Medicine Hat
The Gas City

MEDICINE HAT FIRE SERVICE

RESPONSE COVERAGE OPTIMIZATION

December 2012

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Executive Summary

Report Development

This report has been developed to provide analysis and recommendations which may lead to amendment of the Fire Service Strategic Plan (FSSP), conditionally approved by Council in July of 2010.

Since the adoption of the FSSP in 2010, Fire Services has been involved in numerous technological installations and upgrades as well as initiating changes in dispatch processes to improve response times and service to residents.

In March of 2012, the Commissioner of Public Services directed Fire Services Administration to review available technology and processes and subsequently provide a report on the findings which would possibly amend the FSSP. Direction provided indicated that proposed amendments would not include a change in staffing levels or an increase in the number of response stations, but could include relocation of any existing fire station and a change to current response time guidelines.

This report analyzes the effects of traffic preemption technology, Mobile Computer-Aided Dispatch (CAD), and changes to dispatch processes on fire response coverage. It also reviews the National Fire Protection Association (NFPA) standards referenced in the FSSP. The report includes analysis through the use of the Geographical Information System (GIS). This analysis was done with the cooperation of Fire Services Administration and Nigel Forster, Superintendent of Application Services in the City's Information and Computer Services Department.

Definitions

1. First Arriving Engine Company - consists of four fire fighters and is capable of performing an assessment of the incident, laying initial hose lines, initiating pump operations, and preparing for search and rescue.

2. Full Alarm Assignment - consists of a three station response with 14 fire fighters and is capable of carrying out victim rescue, applying water through multiple hose lines, providing building ventilation, and completing salvage and overhaul on single family residential structures.

Recommendations

1. Approve a response time guideline for first arriving engine company of 4 minutes and 30 seconds travel time or 6 minutes and 20 seconds total response time 90% of the time and outside the response area as soon as reasonably possible.

2. Approve a response time guideline for a full alarm assignment of 10 minutes and 30 seconds travel time or 12 minutes and 20 seconds total response time 90% of the time and outside the response area as soon as reasonably possible.

3. Approve Phase 1 of the capital projects which would include the strategic relocation of Station 2 in 2014/2015 and sale of the current Station 2 property.

4. Approve Phase 2 of the capital projects which would include the construction of a fire station north of the River, in the vicinity of Maple Avenue and Altawana Avenue in 2016/2017.

5. Maintain the current Station 1 location but not as an operational response station. This location could be referred to as Fire Headquarters. Fire Administration, Fire Prevention, Training, and seasonal apparatus could be housed at this location.

6. Continue to install traffic preemption technology on all signal controlled intersections.

Introduction

In 2009, the Council of the City of Medicine Hat approved that Fire Services Administration undertake a study of fire service current and future needs. This led to the development of the Fire Service Strategic Plan (FSSP), a plan that outlined the direction of Fire Services in Medicine Hat for the next 10 years. There were numerous recommendations contained in the FSSP, many of them predicated on the adoption of a 6 minute response time target for first arriving engine companies. These recommendations included the opening of a fourth fire station in the city's south end in 2014, with incremental hiring to occur from 2012-2014 to staff the new station. Renovations were planned for Station 2, with the intent to complete these renovations after the opening of Station 4. Finally, a review would occur in 2017 to consider opening a fifth fire station in the city's north end or relocation of existing Station 1 to an area in the north. Although the plan was approved by City Council in July of 2010, most recommendations were conditionally approved, pending financial approval during the 2012-2014 budget process.

In the fall of 2011, a new operating and capital budget was developed for the years 2012-2014. The capital costs involved with opening a fourth fire station and the associated operating costs were not approved in this three year budget.

In March of 2012, in consideration of the three year budget approval not including operating or capital funding for Station 4, Senior City Administration directed Fire Services Administration to consider ways to optimize fire response coverage without adding human resources or increasing the number of fire stations in the city. This report will discuss strategies that were not available or were not considered in the FSSP that would optimize fire response coverage with minimal impact to ongoing operating costs, and to make recommendations that may amend the FSSP.

History and Status of the Fire Service Strategic Plan (FSSP)

The Medicine Hat Fire Service Strategic Plan was developed and presented to City Council for approval in July of 2010. This document was intended to lay a roadmap for Fire Services in the City of Medicine Hat for the next 10 years. The plan included many recommendations, with some being implemented and in place today. Other recommendations which included infrastructure costs (stations) and operating increases were approved conditionally subject to funding in the 2012-2014 budget process.

For the first time in the Department's history, Geographic Information System (GIS) analysis was used in the development of the FSSP. Five years of response data (2005-2009) was retrieved from the records management database and analyzed to determine how well the Department was meeting a response time guideline of having the first fire engine arrive at an incident within 6 minutes, 90% of the time across the entire city. As represented in the graph pictured here, Fire Services was able to do this less than 60% of the time. This graph in Figure 1 was developed to look at citywide capabilities and represents response in 6 minutes or less, 90% of the time, across the entire city. The Council-approved guideline is 6 minutes or less, 90% of the time and outside the response areas as soon as reasonably possible.

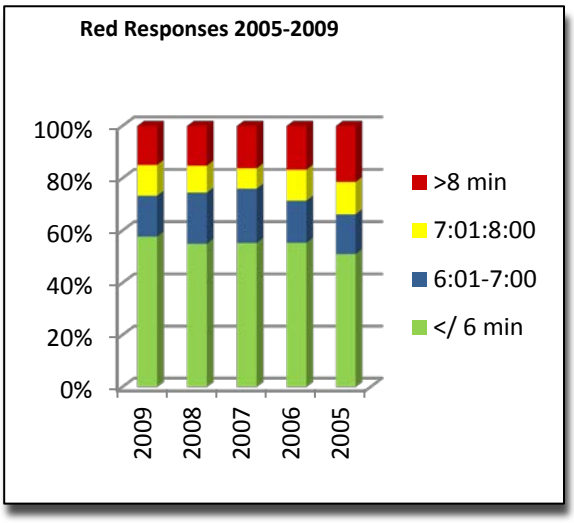

Figure 1: First Arriving Engine in 6 Minutes or Less.

Represented through GIS analysis, the 2010 response areas of Fire Services looked as follows:

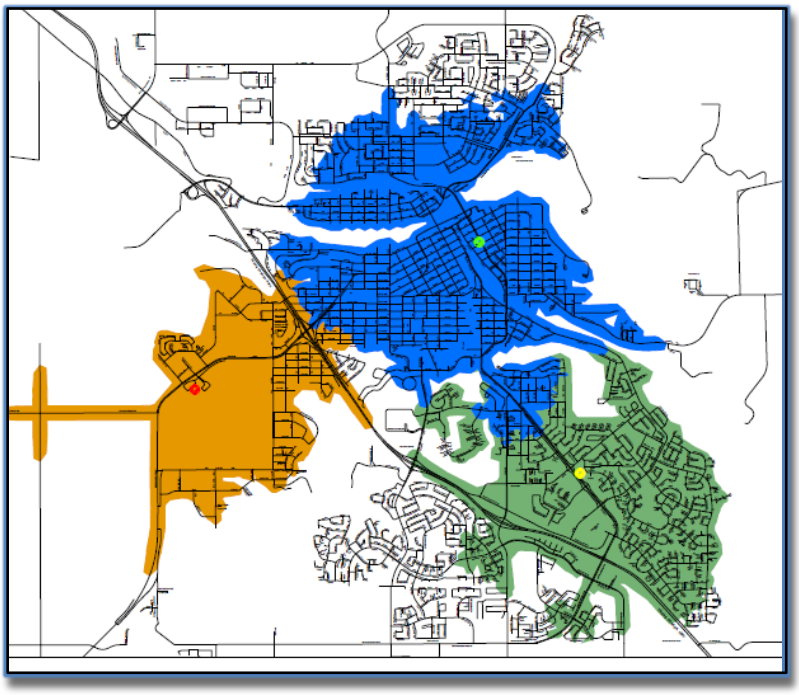

Figure 2: FSSP 6 Minute Response

Considerable portions of residential areas of the city were not within Fire Services' 6 minute response areas, in fact over 30% of the population lived outside of the response areas displayed above.

