish to return to the suppression division. This desire is also discussed in section 3.4. Several reasons were offered, and they are presented below as stated by the interviewees. The comments reflect individual opinions, and should be considered as part of the efforts to reactivate the division and re-engage those employed in the division.

- Lack of direction and planning for the division (note that this is of concern to both senior management and within the division).
- The senior fire prevention officer has limited administrative experience, other than what he has learned on the job, and states he has not had the opportunity to attend courses with respect to time management, organization, or other managerial proficiencies.
There is a perceived lack of support by senior management to “push” code compliance issues that should proceed to the courts.

Fire suppression personnel have no knowledge/understanding of the work and responsibilities of the fire prevention division.

Time management is an issue for division personnel (a time management/scheduling system and program is needed).

Public education is best provided by someone “suited” to that role. Not all division personnel are eager to participate in public education activities.

The consultants agree that whenever positions become vacant in the suppression division those individuals who wish to return to fire suppression should be considered for a change in role. The best prevention officers and educators are individuals with an interest in prevention and education and a willingness to engage with vulnerable populations as well as the general public to “sell” the idea of fire and personal safety. Although not considered exciting like emergency response and firefighting, education and prevention is as, if not more, important. It’s a better, more efficient way to save lives than suppression and rescue. Being a firefighter should not be a prerequisite for filling the role of prevention and education, particularly education. The aptitudes and skills associated with being an educator are completely different from those of being a firefighter.

Interviewees suggested that some of the catalyst for the prevention and education issues relate to time constraints for administration to properly monitor the division. However, responsibility for the apparent malaise within the public education and prevention and education division must reside with the senior fire prevention officer, who, as the person in charge, must take the initiative for a robust prevention and education program. There is no evidence to suggest that the division’s activities are being constrained by the chief or deputies except, perhaps, for some disagreement about when charges should be laid.

Recommendations:

- Revamp the public education and prevention division based on the comments provided in this section.
- Implement a time management program for division personnel.
- Senior department management and personnel in the division should develop a fire prevention policy that identifies priorities and schedules for prevention and public education.
- Develop a fire prevention policy intended to move the department from a reactive to a proactive fire prevention stance that addresses the needs and circumstances of Belleville.
- Develop the administrative skills and knowledge of personnel responsible for the operation of the division.
- Fire prevention officers who wish to return to the fire suppression division should be considered for a change in role when vacancies occur.
- Vacant fire prevention positions should be filled by educators rather than firefighters. Prevention and education candidates do not need to be firefighters to fulfill the role because the skills and aptitudes of firefighters are very different to those of educators or inspectors.
Fire administration should designate prevention and educator positions within the existing complement of five, including the senior prevention officer. We suggest three prevention officers and two public educators. Please see the community risk profile in section 4. Conducting a community risk assessment will assist with determining the complement of prevention officers and educators within the existing division allocation.

- If the individual currently filling the senior prevention officer’s role is one of the staff members who wish to return to the suppression division, the senior prevention officer’s role should thereafter be filled by someone with the administrative aptitude, skills, and background to oversee education and prevention functions and staff, or the position should be eliminated and prevention and education staff should report to a deputy.

3.3 Vision and Mission
The fire department does not have vision and mission statements but recognizes that they are important to establishing purpose and direction.

A vision and mission are contained in a fire master plan developed by a former administration and released in 2009, but the official plan endorsement was rescinded by the City of Belleville. In any event, the master plan pre-dates the current fire administration, and the vision and mission no longer reflect the need and purpose of the fire service.

The lack of a vision and mission may contribute to the apparent scarcity of purpose within the education and prevention department, but only to the extent that the importance of prevention and education may not be driven home to the senior fire prevention officer or individuals that occupy the prevention and education positions.

Recommendation: As a critical part of setting the stage for delivery of core services, Belleville Fire and Emergency Services must develop new vision and mission statements.

There are many definitions of what a vision and mission are, but for the purposes of this discussion a vision statement

- is written succinctly in an inspirational manner that makes it easy for all employees to repeat it at any given time; this means it is short and simple to remember — a few words that say something to the effect of “Our vision is to reduce or eliminate fire, injury, and death through education and prevention”;
- defines the optimal desired future state, the mental picture of what an organization wants to achieve over time;
- provides guidance and inspiration as to what an organization is focused on achieving in 5, 10, or more years;
- functions as the “north star” — it is what all employees understand their work, every day, ultimately contributes toward accomplishing over the long term.

And a mission statement

- defines the present state or purpose of an organization;
Comprehensive Core Services Review
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- answers three questions about why an organization exists:
  - what does the organization do?
  - for whom is it done?
  - how is it done?
- is written succinctly in the form of a sentence or two, but for a shorter time frame (one to three years) than a vision statement;
- is something that all employees should be able to articulate upon request.

Without these organizational goals and objective statements, it is difficult for fire administration to establish an “operating theme” — that is, to make it clear how business will be conducted and for what purpose.

Recommendation: Belleville Fire and Emergency Services should create vision and mission statements that establishes prevention and education, rather than suppression, as the primary purpose of the fire service.

Readers should go to Appendix D and read the interview with former Louisville Fire Chief Russ Sanders titled How I cut civilian deaths without spending more money. It is the second article in Appendix D. At the time of Chief Sanders’ initiative to change the Louisville fire department’s focus to prevention from suppression, the city had a population of about 225,000 (now 616,000) and, admittedly, a different social construct than Belleville. Even so, although Belleville may not have the same challenges of civilian deaths as Louisville, the approach taken in Louisville is still applicable to fire prevention in Belleville.

At the time of the Louisville prevention and education initiative approximately 17% (about 100) of the workforce was eligible to retire. New recruits were required to develop education lesson plans and demonstrate that they could accomplish educational programs. Belleville Fire and Emergency Services will encounter similar challenges if it decides to focus on education and prevention, perhaps not because of a turnover of firefighters but because of possible resistance to firefighters’ primary roles — as in Louisville — becoming that of educators rather than suppression only.

If Belleville decides to accept our recommendations with respect to education and prevention, fire administration will have to work closely with Human Resources and will need the support of city administration and council to effect change that is proactive rather than reactive.

Population increase does not translate into the need for more firefighters

It is important to drive home the fact that even though Belleville’s population is increasing, emergency responses are on a downward trend. So, population increase does not translate into the need for more firefighters. This apparent dichotomy is partially attributable to better building standards and awareness by the public of fire risk. Increased education efforts are likely to reduce emergency
response need even further, although frequency of incidents will not diminish the requirement for an effective firefighting force. We address that subject as part of section 3.4.

Belleville Fire and Emergency Services will require a strategy to deal with keeping emergency services personnel interested and occupied in the face of declining frequency of incidents and responses, and a refocus of the fire service to education and prevention. Emergency services personnel, whether fire, paramedics, or police, join emergency services organizations in part because the perceived excitement of emergency, rescue, and life-saving is an attraction. It is difficult to keep the so-called “Type A” personality engaged when the corporate vision is to prevent incidents from occurring. Dissatisfaction with a prevention role is distinctly possible for staff members who crave action. Activity, by way of frequent and difficult training, is likely to be required to avoid dissatisfaction.

3.4 Suppression, Rescue, and Response
This section is about suppression, rescue, and response and will address station location and resources since they are key to how quickly Belleville Fire and Emergency Services can assemble an effective firefighting or rescue force.

3.4.1 How Many Firefighters Does It Take to Fight a House Fire?
Under normal circumstances, for career fire departments, as noted in NFPA 1710, the answer is 14 firefighters within 9 minutes and 20 seconds⁴ of being notified of a fire incident 90% of the time, 15 if an aerial device is in operation.

Exhibit 22: Initial Full Alarm Assignment; NFPA 1710, on page 33, describes the number of firefighters recommended within NFPA 1710, Section 5.2.4.1, and the duties they should perform in the case of a structure fire in a “typical” 2,000 ft² (186m²), two-story single-family dwelling, without basement, and with no exposures. This “typical” residence is considered to be fully above ground, so there is no basement to search and there are no buildings surrounding the residence that could be threatened.

Based on the experience of thousands of fires and the tasks that have to be performed, and the rate of fire spread, NFPA 1710 considers that 14 firefighters are required to extinguish the typical fire, conduct searches, rescue victims, and protect the safety of firefighters to the extent possible. According to the standard, 14 firefighters should be on scene within 9 minutes and 20 seconds of being notified of a fire incident 90% of the time. However, NFPA 1720, which applies to volunteer firefighters, suggests a variable number of firefighters and response times depending on population density and distance from the fire station (please see Exhibit 23, page 34 [NFPA 1720-14 Table 4.3.2 Staffing and Response Time]).

There are some considerations with respect to the NFPA standards about which readers should be aware, including the following:

- They are voluntary, not legislated or regulatory unless referenced in legislation. As the NFPA regulations state, adopting them or setting local standards is up to the Authority Having Jurisdiction, usually the local council.

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⁴ 80 seconds turnout time plus 480 seconds or less travel time for the deployment of an initial full alarm assignment at a fire suppression incident other than a high-rise (NFPA 1710-2016 4.1.2.1 (2)(4))
• It is up to the City of Belleville to adopt or create service, response, and resource standards that council determines best fit the community.

• Our experience is that there are few communities in North America that meet NFPA standards, particularly the ones relating to response times and number of firefighters, but they are good guidelines upon which communities can base the standards they decide to adopt.

• Notwithstanding the information provided at the beginning of this section and Exhibit 22, in combined departments such as Belleville, volunteers are leveraged as part of a callback to create the depth of response if required. Please see page 13 for an explanation of a combined department. Therefore, there is no intent in this section or the exhibits to suggest that additional career firefighters should be hired to meet NFPA standards.

