CITYGATE ASSOCIATES, LLC
FOLSOM (SACRAMENTO), CA MANAGEMENT CONSULTANTS

FIRE SERVICE STANDARDS OF RESPONSE COVERAGE DEPLOYMENT STUDY FOR THE CITY OF SAN DIEGO FIRE-RESCUE DEPARTMENT

VOLUME 1 OF 2 – MAIN REPORT

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EXECUTIVE SUMMARY

The City of San Diego retained Citygate Associates, LLC to conduct a Fire Services deployment planning study to:

- Further refine the findings of the Regional Fire Service Deployment Study Citygate conducted for the County of San Diego that pertained to Fire-Rescue deployment within the City of San Diego;
- Analyze whether the San Diego Fire-Rescue Department's performance measures are appropriate and achievable given the risks, topography and special hazards to be protected in the City of San Diego;
- Review existing Fire-Rescue Department deployment and staffing models for efficiency and effectiveness and determine how and where alternative deployment and staffing models could be beneficial to address current and projected needs.

The commissioned study was to include:

- A Standard of Response Cover planning analysis (fire station and crew deployment) to examine the levels of firefighting personnel, stations and equipment;
- Fire station and staffing infrastructure triggers for additional resources, if needed;
- Order of magnitude costs and possible financing strategies for changes to the Fire-Rescue Department.

This comprehensive study is presented in several sections including: this Executive Summary summarizing the most important findings and recommendations; the fire station/crew deployment analysis supported by maps and response statistics; and the fiscal costs associated with the proposed recommendations.

It needs to be stated at the front of this study that the Citygate Associates team member who spent time in the City of San Diego found the fire staff at all levels very cooperative and helpful. They are committed to their city, agency, and mission. Given the struggle to keep service levels strong while coping with tight revenues, there is pride and ongoing effort to deliver the best customer service with the currently available resources. Fires are being suppressed and medical calls are being answered with excellent patient care.

We find that even with the suggested improvements identified in this report that can be accomplished over time, at present the City of San Diego Fire-Rescue Department is one of the best metropolitan agencies we have had the pleasure of working with. This study needs to be taken in the context of a "best practices tune-up" for a good agency that does very well with the limited resources given to it.

CITY LEADERSHIP POLICY CHOICES FRAMEWORK

As a starting point, San Diego City leadership needs to remember that there are no mandatory federal or state regulations directing the level of fire service staffing, response times and outcomes. Thus, communities have the level of fire services that they *can afford*, which is not always what they would desire. However, the body of regulations on the fire service provides that *if fire services are provided at all, they must be done so with the safety of the firefighters and citizens in mind* (see regulatory discussion on page 18). Given this situation, the overall challenge for the City is to design fire services within the fiscal constraints that limit the City's ability to staff, train and equip a safe and effective fire/medical response force.

Moreover, it must be acknowledged that the deep and prolonged recession has negatively impacted local government finances and a projected slow recovery will likely constrain the City's ability to fund and fully implement the added resource recommendations of this study.

STUDY PHILOSOPHY FRAMEWORK

In technical studies such as this one, it is all too easy to initially assess isolated data and make quick, non-comprehensive conclusions. The reason this result is so natural is that it follows the familiar thought patterns to which all fire-related parties are accustomed. In contrast with this limited way of thinking, as the Citygate and San Diego Fire-Rescue senior staff worked on this project, Citygate suggested an approach that focused on the "big picture" and desired outcomes at a more comprehensive level. We chose to start with and keep this larger framework in mind to ensure that the final analytical results met the specific, long-term needs of the City of San Diego, including:

- Why – Does San Diego Fire-Rescue exist?

  To provide neighborhood response to mitigate and terminate emergencies while small. To lessen the human and economic impacts of threatening situations.

- How – Does San Diego Fire-Rescue lessen emergency severity?

  With a layered multi-hazard service approach, sensitive to risks, population densities and demands for service.

- What – Does San Diego Fire-Rescue do to control emergencies?

  Deploy the appropriate type of unit for quick first response, followed up as needed with multiple diverse units for complex emergencies.

OVERALL CITYGATE PERSPECTIVE ON THE STATE OF SAN DIEGO CITY'S FIRE SERVICES

In brief, Citygate finds that the challenge of providing fire services in San Diego City is similar to that found in many California cities: providing an adequate level of fire services within the

context of limited fiscal resources, competing needs, growing populations and the uncertainty that surrounds the exact timing and location of future development.

The City has recognized the value of fire prevention and the need to prevent or limit the severity of fires, given the type of housing stock, commercial buildings, younger and elderly residents and the threat of wildland fires on the City's edges. To meet these challenges, the City has adopted safety codes more strenuous than those mandated by state minimums. One example is the wildland fuel management programs.

The City of San Diego does *not* have adequate fire station coverage in all areas, due to the inability to fund fire service expansion as the City developed. Due to recent economic conditions, the City has struggled to even maintain the pre-recession level of daily firefighter staffing as the population and calls for service demands continue.

Citygate's deployment study findings *do recommend* that the City of San Diego needs additional fire stations over time as fiscal conditions allow. The improvements can be phased and some alternative approaches can be tried for smaller areas. However, given the number of additional fire stations necessary, alternative measures alone will not mitigate the entire need for more fire stations and/or units, *if the City wants to deliver fire service to the level of its current performance standards*.

Citygate evaluated all aspects of the Department's deployment system during the preparation of this study. We met extensively with the Command and Field Operations staffs and built comprehensive geographic mapping coverage models. To supplement what the geographic map models predict coverage will be, we also deeply analyzed three years of incident response data. We then met several times with staff to match the analysis results with their real world experience. Finally, we worked together to align Citygate's findings with fire deployment master plans already in place in the Department.

It should be noted that the data measures in this report were for three years before the economic-crisis-driven "brownout" reductions of eight engine companies per day that began on February 6, 2010. Thus, the response time performance in this study is the best that the system delivers with all previously budgeted resources available. This study did not analyze performance after the brownouts were operating.

In this report, Citygate makes observations, key findings and, where appropriate, specific action item recommendations that deserve specific and particular consideration. Overall, there are 15 key findings and 8 specific action item recommendations.