During the development of the FSSP, considerable discussion took place about the feasibility and necessity of Fire Services maintaining a 6 minute response time target for first arriving engine companies, in fact the FSSP stated, "Fire Services' response time compliance could be increased by increasing the response time target and, as mentioned earlier in the Plan, some municipalities have longer response time targets than Medicine Hat" (City of Medicine Hat, 2010, p.23). Response time targets from the comparator municipalities used in the FSSP are represented in the graph in Figure 3, indicating the average response times of comparators is just less than 7 minutes.

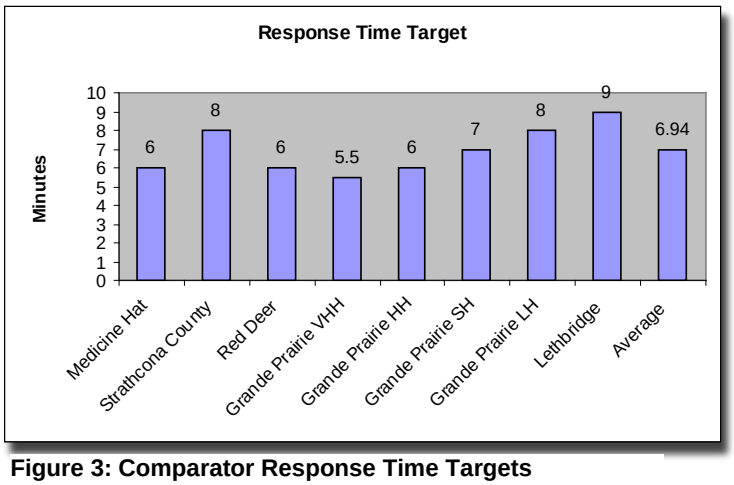

Figure 3: Comparator Response Time Targets

To determine what response time target would be recommended in the FSSP, Fire Services Administration considered several factors, including comparator response time targets, NFPA standards, fire statistics, and scientific study.

NFPA 1710 is the standard for the organization and deployment of fire suppression operations, emergency medical operations, and special operations to the public by career fire departments. The standard states, "The fire department's fire suppression resources shall be deployed to provide for the arrival of an engine company within a 240-second travel time to 90 percent of the incidents" (NFPA, 2010, p.9). This 4 minute travel time coupled with 60 seconds of turn out time, and 60 seconds of call processing time provides a standard of 6 minutes total response time. Call processing is addressed in NFPA 1221 and states, "Ninety percent of emergency alarm processing shall be completed within 60 seconds" (NFPA, 2010, p.15).

The FSSP also referenced information from a 2008 study completed by the National Research Council of Canada. The FSSP states "a 2008 report by the National Research Council of Canada (NRC) indicates occupants of a residence have less than 5 minutes before the residence becomes untenable in a standard fire. A significant residential fire may put occupants who are unable to escape on their own at severe risk before fire fighters are on scene" (City of Medicine Hat, 2010, p.23). Additionally the NRC study addressed structural collapse in new construction and this too was referenced in the FSSP as it states, "Additionally, where fire units arrive on scene in more than six minutes (360 seconds), they could be immediately

Figure 4: Floor Joist Collapse (National Research Council of Canada)

faced with floor collapse conditions in newer residential or commercial construction. Engineered floor joists, unlike dimensional lumber, fail without warning in as little as 325 seconds if fire directly impacts them" (City of Medicine Hat, 2010, p.23).

The 2009 Alberta Fire Commissioner's Statistical Report outlines residential fires as the greatest risk of fire death in the province. The report says, "Residential properties accounted for 75 per cent of fire deaths in 2009 and 76 per cent in the five year period 2005-2009" (aema.alberta.ca, 2011, p.7). Fire statistics in Fire Services' records management system also indicate that residential fires present the greatest risk of injury and death to residents of Medicine Hat. Residential fires are also the most frequent type of fire encountered in the city of Medicine Hat.

Consideration of comparator information, NFPA standards, fire statistics, and scientific study led to Fire Services Administration recommending in the FSSP that a response time guideline of 6 minutes or less 90% of the time for the first arriving engine company and outside the response area as soon as reasonably possible. This recommendation mirrored the response time target recommendation adopted in 2004 and laid the foundation for infrastructure and staffing recommendations required to achieve that target, with the prime area of concern being protection of residential areas.

GIS analysis of Fire Services response capabilities in 2010 indicated that over 11,000 residents in the south end of the city and 9,000 residents in the north end of the city lived outside of the Department's 6 minute response area. Future growth projections indicated an additional 19,000 residents in the south and an additional 3,000 residents in the north would be outside of the 6 minute response time area. For that reason, recommendations were put forth that included a fire station to open in the south part of the city in 2014, with other recommendations to increase coverage for the north end to follow later in the 10 year Plan. The GIS representation of the coverage model appears in Figure 5.

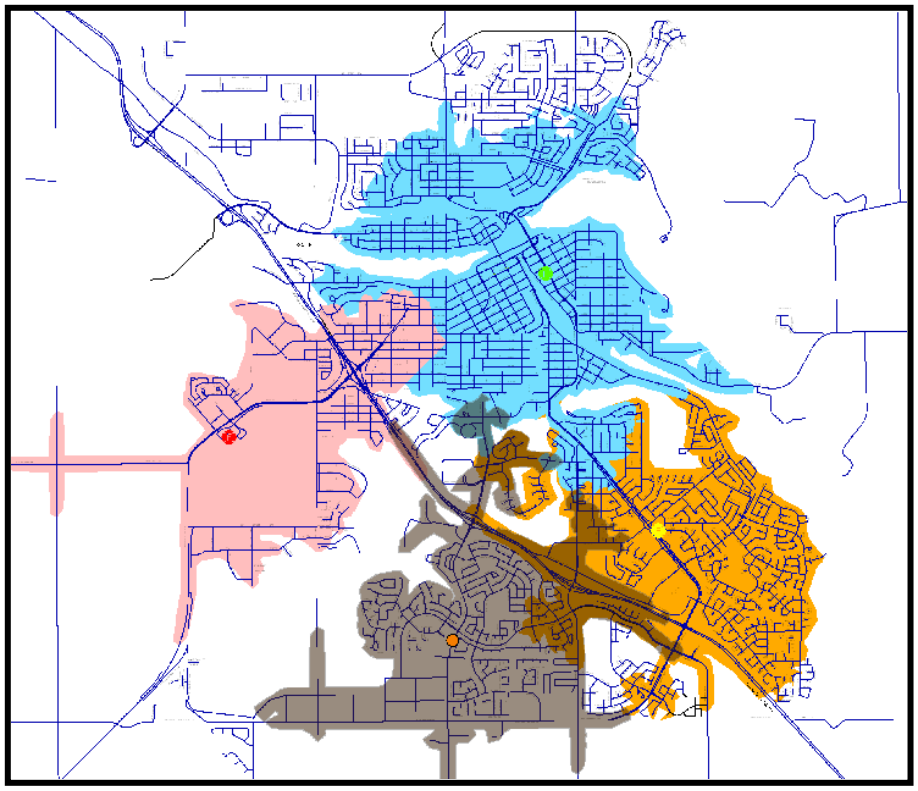

Figure 5: Proposed 4 Station Model (FSSP)

The recommendation to open the fourth fire station in the south in 2014 involved capital costs of $7.5 million and ongoing operating costs of approximately $2.5 million annually. The $2.5 million in operating costs included staffing costs associated with 20 additional fire fighters, fleet lease and insurance costs, and station operating costs.