Exhibit 22: Initial Full Alarm Assignment; NFPA 1710

<table>
<thead>
<tr>
<th>Activity</th>
<th>Number of Firefighters</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Establish incident command outside of the hazard area for the overall coordination and direction of the initial full alarm assignment with a minimum of one member dedicated to this task</td>
<td>1</td>
</tr>
<tr>
<td>(2) Establish an uninterrupted water supply of a minimum of 400 g.p.m. (1520 L/min) for 30 minutes with supply line(s) maintained by an operator</td>
<td>1</td>
</tr>
<tr>
<td>(3) Establish an effective water flow application rate of 300 g.p.m (1140 L/min) from two handlines, each of which has a minimum flow rate of 100 g.p.m. (380 L/min) with each handline operated by a minimum of two members to effectively and safely maintain the line</td>
<td>4</td>
</tr>
<tr>
<td>(4) Provide one support member for each attack and backup line deployed to provide hydrant hookup and to assist in laying of hose lines, utility control, and forcible entry</td>
<td>2</td>
</tr>
<tr>
<td>(5) Provide at least one victim search and rescue team, with each such team consisting of a minimum of two members</td>
<td>2</td>
</tr>
<tr>
<td>(6) Provide at least one team, consisting of a minimum of two members, to raise ground ladders and perform ventilation</td>
<td>2</td>
</tr>
<tr>
<td>(7) If an aerial device is used in operations, one member is to function as an aerial operator to maintain primary control of the aerial device at all times</td>
<td>1</td>
</tr>
<tr>
<td>(8) Establish an initial rapid intervention crew (IRIC) consisting of a minimum of two properly equipped and trained members</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
</tr>
</tbody>
</table>
**Comprehensive Core Services Review**  
**City of Belleville Fire and Emergency Services**

Exhibit 23: NFPA 1720 Deployment Standards

<table>
<thead>
<tr>
<th>Demand Zone*</th>
<th>Demographics</th>
<th>Minimum Staffing Required**</th>
<th>Response Time (minutes) ***</th>
<th>Meets Objective (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>&gt;1000 people /2.6 sq. km</td>
<td>15</td>
<td>9</td>
<td>90</td>
</tr>
<tr>
<td>Suburban</td>
<td>500–1000 people /2.6 sq. km</td>
<td>10</td>
<td>10</td>
<td>80</td>
</tr>
<tr>
<td>Rural</td>
<td>&lt; 500 people / 2.6 sq. km</td>
<td>6</td>
<td>14</td>
<td>80</td>
</tr>
<tr>
<td>Remote</td>
<td>Travel distance &gt; 12.8 km</td>
<td>4</td>
<td>Dependent on travel distance</td>
<td>90</td>
</tr>
<tr>
<td>Special Risk</td>
<td>Determined by AHJ based on risk</td>
<td>Determined by AHJ</td>
<td>Determined by AHJ</td>
<td>90</td>
</tr>
</tbody>
</table>

**Activity**

- **Interior Fire Suppression**: Sufficient personnel, equipment and resources  
  - Minimum on Scene Initial Attack Time: 4 minutes  
  - Response Time: 2 minutes after assembly of necessary resources on scene  
  - Objective: 4.6%  
  - Meets Objective: 90%

So, is NFPA 1710 right and 14 or 15 firefighters, at minimum, are required to fight a residential fire, or are fewer than 14 firefighters acceptable in a rural area? In the case of a combined service such as Belleville, the determination of the best possible response to areas that range from urban to rural must be made by the city. Additionally, one response model does not fit all areas. It’s important to note that this variability in response targets underlines the need for the career and volunteer firefighters to be mutually supporting and to work as one fire department.

The critical factors to be considered for optimum response to structure fires is speed of response, equipment adequacy, and the number of trained responders.

It is likely that almost everyone who has had to make decisions about resources allocated to fire departments has been presented with the following fire propagation curve (Exhibit 24) found in Annex A of NFPA 1710-16.
Exhibit 24: NFPA Fire Propagation Curve

The figure is intended to show the time available before fire spreads beyond the room of origin and, possibly, flashover occurs. An explanation of Exhibit 24 can be found in NFPA A.5.2.2.2.1:

A.5.2.2.2.1 An early, aggressive, and offensive primary interior attack on a working fire, where feasible, is usually the most effective strategy to reduce loss of lives and property damage. In Figure A.5.2.2.2.1, the line, which combines temperature rise and time, represents a rate of fire propagation in an unsprinklered room and roughly corresponds to the percentage of property destruction. At approximately 10 minutes into the fire sequence, the hypothetical room of origin flashes over. Extension outside the room begins at that point. Consequently, given that the progression of a structure fire to the point of flashover (i.e., the very rapid spreading of the fire due to superheating of room contents and other combustibles) generally occurs in less than 10 minutes, two of the most important elements in limiting fire spread are the quick arrival of sufficient personnel and equipment to attack and extinguish the fire as close to the point of its origin as possible.

Admittedly, some fires don’t progress to flashover because a resident or bystander has taken some action, the nature of a fire or fuel restricts the progress to some extent, firefighters arrive in a short period of time, or for some other reason. The unfortunate, unpredictable nature of fires is why fire professionals take the position that an adequate number of firefighters need to be available to respond quickly to stop the spread and provide rescue when necessary, and others — usually not firefighters — contend that most fires are minor in nature and don’t develop beyond the room of origin. It is reasonable to point out the possibility that some fires do not progress because firefighters arrive quickly enough to control them.
Firefighters will also advise that the type of building construction, particularly floor joists, is a factor that elevates firefighting risk and risk to occupants. In the last 30 years many residential and commercial builders have used composite floor joists, as presented in Exhibit 25, rather than dimensional lumber (Exhibit 26).

Exhibit 25: Composite Floor Joists

Composite floor joists are sometimes referred to as “lightweight construction” because of their manufacture from oriented strand board and nominal 2 x 3-inch or 2 x 4-inch flanges. Composite joists will burn through in 25% to 50% of the time of dimensional lumber, thus possibly increasing risk if response is delayed. Some building codes now require composite joists to be covered with fire-rated drywall or an E-84 intumescent coating, although many buildings that firefighters enter will have been built prior to codes requiring coating or drywall. This is a legitimate concern and one of the reasons that firefighters point to as a need for rapid response.

Exhibit 26: Dimensional Lumber Joists

3.4.2 National Institute of Standards and Technology

A landmark study that helps to answer the question of “How many firefighters are required at a fire?” was completed by the National Institute of Standards and Technology (NIST). NIST is an independent agency of the U.S. Department of Commerce and provides scientific measurement and standards for a wide range of products and services.

The abstract at the outset of the NIST report recognizes that “local decision-makers are challenged to balance … community service expectations with finite resources, without a solid technical foundation for evaluating the impact of staffing and deployment decisions on the safety of the public and firefighters.”

A five-page report excerpt can be found at Appendix E, and it is important to read it to gain the best perspective and understanding of our conclusions at the end of this section. It can be summarized briefly as follows:
NIST conducted more than 60 full-scale fire experiments to determine the impact of crew size, first-due engine arrival time, and subsequent apparatus arrival times on firefighter safety and effectiveness at a low-hazard residential structure fire.

The report quantifies the effects of changes to staffing and arrival times for residential firefighting operations.

The report addresses resource deployment in the context of a single structure type and risk level, but recognizes that public policy decisions regarding the cost-benefit of specific deployment decisions are a function of many other factors including geography, local risks and hazards, available resources, and community expectations. The NIST report does not specifically address these other factors.

The field experiments contribute significant knowledge to the fire service industry. The results provide:

- a quantitative basis for the effectiveness of four-person crews for low-hazard response in NFPA 1710;
- valid measures of total effective response force assembly on scene for fireground operations;
- valid assessment of the expected time-to-critical-task performance measures for low-hazard structure fires;
- tenability measures associated with a range of modelled fires.

In a rapidly developing fire scenario, critical factors impacting the outcome are:

- speed of response;
- equipment adequacy;
- the number of trained responders;
- effectiveness of the chosen strategy; and
- timeliness for completion of the tasks necessary to successfully implement the strategy.

So how does all the information about building construction, NIST experiments, and assembling an effective firefighting force affect the City of Belleville? At the beginning of section 3.4 we indicated that the purpose of the section was to address station location and resources since they are key to how quickly Belleville Fire and Emergency Services can assemble an effective firefighting or rescue force.

We can conclude that Belleville Fire and Emergency Services doesn’t have enough firefighters on duty in the urban area to assemble an effective force of 14 or 15 firefighters within 9 minutes and 20 seconds of being notified. A maximum of 13 firefighters will be on duty at both urban stations, assuming there are no absences. More commonly 10 are on duty. Nevertheless, it is possible that during weekday daytime hours when fire prevention officers and fire administration are on duty, assembling 15 firefighters in a short period of time may be possible. However, it is unlikely any other time. And, there will be times — for example, during usual business hours when volunteers may be at work — when there is an inadequate number of volunteers available to effectively fight fires in rural areas.
We can conclude that if, in a rapidly developing fire scenario, critical factors impacting the outcome are

- speed of response,
- equipment adequacy, and
- the number of trained responders,

then there are areas of Belleville to which stations 1 and 2 should be responding rather than rural stations. In particular, the area north of the 401, which has traditionally been responded to by station 4, should be responded to from the urban stations. We understand the concern, on the part of both the volunteers and career staff, that will be precipitated by this conclusion. Volunteers will note that the area north of the 401 has historically been part of their response area, and career staff and their association may assert that travelling north of the 401 will mean additional career staff will have to be called in to cover the urban area.

We understand the impact on station 4’s dedicated volunteers, but our conclusions are based on best public safety rather than historical coverage. Two questions still to be answered are “How far north should the urban stations respond?” and “Is it reasonable, considering the cost to renovate or replace station 4, to decommission it?” We address the last question in section 3.4.3, and we will show that the risk of concurrent incidents or severe incidents is sufficiently low in Belleville not to require calling in career staff to cover if one of the urban fire trucks travels north of the 401. Finally, we are also aware of the conundrum of tax rate differential between the areas north and south of the 401 and the possibility that some residents and businesses north of the 401 will receive an urban level of fire protection even though it may not be reflected in the tax structure. However, resolving or commenting on that issue is beyond the scope of this study.

### 3.4.3 Stations 1, 2, and 4 Convergence

Our calculations, as can be seen in the maps in Exhibit 20: Area Covered, by Station, 12 Minutes After a Call for Help Is Received and Exhibit 21: Area Covered, by Station, 14 Minutes After a Call for Help Is Received, indicate the point to which stations 1 and 2 can reach, in approximately the same time as station 4 can arrive, is from 2.5 to 4 kilometres south, west, and southwest of station 4. It is uncertain whether station 4 or station 1 can arrive sooner at incidents north of Harmony Road and Ashley Street. The halfway point between stations 4 and 5 is south of Sills Road on Highway 37 and about three to three and a half kilometres from station 4.

Station 4 is well cared for by the volunteers, but it is a tired station and mostly inadequate. Fire administration have discussed adding about 70 feet to the front of the station to better accommodate existing apparatus and staff and to accommodate future vehicles that may be larger. Pomax believes that replacement may be a more judicious approach, but whether renovated or replaced, the cost, conservatively,
will be hundreds of thousands to two million dollars. We have already established that there are fewer than a dozen incidents of all types in the portion of station 4’s area that can’t be covered by other stations, and those that may occur within that radius will experience two to three minutes of additional wait time if served from other than station 4.