THE MAIN CHALLENGE

One can summarize the fire service deployment challenge that faces the City by stating that at the City's desired firefighting response time performance measures, there are just not enough fire crews and stations in all areas. The deployment system was challenged to grow as the City

extended beyond the urban core into areas bisected by canyons and hills in the coastal areas of San Diego County. The topography and resultant non-grid road network makes efficient fire station spacing very difficult, thus raising the number of needed stations, which even in good economic times were a challenge to provide.

Over the years, the City spaced fire stations in the center of new growth areas, but did not backfill with other stations and fully interconnect the fire station system to provide equitable response time performance to all substantially developed neighborhoods. Thus, response time gaps occurred and have accumulated over the last several decades of growth. This issue did not occur quickly and, given the size of what will be needed to improve the deployment system, improvements will take years.

Field Operations Deployment (Fire Stations and Staffing)

Fire department deployment, simply stated, is about the *speed* and *weight* of the attack. Speed calls for first-due, multi-hazard intervention units (engines, ladder trucks and specialty companies) strategically located across a department. These units are tasked with controlling everyday, average emergencies without the incident escalating to second alarm or greater size, which then unnecessarily depletes the department's resources as multiple requests for service occur. Weight is about multiple-unit response for significant emergencies like a "room and contents structure fire," a multiple-patient incident, a vehicle accident with extrication required, or a complex rescue or wildland fire incident. In these situations, departments must assemble enough firefighters in a reasonable period in order to control the emergency safely without it escalating to greater alarms.

In Section 2 of this study, Standards of Response Cover (Station/Staffing) Analysis, Citygate's analysis of prior response statistics and use of geographic mapping tools reveals that the City has *a significant fire station location and staffing issue to rectify as fiscal resources allow*.

While no one city (even a metropolitan one) can stand by itself and handle everything and any possibility without help, a desirable goal is to field enough of a response force to handle a community's day-to-day responses for primary single-unit response needs equitably to all neighborhoods, as well as be able to provide an effective initial response force (first alarm) to moderately serious building fires.

In summary, the 2009 total citywide total response times are presented below.

For priority serious medical incidents, the following fractile results for total response time (fire dispatch receipt of call to first unit arrived) were:

Measure	90% Minute Goal	Goal Source	Actual Performance
Fire Receipt to Arrival	<= 06:00	Current City of SD	49.7%
Fire Receipt to Arrival	<= 07:30	Citygate Recommendation	77.2%
Fire Receipt to Arrival	<= 08:50	City of SD Actual Compliance	90.2%

The current City goal point is equivalent to 6 minutes total response time from fire dispatch receiving the call.

Travel time – Here are the citywide travel time measures for 2009 to serious medical incidents. While not inclusive of fires, given the high number of EMS incidents, this measure is the most descriptive of citywide fire crew response time performance:

Measure	90% Minute Goal	Goal Source	Actual Performance
Travel	<= 04:00	Desired San Diego City Performance Minute	55.2%
Travel	<= 06:20	Actual Performance Minute	90.9%

Effective Response Force – Where 3 engines, 1 ladder truck and 1 battalion chief all arrived:

Measure	90% Minute Goal	Goal Source	Actual Performance
Fire Receipt to Arrival	<= 10:00	Current City of SD	49.8%
Fire Receipt to Arrival	<= 10:30	Citygate Recommendation	55.4%
Fire Receipt to Arrival	<= 15:00	City of SD Actual Compliance	89.7%

GEOGRAPHIC COVERAGE CHALLENGES

A natural question becomes, at what minute of travel does the existing station network reach 90 percent coverage of the current public street network? The table below shows the public (not military or private) road miles covered for each minute of fire crew travel time:

Public Road Miles Covered per Minute of Fire Crew Travel Time

	Existing Station Coverage	
Travel Time	**Miles**	**Percent Covered**
4 Minute	2,329	60.32%
5 Minute	3,146	81.50%
6 Minute	3,544	91.80%
Total	**3,860**	**100.00%**

While it may appear to be easy to add fire stations to increase coverage per minute of travel, this study will explain in detail that given the topography and road network in the City of San Diego, it is difficult and expensive to extend coverage out to the distal ends of the road network. This is because past a certain point, each new station adds very little new coverage as the remaining gaps become smaller and smaller.

FINDINGS AND RECOMMENDATIONS

Citygate's deployment findings and recommendations are listed below. For reference purposes, the findings and recommendation numbers refer to the sequential numbers in the main body of the report.

Finding #1: While the City has developed fire deployment goals, they can be improved to include a beginning time measure starting from the point of fire dispatch receiving the 911-phone call, and a goal statement tied to risks and outcome expectations. The deployment measure should have a second measurement statement to define multiple-unit response coverage (Effective Response Force) for serious emergencies. Making these deployment goal changes will strengthen the measures and meet the best practice recommendations of the Commission on Fire Accreditation International and the NFPA.

Finding #2: The City of San Diego is very difficult to cover efficiently with a cost-effective quantity of fire stations due to the non-grid street network and very difficult coastal topography with canyons, mesas and other natural barriers.

Finding #3: Much of the City is substantially developed and is of urban and suburban population densities. Given the populations and diverse risks in the developed areas, the City should have fire service deployment goals to deliver an urban level of first-due fire unit coverage, which would be 4 minutes of travel time for the best possible outcomes in the most populated areas and 5 minutes travel in the less populated and lighter risk zones.

Finding #4: Increasing coverage at the 4th minute of travel would require 27 additional fire stations increasing total station coverage to 72 percent of the public road network.

Finding #5: If the policy choice were to implement a deployment model balanced to provide the entire City 5 minutes of travel time coverage from a neighborhood response resource, then 19 additional stations would extend coverage to 90 percent of the public road network. While adding one minute to the travel time places it one minute above the NFPA 1710 national best practice recommendation, it is a reasonable adjustment given the City's complex road network and difficulty in achieving 4-minute travel time coverage, even with an extraordinary expense in fire stations that would only cover just a few miles of roads past the 4th minute.

Finding #6: In addition to the need for multiple neighborhood based first-response units, based on the first alarm concentration gap analysis of ladder truck and battalion chief coverage, improving citywide first alarm effectiveness at 8 minutes travel to 90 percent of the public road network will also require the addition of 4 ladder trucks and 2 battalion chief units.