In the City of Medicine Hat, every $500,000 increase in operating costs equates to a 1% tax increase. Opening the fourth fire station would result in a tax increase of 5% to residents to fund the operating increase and a further 1% increase to fund debt servicing costs. When the 2012-2014 budget was approved in March of 2012, it included tax increases of 4.9%, 5.5%, and 5.5% in each of the three years respectively, to pay for the services and additional operating costs which Senior City Administration and ultimately City Council deemed necessary. As mentioned earlier in this report, the budget did not include funding of the infrastructure and suppression staffing recommendations included in the FSSP. These additions would have added another 6% tax increase over the three years of the budget period.

Ongoing Projects and Related Concerns

Fire Service continues to be involved in numerous projects to increase service levels to the residents and safety to Fire Services' staff. These projects include installation of traffic preemption devices, installation of Mobile Data Terminals (MDT) equipped with Mobile Computer-Aided Dispatch (CAD) in fire response vehicles, and improvements to fire dispatch processes.

Preliminary investigative work was conducted for the traffic preemption project in 2008 for consideration in the 2009-2011 budget. The project was approved for the 2009-2011 budget period and work on the project began shortly after the presentation of the FSSP to City Council in July of 2010. At the time the investigative work was done, the cost of this technology was high. The Department proposed that 15 additional intersections on major thoroughfares be equipped with traffic preemption equipment to bring the total number of controlled intersections to 24 out of approximately 54 intersections. When a request for proposals was developed in 2011, it was apparent that technological advances had dramatically lowered the cost of these systems, allowing the City to equip all intersections within the approved capital budget.

In 2009/2010 when the FSSP was developed, the City's Municipal Works Department and Fire Services considered these devices as safety improvements and did not consider them as a way to optimize response coverage, due to the limited number of planned intersection installations. In fact the FSSP states, "It is important to note that Fire Services does not consider the installation of these devices as a method to reduce travel time to emergency incidents; these devices simply provide an increase in safety to responders and other users of the road" (City of Medicine Hat, 2010, p.17). Studies researched in 2012 indicate that there are response coverage benefits realized when significant portions of a municipality utilize traffic preemption technology.

The MDT project, which included the installation of Mobile CAD, was also approved for the 2009-2011 budget period, and work began on the project in late 2010. It was acknowledged in the FSSP that Mobile CAD could reduce response time as the FSSP stated, "Automatic GPS routing will reduce turn out time as apparatus operators will not have to verify incident locations on paper maps before responding" (City of Medicine Hat, 2010, p.42); however, the impact of the MDT project on response time was not considered in the GIS analysis done for the FSSP.

Prior to 2011, Fire Services employed a pre-alert tone in its fire dispatch processes. This pre-alert tone was broadcast by fire dispatchers as soon they confirmed there was a call for service. The dispatcher would then interrogate through the key questions in the Fire Priority Dispatch Protocol and provide limited initial information, thereby initiating a response. The dispatching of units usually occurred within 60 seconds of the pre-alert tones. Those 60 seconds were to be used by fire fighters to ready themselves to respond. An update was provided by fire dispatchers once they had completed the interrogation as outlined in the protocol. The process is represented visually as follows:

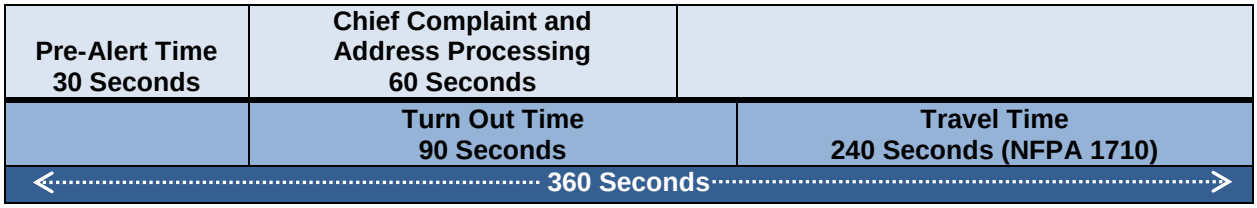

Figure 6: Pre-2011 Pre-Alert Model

Two fundamental problems surfaced with the use of pre-alert in this manner. First, fire fighters, over time, would not ready themselves to respond due to the high number of incidents that required response from a station other than the one in which they were working. They waited for the initial dispatch information which included the address to make sure it was their response zone. This behaviour was addressed numerous times but would inevitably creep back into the system, causing turn out to begin later than it should have, thereby increasing the total response time to the incident. The second problem involved lack of available information after the key questions were asked. At times, the fire dispatcher had extremely limited information to provide Fire Services and this would cause the Platoon Chief to contact the dispatcher requesting more information, disrupting the dispatcher's interrogation of the caller, again slowing the overall process.

In January of 2011, Fire Services initiated a different dispatch process. Pre-alert was discontinued, so the dispatcher followed the protocol as written, not alerting Fire Services until they had completed the entire interrogation of the caller. This method is how the vast majority of 9-1-1 call centers handle fire dispatch and is in accordance with the Priority Dispatch Fire Protocol. Fire Services Administration believed that if the dispatcher could meet the standard as outlined in NFPA 1221 (process the call within 60 seconds) and provide all of the necessary information, then fire fighters could ready themselves to respond within 60 seconds (NFPA 1710 previous editions) maintaining current response coverage. This model also allowed Fire Services Administration to develop response determinants, which are provided to the Department at the time of dispatch, along with the chief complaint and address, to improve consistency of response amongst all platoons. The model is represented below:

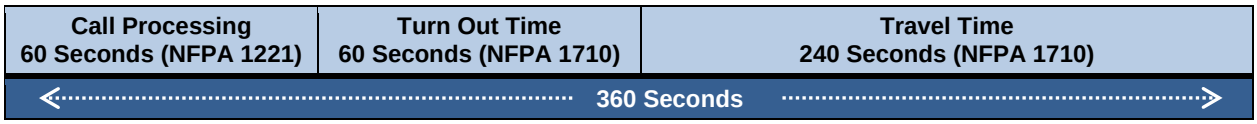

Figure 7: NFPA Dispatch Model

As Fire Services monitored dispatch and turn out times through 2011 and early 2012, it became apparent that dispatchers were rarely able to process calls within 60 seconds due to difficulties encountered such as language barriers, uncooperative callers, and the high number of cell phone calls received requiring address and phone number verification, as cell phones do not provide automatic number information or automatic location information, referred to as ANI/ALI in dispatch jargon. Additionally fire fighters could not ready themselves for turn out in 60 seconds due to their involvement in other duties such as commercial fire inspections or training activities.

The fact that dispatchers require anywhere from 60-120 seconds to process calls, and fire fighters need close to 90 seconds to turn out, adds a significant amount of time to the overall response time, further reducing compliance levels. It was obvious that a review of this process was required in 2012.

Project Scope

On March 26, 2012 the City's Public Services Commissioner directed Fire Services Administration to consider alternative methods of optimizing fire response coverage. That direction included four basic assumptions: any fire station could be relocated to improve coverage, Fire Services would continue to utilize three response stations, suppression staffing would stay at current levels, and the current response time guideline could be amended.
The scope of this project included:

1. An analysis of possible time savings through:
    a. the installation of traffic preemption technology,
    b. use of Mobile CAD,
    c. changes to the dispatch process, and
    d. review of NFPA standards related to response time.

The project scope included the surveying of numerous municipalities, the review of studies involving traffic pre-emption and Mobile CAD, and the initiation of technological and process changes to fire dispatch. This information would be analysed through the use of GIS and new models for fire response would be developed, including possible relocation of fire stations to represent optimal fire response coverage utilizing current human resources.