If this was a greenfield determination and the decision to be made was whether to establish a new station near the current site, we expect that spending two million dollars or more to cover fewer than 12 calls a year — only one or two of which are fires — would not be acceptable. Also, if the Harmony Road station was relatively new the coverage and response questions would still exist, but decommissioning might not be part of the discussion.

A decision point that remains, assuming the city accepts our recommendation that stations 1 and 2 should respond to the area north of the 401, is how far north should they respond? Theoretically, we have established that the response demarcation from station 4 is within four kilometres of the Harmony Road station. But that determination has to be refined by fire administration by way of detailed analysis of each incident to which station 4 responds, including the number of firefighters that arrive on scene in private vehicles and the time each arrives. Tracking of that nature, for a one-year period or greater, would clarify the service area to which the urban stations and station 4 should respond, or if station 4 should be decommissioned.

3.4.4 Concurrent Calls, Call In, and Risk in the Urban Area

We anticipate that the Belleville Professional Firefighters’ Association may suggest that additional staff should be called in if a truck leaves the urban area in case a concurrent urban incident occurs.

Assessment of concurrent calls in Belleville over the past five years enabled us to find the following:

- The majority of concurrent calls were due to public assistance incidents and alarms.
- Several were medical calls.
- Several were due to electrical incidents and wires down.
- Three were non-structural fire incidents: two with cars and one a rubbish fire.
- We did not find any incidents where a structural fire occurred at the same time as another incident, whether emergency, non-emergency, or public assistance.

Exhibit 27: Concurrent Incidents Station 1 and 2 2013–2017

<table>
<thead>
<tr>
<th>Year</th>
<th>Station 1</th>
<th>Station 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>Number of Incidents: 3</td>
<td>Number of Incidents: 9</td>
</tr>
<tr>
<td></td>
<td>3 public service non-emergency incidents</td>
<td>Simultaneous residential alarms</td>
</tr>
<tr>
<td></td>
<td>Simultaneous residential alarms</td>
<td>Pumper at electrical wires down; Aerial sent to Electrical Wires Overhead</td>
</tr>
<tr>
<td></td>
<td>Pumper and aerial at separate Electrical Wires Down incidents; 2nd Pumper sent to Public Service: CO Detector call</td>
<td>Pumper and aerial at separate electrical wires down incidents</td>
</tr>
</tbody>
</table>
### Year | Number of Concurrent Incidents
--- | ---
2014 **Station 1**
| Number of Incidents: 5 |
| Rescue was at a public service call; Pumper was sent to a defibrillation incident |
| Public service non-emergency incident |
| Pumper was at a non-emergency public service call; Pickup truck was sent to Electrical: wires down |
| Non-emergency public service call |
| Pumper was at a medical assistance incident; Rescue was sent to a public service call |

**Station 2**
| Number of Incidents: 1 |
| Pumper was at Public Service CO Detector (two calls to same address); 2\textsuperscript{nd} Pumper sent to Medical Emergency (no address) |

2015 **Station 1**
| Number of Incidents: 1 |
| Pumper was at a CO detector public service call; 2\textsuperscript{nd} Pumper was sent to a medical emergency |

**Station 2**
| Number of Incidents: 1 |
| Pumper was at a public service call; Aerial sent to medical assistance |

2016 **Station 1**
| Number of Incidents: 0 |
| Pumper was at medical assistance: 2\textsuperscript{nd} Pumper sent to auto extrication incident |
| Pumper was at Fire/Smoke Non-Structural Vehicle incident; Aerial was sent to public service call |
| Pumper was at Fire/Smoke: Non-Structural: Rubbish incident; Aerial was sent to auto extrication |

**Station 2**
| Number of Incidents: 3 |

2017 **Station 1**
| Number of Incidents: 4 |
| Rescue was at a Fire/Smoke: Non-Structural: Vehicle incident; Pumper was sent to a non-emergency public service call |
| Rescue was at a public service call; Pumper was sent to medical assistance |
| Pumper was at an Electrical: Wiring Overhead call; 2\textsuperscript{nd} Pumper sent to medical assistance |
| Pumper was at Electrical Wires Down incident; Rescue was sent to Electrical Wiring Overhead incident |

**Station 2**
| Number of Incidents: 0 |

There is a possibility that if stations 1 and 2 respond into areas north of Highway 401 that the additional call volume may increase the likelihood of concurrent calls. But in the period 2013–2017 there were between six and nine structural fire incidents each year to which station 4 was first dispatched. In 2017 station 4 was the first responding station to 94 incidents of all types; in 2016, 126; in 2015, 98. In other
words, on average, 8 to 10 times a month. Considering that incident volume at all stations has been trending down from 2013–2017, it is unlikely that several additional responses north of Highway 401 by stations 1 and 2 will have any effect on concurrent call incidences. Additionally, if the Ministry of Health proceeds with the implementation of Medical Priority Dispatch at ambulance communication centres, it’s possible that Belleville Fire and Emergency Services will experience a decline of 20% or more of the current 480 medical and medical assistance calls each year.

In conclusion, we find that if the city restructures response areas as recommended in this report, there is no evidence to support the need to call in backup career staff for coverage if stations 1 or 2 respond to incidents north of Highway 401. In fact, this applies to all urban areas of the city.

### 3.4.5 Relocation of Station 2

Station 2 was commissioned in 1949 and plans should be put in place for its replacement. Exhibit 28, on page 42, demonstrates travel times throughout Belleville if station 2 is relocated northwest of its current location. Another four map plates, depicting the same travel times shown in Exhibit 18 to Exhibit 21, are included in Appendix F, which can be compared to Exhibit 18 to Exhibit 21.

Please note that Exhibit 28 depicts actual on-the-road travel time, which, while similar to Exhibit 18 to Exhibit 21, does not factor in call handling and turnout time. The travelled area is similar, but Exhibit 28 shows about 37 seconds more on-road time.

Relocating station 2 has the following effects:

- initial response (see the 8-minute maps) north of the 401 on Sidney Street is improved, but coverage north of the 401 on Front Street is very slightly reduced;
- first vehicle response is improved to the southwest neighbourhood, but two-vehicle response to south and southeast Belleville, where there is a greater history of structure fires, is reduced by an estimated 60 seconds;
- impact on response north of the 401 and into station 4’s current coverage is marginal compared to station 2’s existing location on Moira Street;
- in either location scenario the demarcation point seems to be approximately 12 minutes after the incident begin time; in other words, station 2 — from either location — can reach within three kilometres south of station 4 in the same time it takes station 4 to respond to that area.

**Recommendation:** Plans to relocate station 2 northwest of the current location should be initiated. Relocating station 2 will maintain or improve coverage into areas of Belleville north of Highway 401 and improve first vehicle response to southwest Belleville. Second vehicle coverage to south and southeast Belleville may take an additional 60 seconds but will still be within standards for second-on-scene apparatus. Efforts to reduce call handling and turnout time may mitigate the additional time for second vehicle arrival into the south and southeast.
Exhibit 28: Travel Time Contours Relocated Station 2

City of Belleville Fire Response
Travel Time Contours
Relocated Fire Station 2

Legend
- New Station 2
- Existing Fire Station
- Road
- Railway
- City Boundary
- WaterFeatures

Travel Time Contour
- 4 Min
- 8 Min
- 10 Min

[Map showing travel time contours for relocated fire station 2 in City of Belleville]
4. Organization and Administration

Section 1.1 of this report outlines the project intent and the elements of the fire and emergency services to be reviewed. They include

- fire administration;
- emergency planning;
- community risk profiles;
- public education;
- fire suppression;
- technical rescue an operations;
- training and professional development; and
- communications.

Some of those areas, such as public education, prevention, and suppression have been addressed earlier in the report. Other areas that have been reported on thus far such as response data analysis, staff levels, and station location have been time-consuming to assess, labour intensive to analyze for various scenarios, and arduous in terms of condensing the information in order to explain the basis for recommendations. That process is not exclusive to Belleville’s project but occurs, to varying degrees, in all projects. The real challenge is to offer substantive comments in areas such as

- fleet and apparatus;
- emergency planning;
- community risk profiles;
- training and professional development;
- communications; and
- job design and responsibility.

In the first instance, with respect to data analysis, staff levels, and station location, we have relatively good data gathering available as a result of the CAD system. As with anything, the CAD data could be improved, but it is generally more than adequate. But record-keeping and detailed information for the six bullets listed above, plus apparatus and equipment, are sparse and inconsistent.

We need to make it abundantly clear that there is no suggestion that the fire service administration team is not doing their job. They are; the team is well liked; everyone we have interviewed clearly indicated that the chief and deputies are engaged and concerned about staff and the fire department, and that there have been general improvements in the fire department in recent years. But there is a dearth of information for decision-making, as outlined below.

Fleet and Apparatus

Very recently the city implemented the WorkTech Asset and Fleet Management program (part of Central Square Technologies). This is a positive step toward better tracking of fleet costs and maintenance requirements. Prior to WorkTech implementation, one of the deputies tracked capital, maintenance, and repair costs in an Excel spreadsheet, and only 2016 and 2017 were available to us (2018 would be available now also). As well, there are no consolidated records prior to 2016, although individual work orders and invoices are available.
Even though WorkTech is now available, the deputy continues to provide tracking and entries to the software program. We suggested that having a deputy perform this administrative function may not be a cost-effective way of maintenance tracking and suggested that it could be accomplished by the confidential administrative person. We were surprised to discover that there isn’t a confidential administrative person to provide support to the chief and deputies.

The fire department administrative position is within the Canadian Union of Public Employees bargaining unit. We recommend it should be outside the bargaining unit. We are patently aware of the reasoning that maintaining confidentiality is a job requirement that does not have to be associated with being an excluded position, and that an individual could be relieved of their employment or reassigned if they do not maintain confidentiality, but in practical application, employing an excluded administrative position contributes significantly to the ease of conducting confidential fire department or city business.

We have discussed individual vehicle questions and issues with fire administration, and the team is very knowledgeable about which vehicles are problematic or need to be replaced. But in terms of vehicle history prior to the implementation of WorkTech, the knowledge is inherent with a few administrative staff rather than system based.

Maintenance and repair are being completed by a third-party garage, and fire administration is very happy with the service being provided. Fire vehicles are technically complicated and fire administration ensures that third-party technicians have Emergency Vehicle Technician certification.

Several trucks should be replaced, or removed from service and not replaced. We have discussed specific apparatus with fire administration, particularly within the context of decommissioning station 4 and redistributing or reducing the fleet and possibly avoiding capital costs of planned replacements.

**Recommendation:** Fire administration should, as soon as possible, transfer fleet record-keeping from the deputy to an excluded administrative person.