Finding #7: Emergency incident requests are evenly distributed over the months, week of the year and day of week. This means that the deployment model should not have widely different staffing patterns. The Department needs a constant baseline of response resources.

Finding #8: There is tapering off of emergency incident demand from midnight to 7 AM. As the day becomes busy the hourly demand for service is fairly high and constant from 10 AM to 7 PM. Peak activity units on partial day staffing such as the paramedic ambulances are already deployed on assist areas at peak hours experiencing high simultaneous calls for service.

Finding #9: San Diego Fire-Rescue's ambulance call processing times are consistent with national call sorting practices. The Department needs to place greater emphasis on procedures to get the first-due engine dispatched in less time, closer to the ambulance performance point.

Finding #10: For crew turnout time performance, San Diego Fire-Rescue excels in this area and is the largest department Citygate has seen to perform this well at the 90-second point for structure fire turnout time.

Finding #11: The citywide and individual fire station area *travel* times correlate with the geographic model travel time predictions, in that there are not enough fire stations in some areas to achieve the City's 4-minute *travel* time to 90 percent of the

incidents in urban areas. This is due to a combination of not enough fire stations combined with the effects of a non-grid street network in other areas.

Finding #12: The incident response measures for a Full Effective Response Force show that outside of three fire station areas in the downtown core, none of the other 44 fire station areas can deliver 3 engines and 1 ladder truck to 90 percent of building fires within a desired goal point of 10:30 minutes total response time, of which 8 minutes is travel time. The fire station areas are too large, there are not enough stations, and some units are busy and unavailable at peak hours of the day.

Finding #13: The message from the deficient response time analysis tables is that within the 24.46 percent or 25,834 Priority 1 calls with response times exceeding City goals, there are 8,203 that exceed 9 minutes and *this occurs every hour somewhere, every day*. In the nine peak hours where performance is the most deficient, every hour period for all 365 days, has at least one Priority 1 incident with the first due unit arriving *2 minutes later* than the desired goal point.

Finding #14: Due to very high call for service volumes in the downtown core, and the vertical (high-rise) building populations, multiple units and stations will be always be needed to cover not just geographic travel time, but to provide enough units at peak demand hours to maintain adequate customer service to all incidents.

Finding #15: The current technology to alert fire stations crews of what and where to respond is 21 years old, technically obsolete and, in many cases, inserts unnecessary time delays into the crew dispatching process.

Based on the above findings, Citygate's recommendations are:

Recommendation #1: **Adopt Revised Deployment Measures:** The City should adopt revised performance measures to direct fire crew planning and to monitor the operation of the Department. The measures should take into account a realistic company turnout time of 1:30 minutes and be designed to deliver outcomes that will save patients medically salvageable upon arrival; and to keep small, but serious fires from becoming greater alarm fires. Citygate recommends these measures be:

1.1 **Distribution of Fire Stations:** To treat medical patients and control small fires, the first-due unit should arrive within 7:30 minutes, 90 percent of the time from the receipt of the 911 call in fire dispatch. This equates to 1-minute dispatch time, 1:30 minutes/seconds company turnout time and 5 minutes drive time in the most populated areas.

1.2 **Multiple-Unit Effective Response Force for Serious Emergencies:** To confine fires near the room of origin, to stop wildland fires to under 3 acres when noticed promptly and to treat up to 5 medical patients at once, a multiple-unit response of at least 17 personnel should arrive within 10:30 minutes/seconds from the time of 911-call receipt in fire dispatch, 90 percent of the time. This equates to 1-minute dispatch time, 1:30 minutes/seconds company turnout time and 8 minutes drive time spacing for multiple units in the most populated areas.

Recommendation #2: **Adopt Fire Station Location Measures:** To direct fire station location timing and crew size planning as the community grows, adopt fire unit deployment performance measures based on population density zones in the table below. The more specific, measurable and consistent the policy is, the more it can be applied fairly to all uses and easily understood by a non-fire service user.

Proposed Deployment Measures for San Diego City Growth

By Population Density Per Square Mile

	Structure Fire Urban Area	Structure Fire Rural Area	Structure Fire Remote Area	Wildfires Populated Areas
	>1,000-people/sq. mi.	1,000 to 500 people/sq. mi.	500 to 50 people/sq. mi. *	Permanent open space areas
1st Due Travel Time	5	12	20	10
Total Reflex Time	7.5	14.5	22.5	12.5
1st Alarm Travel Time	8	16	24	15
1st Alarm Total Reflex	10.5	18.5	26.5	17.5

* Less than 50 people per square mile there is acknowledgment that fire and EMS services are going to be substandard.

Recommendation #3: **Aggregate Population Definitions:** Where more than one square mile is not populated at similar densities, and/or a contiguous area with different zoning types aggregates into a population "cluster," these measures can guide the determination of response time measures and the need for fire stations:

Area	Aggregate Population	First-Due Unit Travel Time Goal
Metropolitan	> 200,000 people	4 minutes
Urban-Suburban	< 200,000 people	5 minutes
Rural	500 - 1,000 people	12 minutes
Remote	< 500	> 15 minutes

Recommendation #4: **Near Term Deployment Options:** As the City struggles with the economic downturn, it should consider this phasing of deployment changes:

- Do nothing
- Add back the 8 brownout engines
- Add back some of the 4-firefighter brownout engines as peak hour demand units*
- Implement gap area engines and/or Fast Response Squads.*

  * *Meet and confer on impacts, work schedules, position compensation.*

Recommendation #5: **Adopt the Priority Criteria of this Study for Where to Add Resources:** Use of the tools and methods in this study would result over time as resources allow the addition of:

- 10 additional 4-firefighter staffed engine companies
- 9 new "Fast Response Squads"
- 4 additional aerial ladder trucks
- 2 additional field battalion chiefs.

Recommendation #6: **Fire Engine Dispatch Process:** The Department has to improve the procedures to achieve a decrease of the dispatch queue time for the first responding engine company.

Recommendation #7: **Fast Response Squads:** The Department should immediately begin detailed planning to fully design and cost a pilot program of two-firefighter Fast Response Squads to assist in smaller deployment gaps where there are high simultaneous incident workloads. Unit type and capabilities are defined in Section 2.7.9.