Survey

A survey of 22 department managers from 18 small, medium, and large city fire departments across Canada was conducted in an attempt to garner actual statistics-based performance measurements concerning the use of traffic preemption, Mobile CAD, and dispatch pre-alert tones. The following cities were included in the survey (an asterisk (*) behind the city's name indicates they responded to the survey):

Airdrie, Alberta *
Calgary, Alberta *
Edmonton, Alberta *
Fort McMurray, Alberta *
Grande Prairie, Alberta *
Lethbridge, Alberta
Red Deer, Alberta
St. Albert, Alberta
Strathcona County, Alberta *
Delta, British Columbia
Surrey, British Columbia *
Vancouver, British Columbia
Brandon, Manitoba *
Brantford, Ontario *
Moose Jaw, Saskatchewan *
Prince Albert, Saskatchewan *
Regina, Saskatchewan *
Yorkton, Saskatchewan *

The survey questions sent to these department heads were as follows:

Traffic Preemption Questions:

Traffic preemption devices are used to change traffic signals from red to green in order to allow traffic to clear intersections so emergency vehicles may travel through the intersection on a green light.

1. *Does your municipality use traffic preemption devices? If yes, are they used on all traffic light controlled intersections?*

2. *If your community uses traffic preemption devices have you ever measured the effect on emergency vehicle response time? If you have measured the effect, what response time reduction is attributed to traffic preemption devices?*

Mobile Computer-Aided Dispatch (CAD) Questions:

Mobile CAD is a software program installed on a computer terminal in the truck which allows critical information to be transferred directly from a dispatch computer to a mobile computer. Mobile CAD systems may also provide routing information to responding units.

1. *Are your emergency vehicles equipped with Mobile CAD?*

2. *If your emergency vehicles are equipped with Mobile CAD, have you ever measured the effect on emergency vehicle response time? If you have measured the effect, what response time reduction is attributed to Mobile CAD?*

Dispatch Questions:

Pre-alert tones are tones that are received well in advance of the dispatcher providing the chief complaint and address. These pre-alert tones are designed to allow fire or medical crews to prepare for response while call interrogation is in progress, allowing two processes to occur simultaneously, theoretically reducing overall response times.

1. *Does your emergency service utilize any type of pre-alert tones when dispatching emergency response vehicles and crews?*

2. *If your emergency service utilizes pre-alert tones, have you ever measured the effect on emergency vehicle response time? If you have measured the effect, what response time reduction is attributed to the use of pre-alert tones?*

As indicated, 13 of the 18 surveyed departments (72%) responded to the survey. The data provided is illustrated in the table below.

Department	Traffic Preemption?	Response Time Reduction?	Mobile CAD?	Response Time Reduction?	Pre-Alert?	Response Time Reduction?
Calgary, AB	Yes	Not measured	Yes	Not measured	Yes	Not measured
Grande Prairie, AB	Yes	Not measured	Yes	Not measured	No	-
Moose Jaw, SK	Yes	Not measured	No	-	No	-
Prince Albert, SK	No	-	No	-	Yes	Not measured
Brandon, MB	No	-	No	-	Yes	Not measured
Edmonton, AB	Yes	Not measured	Yes	Not measured	Yes	30 seconds
Wood Buffalo, AB	No	-	No	-	No	-
Yorkton, SK	No	-	No	-	Yes	Not measured
Airdrie, AB	Yes	Not measured	No	-	Yes	Not measured
Swift Current, SK	No	-	No	-	Yes	Not measured
Brantford, ON	Yes	33 seconds	No	-	No	-
Surrey, BC	Yes	14 seconds	Yes	15 seconds	Yes	Not measured
Regina, SK	Yes	Not Measured	Yes	Not Measured	No	-

Figure 8: Survey Results

The survey results indicate there are numerous departments employing traffic preemption technology, Mobile CAD, and dispatch pre-alert tones; however, there have been limited internal studies completed by the surveyed departments. Many respondents included anecdotal comments such as these random samples; “I am not sure what studies have been conducted, but I am sure they have reduced response times,” and, “We have monitored but not measured accurately.” These types of comments indicate an improvement in response coverage, but do not provide empirical data for comparative purposes. Other departments such as Edmonton and Surrey provided detailed information on how measured reductions in response times were attributed to one or more of the three surveyed factors.

Traffic Preemption Studies

There have been numerous studies completed on traffic preemption in jurisdictions all over North America. Safety improvements calculated through monitoring of a decrease in vehicle collisions are easy to measure, and an increased level of safety should be realized in Medicine Hat as well. More difficult to ascertain from the studies is how much response time improvement can be expected in Medicine Hat once the system is implemented.

The United States Federal Highway Administration completed an in-depth report on traffic preemption. In the report there are several examples of response time improvement discussed from across the United States. The report states, "Emergency Vehicle Preemption (EVP) can improve emergency vehicle (EV) response times by reducing the probability that responding EV's will arrive at intersections during red signal phase and encounter significant queues" (Federal Highway Administration, 2006, p.3-1).

The City of Denver completed one of the earlier studies on traffic preemption in 1978. In this study the, "data showed EV response times decreased from 16 percent to 23 percent with savings of approximately 70 seconds per response on a route with three to six signalized intersections" (Federal Highway Administration, 2006, p.3-1).

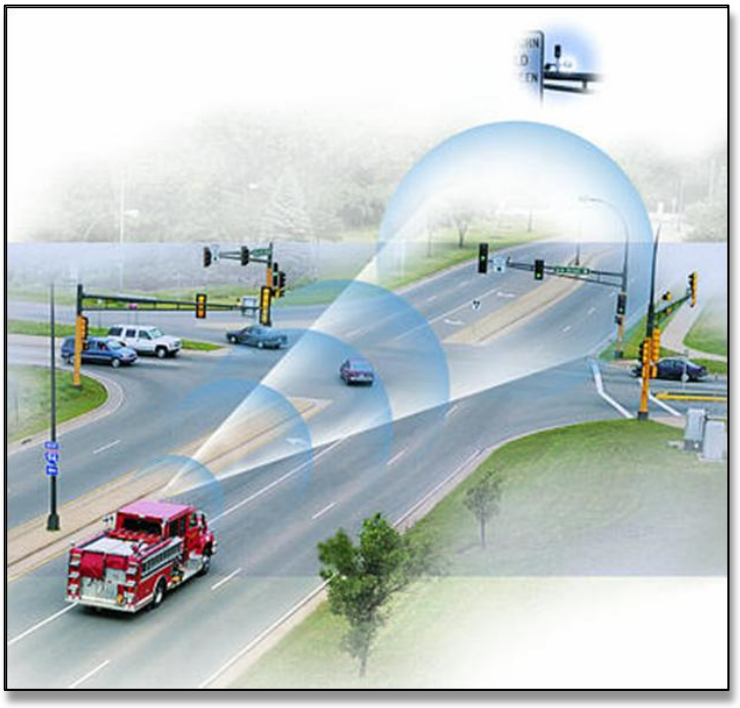

Figure 9: Beam Style Traffic Preemption

A field test conducted in the City of Houston in 1991 also discovered traffic preemption could make a significant difference in response times. "Field tests were run to measure travel time for emergency vehicles (without sirens activated) before and after installation at 22 intersections within two fire districts (11 per district). After a year of operations, the average emergency vehicle travel time decreased 16 percent in one district, and 23 percent in the other" (www.benefitcost.its.dot.gov, 1991, p.1).

More recently, in 2003, the City of Surrey Fire Service completed a study on expanding the traffic preemption system in that municipality. The service went as far as developing an excel tool to predict the effect on traffic preemption expansion. "Results from the analyses showed that the proposed expansion of preemption controlled intersections will help the Fire Service respond to emergencies more quickly. Using the technology, existing fire stations will become more effective, and the traditional method of improving response time by constructing additional stations and/or hiring staff can be avoided" (City of Surrey, 2003, p. 6). In Surrey, "the average time saved per call works out to 14 seconds" (Mark, 2004, p.25).

Finally, the last study referenced in this report was completed by York Regional EMS (York, Ontario). That study was completed in 2009 and found that 58 seconds could be saved (a 12% reduction) on each EMS run. The study states, "The pilot travel delay study indicated a 58 second reduction time. If a similar reduction region-wide were to be achieved through the addition of new staff and ambulances alone, it is estimated that 3 new 24-hour ambulances would be required at an estimated cost of 3.6 million dollars above the current operating budget annually" (Regional Municipality of York, 2010, p.3).