**Emergency Management and Planning**

The purpose of emergency planning is to ensure contingencies are in place to accommodate and handle unknown and unexpected events, and to support education and preparedness to ensure people, businesses, industry, and the city can remain safe until authorities are able to mitigate an incident. City departments collaborate with other emergency services to gain the benefit of cumulative experience and knowledge. In addition to city departments, other emergency partners include

- neighbouring emergency services;
- county paramedic services;
- utilities providers such as Ontario Hydro, Union Gas, Veridian Power;
- Department of Transportation and other provincial departments;
- conservation authorities;
- hospitals and other health care agencies; and
- others depending on the nature of an emergency.
In Belleville, the fire chief is the emergency management coordinator and is aided by an emergency management assistant. The role of the emergency management assistant is to work with all city departments and other agencies to ensure plans are made to reduce the impact of major events. Although assigned to the fire department, the emergency management assistant works between and with multiple departments and outside partners.

Our understanding is that the current function and activity works well. We cannot suggest any recommendations.

Community Risk Profile
A community risk assessment is an evaluation of risk level and where risk exists. While that statement sounds obvious and straightforward, it isn’t. The following definitions have to be observed and applied in order to arrive at an accurate risk profile. The risk for one area of a community does not reflect risk for other sectors.

- **Risk assessment**: The process of considering issues such as whether a risk level is high or low, the priority to be awarded to the risk, and whether the level of risk is tolerable or not; it involves a value-for-money assessment, as defined below.
- **Risk**: A reference to the likelihood (frequency) of incidents and their potential outcome (injury and damage). Incidents that are more likely and can cause more injury or damage are high risk.
- **Predominant risk**: Those public safety incidents that pose a significant risk to life and property and on which to base resource planning.
- **Major incidents**: Any emergency that requires the implementation of special arrangements by one or all of the emergency services and that will generally include the involvement, either directly or indirectly, of large numbers of people.
- **Locality**: The area to which fire apparatus from a specific fire station are usually mobilized when incidents occur.
- **Prevention and Education**: The provision of information, publicity, and encouragement in respect of the steps to be taken to prevent fires and accident, death or injury because of fire or accident, and the steps to be taken to detect fires and enable escape, or to avoid injury from other means.
- **Response**: The provision of emergency response resources for the purpose of extinguishing fire, protecting life and property, and rescue, including receiving emergency calls, mobilizing a response, and the equipment and firefighters required at an incident.
- **Resilience**: The capacity of the fire service to sustain an acceptable level of function in the event of an emergency or other major event.
- **Value for money**: The consideration of costs, making the most of money spent, and making sure that services meet the needs of communities and authorities’ priorities.
- **Integrated risk management planning**: The process of determining how prevention, protection, and response activities can be best used to mitigate the impact of risks on communities in a cost-effective way.
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City of Belleville Fire and Emergency Services

We requested a recent community risk assessment, but a copy could not be found. Fire administration suggests the last assessment might have been completed as part of the provincial Municipal Fire Information Survey between 2010 and 2012.

**Recommendation:** A comprehensive municipal risk assessment is not a small task and will occupy 120 to 160 hours once a risk assessment is drafted and submitted to city administration and council. A risk assessment is an important part of preparing the community for adequate response to emergencies and rationalizing resources. The fire service should complete a risk assessment as soon as possible.

**Training and Professional Development**
Training and professional development has challenges similar to those of several other topics in this section with respect to finding documentation. As one of the deputies noted: “Unfortunately, record-keeping has been identified as one of the topics we require some work on.” Administration was able to provide us with firefighter training levels equivalent to NFPA training standards. The Ontario Office of the Fire Marshal and Emergency Management is shifting its training standards to NFPA standards and is granting firefighters in Ontario equivalency as applicable.

We were also told that “rural staff have access to the same training as our urban staff. Qualifications are a little more challenging to define, but the expectations for service delivery are the same.”

There is one training officer for the career component of the combined fire service. Fire administration should assess whether one training officer is adequate for the fire department. Two volunteer training officer positions support the volunteer stations, but more than one training officer may be required to ensure consistent training across the organization. Volunteer firefighters are expected to achieve the same standards and provide the same services as career firefighters and may benefit by having a dedicated full-time training officer. That doesn’t suggest that the current volunteer officers are not capable of continuing the service they have been providing for years, but in times of emergency the public often doesn’t differentiate between volunteers and career firefighters and expects a similar level of service. In addition, it takes a substantial amount of time for volunteer training officers to create and deliver adequate training programs. Consideration should be given to whether a second full-time training officer would be advantageous. Reassigning a fire prevention complement would allow for the creation of a training position without increasing overall staff levels.

**Training Facilities**
The fire service currently has a training facility in buildings once occupied by the Belleville Agricultural Society. Those buildings are scheduled to be demolished to make way for development, which means that the fire service will require other facilities because training — and its frequency — is even more important than it once was.

Most fortunately, the incidence of fires and other emergencies is stabilizing or decreasing across most areas of Canada. Specific to Belleville, the downward trend can be seen in Exhibit 5 to Exhibit 10, starting on page 8. This means that there are fewer events during which firefighters can gain experience. In addition, 24-hour shifts also reduce the number of incidents whereby firefighters gain experience because individual firefighters are on duty only 8 days a month versus 20 if working eight-
hour shifts. And, even though firefighters are present the same number of hours throughout those 8
days of 24-hour shifts, incident occurrence patterns mean that they do not respond to as many fire and
rescue incidents as they would working 20 days a month.

Fewer incidents, and less experience because of 24-hour shifts, means that Belleville Fire and
Emergency Services has to maintain, and perhaps increase, the training regimen to maintain skills and
teamwork, and ensure effectiveness with minimal risk to the public when fire and other serious
incidents occur.

- This underlines the need to ensure adequate and formal training facilities are readily available
to Belleville’s Fire and Emergency Services. Belleville’s Fire and Emergency Services and the city
should move as quickly as possible to find a site to build a training facility, considering the
length of time it will take to commission a facility.

Recommendations:

- Create a formal training curriculum.
- Implement a local or commercial record-keeping system for training programs for both
  volunteer and career firefighters.
  - Our understanding is that training activity can be documented in Belleville Fire and
    Emergency Services’ record management system but that some staff are reluctant to use
    the feature. That feature should be used to ensure accurate tracking of training
    completion.
- Consider a second full-time training position, possibly by reassigning a complement from a
  fire prevention officer’s position, thereby enabling consistent training officer support to both
  the career and volunteer sections of the combined fire service. This does not mean an
  additional position should be put into place to compensate for a reassigned position.
- Although firefighter training requires specific knowledge about firefighting and rescue
  techniques, candidates for the position(s) should also have formal training in adult education
  techniques.
- We are pleased that $200,000 has been allocated to the fire service capital fund for land
  acquisition for a training facility although it was deferred, during city budget discussions, to
  2020. In any event, Belleville Fire and Emergency Services and the city should move as quickly
  as possible to find a site to build a training facility, considering the length of time it will take
  to commission a facility.
Communications
Quantifying communications and associated issues is another challenge, again because of record-keeping.

- Communications officers are probationary firefighters awaiting an opportunity to move to the suppression division:
  - they joined the fire service to be firefighters, not radio operators;
  - aptitudes necessary to be a successful radio operator / communicator are significantly different to those of a firefighter;
  - functioning as a radio operator, especially when dispatching multiple fire agencies, is much more difficult than lay people recognize;
  - the nature of using probationary firefighters as radio operators also means a turnover in that job function — and subsequent new staff members and reduced efficiency — each time a probationary staff member moves to the suppression division.

- Radio operators work a 24-hour shift the same as firefighters, and they are relieved by firefighters for meals and other breaks. Cots are available in the dispatch room for firefighters to rest during quiet times, mostly at night. We are not aware of incidents where radio operators slept through a radio or telephone call.

- The radio operator job function, in addition to receiving emergency calls from the public and dispatching multiple fire department clients, includes answering administrative calls, requests for burn permits, and alarm testing notifications.
  - There are no records of telephone call volumes or distribution available through the fire department or city telephone system management information system. Radio operators were asked to keep a manual count of other than emergency calls for several months, which is shown in Exhibit 29.

Exhibit 29: Non-emergency Telephone Calls Received at Fire Communications Centre

<table>
<thead>
<tr>
<th></th>
<th>Administration</th>
<th>Burn Permit Inquiry</th>
<th>Burn Status</th>
<th>Other Dept General</th>
<th>Alarm Testing</th>
<th>Firefighter/ Private</th>
<th>Fire Prevention</th>
<th>Other (pocket dial)</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>August</td>
<td>31</td>
<td>485</td>
<td>85</td>
<td>111</td>
<td>467</td>
<td>24</td>
<td>52</td>
<td>138</td>
<td>1393</td>
</tr>
<tr>
<td>September</td>
<td>24</td>
<td>422</td>
<td>2</td>
<td>87</td>
<td>457</td>
<td>21</td>
<td>36</td>
<td>142</td>
<td>1191</td>
</tr>
<tr>
<td>October</td>
<td>28</td>
<td>490</td>
<td>25</td>
<td>119</td>
<td>640</td>
<td>24</td>
<td>34</td>
<td>147</td>
<td>1507</td>
</tr>
<tr>
<td>November</td>
<td>18</td>
<td>196</td>
<td>2</td>
<td>111</td>
<td>455</td>
<td>15</td>
<td>29</td>
<td>95</td>
<td>921</td>
</tr>
<tr>
<td>December</td>
<td>24</td>
<td>370</td>
<td>6</td>
<td>98</td>
<td>446</td>
<td>10</td>
<td>32</td>
<td>144</td>
<td>1130</td>
</tr>
</tbody>
</table>

- Non-emergency calls received in the five months indicated in Exhibit 29 translate to over 14,700 annually. Even though we assume that burn permit inquiries may decrease in winter months it is plausible to conclude that approximately 12,000 or more non-emergency calls are received each year. We estimate that to be about 40 a day since most would be received on weekdays, and again we assume that most would be received during business hours.

- We understand that radio operators, when occupied by emergencies, allow administrative calls to go to a message centre or remain unanswered.
The majority of administrative calls could be capably handled by online programs or telephone menus. Similar programs handle applications for building and other permits, and for reporting non-emergency concerns. Many fire departments across Ontario and Canada have moved to online programs.

We’re concerned that radio operators work 24-hour shifts. We understand the attractiveness of a 24-hour shift in that only a few days a month are worked to fulfill the required work hours. While that may be satisfactory for firefighters who can sleep during specific hours when calls aren’t occurring, personal experience causes us to question the ability of dispatchers to become immediately alert from a state of sleep in order to take important details of an emergency call and dispatch responders in a timely manner.