Recommendation #8: **<u>Replace In-Station Alerting System:</u>** The City should make it a priority to replace the 21-year-old fire crew in-station alerting system at an approximate cost of $3.4 million. This will improve response times via a one-time capital expense without adding any more response crews.

<u>Additional Resources:</u> If the City can provide the revenue to improve response times, these are Citygate's recommended sites in Citygate's priority order to improve service in the identified gap areas:

Citygate Priority	FRS Eligible	Sites @ 5-min to 90%	Additive Population Per Gap 5-min	Additive Calls Per Gap 5-min
1	NO	Home Ave	10,271	683
2	NO	Paradise Hills	11,486	787
3	NO	College	6,729	403
4	NO	Skyline	19,803	1,384
5	YES	Encanto	9,715	710
6	NO	Stresemann / Governor	8,670	597
7	NO	Mission Bay / Pacific Beach	19,011	1,935
8	NO	UCSD	10,248	1,283
9	YES	Liberty Station	2,117	1,127
10	YES	University City	4,753	456
11	NO	Torrey	11,946	567
12	NO	Serra Mesa	15,646	1,553
13	NO	Mira Mesa	1,437	393
14	YES	East Otay	634	140
15	YES	Scripps Miramar	4,867	160
16	YES	San Pasqual	21	130
17	YES	Linda Vista	6,371	501
18	YES	Black Mountain Ranch	1,384	51
19	YES	Mission Valley	16,174	1,517
	9 FRS's	**Total:**	**161,283**	**14,377**

Improving response capability to all 19 gaps using a 5-minute travel time model achieves the following:

- 161,283 residents receive improved coverage by at least 1-minute travel time;
- 14,377 incidents receive improved service;
- A mix of 19 resources also adds weight of attack to first alarm coverage as well as depth of capacity in high workload areas;
- Sites 11 through 19 only add 10 miles of new coverage each;
- Of these 19 sites, Citygate believes 6 are the most critical, taking into consideration all the factors. Just these 6 sites would improve service to 66,674 residents and 4,564 delayed response time incidents. They are:
  - Home Avenue
  - Paradise Hills
  - College
  - Skyline
  - Encanto
  - Stresemann/Governor.
- For improved ladder truck and battalion chief coverage, the geographic and workload analysis concluded that the system needs:
  - Four (4) additional ladder trucks
  - Two (2) additional field battalion chief units.

COSTS AND SUGGESTED PHASING

If the City decides to add these enhancements as recommended by Citygate, the table below provides the associated annual estimated cost in FY 10-11 dollars:

Operating Macro Costs

Resource – Staff & Operating	Cost in $ Millions	Quantity for 5-Minute Coverage @ 90%	Totals
2-FF Fast Response Squads	1.0	9	9.0
Single engine staffed station	2.2	6	13.2
Double staffed station	4.4	4	17.6
Batt Chief	0.53	2	1.1
Total			**$40.9**

Capital Macro Costs

Resource	Cost in $ Millions	Quantity for 5-Minute Coverage @ 90%	Totals
Engine	0.78	10	7.8
Ladder	1.1	4	4.4
Fast Response Squad	0.4	9	3.6
Single station	7	6	42.0
Double station	8	4	32.0
Fast Response Squad Station	.5	9	4.5
Replace Fire Station Crew Alert System	3.4	-	3.4
Total			**$97.7**

PRIORITIES AND TIMING

Some of the recommendations in this planning effort requiring minimal additional resources can be worked on in parallel. Others will take several fiscal years, both in time and funding. Given these two realities, Citygate recommends two short-term priorities and one long-term priority:

Short-Term Priority One

- Absorb the policy recommendations of this fire services study and adopt revised Fire Department performance measures to drive the deployment of firefighting and emergency medical resources.
- Create a task force to fully study the Fast Response Squad concept. Bring forward an implementation pilot project and costs.

Short-Term Priority Two

- Add back brownout engines per the priority methodology used in this study.
- Identify revenues to replace the failing fire station alerting system to ensure timely incident notification to emergency responders.
- Identify revenue sources to increase the Department's deployment system.
- Add additional primary engine and Fast Response Squads as revenues allow.

Long-Term Priority

- Monitor the performance of the deployment system using adopted deployment measures and the methods in this study.

SECTION 1—INTRODUCTION AND BACKGROUND

1.1 REPORT ORGANIZATION

This report is structured into the following sections that group appropriate information together for the reader.

This Volume (**Volume 1**) includes:

Section 1 Introduction and Background: Background facts about the City of San Diego's current Fire Services.

Section 2 Standards of Response Cover (Staffing/Station) Analysis: An in-depth examination of the Fire Department's deployment ability to meet the community's risks, expectations and emergency needs.

Section 3 Fiscal Impacts: An outline of the costs to implement this study's recommendations.

Separately attached:

Volume 2 Map Atlas

1.1.1 Goals of Report

As each of the sections mentioned above imparts information, this report will cite findings and make recommendations, if appropriate, that relate to each finding. There is a sequential numbering of all of the findings and recommendations throughout Section 2 of this report. To provide a comprehensive summary, a complete listing of all these same findings and recommendations in order is shown in the Executive Summary. Finally, the report brings attention to the highest priority needs and possible timing in Section 3.

This document provides technical information about how the City's fire services are currently deployed and, if deficiencies exist, what the options are to address them. This information is presented in the form of recommendations and policy choices for the City of San Diego leadership and community to discuss.

The result is a solid technical foundation upon which to understand the advantages and disadvantages of the choices facing the City of San Diego leadership and community on how best to provide fire services, and more specifically, at what level of desired outcome and expense as the City deals with the results of the negative national and local economy.

1.1.2 Limitations of Report

In the United States, there are no federal or state regulations on what a minimum level of fire services has to be. Each community, through the public policy process, is expected to

understand the local fire risks, their ability to pay, and then to choose their level of fire services. **If** fire services are provided at all, the federal and state regulations specify how to do it safely for the personnel providing the service and the public.

While this report and technical explanation can provide a framework for the discussion of fire services for the City of San Diego, neither this report nor the Citygate consulting team can make the final decisions or cost out in detail every possible alternative. Once policy choices are given approval, City staff can conduct any final costing and fiscal analysis as normally done in the operating and capital budget preparation cycle.