These studies indicate there are significant improvements in response times realized in some jurisdictions. Cities such as Denver or Houston, or the Regional Municipality of York experience a much greater traffic congestion problem than what occurs in Medicine Hat; therefore, it is unlikely Fire Services would see such dramatic improvements in response times attributed to traffic preemption. As discussed, Surrey achieved a 14 second gain attributed to traffic preemption. As that municipality has both an urban and suburban area with longer distances between traffic lights, it is a better comparator for prediction of response time savings than the other, much larger jurisdictions. As the City of Medicine Hat is installing preemption devices on almost all traffic light controlled intersections, rather than the expansion that occurred in Surrey, it was expected there would be a time savings greater than what was realized in Surrey.

The Medicine Hat Fire Service performed field tests to quantify the response time saving with preemption technology at signalized intersections. In these controlled tests, a fire engine first approached a signalized intersection slowing to half response speed before resuming its previous speed in order to simulate stopping for a red traffic signal. Under the same conditions, the vehicle then travelled through the same intersection but was able to maintain its response speed by using preemption technology. The results of this field test demonstrated an average time saving of 8 seconds per intersection with preemption performance.

Further field tests were done to simulate actual fire engine response. A fire engine travelled typical routes in which it passed through six signalized intersections. Following the assumption that 50% of signalized intersections would involve a red traffic signal, the vehicle approached every other intersection slowing to half response speed before resuming its previous speed. To simulate differential performance under the same conditions using preemption technology, the vehicle travelled through the intersections maintaining its response speed. These tests were conducted in daytime and evening traffic to simulate multiple scenarios and replicated typical travel times from 4 minutes to 4 minutes and 30 seconds. The results of these field tests demonstrated an average time savings of 22 seconds per run with the simulated preemption performance.

The results of these two test methods are supportive of each other. The individual intersection test findings of an 8 second savings per intersection closely support the 22 second savings found during the simulated response runs through six signalized intersections, encountering three red signals.

Mobile CAD Studies

Published studies examining what effect Mobile CAD has on response times are extremely limited in number. Information is readily available describing how Mobile CAD works, but that information is not relevant to this report in the context of response coverage optimization.

Many jurisdictions relate the use of Mobile CAD to reduced response times, but do not substantiate the data, at least in the public domain. The City of Nanaimo writes on its website that, "The technology reduces response time, specifically the components of dispatch time and firefighter turn out time. Each Engine is now equipped with a laptop computer and FDM MobilCAD software linked through wireless networks into the Computer-Aided Dispatch system (CAD)" (www.nanaimo.ca, 2012, p.1). Of interest in the preceding citation is the comment on reducing response time through the components of dispatch time and firefighter turn out time. Medicine Hat's 9-1-1 Communications call center already utilizes CAD; therefore, we are unlikely to see improvements in response times that are related to finding efficiencies in dispatch due to the addition of Mobile CAD unless significant work is done on the CAD database to provide automatic response determinants and automatic unit assignment. However, the citation reference to fire fighter turn out time improvement is relevant to Fire Services. Mobile CAD being introduced in the Department will also utilize automatic vehicle location (AVL) which is a seamless add on product to Mobile CAD. AVL will utilize pre-loaded GIS mapping of the city including streets, addresses, hydrant locations, etc. and will allow Mobile CAD to automatically indicate the best route from the emergency vehicle location to the incident location.

Currently, apparatus drivers in Fire Services spend approximately 15 seconds using paper maps locating the incident and planning the best travel route. Happening concurrently, the fire officer uses a manual address location program, created by the City's GIS Department, to find the location of the incident. Mobile CAD will eliminate this 15 second period as the route will be provided automatically by the AVL software. This suggested 15 second time savings attributed to Mobile CAD is reinforced by Deputy Chief Karen Fry from the Surrey Fire Service where she writes in an email response, "Since we've implemented Mobile CAD, our turn out times have been reduced as well as our improved Dispatcher availability. If we report in averages for our first in unit on emergency calls for total response times: 2007 = 5:44 and 2012 = 5:30, a difference of 14 seconds, but we have been working on improving our turn out times within our stations, so I cannot validate that the reason for the improvement is Mobile CAD alone" (Fry, 2012). Deputy Chief Fry indicated this time saving may not be solely attributed to Mobile CAD, but studying the current system in Fire Services provides enough confidence to predict a 15 second time savings to be realized. Although this time savings will not reduce overall response time, as turn out will happen concurrently with dispatch call interrogation, it will ensure that fire fighters have competed turn out and are ready to respond when the dispatcher reaches the send point in the protocol and dispatches fire units.

NFPA Standard 1710

The 2010 revision of NFPA 1710 has changed to reflect a longer fire fighter turn out time for fire calls than what was provided in the earlier edition. Turn out time has increased from 60 seconds to 80 seconds. Call taking time remains at 60 seconds and travel time remains at 240 seconds (4 minutes) in the standards. This effectively increases the total response time suggested in the standard to 380 seconds or 6 minutes and 20 seconds from the previous 6 minute standard.

Dispatch Process Changes

The move away from pre-alert tones in January of 2011 caused response times to increase due to the fact that both dispatch caller interrogation and fire fighter turn out took longer than expected. It became evident that the Department needed to return to the use of pre-alert tones to improve response time, but the problems encountered with the previous pre-alert system needed to be eliminated, while the use of response determinants (recommended apparatus) developed under the 2011 – current system, needed to continue.

Eliminating pre-2011 pre-alert problems was accomplished through the installation of a software program from FDM called Active Incident Monitor (AIM). AIM is displayed on separate computer monitors in the Platoon Chiefs' and Station Captains' offices. This program allows these officers to see the information displayed live from CAD in 9-1-1, including the address and dispatcher's notes as the call is interrogated. This addresses the issue of the Platoon Chief calling the dispatcher for additional information and perhaps interrupting a problematic caller interrogation, thereby slowing down the overall process.

Also, AIM allows the Platoon Chief to inform the appropriate station(s) of a pending response in their area(s). This ensures fire fighters begin readying themselves immediately for a response in their area(s) rather than waiting for station determination from dispatch to the Platoon Chief. Dispatch does not provide dispatch information to fire immediately following the pre-alert tones as dispatch continues to interrogate the caller until reaching the appropriate "send" point in the fire dispatch protocol. At that point, the Platoon Chief is given the chief complaint, response determinants, and address confirmation.

Fire Services Administration has determined the implementation of new technology and processes, together with the adoption of the new NFPA standard of 6 minutes and 20 seconds, 90% of the time will allow an additional 30 seconds of travel time to be projected in the GIS analysis presented later in this report.

GIS Analysis

Key to development of the strategic recommendations that are proposed in this report is the analysis and modeling made available through GIS technology. "Unlike previous methods that employed grid and concentric circle analysis, GIS simulates the real road network of the area being analyzed. A high degree of accuracy is ensured by using actual travel distances, vehicle speeds, time delays for roadway conditions (e.g. congestion, turning radius, weather, hills), accounting for one-way or unusable roadways, and implementing user-defined risk factors" (ESRI, 2007, p.14).

Fire Services used GIS analysis during the development of the FSSP. Consideration of the additional factors discussed previously in this report has allowed Fire Services and the City of Medicine Hat GIS Department to develop and present, in this document, new models that will allow recommendations to be made that may amend the FSSP.

Before the effects of traffic preemption, Mobile CAD, and dispatch pre-alert changes were given consideration, a review of the road network speeds was conducted in the GIS database. Road segment speed changes on certain arterial roads such as the Trans-Canada Highway and major arterial routes with high speed limits were completed. Next, the 22 second average improvement in response times due to traffic preemption was built into the model. Finally, the time savings of Mobile CAD and dispatch pre-alert reduced total time for average call taking and turn out time to 110 seconds from 120 seconds. This, coupled with a 20 second increase in the total response time standard from NFPA 1710 is represented in the modeling by allowing a 30 second longer travel time model to be presented.