Radio operators should work a shift of no more than 12 hours but we also admit that there is not substantial research directly applicable to radio operators / dispatchers. Studies such as those listed below are mostly applicable to firefighters, but we expect that the findings are valid for all emergency service workers on extended shifts.

- Optimizing fire department operations through work schedule analysis, alternative staffing, and non-productive time reduction: https://apps.dtic.mil/dtic/tr/fulltext/u2/a621444.pdf
- The physical demands upon (Dutch) fire-fighters in relation to the maximum acceptable energetic workload: http://dare.ubvu.vu.nl/bitstream/handle/1871/29230/167794.pdf?sequence=1
- Firefighter Staffing Including Temporary Absences and Wastage: https://ideas.repec.org/a/inm/oropre/v54y2006i2p353-365.html
- The Effects of Sleep Deprivation on Fire Fighters and EMS Responders: https://www.iafc.org/docs/default-source/1safehealthshs/progssleep_sleepdeprivationreport.pdf?sfvrsn=f9e4da0d_2

One of the few ways to determine whether extended shifts by radio operators / dispatchers may be detrimental to both the radio operators and public safety is to observe the communications centre for several 24-hour periods and document activity and awareness. This is a difficult observation to undertake but would assist in clarifying whether extended shifts have an impact on staff, other emergency service clients, and public safety.
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Recommendations:

- Utilize online programs or automatic telephone features to serve routine permit applications such as open air burning or to report non-emergency concerns.
- Evaluate, through observation, whether 24-hour shifts are detrimental to radio operators, clients, and public safety.
- Evaluate the logistics and opportunities to replace probationary firefighters, as they move from dispatch to the suppression division, with civilian professional full-time radio operators / dispatchers.
  - Concurrent with this recommendation, to accommodate circadian rhythm, new hires should work no more than a 12-hour shift.

Job Design and Responsibility
We inquired about job descriptions and objectives for all positions. At this time “job descriptions are in draft and are somewhat under development and have been used recently to frame expectations of persons entering into roles within the fire service.”

Job descriptions are an important part of setting expectations and deliverables. They take substantial time to craft properly so they are clear to incumbents and not subject to substantial interpretation in cases where roles and responsibilities are in dispute.

Recommendation: Job descriptions and expectations for all positions should be drafted as soon as possible and should include critical objectives for fulfilling roles and responsibilities.

4.1 Establishing and Regulating Bylaw
We understand that Belleville’s Establishing and Regulating Bylaw was last updated in April of 2011, almost eight years ago. Communiqué 2017-06 from the Office of the Fire Marshal addresses establishing and regulating bylaws.

The communiqué\(^5\) states

*The administration and governance of a fire department may be guided by an establishing and regulating bylaw, other municipal bylaws, council resolutions, agreements, policies, operating guidelines, and the interaction of the fire department with other municipal services, departments, committees and officials. Through bylaws and resolutions, municipal council has the means to identify the core services of the fire department, and the types and level of fire protection services it provides, based on local needs and circumstances.*

*Please note that, under section 14 of the Municipal Act, 2001, when there is a conflict between a bylaw and a provincial or federal statute or regulation, the latter prevails. An establishing and regulating bylaw is a municipal council document outlining policy for fire departments. It can be used to show how the municipality delivers fire protection services it has determined are necessary according to its needs and circumstances, as is required by the Fire Protection Act.*

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\(^5\)https://www.mscs.jus.gov.on.ca/english/OfficeFireMarshal/FireServiceResources/Communiqu%C3%A9s/201706.html
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and Prevention Act, 1997 (FPPA). An establishing and regulating bylaw can state the type and level of fire protection services provided and may include policy direction in the following areas:

- legislative/regulatory requirements that may affect the delivery of fire protection services (e.g., FPPA, Occupational Health and Safety Act, and Environmental Protection Act);
- Fire Marshal directives;
- best practices (e.g., Ontario Fire Service Section 21 Advisory Committee guidance notes, National Fire Protection Association standards);
- general functions and core services to be delivered;
- goals and objectives of the fire department;
- general responsibilities of fire department personnel;
- organizational structure;
- authority to proceed beyond established response areas;
- authority to apply costs to property owners for fire investigations; and
- authority to effect necessary fire department operations, in consultation with the municipality’s legal resources.

When setting or amending the levels of service in the establishing and regulating bylaw, municipal council, in consultation with the fire chief, should keep in mind the following considerations:

- the current needs and circumstances of the municipality;
- requirements and expectations, such as the following:
  - training requirements based on current standards and practices;
  - acquisition and maintenance of appropriate equipment; and
  - appropriate record keeping.
- the extent of fire department funding necessary to achieve and maintain the stated levels of service.

The OFMEM\(^6\) recommends that municipal councils review their establishing and regulating bylaws annually to ensure the level of services they are providing are in accordance with the current needs and circumstances of their municipality.

Recommendation: The City of Belleville update its Establishing and Enabling Bylaw as soon as possible, observing the content of the Office of the Ontario Fire Marshal’s communiqué referenced here.

4.2 Organization and Administration Conclusions
Belleville Fire and Emergency Services are fulfilling all the requirements of their roles to the extent they can fulfill them, but there aren’t enough people in administration. Internally, Pomax has discussed several organizational options for the fire administration:

1. The status quo. This model assumes that the administration complement is sufficient to

\(^6\) Office of the Fire Marshal and Emergency Management
organize and complete all the tasks required, including the many undertakings laid out in this report.

2. Enhance the organization by adding assistant chiefs, who have true management function and responsibility, with operational responsibility primarily for urban stations so that current administration can concentrate on catching up with existing needs (again, as discussed in this report).

3. Enhance administration by one chief business officer responsible for administration. We envision this position initially as a two-year contract with responsibility for administrative, data, information, and functional organization, thus enabling the chief and deputies to concentrate on maintaining and improving staff and functional relationships, and managing a culture shift (often referred to as a paradigm shift) to focus on prevention and education.

**Recommendation:** We recommend option 3, with the possibility that the following long-term options be considered over the next two years:

1. Continue the chief business officer position as a permanent complement.
2. Discontinue the chief business officer position upon all existing and new tasks being accomplished and the fire department being in an acceptable organizational position.
3. If the chief business officer’s position is discontinued, implement the assistant chiefs’ positions as noted in option 2 above.
4. Return to the status quo if all existing and new tasks are accomplished and the fire department is in an acceptable organizational position.
5. Make all efforts to exempt the administrative assistant’s position from the bargaining unit.

In closing this report, we note that organization, formal documentation, and robust data and information are central to the successful administration of any organization, not just fire departments. From a core functionality perspective, Belleville Fire and Emergency Services hasn’t accomplished those objectives. These aren’t criticisms. The issues were chronic well before the current administration. We are also very confident that the right administrative team is in place, but it has an onerous amount of organizational and administrative work to catch up on, and there should be no expectation that it can be accomplished without assistance as we have recommended.

**Future Strategy:**
There are other subject areas that should be considered as strategic plan content but that are still core to the operation and continuation of a fire and emergency services program.

**Dedicated Information Technology Support**
The intent of Belleville Fire and Emergency Services is to take on a greater number of fire dispatch clients. The department will need information technology support to accomplish that, particularly in areas of radio replacement, Next Generation 9-1-1 development, network support, record management systems, and CAD, and to coordinate technology with other city departments.
Continuous Improvement Program
The department has several challenges, and it may seem premature to suggest the implementation of a continuous improvement program, but it is essential to ensure that staff members maintain and improve their operational and administrative skills. This is envisioned as a future strategic initiative within the next 12 to 24 months.

Succession Planning
Succession planning is a process for identifying and mentoring future fire service leaders. While it is most often thought to apply to executive-level fire department staff, it can also be successful in promoting culture and change within future leaders at the operational level.

Belleville Fire and Emergency Services does not have a formal succession plan, but we encourage the implementation of one within the next 12 to 18 months.

Protective Services Advisory Committee
We notice that there are a number of departmental advisory committees within the city’s organization such as the planning advisory committee, transit advisory committee, and others. Our experience is that most fire services that we have had as clients work through an advisory committee composed of council and public representatives. Indications from these clients are that process and changes are expedited when an advisory committee is in place rather than bringing all issues directly to council. Further, it is reported that council time is sometimes avoided since some matters are brought from the advisory committee to council as recommendations within resolutions.

Recommendation: The city should strongly consider implementing a Protective Services (fire) Advisory Committee.
Appendix A: Fire Stations
Station 1
60 Bettes Street, Belleville

Station 2
72 Moira Street West, Belleville
Station 3
4867 Old Highway #2, Thurlow

Station 4
516 Harmony Road, Corbeyville
Station 5
30 Hoskin Road, Plainfield
Appendix B: Emergency Incident Heat Map
Appendix C: Structure Fire Locations 2013–2017
CITY OF BELLEVILLE FIRE RESPONSE
2017 Structure Fire Events

Legend
- 2017 Structure Fire
- Firehall
- Road
- Railway
- City Boundary
- WaterFeatures

Kilometers
CITY OF BELLEVILLE FIRE RESPONSE
2013 Structure Fire Events

Legend
- Firehall
- 2013 Structure Fire
- Road
- Railway
- City Boundary
- WaterFeatures

Kilometers
0.51 2 3
Appendix D: Fire Rescue Articles
How 'fire porn' hurts the fire service

Until prevention becomes as much of a turn on as fire porn, we will not fulfill our mission to protect lives and property, July 20, 2014

By: Billy D. Hayes

Do you prefer prevention or porn?

For the record, I’m not talking about the kind of porn that will get you fired if you watch it at work. I’m referencing "fire porn."

You know, the exciting stuff you see on the cover of almost every fire service trade publication, YouTube, and most fire and emergency services websites: structures on fire, helmets melting, gear smoking, lots of destruction.

Let’s face it, it sells.

This was recently confirmed by a friend who’s an editor of one of those publications; he said that he would gladly replace those photos with prevention images if I can assure him that he won't lose subscribers.

To his defense, we all know that if we start replacing fire porn with photos of firefighters installing smoke alarms or car seats, conducting pre-fire plans or company inspections, or even teaching a CPR class, the fire service would go into shock.

I mean really, who wants to watch a video about how to conduct risk assessment in their local communities? Boring!

We know we would rather watch a dash cam or amateur video of a structure fire and debate strategy and tactics and talk about how that department should have been more aggressive.

The paradox

A paradox is a statement that contains conflicting ideas or concepts. It's similar to having a policy to have only the best gear money can buy, but showing up with only enough cash for what’s on sale.