It should be noted that the data measures in this report were for three years before the economic-crisis-driven "brownout" reductions of eight engine companies per day that began on February 6, 2010. Thus, the response time performance in this study is the best that the system delivers with all previously budgeted resources available. This study did not analyze performance after the brownouts were operating.

1.2 BACKGROUND

This project involved the development of a Fire Services deployment analysis. This effort involved the study of the fire services risk within the City of San Diego. In this report, the term "Department" will be used when referring to San Diego Fire-Rescue itself, and the term "City" will be used when referring to the City of San Diego.

The Mayor's Office commissioned this study and resultant planning recommendations to evaluate the current capacity of the Department to respond to emergency fire, rescue, and medical incidents within its area. The study was to:

- Further refine the findings of the Regional Fire Service Deployment Study Citygate conducted for the County of San Diego that pertained to Fire-Rescue deployment within the City of San Diego;
- Analyze whether the San Diego Fire-Rescue Department's performance measures are appropriate and achievable given the risks, topography and special hazards to be protected in the City of San Diego;
- Review existing Fire-Rescue Department deployment and staffing models for efficiency and effectiveness and determine how and where alternative deployment and staffing models could be beneficial to address current and projected needs;
- Provide an in-depth Standard of Response Cover planning analysis (fire station and crew deployment) to examine the levels of firefighting personnel, stations and equipment;
- Identify fire station and staffing infrastructure triggers for additional resources, if needed;

- Present order of magnitude costs and possible financing strategies for changes to the Fire-Rescue Department.

In its entirety, this analysis and corresponding findings and recommendations will allow the City to make informed policy decisions about the level of fire services desired and the best method to deliver and fund them.

The challenges facing the City are not unique. At the start of this project in the fall of 2010, the City faced the challenges that all California communities did with revenue not matching needs in an atmosphere made worse by a state budget deficit. This Fire Service deployment study has to acknowledge that the City may desire improved fire services, but in the near term cannot afford any improvements. Thus, the plan will have to suggest how to prioritize existing services to revenues, while laying out a road map for future improvements that can be followed as revenue growth occurs.

1.3 City of San Diego Project Approach and Research Methods

Citygate used several tools to gather, understand, and model information about the City and Department for this study. We started by making a large document request to the Department to gain background information on costs, current and prior service levels, the history of service level decisions and what other prior studies, if any, had to say.

In subsequent site visits, the Citygate team member followed up on this information by conducting focused interviews of fire management team members and other appropriate City staff. We reviewed demographic information about the City, proposed developments, and managed growth projections. As we collected and understood information about the City and Department, Citygate obtained electronic map and response data from which to model current and projected fire services deployment. The goal was to identify the location(s) of stations and crew quantities required to serve the City as it develops.

Once Citygate gained an understanding of the Department service area with its fire, rescue, and EMS risks, the Citygate team developed a model of fire services that was tested against the mapping and prior response data to ensure an appropriate fit. This resulted in Citygate being able to propose an approach to deploying fire services that would also meet reasonable expectations and fiscal abilities.

1.4 City of San Diego Fire-Rescue Department Background Information

The City of San Diego is the second largest city by population in California and the eighth largest in the nation. It is a vibrant, thriving city vitally important to the state and national economy. The City is very diverse in the types of risks to be protected by San Diego's Fire-Rescue Department. The City has most every type of firefighting and technical rescue risk found in the United States today, except for a major oil refinery. Most hazardous chemicals and

commodities can be found in San Diego's businesses, the port and shipping transportation community.

The physical building structures also are very diverse from the international airport terminal to 205 high-rise buildings to cruise ships and suburban single-family homes. According to the State of California Finance Department, in January 2010, the City's resident population was 1,376,173. This figure does not include the daily workforce that comes in from other communities, tourism, military personnel, the airports, the port and what is on the road network passing through the county.

Over an operational area approximately 342 square miles, San Diego Fire-Rescue has to be deployed to handle anything from a single-patient medical emergency in an easy-to-access situation such as a home, to emerging serious fires in complex buildings. Just the international airport handles over 30,000 passengers per day, which is larger than the entire population of Coronado or Lemon Grove.

Then there are the special industrial risks, including the oceanfront beaches, Mission Bay, the sports venues, and the extreme wildland fire risk.

For disasters, the City has to be prepared to handle most of what any place in the world might experience. Serious storms, earthquakes, major airplane crashes and two historic wildland fires have brought serious damage to the City over its lifetime.

The challenge faced by the City is to protect these risks, which occur in very different quantities and locations. Just the resident population density alone varies greatly from the highest in the downtown high-rise core to suburban Rancho Bernardo for example. Thus, San Diego is a collection of diverse communities, not a singular entity with few and homogenous risks to protect.

1.4.1 Deployment Challenge Questions

Such a spread of risks across a very diverse topography creates several challenging questions: Should there be a baseline, somewhat equal, protective effort to all neighborhoods and then a larger, more technical response, to key risks that are above the baseline amount? Should the baseline deployment system be staffed higher where high call for service counts occur or spread out thinly to cover the vast geography? The details in this study will address all of these issues.

1.5 Regulation Affecting the Fire Service

In addition to restrictions on local government finance, there have been a number of newer state and federal laws, regulations, and court cases over the last decade that limit the flexibility of cities in determining their staffing levels, training, and methods of operation. These are given an abbreviated overview below:

- 1999 OSHA Staffing Policies – Federal OSHA applied the confined space safety regulations for work inside tanks and underground spaces to America's firefighters. This requires in atmospheres that are "IDLH" (Immediately Dangerous to Life and Health) that there be teams of two inside and two outside in constant communication, and with the outside pair equipped and ready to rescue the inside pair. This situation occurs in building fires where the fire and smoke conditions are serious enough to require the wearing of self-contained breathing apparatus (SCBA). This is commonly called the "2-in/2-out" policy. This policy requires that firefighters enter serious building fires in teams of two, while two more firefighters are outside and immediately ready to rescue them should trouble arise.

- While under OSHA policy one of the outside "two-out" personnel can also be the incident commander (typically a chief officer) or fire apparatus operator, this person must be fully suited-up in protective clothing, have a breathing apparatus donned except for the face piece, meet all physical requirements to enter IDLH atmospheres and thus be ready to immediately help with the rescue of interior firefighters in trouble.