GIS Models

With the new information, the model was developed to visualize what response coverage would be achieved without relocating any of the three fire stations. With the revised GIS road network speeds and allowances made for time savings in dispatch and turn out, the 6 minute and 20 second response model is represented in Figure 10.

GIS analysis of census data reveals the model pictured here improves coverage to 82% of the population living within a 6 minute 20 second response area, over the modeling which was done in the FSSP that indicated 68% of the population lived within Fire Services' 6 minute response area.

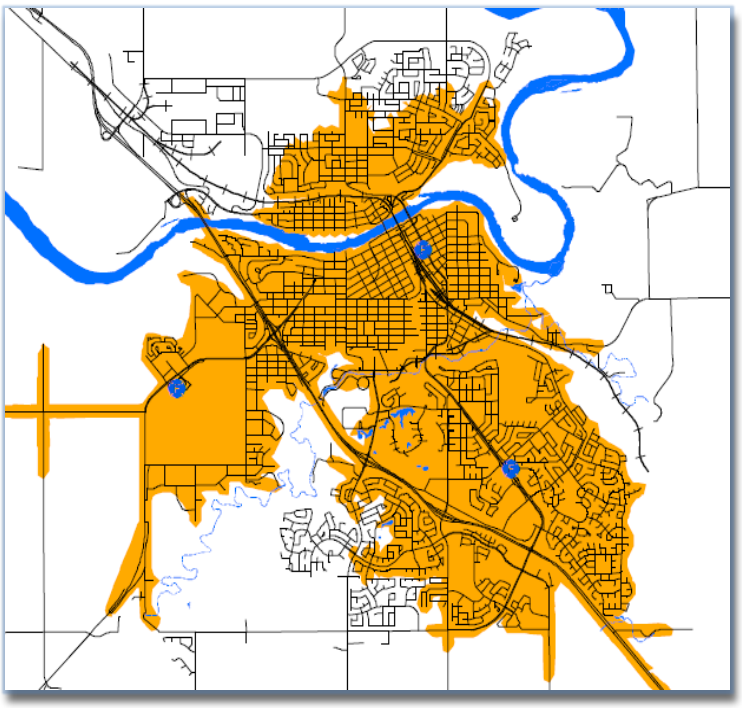

Figure 10: Existing Station - 6 Minute 20 Second Response

Equally important to Fire Services is the modeling for full alarm assignments. A full alarm assignment is a three station response which places 14 fire fighters on scene. The NFPA 1710 standard for this target is within 10 minutes and 20 seconds 90% of the time (NFPA, 2010, p.9). Full alarm assignment coverage for existing station locations is represented in Figure 11.

The modeling indicates that Fire Services cannot achieve complete full alarm assignment coverage within 10 minutes (Figure 11); however, the modeling indicates a significant improvement over what was presented in the FSSP (Figure 12).

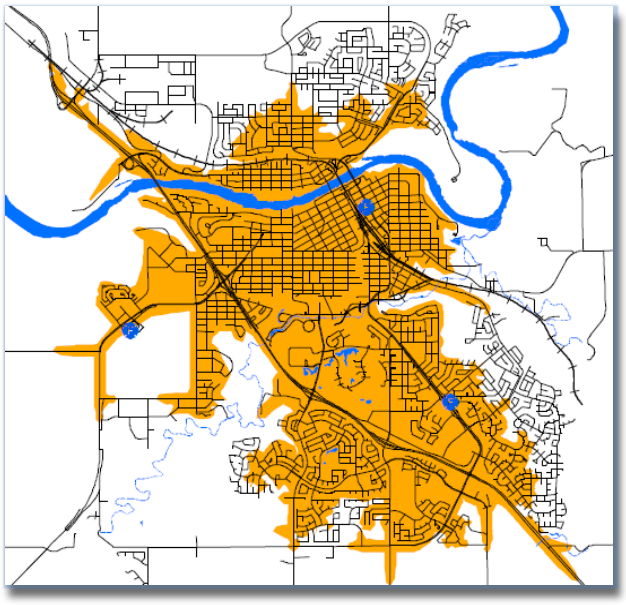

Figure 11: Full Alarm Assignment 10 Minutes

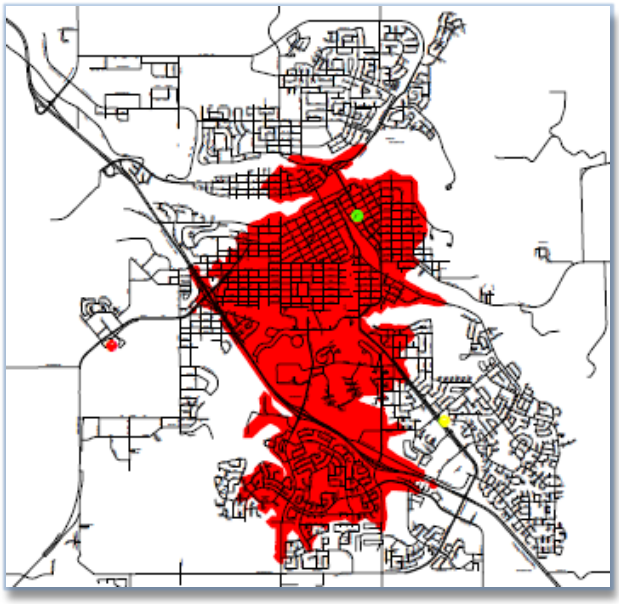

Figure 12: Full Alarm Assignment 10 Minutes (FSSP)

A 12 minute, 20 second full alarm assignment target is required to achieve coverage over the entire city (Figure 13). This full alarm assignment modeling is an improvement over what was projected in the FSSP (Figure 14). This improvement is due to the addition of traffic preemption technology to all intersections within the city.

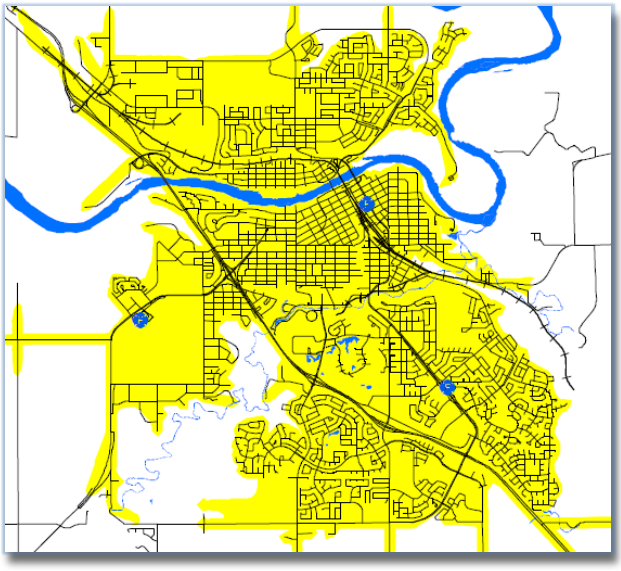

Figure 13: Full Alarm Assignment - 12 Minutes 20 Seconds

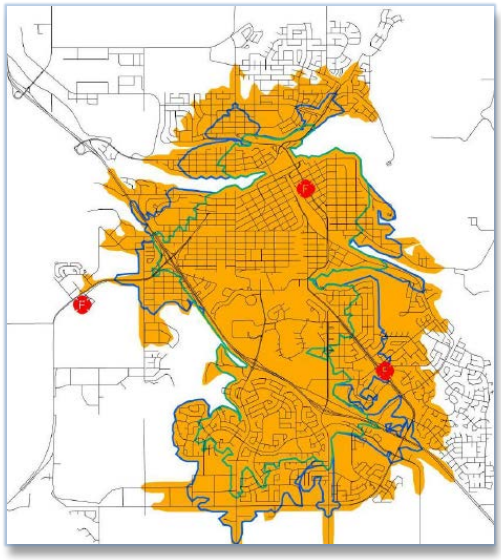

Figure 14: 12 Minute Full Alarm Assignment (FSSP)

The direction from Senior City Administration indicated that any station could be relocated to optimize response coverage. With the assistance of the City of Medicine Hat GIS Department, numerous combinations were analyzed to determine optimal response coverage. The best combination involved relocation of Station 1 from 440 Maple Avenue to a location on the north side of the Maple Avenue Bridge, and the strategic relocation of Station 2 from Dunmore Road. That modeling representing 6 minutes, 20 seconds of total response time is pictured in Figure 15. The model indicates that relocation of Station 1 and Station 2 will place 95% of the population within Fire Services' 6 minute 20 second response area.