"To protect lives and property" is a paradox in the fire service. Our words say one thing, but our actions say otherwise.

Most in the fire service believe that only occurs when dispatched at the point where lives and property are being or are already lost. It’s a culture that has evolved for decades. Ah, the good old "culture" word. How did that happen?

Culture evolves when values and behaviors become the situational norm. When uninterrupted, those norms have validation from where the values came from.

This is the process, or cycle, of cultural development. In other words, if nothing changes, we can plan on hearing, "It's always been done this way."
Marketing the job
So here we are at the crossroads. Can we break this cycle? Can we change the culture of embracing our mission? Can we change behaviors and values to prevent the paradox from occurring?

As I was attending the National Volunteer Fire Council conference in South Carolina, I saw the paradox in action. While grabbing dinner, I ran into a young man covered in fire tattoos and sporting an FDNY T-shirt.

I simply asked him if he was in the brotherhood and where he worked. He was a volunteer who had just recently relocated from Pennsylvania and was looking for a career position in the Myrtle Beach area.

We chatted for a few minutes, and he told me of his volunteer companies in Pennsylvania and how his department was used for mutual aid because they were very aggressive. I asked if he had paid any attention to the NIST studies on thermal attack.

The young man said no. So, I dug a little deeper and asked if he has ever read the book "Fire Command" by Chief Brunacini. He replied with, "Who?"

I also asked if he had read either one of the "America Burning" publications. "No."

So, I wished him well in his endeavors, gave him my card and headed back to my hotel.

The old guard
It rang clear to me that this talented young man may be headed for the paradox like so many others in our profession. Visions of sugarplums dancing in our heads have been replaced with the grandeur of flames through the roof or pushing out the windows, making an aggressive interior attack, or dragging a victim out.

I know, there are those who say that's what we get paid to do. I've seen and heard it said by some of the "fire porn stars" that the fire service only exists for suppression.

I've even had an operations chief tell me that we get paid to die for property just like we do for people.

I do not believe that to be true.

There is a time and place for that. We need to be tactically trained and prepared to do that as needed and when called upon.

We need the bravery to carrying on the tradition of saving lives, as so many before us who didn't have the luxury of the resources and technology we have today.

Action items
But, if we say we that our motto is to protect lives and property, then we need to embrace that from the prevention standpoint, make it a priority and find a way to make it sexy.

The fire service leadership needs to step up. It needs to happen at the U.S. Fire Administration, the International Association of Fire Chiefs, the International Association of Fire Fighters, and in every state and local fire service organization.

That also means changing the fire porn we watch. Slowly, we need to begin assimilating our fire service members by adding more community risk reduction and prevention presentations to conference shows;
by adding more columns, articles, and photos to our trade publications; and by training new members that preventing the incident from occurring is our foremost mission — that we respond when failure in prevention has occurred.

We need those in the fire service to be "turned on" by prevention.

**The other paradox**

Another component of this paradox is we have to get water on it as quickly as we can, and I agree. Don't fire sprinklers help accomplish that?

Yet, the fire service has not fully embraced residential fire sprinklers. So where does the "protect lives and property" play into this?

In fact, we have even allowed the public to play into the paradox because we haven't invested time to educate them to the importance of residential fire sprinklers. Hence, we find the public, in many cases, are in opposition and aligned with the home-builders' associations.

Although the total number of fires are decreasing, those we have are burning differently due to construction and contents. And, we have many other things we respond to.

**It's not sexy**

We should address injury prevention, health-related issues, environmental issues that we are the first to arrive, and so much more. But our attention in prevention seemingly only applies to fire, which I understand is low frequency but high risk.

I know that I will draw criticism from this column. It's not popular, it's not sexy, and it goes against what so many joined our profession to do because of the way we have marketed the job.

Please don't misinterpret my message. I support suppression. But shouldn't that suppression begin through prevention and not just when destruction is under way?

How long can we exist in the paradox and how can we transition from "fire porn stars" to "fire and injury prevention stars?"

The bigger question is why do we have to choose? Why can't we be both?

Be safe.

**About the author**

Billy D. Hayes served as the chief program officer for the National Center Fire and Life Safety. He has served as vice president of university relations for Columbia Southern University, director of public information and community affairs for the District of Columbia Fire and EMS Department, chief of fire services for Riverdale, Ga., and is a past-president of the Metro Atlanta Fire Chiefs Association. He is a graduate of Georgia Military College, Columbia Southern University and the National Fire Academy's Executive Fire Officer Program. He served as the advocate program manager for the Everyone Goes Home campaign through the National Fallen Firefighters Foundation and is a FireRescue1/Fire Chief Editorial Advisory Board member. He can be contacted at Billy.Hayes@firerescue1.com.
Interview: How I cut civilian deaths without spending more money

Former Louisville Fire Chief Russ Sanders discusses how he brought the city back from the brink of being the worst for civilian fire fatalities — under budget.

May 12, 2014

By Rick Markley

When Russ Sanders took over as fire chief in Louisville, it had one of the highest rates per capita of civilian fire deaths in the United States. Nine years later, civilian fire deaths were down 30 percent, fire injuries were down 50 percent and property loss was down $1.5 million.

Chief Sanders retired from the fire department in 1995 and now serves as NFPA's central regional director and executive secretary for the Metro Fire Chiefs Association and has co-authored two structural firefighting textbooks.

There are concise, proven steps that will reduce the number of multiple-fatality fires, many of those victims being children

According to the U.S. Fire Administration, annually from 2009 to 2011, an estimated 2,495 civilian fire fatalities resulted from 1,600 fatal fires in residential buildings. When civilian fatalities were averaged across all residential fires, the overall fatality rate was nearly 6 civilian fatalities per 1,000 residential fires.

How Chief Sanders reversed Louisville's grim civilian death trend is something many fire chiefs can replicate today. I talked with him about that program.

Was there a particular civilian death that set this plan in motion?

It was probably more than one, but I remember carrying twins out on Mother's Day — both of them dead and their feet were actually burned off. I didn't have any guilt. I knew we did everything we were trained to do and everything we could have possibly done.

We had just over 600 firefighters and I went to every single company on every shift and sat down face-to-face and said 'our mission has not changed, but we've been going about it all wrong and that's going to change.'

We had programs to conduct home inspections and install smoke alarms in the early '80s. So it wasn't like we were doing nothing. The problem was known. I went to the radical point of saying that from this day forward success is through education.

If you go on a home inspection and find a smoke alarm without a battery, you failed to educate that homeowner. Your biggest indication of failure is when you are rolling out the door with lights flashing and sirens blaring responding to a fire that should have been prevented.

What obstacles did you have early on?

When I took over the department, we tracked our efforts by how many feet of hose we laid and how many feet of ladder we raised. It is good information to know, but it becomes your goal — it was bragging stuff.
Comprehensive Core Services Review
City of Belleville Fire and Emergency Services

When I came in with this radical approach, I had a lot of people leave. The department had gone to a state pension plan and it allowed a lot of people to retire. Almost 100 people retired at one time.

I remember them doing interviews with the media saying they didn't come here to be a school teacher or hold old ladies' hands. I wished them the best, but it was time for them to leave.

I had an opportunity to bring in 100 new people and didn't have to teach old dogs new tricks.

From day one in recruit school they had to develop lesson plans and put on programs.

We had a lot of high-rise buildings with elderly and low-income residents with no sprinklers; [sprinkler retrofitting] was one of the big success stories.

Part of the problem was an aggressive misinformation campaign. I remember walking out of a high-rise sprinkler meeting with police escort ... because an association had slid flyers under everybody's doors with all this misinformation that we were going to put them out in the street.

**What did your plan to reduce civilian deaths look like?**
We told the firefighters it was going to be their responsibility to figure out the problems in their particular response district. We gave them every tool we could, but it was their responsibility to create the programs that solve those problems.

For example, it was clear that unsprinkled high-rise, low-income buildings were death traps.

We went through SWOT (strength, weakness, opportunity, threat) and PEST (political, economic, social, technology) process. We would look at each issue to see if there was a political, economic, social or technological solution.

The SWOT process was the foundation for building the budget. The budget for the department started at the company level. They would have to go through justifying the programs and the cost. It was really a beautiful thing.

**Can you give an example?**
One of the solutions from these processes was a high-rise retrofit. Louisville was one of the first cities to pass a sprinkler retrofit ordinance. We built an entire plan working with the downtown companies and got political support.

We declared those buildings an eminent hazard. NFPA 1 is the only regulation that requires all high-rises be retrofitted with sprinklers and the language in it is from the Louisville ordinance.

Every high-rise in Louisville is now sprinklered and we haven't had a fire death in one since.

**Why do you think this plan worked?**
The reason it was so successful was [firefighters] had ownership in that program. If I would have said, "we're going to have a high-rise retro-fit program and this is how we're going to do it," it probably wouldn't have been successful.

The retro-fit program was more mine because of the high-profile problems, but the community-service programs I had zero to do with them.
Today there is a big debate about photoelectric and ionization smoke alarms. It's clear from the research that both have pros and cons, but some people today discount the ionization technology as being useless or even dangerous. I believe photoelectric is the better choice, but every smoke alarm we installed was ionization, and a big percentage of that 30 percent fatality decrease was because of all the smoke alarms we installed.

The policy to actually install, rather than simply distribute, smoke alarms came from the company level. I'll never forget it. We had Truck Four responded to a fire on July 4, 1989; six kids died in the house and a smoke alarm we provided was sitting on the coffee table and had never been installed.

That was easy for Truck Four to say no longer were they going to give smoke alarms out; they were going to install them. That grew department-wide. We went to every single door and installed smoke alarms.

**What did the plan cost?**
At the end of the day, my budget was going down because we were throwing a hell of a lot more money at programs that weren't working.

We reduced spending by an annual average of $382,000. While the city's budget increased by more than 42 percent during this time, which was a nine-year period, our budget had only increased by 29 percent.

We were wasting a lot of money on programs that just weren't working. And we didn't really do any evaluation. If a program had always been in place, we just kept doing it.

The way it works in city government, if you take a program off the table you may never get that money back — even if you know there's a better way to do it. I was lucky because I had a mayor who bought into what we were doing hook, line and sinker. He was a big-time champion of the fire department.

**Was there a reduction in operating expenses with the drop in deaths and injuries?**
I don't know that we ever did that conscious calculation. We were probably putting more wear and tear on the apparatus on home inspections and pre-incident planning.

The pub-ed side probably did not save money as much as it saved lives, injuries and property. It reduced fire, so there's no question it saved the community money. But if you are talking about my particular budget, I don't think it played much of a role.