- May 2001 National Staffing Guidelines (NFPA 1710) – The National Fire Protection Association (NFPA) Standard on Career Fire Service Deployment was issued ten years ago. While *advisory* to local governments, as it starts to become locally adopted and used, it develops momentum, forcing adoption by neighboring communities. NFPA 1710 calls for four-person fire crew staffing, arriving on one or two apparatus as a "company." The initial attack crew should arrive at the emergency within four minutes travel time, 90 percent of the time, and the total effective response force (first alarm assignment) shall arrive within eight minutes travel time, 90 percent of the time. These guidelines will be explained and compared to the City of San Diego in the deployment measures section of this document.

- The on-scene incident commanders (battalion chiefs) at hazardous materials incidents must have certification compliant with NFPA 472, *Standard for Emergency Response to Hazardous Materials Incidents*. This is also now an OSHA requirement.

- CAL OSHA Requirements – Among the elements required is a safety orientation for new employees, a hazard communications system for employees to communicate hazards to supervisors, the CAL-OSHA process for post-injury reviews, the required annual report of injuries, and a standard for safety work plans. Employers have many different responsibilities under the Occupational Safety and Health Act of 1970 and the Code of Federal Regulations (CFR). Initially OSHA focused its efforts on the private sector; more recently, it has

turned its attention to the public sector and specifically the fire service. All of this raises (appropriately for safety) fire agency training and equipment costs.

1.6 Negative Pressures on Volunteer-Based Fire Services

While the City of San Diego does not operate a volunteer firefighter system, wholly or in part, a common question is why not solve some of a city's fire staffing problems with volunteers? To pre-address this question, here is a brief overview of the state of depending on volunteer firefighters:

All volunteer-based fire departments are under great pressure today to maintain an adequate roster. The reasons for this are not unique to any one type of community and are placing pressure on small community volunteer systems across the state and nation:

- Economic pressures result in more two-income families and less time to volunteer.
- In a commuter economy, more jobs are clustered in metropolitan and dense suburban areas. Communities throughout the City of San Diego increasingly have residents who work elsewhere, and many of the younger age people who would consider volunteering are just too busy.
- Due to the growth in society of complex systems and technology, the fire service was given more missions, like emergency medical services, hazardous materials response, and technical rescue. This dramatically increased the legally mandated training hours for volunteers, causing many to drop out as the time commitments became unbearable.

This change, coupled with all the other factors, means that volunteer firefighter programs dry up due to lack of members. Additional training and additional responses mean a significant time commitment for "true" volunteers, who are serving for love of the community and to give something back. Most departments feel that it takes 100-120 hours of training per year to meet safety minimums, and this time is expended before a volunteer goes on a single incident.

As this report will explain in detail, City of San Diego fire services are already spread thin. Even if a small volunteer cadre could be found to assist with non-emergency work, volunteer programs take design, supervision, and some fiscal support. In Citygate's opinion, the needs of the City of San Diego Fire-Rescue Department far outweigh what a small volunteer or per diem apprentice firefighter program could solve. More importantly, just creating and operating such a program would drain the already thin administrative staffing from managing critical day-to-day operations.

SECTION 2—STANDARDS OF RESPONSE COVER (STATION/STAFFING) ANALYSIS

Section Intent: This section serves as an in-depth analysis of the San Diego Fire-Rescue Department's current ability to deploy and meet the emergency risks presented in the City. The response analysis will use prior response statistics and geographic mapping to help elected officials and the community visualize what the current response system can and cannot deliver.

2.1 GENERAL FIRE DEPLOYMENT BACKGROUND INFORMATION

The Commission on Fire Accreditation International recommends a systems approach known as "Standards of Response Coverage" to evaluate deployment as part of the self-assessment process of a fire agency. This approach uses risk and community expectations on outcomes to assist elected officials in making informed decisions on fire and EMS deployment levels. Citygate has adopted this methodology as a comprehensive tool to evaluate fire station location. Depending on the needs of the study, the depth of the components can vary.

This study will also reference and use as benchmarks the best practice recommendations of other organizations, specifically the National Fire Protection Association (NFPA) and the Insurance Service Office (ISO).

The Standard of Response Coverage systems approach to deployment, rather than a one-size-fits-all prescriptive formula, allows for local determination of the level of deployment to meet the risks presented in each community. In this comprehensive approach, each agency can match local need (risks and expectations) with the costs of various levels of service. In an informed public policy debate, a city council "purchases" the fire, rescue, and EMS service levels (insurance) the community needs and can afford.

While working with multiple components to conduct a deployment analysis is admittedly more work, it yields a much better result than any singular component can. If we only look to travel time, for instance, and do not look at the frequency of multiple and overlapping calls, the analysis could miss over-worked companies. If we do not use risk assessment for deployment, and merely base deployment on travel time, a community could under-deploy to incidents.

The Standard of Response Cover process consists of eight parts:

1. Existing Deployment – each agency has something in place today.
2. Community Outcome Expectations – what does the community expect out of the response agency?
3. Community Risk Assessment – what assets are at risk in the community?
4. Critical Task Time Study – how long does it take firefighters to complete tasks to achieve the expected outcomes?

5. Distribution Study – the locating of first-due resources (typically engines).

6. Concentration Study – first alarm assignment or the effective response force.

7. Reliability and Historical Response Effectiveness Studies – using prior response statistics to determine what percent of compliance the existing system delivers.

8. Overall Evaluation – proposed standard of cover statements by risk type.

Fire department deployment, simply stated, is about the ***speed*** and ***weight*** of the attack. Speed calls for first-due, multi-hazard intervention units (engines, ladder trucks and specialty companies) strategically located across a department. These units are tasked with controlling everyday, average emergencies without the incident escalating to second alarm or greater size, which then unnecessarily depletes the department resources as multiple requests for service occur. Weight is about multiple-unit response for significant emergencies like a room and contents structure fire, a multiple-patient incident, a vehicle accident with extrication required, or a heavy rescue incident. In these situations, departments must assemble enough firefighters in a reasonable period in order to control the emergency safely without it escalating to greater alarms.

Thus, small fires and medical emergencies require a single- or two-unit response (engine and ambulance) with a quick response time. Larger incidents require more companies. In either case, if the companies arrive too late or the total personnel sent to the emergency are too few for the emergency type, they are drawn into a losing and more dangerous battle. The art of fire company deployment is to spread companies out across a community for quick response to keep emergencies small with positive outcomes, without spreading the stations so far apart that they cannot quickly amass enough companies to be effective in major emergencies.