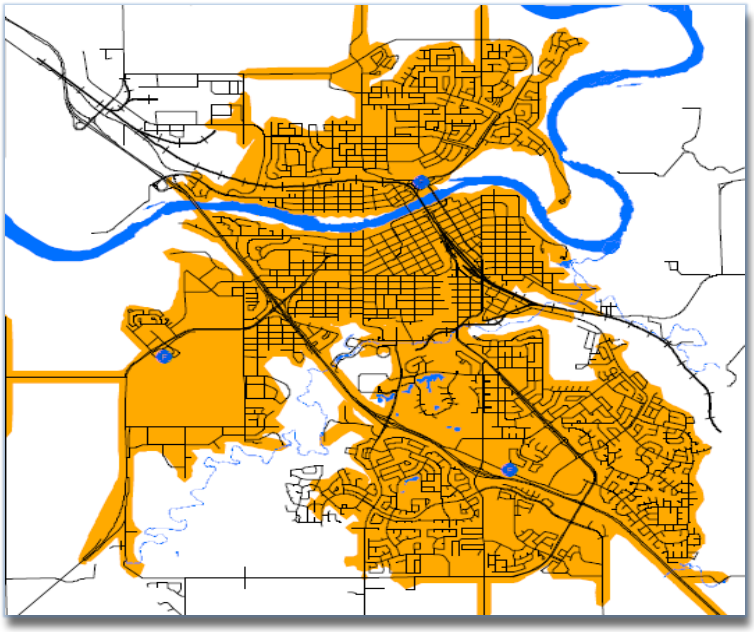

Figure 15: Relocating Station 1 and 2 - 6 Minute 20 Second Response

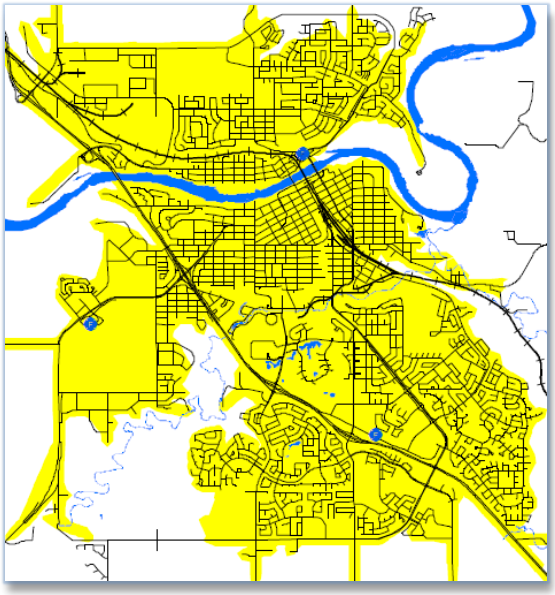

Figure 16: 12 Minute 20 Second Full Alarm Assignment: New Modeling

The full alarm assignment capacity does not change significantly with the relocation of Station 1 and 2 even though the stations are further apart. This again is due to traffic preemption allowing second and third arriving engines to sustain a higher average response speed. A 12 minute 20 second guideline is required to achieve full alarm assignment coverage in the relocation model as shown in Figure 16.

GIS modeling including analysis of the effects of traffic preemption, Mobile CAD and dispatch changes, indicates that Fire Services can, by relocating two of the three stations, achieve coverage of 95% of the city's population within 6 minutes and 20 seconds or less, 90% of the time. A full alarm assignment can be achieved in 12 minutes and 20 seconds or less, 90% of the time across the city.

Capital Cost Projections

Review of FSSP Costs

As this report may provide the basis for amendments to the FSSP, it is important to review the capital costs conditionally approved in the FSSP. Following is the financial implication summary from the July 7, 2010 Decision Item presented to City Council.

2014	**Design and construction of Station 4**	**$5,500,000**
2014	**Acquisition of apparatus and equipment**	**$1,500,000**
2014	**Station 4 land acquisition if required**	**$500,000**
2015	**Completion of renovations for Station 2**	**$2,000,000**

Figure 17: Capital Cost Summary (FSSP)

The capital costs presented in 2010 represented a total commitment of $9.5 million dollars. In addition, increased staffing and operating costs would be incurred totaling approximately $2.5 million annually.

Sequence of Capital Projects

The adoption of a 6 minute and 20 second response time guideline, improves the percentage of population covered from the 68% reported in the FSSP to 81.6%. The relocation of Station 2 as discussed increases the population within the response area by an additional 9% (90.6% total). The relocation of Station 1 as discussed, increases the population within the response area by an additional 4.6%. After both response stations are relocated, first arriving engines in 6 minutes and 20 seconds will cover 95.2% of the city's population.

These percentage increases indicate that the relocation of Station 2 first would benefit a greater percentage of the population. This compares similarly to the recommendation made in the FSSP to build a fourth station in the south before considering any expansion northward.

	Population living outside of 6 minute 20 second response area					
City Population = 61,197	**Citywide**	**%**	**South**	**%**	**North**	**%**
Before station relocation	11,235	18.4%	6,648	10.9%	4,587	7.5%
After station relocation	2,914	4.8%	1,148	1.9%	1,766	2.9%
Percentage improvement		**13.6%**		**9.0%**		**4.6%**

Figure 18: Response Coverage Improvement

New Model Costs

In the modeling presented in this report, relocation of Stations 1 and 2 would be required to achieve 95% coverage with a 6 minute 20 second response time guideline for first arriving engines. Capital costs involve relocation of two response stations and include possible land acquisition costs; however, there would be no renovation costs for Station 2, as it is recommended that the property be sold.

2014/2015	**Design, construction, and land acquisition - relocated Station 2**	**Not exceeding $6,500,000**
2015/2016	**Sale of existing Station 2**	**Not less than ($500,000)**
2016/2017	**Design, construction, and land acquisition - relocated Station 1**	**Not exceeding $7,500,000**
2017/2018	**Sale of existing Station 1**	**Not less than($500,000)**

Figure 19: New Model Capital Costs

Cost for capital expenditures will not exceed $13.0 million dollars in this model. Costs are included for land acquisition for the relocation of Stations 1 and 2 in case there are no options available on City owned land, or if proposed City owned land requires significant leveling, elevation changes, accommodation for utility right of ways, or relocation of utilities. Important to note is there are no additional apparatus acquisition costs ($1.5 million) or costs associated with operating a fourth station ($2.5 million annually).

Alternative Option

Fire Services uses many pieces of seasonal and backup fire apparatus such as a jet boat, ice rescue equipment, a fire engine, and numerous light attack or brush fire trucks. Storage of this seasonal and backup apparatus is a continual challenge; therefore, the concept of operating the Department out of four buildings, three of those being active response stations, should be examined. If the current Station 1 was to be retained, it could continue to house Fire Administration, Training, and the Fire Prevention Branch. The apparatus floor at Station 1 could then be used for seasonal and backup apparatus storage as well as storage of antique apparatus.

This would change the capital costs projections and would also have an effect on the Department's operating budget as approximately $150,000 - $200,000 of annual operating costs for the current Station 1 would continue.