But, the fewer fires you make the fewer firefighters are going to get injured.

**What can volunteer departments do to make a difference?**
In the smaller departments it would be easier without all the bureaucracy. The bottom line is: if you want to have success, you must create ownership at the lowest level where the rubber hits the road. It is really that simple.

If you've got people in a rural department, get out there and discover where are the problems, the threats. Maybe you have to help them a little with teaching them how to do brainstorming and clearly define what a problem is.
Comprehensive Core Services Review
City of Belleville Fire and Emergency Services

Why fire prevention is a core fire service function
The fire service can reduce civilian fire deaths by shifting its attitude, data collection practice and funding priorities, Aug 25, 2016

By: Billy D. Hayes

Dubious honor
For the last several years, Alabama has been among the top in civilian fire deaths — something that no state should desire to be at the top of the list in. Residents of Alabama have a greater risk of dying in fires than those in most other states.

According to the U.S. Fire Administration, Alabama ranks third for deadly fires per capita only behind the District of Columbia and Mississippi.

Like most states, the very poor, the very old and the very young suffer the most. And like most other states, unattended cooking, careless use of smoking products, space heaters and extension cords as well as unsafe storage of combustibles are the leading causes of fires that kill Alabama residents.

While that is bad news, Alabama has answered the call with championship focus and determination. The charge was, and still is, being led by Chief Martin and our recently retired State Fire Marshal Ed Paulk (Fire Chief A.J. Martin of the Tuscaloosa Fire and Rescue Department was named Alabama Career Fire Chief of the Year, Southeastern Career Fire Chief of the Year and International Career Fire Chief of the Year all in the same year).

I recently sat down with Chief Martin while attending the very first Alabama Fire Safety Summit hosted by the National Fire Protection Association at the Alabama Fire College to talk about the Turn Your Attention to Fire Prevention campaign.

The campaign is endorsed by the Alabama Fire Marshal's Office, Alabama Fire Marshal Association, Southeastern Association of Fire Chiefs and the fire chiefs' associations of Florida, Georgia, Kentucky, Mississippi, Tennessee and West Virginia.

In the beginning
In 2014, after reviewing the statistics for the previous years, State Fire Marshal Paulk reached out to the Alabama Association of Fire Chiefs for help finding an intervention for this civilian fire death epidemic plaguing the state.

Chief Martin invited key state fire service leaders to a meeting with the directive that invitees not send a representative but attend in person. All who were invited attended. The outcome was to embrace fire prevention as a core service.

Those who know me know this struck a chord in my heart. I have written, presented and advocated nationally that we fail to meet our mission of protecting lives and property because we are a predominantly reactive service.

I get it. Fire prevention isn’t sexy or exciting. But I guarantee that we save more lives through prevention than we do through suppression, we just don't know about it.
That does not take away from the need for suppression. When it's time, we roll. And when we roll, we see it on the news, Internet or magazines and that leads to the current culture of what most believe the fire service is about, and it's not prevention.

But if it doesn't happen because it's prevented, then we never know about it. That makes it hard for us to rally around and carry a prevention banner because we only get called for the bad stuff. So that leads to one of the problems — reporting. And the public is partly to blame.

Data mining
But let's face it, our reporting leaves a lot to be desired. My last column "Why Fire Service Data Matters" addressed our shortcomings in data collection and application, as well as its importance.

While we know fire investigation is a tricky and difficult process, we also know that we can be guilty of putting junk data in, which results in getting junk data out. Many of the fatal fire causes are either undetermined or under investigation, and seldom change.

In many cases, "undetermined" is legitimate. But we also know that we can be lazy when completing some of our reports. And it's not just that.

Often, we lack the training or personnel to conduct a thorough investigation, thus relying upon outside agencies such as the state fire marshal, ATF and even the private sector. Often, by time the findings are complete, the urgency of prevention has missed its branding, awareness and market time.

A component of education is to encourage the public to communicate with us when an event occurred even if we weren't dispatched.

- What if we knew about smoke alarm activations that alerted a family?
- What if we knew about fire extinguisher use for incidents that we weren't called for?
- What if we knew about grease fires that were extinguished in the home without us knowing?

A matter of priority
Many of the things that we teach, that we could measure our success and include in our data, we know nothing about because the public is either scared to let us know or have never been told that we want to know about it.

The federal government has put a lot of money, time and effort into Zika awareness and control. At the time of this writing, I can only find where one individual has died from Zika in the U.S.

So far this year, we are at nearly 1,400 civilian fire fatalities in the U.S. and 50 here in Alabama. Every year we see similar numbers.

It's time for the fire service to call this an epidemic and demand more funding for our U.S. Fire Administration to help us cure the epidemic.

I could go on and on about all of the reasons and concerns, but let's focus on the mission of the Turn Your Attention to Fire Prevention campaign — that is to erase fire deaths in Alabama.

But the underlying goal is to help change the focus and culture of the state's fire service to embrace that preventing the fire from occurring is the core of our existence.

About the author
Billy D. Hayes served as the chief program officer for the National Center Fire and Life Safety. He has served as vice president of university relations for Columbia Southern University, director of public information and community affairs for the District of Columbia Fire and EMS Department, chief of fire services for Riverdale, Ga., and is a past-president of the Metro Atlanta Fire Chiefs Association. He is a graduate of Georgia Military College, Columbia Southern University and the National Fire Academy's Executive Fire Officer Program. He served as the advocate program manager for the Everyone Goes Home campaign through the National Fallen Firefighters Foundation and is a FireRescue1/Fire Chief Editorial Advisory Board member. He can be contacted at Billy.Hayes@firerescue1.com.
Appendix E: NIST Report on Residential Fireground Experiments Summary
Report on Residential Fireground Field Experiments

NIST Technical Note 1661

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Edited by Bill Robinson

U.S. Department of Commerce
Gary Locke, Secretary

National Institute of Standards and Technology
Patrick D. Gallagher, Director

April 2010
Service expectations placed on the fire service, including Emergency Medical Services (EMS), response to natural disasters, hazardous materials incidents, and acts of terrorism, have steadily increased. However, local decision-makers are challenged to balance these community service expectations with finite resources without a solid technical foundation for evaluating the impact of staffing and deployment decisions on the safety of the public and firefighters.

For the first time, this study investigates the effect of varying crew size, first apparatus arrival time, and response time on firefighter safety, overall task completion, and interior residential tenability using realistic residential fires. This study is also unique because of the array of stakeholders and the caliber of technical experts involved. Additionally, the structure used in the field experiments included customized instrumentation; all related industry standards were followed; and robust research methods were used. The results and conclusions will directly inform the NPFA 1710 Technical Committee, who is responsible for developing consensus industry deployment standards.

This report presents the results of more than 60 laboratory and residential fireground experiments designed to quantify the effects of various fire department deployment configurations on the most common type of fire — a low hazard residential structure fire. For the fireground experiments, a 2,000 sq ft (186 m²), two-story residential structure was designed and built at the Montgomery County Public Safety Training Academy in Rockville, MD. Fire crews from Montgomery County, MD and Fairfax County, VA were deployed in response to live fires within this facility. In addition to systematically controlling for the arrival times of the first and subsequent fire apparatus, crew size was varied to consider two-, three-, four-, and five-person staffing. Each deployment performed a series of 22 tasks that were timed, while the thermal and toxic environment inside the structure was measured. Additional experiments with larger fuel loads as well as fire modeling produced additional insight. Report results quantify the effectiveness of crew size, first-due engine arrival time, and apparatus arrival stagger on the duration and time to completion of the key 22 fireground tasks and the effect on occupant and firefighter safety.
Executive Summary

Both the increasing demands on the fire service - such as the growing number of Emergency Medical Services (EMS) responses, challenges from natural disasters, hazardous materials incidents, and acts of terrorism — and previous research point to the need for scientifically based studies of the effect of different crew sizes and firefighter arrival times on the effectiveness of the fire service to protect lives and property. To meet this need, a research partnership of the Commission on Fire Accreditation International (CFAI), International Association of Fire Chiefs (IAFC), International Association of Firefighters (IAFF), National Institute of Standards and Technology (NIST), and Worcester Polytechnic Institute (WPI) was formed to conduct a multiphase study of the deployment of resources as it affects firefighter and occupant safety. Starting in FY 2005, funding was provided through the Department of Homeland Security (DHS) / Federal Emergency Management Agency (FEMA) Grant Program Directorate for Assistance to Firefighters Grant Program — Fire Prevention and Safety Grants. In addition to the low-hazard residential fireground experiments described in this report, the multiple phases of the overall research effort include development of a conceptual model for community risk assessment and deployment of resources, implementation of a generalizable department incident survey, and delivery of a software tool to quantify the effects of deployment decisions on resultant firefighter and civilian injuries and on property losses.

The first phase of the project was an extensive survey of more than 400 career and combination (both career and volunteer) fire departments in the United States with the objective of optimizing a fire service leader’s capability to deploy resources to prevent or mitigate adverse events that occur in risk- and hazard-filled environments. The results of this survey are not documented in this report, which is limited to the experimental phase of the project. The survey results will constitute significant input into the development of a future software tool to quantify the effects of community risks and associated deployment decisions on resultant firefighter and civilian injuries and property losses.

The following research questions guided the experimental design of the low-hazard residential fireground experiments documented in this report:

1. How do crew size and stagger affect overall start-to-completion response timing?

2. How do crew size and stagger affect the timings of task initiation, task duration, and task completion for each of the 22 critical fireground tasks?

3. How does crew size affect elapsed times to achieve three critical events that are known to change fire behavior or tenability within the structure:
   a. Entry into structure?
   b. Water on fire?
   c. Ventilation through windows (three upstairs and one back downstairs window and the burn room window).

4. How does the elapsed time to achieve the national standard of assembling 15 firefighters at the scene vary between crew sizes of four and five?

In order to address the primary research questions, the research was divided into four distinct, yet interconnected parts:

- **Part 1 — Laboratory experiments to design appropriate fuel load**
- **Part 2 — Experiments to measure the time for various crew sizes and apparatus stagger (interval between arrival of various apparatus) to accomplish key tasks in rescuing occupants, extinguishing a fire, and protecting property**
- **Part 3 — Additional experiments with enhanced fuel load that prohibited firefighter entry into the burn prop - a building constructed for the fire experiments**
- **Part 4 — Fire modeling to correlate time-to-task completion by crew size and stagger to the increase in toxicity of the atmosphere in the burn prop for a range of fire growth rates.**

The experiments were conducted in a burn prop designed to simulate a low-hazard fire in a residential structure described as typical in NFPA 1710® Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments. NFPA 1710 is the consensus standard for career firefighter deployment, including requirements for fire department arrival time, staffing levels, and fireground responsibilities.