Given the need for companies to be stationed throughout a community for prompt response instead of all companies responding from a central fire station, communities such as San Diego are faced with neighborhood equity of response issues. When one or more areas grow beyond the reasonable travel distance of the nearest fire station, the choices available to the elected officials are limited: add more neighborhood fire stations, or tell certain segments of the community that they have longer response times, even if the type of fire risk found is the same as other areas.

For the purposes of this fire services study, Citygate used all eight components of the Standards of Response Cover process (at varying levels of detail) to understand the risks in the City, how the City is staffed and deployed today, and then modeled those parameters using geographic mapping and response statistical analysis tools. The models were then compared to the proposed growth in the City so that the study can recommend changes, if any, in fire services to the City's service area.

Thus, Citygate tailored the deployment recommendations in this report to the City's unique needs, and did not only use one-size-fits-all national recommendations.

The next few subsections in this section will cover the City area factors and make findings about each component of the deployment system. From these findings of fact about the City's fire deployment system, the study is then able to make deployment change recommendations.

2.2 City of San Diego Community Outcome Expectations – What is Expected of the Fire-Rescue Department?

The next step in the Standards of Response Cover process is to review existing fire and emergency medical outcome expectations. This can be restated as follows: for what purpose does the current response system exist? Has the governing body adopted any response time performance measures? If so, the time measures used by the City need to be understood and good data collected.

The community, if asked, would probably expect that fires be confined to the room or nearby area of fire origin, and that medical patients have their injuries stabilized and be transported to the appropriate care location. Thus, the challenge faced by the City is maintaining an equitable level of fire service deployment across the entire City service area without adding significantly more resources as demand for services grows and traffic congestion increases, slowing response times.

The Insurance Services Office (ISO) Fire Department Grading Schedule would like to see first-due fire engines stations spaced 1.5 miles apart and ladder trucks spaced 2.5 miles apart, which, given travel speeds on surface streets, is a 3- to 4-minute travel time for first-due engines and a 7- to 8-minute travel time for first-due ladder trucks. The National Fire Protection Association (NFPA) guideline 1710 on fire services deployment suggests a 4-minute travel time for the initial fire apparatus response and 8 minutes travel time maximum for the follow-on units. This recommendation is for departments that are substantially staffed by career firefighters, as the City is.

The ISO grades community fire defenses on a 10-point scale, with Class 1 being the best. Historically, the City has been evaluated as a Class 3 department in its urban areas meaning the fire engine and ladder truck coverage is similar to many lighter suburban density fire departments. For many reasons, it is not necessary for an agency to only deploy to meet the ISO measures. The ISO criteria are designed to evaluate the fire protection system for the purposes of underwriting a department's ability to stop a building fire *conflagration*. The ISO system does not address small fires, auto fires, outdoor fires and emergency medical incidents. In addition, underwriters today can issue fire premiums in Grading Schedule "bands" such as 3-5 and give safer buildings a single rating of Class 1, for example.

Thus, if an agency only tries to meet the ISO or NFPA station placement criteria, they do not necessarily deliver better outcomes, given the diversity of risk across American communities. Importantly within the Standards of Response Coverage process, positive outcomes are the goal, and from that company size and response time can be calculated to allow efficient fire station

spacing. Emergency medical incidents have situations with the most severe time constraints. In a heart attack that stops the heart, a trauma that causes severe blood loss, or in a respiratory emergency, the brain can only live 8 to 10 minutes maximum without oxygen. Not only heart attacks, but also other emergencies can cause oxygen deprivation to the brain. Heart attacks make up a small percentage; drowning, choking, trauma, constrictions, or other similar events have the same effect on the brain and the same time constraints. In a building fire, a small incipient fire can grow to involve the entire room in a 4- to 5-minute time frame. The point in time where the entire room becomes involved in fire is called "flashover," when everything is burning, life is no longer possible, and the fire will shortly spread beyond the room of origin.

If fire service response is to achieve positive outcomes in severe EMS situations and incipient fire situations, ***all*** the companies must arrive, size up the situation and deploy effective measures before brain damage or death occurs or the fire spreads beyond the room of origin.

Given that the emergency started before or as it was noticed and continues to escalate through the steps of calling 911, dispatch notification of the companies, their response, and equipment set-up once on scene, there are three "clocks" that fire and emergency medical companies must work against to achieve successful outcomes:

- The time it takes an incipient room fire to fully engulf a room in 4 to 5 minutes, thus substantially damaging the building and most probably injuring or killing occupants.
- When the heart stops, the brain starts to die from lack of oxygen in 4 to 6 minutes and brain damage becomes irreversible at about the 10-minute point.
- In a trauma patient, severe blood loss and organ damage becomes so great after the first hour that survival is difficult if not impossible. The goal of trauma medicine is to stabilize the patient in the field as soon as possible after the injury, and to transport them to a trauma center where appropriate medical intervention can be initiated within one hour of the injury.

Somewhat coincidently, in all three situations above, the first responder emergency company must arrive on-scene within 5 to 7 minutes of the 911-phone call to have a chance at a successful resolution. Further, the follow-on (additional) companies for serious emergencies must arrive within the 8- to 11-minute point. These response times need to include the time steps for the dispatcher to process the caller's information, alert the stations needed, and the companies to then don OSHA-mandated safety clothing and drive safely to the emergency. The sum of these three time steps – dispatch, company turnout and drive time – comprises "total reflex," or total response time. Thus, to get the first firefighters on-scene within only 5 to 7 minutes of the 911-call being answered is very challenging to all parts of the system, as this study will describe later in detail.

The three event timelines above start with the emergency happening. It is important to note the fire or medical emergency continues to deteriorate from the time of inception, not the time the

fire engine actually starts to drive the response route. It is hoped that the emergency is noticed immediately and the 911 system is activated. This step of awareness – calling 911 and giving the dispatcher accurate information – takes, in the best of circumstances, 1 minute. Then company notification and travel take additional minutes. Once arrived, the company must walk to the patient or emergency, size up the problem and deploy their skills and tools. Even in easy-to-access situations, this step can take 2 or more minutes. It is considerably longer up long driveways, apartment buildings with limited access, multi-storied office buildings or shopping center buildings such as those found in parts of the City.