2014/2015	**Design, construction, and land acquisition - relocated Station 2**	**Not exceeding $6,500,000**
2015/2016	**Sale of existing Station 2**	**Not less than ($500,000)**
2016/2017	**Design, construction, and land acquisition - 3rd response station (north of river)**	**Not exceeding $6,500,000**

Figure 20: Optional Model Capital Costs

Capital costs in this option will not exceed $12.5 million. The capital cost of this option is slightly lower, and it would resolve many issues facing the City today, including storage of equipment for Fire Services and centrally locating Fire Administration, Prevention, and Training.

Future City Growth Considerations

Future growth of the city has an impact when considering the relocation of fire stations. The relocation and associated capital expenditures need to address long term city growth to avoid similar expenses from occurring in the future. Analyzing future growth will also allow for an estimate of when a fourth response station may be required.

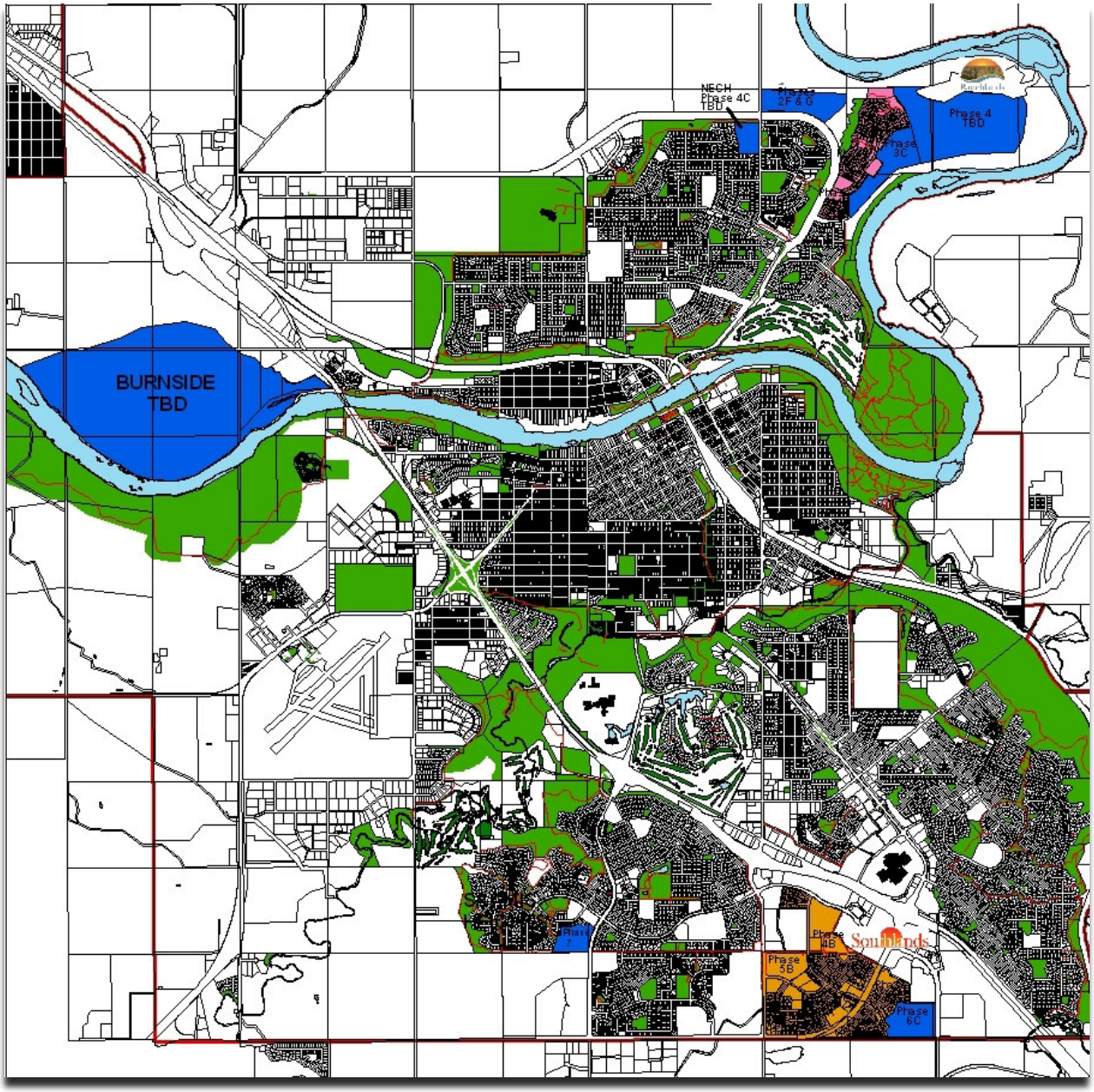

Figure 21: City Growth Nodes

The following table presents the growth timetable as estimated in consultation with Land and Properties and illustrates how the station relocation model presented in Figure 15 will accommodate that estimated growth. Accurate GIS modeling of proposed subdivisions cannot be completed where no road network plan exists, so the coverage estimates, although highly probable, remain an estimate as well.

Subdivision Development	Estimated Date of Development	Effective Response From Station(s)
Southlands Phase 6C	2013-2015	Within response area from relocated Station 2
Saamis Heights Phase 7	2016-2017	Within response area from relocated Station 2
Cimarron Phase 1	Unknown	Within response area from relocated Station 2
Cimarron Additional Phases	Unknown	Partially outside of response area
Cancarb Lands	2018-2020	Within response area of relocated Station 1
Ranchlands Phase 3C	2018-2020	Within response area of relocated Station 1
Ranchlands Phase 4	2020-2022	Partially outside of response area
Burnside	2022+	Partially outside of response area

The Ranchlands Phase 4 and future Cimarron developments will likely lie partially outside of the response areas. Although outside of the 6 minute 20 second response area, these expanding areas would not require the additional measures outlined under the Alberta Building Code for the prevention of High Intensity Residential Fires (HIRF) because Fire Services would be able to respond to these areas within 10 minutes (building preservation issue).

Examining growth areas and associated growth timelines in the City would suggest that a fourth response station would not be required until there was substantial growth in the northwest sector of the city. This growth may include the building of an Event Center with the accompanying development and/or the development of the Burnside subdivision. It is estimated the timing of this growth may delay the need for a fourth response station for eight to ten years (2020-2022) by relocating Stations 1 and 2 as outlined in this report.

Recommendations

1. Approve a response time guideline for first arriving engine companies of 4 minutes and 30 seconds travel time or 6 minutes and 20 seconds total response time 90% of the time and outside the response area as soon as reasonably possible.

2. Approve a response time guideline for a full alarm assignment of 10 minutes and 30 seconds travel time or 12 minutes and 20 seconds total response time 90% of the time and outside the response area as soon as reasonably possible.

3. Approve Phase 1 of the capital projects which would include the strategic relocation of Station 2 in 2014/2015 and sale of the current Station 2 property.

4. Approve Phase 2 of the capital projects which would include the construction of a fire station north of the River, in the vicinity of Maple Avenue and Altawana Avenue in 2016/2017.

5. Maintain the current Station 1 location but not as an operational response station. This location could be referred to as Fire Headquarters. Fire Administration, Fire Prevention, Training, and seasonal apparatus could be housed at this location.

6. Continue to install traffic preemption technology on all signal controlled intersections.

Summary and Conclusions

The affordability and sustainability of a 6 minute response time target caused City Council to consider investigating amendments to the FSSP. The timing for this direction was good as Fire Services was beginning to incorporate new technology into its operations. These technologies included traffic preemption and Mobile CAD. Although these technologies were being incorporated with safety and efficiency improvements in mind, the actual effect on response times or response coverage have now been considered.

The analysis of these technologies has created promising predictive models. Through implementation of traffic preemption technology, Mobile CAD, dispatch pre-alert, relocation of two of the three existing fire stations, and adoption of the new NFPA 1710 response time standard, Fire Services Administration predicts that the Department can achieve 95% coverage (residential).

From a financial perspective, The City of Medicine Hat may be able to operate Fire Services from three response stations longer than planned in the FSSP, providing a high level of service while delaying substantial increases in operating costs.

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