Limitations of the study include firefighters’ advance knowledge of the burn prop, invariable number of apparatus, and lack of experiments in elevated outdoor temperatures or at night. Further, the applicability of the conclusions from this report to commercial structure fires, high-rise fires, outside fires, terrorism/natural disaster response, HAZMAT or other technical responses has not been assessed and should not be extrapolated from this report.

**Primary Findings**

Of the 22 fireground tasks measured during the experiments, results indicated that the following factors had the most significant impact on the success of fire fighting operations. All differential outcomes described below are statistically significant at the 95 % confidence level or better.

**Overall Scene Time:**

The four-person crews operating on a low-hazard structure fire completed all the tasks on the fireground (on average) seven minutes faster — nearly 30 % — than the two-person crews. The four-person crews completed the same number of fireground tasks (on average) 5.1 minutes faster — nearly 25 % — than the three-person crews. On the low-hazard residential structure fire, adding a fifth person to the crews did not decrease overall fireground task times. However, it should be noted that the

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1 A low-hazard occupancy is defined in the NFPA Handbook as a one-, two-, or three-family dwelling and some small businesses. Medium hazards occupancies include apartments, offices, mercantile and industrial occupancies not normally requiring extensive rescue or firefighting forces. High-hazard occupancies include schools, hospitals, nursing homes, explosive plants, refineries, high-rise buildings, and other highlife hazard or large fire potential occupancies.
benefit of five-person crews has been documented in other evaluations to be significant for medium- and high-hazard structures, particularly in urban settings, and is recognized in industry standards.²

Time to Water on Fire:
There was a 10% difference in the “water on fire” time between the two- and three-person crews. There was an additional 6% difference in the “water on fire” time between the three- and four-person crews. (i.e., four-person crews put water on the fire 16% faster than two-person crews). There was an additional 6% difference in the “water on fire” time between the four- and five-person crews (i.e. five-person crews put water on the fire 22% faster than two-person crews).

Ground Ladders and Ventilation:
The four-person crews operating on a low-hazard structure fire completed laddering and ventilation (for life safety and rescue) 30% faster than the two-person crews and 25% faster than the three-person crews.

Primary Search:
The three-person crews started and completed a primary search and rescue 25% faster than the two-person crews. The four- and five-person crews started and completed a primary search 6% faster than the three-person crews and 30% faster than the two-person crew. A 10% difference was equivalent to just over one minute.

Hose Stretch Time:
In comparing four-and-five-person crews to two-and three-person crews collectively, the time difference to stretch a line was 76 seconds. In conducting more specific analysis comparing all crew sizes to the two-person crews the differences are more distinct. Two-person crews took 57 seconds longer than three-person crews to stretch a line. Two-person crews took 87 seconds longer than four-person crews to complete the same tasks. Finally, the most notable comparison was between two-person crews and five-person crews — more than 2 minutes (122 seconds) difference in task completion time.

Industry Standard Achieved:
As defined by NFPA 1710, the “industry standard achieved” time started from the first engine arrival at the hydrant and ended when 15 firefighters were assembled on scene.¹ An effective response force was assembled by the five-person crews three minutes faster than the four-person crews. Based on the study protocols, modeled after a typical fire department apparatus deployment strategy, the total number of firefighters on scene in the two- and three-person crew scenarios never equaled 15 and therefore the two- and three-person crews were unable to assemble enough personnel to meet this standard.

Occupant Rescue:
Three different “standard” fires were simulated using the Fire Dynamics Simulator (FDS) model. Characterized in the Handbook of the Society of Fire Protection Engineers as slow-, medium-, and fast-growth rate⁴, the fires grew exponentially with time. The rescue scenario was based on a non-ambulatory occupant in an upstairs bedroom with the bedroom door open. Independent of fire size, there was a significant difference between the toxicity, expressed as fractional effective dose (FED), for occupants at the time of rescue depending on arrival times for all crew sizes. Occupants rescued by early-arriving crews had less exposure to combustion products than occupants rescued by late-arriving crews. The fire modeling showed clearly that two-person crews cannot complete essential fireground tasks in time to rescue occupants without subjecting them to an increasingly toxic atmosphere. For a slow-growth rate fire with two-person crews, the FED was approaching the level at which sensitive populations, such as children and the elderly are threatened. For a medium-growth rate fire with two-person crews, the FED was far above that threshold and approached the level affecting the general population. For a fast-growth rate fire with two-person crews, the FED was well above the median level at which 50% of the general population would be incapacitated. LARGER crews responding to slow-growth rate fires can rescue most occupants prior to incapacitation along with early-arriving larger crews responding to medium-growth rate fires. The result for late-arriving (two minutes later than early-arriving) larger crews may result in a threat to sensitive populations for medium-growth rate fires. Statistical averages should not, however, mask the fact that there is no FED level so low that every occupant in every situation is safe.

Conclusion:
More than 60 full-scale fire experiments were conducted to determine the impact of crew size, first-due engine arrival time, and subsequent apparatus arrival times on firefighter safety and effectiveness at a low-hazard residential structure fire. This report quantifies the effects of changes to staffing and arrival times for residential firefighting operations. While resource deployment is addressed in the context of a single structure type and risk level, it is recognized that public policy decisions regarding the cost-benefit of specific deployment decisions are a function of many other factors including geography, local risks and hazards, available resources, as well as community expectations. This report does not specifically address these other factors.

The results of these field experiments contribute significant knowledge to the fire service industry. First, the results provide a quantitative basis for the effectiveness of four-person crews for low-hazard response in NFPA 1710. The results also provide valid measures of total effective response force assembly on scene for fireground operations, as well as the expected performance time-to-critical-task measures for low-hazard structure fires. Additionally, the results provide tenability measures associated with a range of modeled fires.

Future research should extend the findings of this report in order to quantify the effects of crew size and apparatus arrival times for moderate- and high-hazard events, such as fires in high-rise buildings, commercial properties, certain factories, or warehouse facilities, responses to large-scale non-fire incidents, or technical rescue operations.

² NFPA Standard 1710 - A.5.2.4.2.1 ... Other occupancies and structures in the community that present greater hazards should be addressed by additional fire fighter functions and additional responding personnel on the initial full alarm assignment.
⁴ As defined in the handbook, a fast fire grows exponentially to 1.0 MW in 150 seconds. A medium fire grows exponentially to 1 MW in 300 seconds. A slow fire grows exponentially to 1 MW in 600 seconds. A 1 MW fire can be thought-of as a typical upholstered chair burning at its peak. A large sofa might be 2 to 3 MWs.
The fire service in the United States has a deservedly proud tradition of service to community and country dating back hundreds of years. As technology advances and the scope of service grows (e.g., more EMS obligations and growing response to natural disasters, hazardous materials incidents, and acts of terrorism), the fire service remains committed to a core mission of protecting lives and property from the effects of fire.

Firefighting is a dangerous business with substantial financial implications. In 2007, U.S. municipal fire departments responded to an estimated 1,557,500 fires. These fires killed 3,430 civilians (non-firefighters) and contributed to 17,675 reported civilian fire injuries. Direct property damage was estimated at $14.6 billion dollars (Karter, 2008). In spite of the vigorous nationwide efforts to promote firefighter safety, the number of firefighter deaths has consistently remained tragically high. In both 2007 and 2008, the U.S. Fire Administration reported 118 firefighter fatalities (USFA 2008).

Although not all firefighter deaths occur on the fireground — accidents in vehicles and training fatalities add to the numbers — every statistical analysis of the fire problem in the United States identifies residential structure fires as a key component in firefighter and civilian deaths, as well as direct property loss. Consequently, community planners and decision-makers need tools for optimally aligning resources with the service commitments needed for adequate protection of citizens.

Background
Despite the magnitude of the fire problem in the United States, there are no scientifically based tools available to community and fire service leaders to assess the effects of prevention, fixed sprinkler systems, fire fighting equipment, or deployment and staffing decisions. Presently, community and fire service leaders have a qualitative understanding of the effect of certain resource allocation decisions. For example, a decision to double the number of firehouses, apparatus, and firefighters would likely result in a decrease in community fire losses, while cutting the number of firehouses, apparatus, and firefighters would likely yield an increase in the community fire losses, both human and property. However, decision-makers lack a sound basis for quantifying the total impact of enhanced fire resources on the number of firefighter and civilian lives saved and injuries prevented.

Studies on adequate deployment of resources are needed to enable fire departments, cities, counties, and fire districts to design an acceptable level of resource deployment based upon community risks and service provision commitment. These studies will assist with strategic planning and municipal and state budget processes. Additionally, as resource studies refine data collection methods and measures, both subsequent research and improvements to resource deployment models will have a sound scientific basis.
Appendix F: Relocated Station 2 Response Area
CITY OF BELLEVILLE FIRE RESPONSE
8-Minute Response Time
(Travel Time: 3'23" Urban, 0'0" Rural)
Station 4 Decommissioned & Station 2 Relocated

Legend
- Fire Station
- Relocated Station 2

Travel Time Contour
- Fire Station 1
- Fire Station 3
- Fire Station 5
- Relocated Fire Station 2
- Road
- Railway
- City Boundary
- WaterFeatures
CITY OF BELLEVILLE FIRE RESPONSE 10-Minute Response Time
(Travel Time: 5'23" Urban, 0'28" Rural)
Station 4 Decommissioned & Station 2 Relocated

Legend
- Fire Station
- Relocated Station 2
- Road
- Railway

Travel Time Contour
- Fire Station 1
- Relocated Fire Station 2
- Fire Station 3
- Fire Station 5
- City Boundary
- WaterFeatures
CITY OF BELLEVILLE FIRE RESPONSE 12-Minute Response Time
(Travel Time: 7'23" Urban, 2'28" Rural)
Station 4 Decommissioned & Station 2 Relocated

Legend
- Fire Station
- Relocated Station 2
- Road
- Railway

Travel Time Contour
- Fire Station 1
- Relocated Fire Station 2
- Fire Station 3
- Fire Station 5
- City Boundary
- WaterFeatures
CITY OF BELLEVILLE FIRE RESPONSE 14-Minute Response Time
(Travel Time: 9'23" Urban, 4'28" Rural)
Station 4 Decommissioned & Station 2 Relocated

Legend
- Fire Station
- Relocated Station 2
- Road
- Railway

Travel Time Contour
- Fire Station 1
- Relocated Fire Station 2
- Fire Station 3
- Fire Station 5
- City Boundary
- Water Features