2.2.1 City of San Diego Existing Policy

The City's General Plan Safety element, last updated in 2008, states for the fire services goal in the Safety Element Section: "Protection of life, property, and environment by delivering the highest level of emergency and fire-rescue services, hazard prevention, and safety education"

This service level goal is further defined by these key policies for fire service *deployment* measures in Section PF-D.1:

- **PF-D.1**. Locate, staff, and equip fire stations to meet established response times. Response time objectives are based on national standards. Add one minute for turnout time to all response time objectives on all incidents.
  - Total response time for deployment and arrival of the first-in engine company for fire suppression incidents should be within four minutes 90 percent of the time.
  - Total response time for deployment and arrival of the full first alarm assignment for fire suppression incidents should be within eight minutes 90 percent of the time.
  - Total response time for the deployment and arrival of first responder or higher-level capability at emergency medical incidents should be within four minutes 90 percent of the time.
  - Total response time for deployment and arrival of a unit with advanced life support (ALS) capability at emergency medical incidents, where this service is provided by the City, should be within eight minutes 90 percent of the time.
- **PF-D.2.** Deploy to advance life support emergency responses EMS personnel including a minimum of two members trained at the emergency medical technician-paramedic level and two members trained at the emergency medical technician-basic level arriving on scene within the established response time as follows:

- Total response time for deployment and arrival of EMS first responder with Automatic External Defibrillator (AED) should be within four minutes to 90 percent of the incidents; and
- Total response time for deployment and arrival of EMS for providing advanced life support should be within eight minutes to 90 percent of the incidents.

- **PF-D.3.** Adopt, monitor, and maintain service delivery objectives based on time standards for all fire, rescue, emergency response, and lifeguard services.
- **PF-D.5.** Maintain service levels to meet the demands of continued growth and development, tourism, and other events requiring fire-rescue services.

  a. Provide additional response units, and related capital improvements as necessary, whenever the yearly emergency incident volume of a single unit providing coverage for an area increases to the extent that availability of that unit for additional emergency responses and/or non-emergency training and maintenance activities is compromised. An excess of 2,500 responses annually requires analysis to determine the need for additional services or facilities.

- **PF-D.6.** Provide public safety related facilities and services to assure that adequate levels of service are provided to existing and future development.
- **PF-D.7.** Evaluate fire-rescue infrastructure for adherence to public safety standards and sustainable development policies (see also Conservation Element, Section A).
- **PF-D.8.** Invest in technological advances that enhance the City's ability to deliver emergency and fire-rescue services more efficiently and cost-effectively.

The Fire-Rescue Department further defined these General Plan policies in its 2005 Standards of Response Cover Study and its budget performance measures as:

- A first responding four-person engine company shall arrive at the scene of an emergency within an average of five minutes or less from the time of page received.
- A unit with advanced life support capability will arrive at emergency medical incidents within five minutes 90 percent of the time, from point of dispatch.
- Truck companies will arrive at the scene of an emergency within an average of nine minutes from the time of page received.
- An effective response force will arrive at the scene of an emergency within 9 minutes or less 95 percent of the time from the time of page received.

- The Hazardous Incident Response Team will arrive at scene within 60 minutes from point of dispatch 90 percent of the time to the contract provided service area.
- The Aviation Rescue and Firefighting units at the San Diego International Airport will arrive at the mid-point of the runway within three minutes of alarm received.
- The Urban Search and Rescue Task Force will be capable of mobilizing within a four-hour timeframe for an over-the-road response and six hour timeframe for an air response.
- The first-in engine company will place one line in-service at 150 gallons per minute (GPM) and initiate mitigation efforts within one minute of arrival.
- An effective response force for a low risk occupancy will place a water supply in service at a minimum 400 GPM for 30 minutes and include: one attack line in service with two firefighters at 150 GPM, a second attack line with two firefighters at a minimum of 150 GPM, one ventilation team consisting of two firefighters, one search and rescue team consisting of two firefighters, establish command outside the hazard area with a dedicated position and the capability of flowing 400 GPM without interruption
- An effective response force for medium risk occupancy will provide in addition to resources for low risk the capability to flow 1,000 GPM without interruption, two ventilation teams, two search and rescue teams, and a rapid intervention crew of four firefighters.
- An effective response force for a high risk occupancy will provide in addition to resources for low and medium, two, 2 ½ inch attack lines in-service, one on the fire floor and one on the floor above, one additional ventilation team, one additional search and rescue team, establish lobby control as well as overall command, and supplement the fire protection systems as needed.

2.2.2 Critique of San Diego City Response Measures

Current best practice nationally is to measure percent completion of a goal (i.e., 90 percent of responses) instead of an average measure, as many fire departments did in the past. Response goal measures should start with the time of fire dispatch receiving the 911-call to the arrival of the first unit at the emergency, and the measure should state what is delivered and what the expected outcome is desired to be.

Percent of completed goal measures are better than the measure of average, because average just identifies the central or middle point of response time performance for all calls for service in the data set. From an average statement, it is impossible to know how many incidents had response times that were considerably over the average or just over. For example, if a department had an average response time of 5 minutes for 5,000 calls for service, it cannot be determined how many

calls past the average point of 5 minutes were answered slightly past the 5th minute, in the 6th minute or way beyond at 10 minutes. This is a significant issue if hundreds or thousands of calls are answered much beyond the average point.

The City of San Diego General Plan Goal and policy statements are generally consistent with best practices, but in key parts are too vague to be measurable. For example, "national standards" are not defined and on other occurrences, the specific begin and end point of "total response time" are not stated to allow for measures that can use existing dispatch time records. Some goal statements include total response time, but the minutes cited are actually *travel* time from national recommendations.

Some of the Fire-Rescue Department's measures use "average" instead of percent of goal statements; others use percent of goal and the begin and end time terminology in some vary.

Finding #1: While the City has developed fire deployment goals, they can be improved to include a beginning time measure starting from the point of fire dispatch receiving the 911-phone call, and a goal statement tied to risks and outcome expectations. The deployment measure should have a second measurement statement to define multiple-unit response coverage (Effective Response Force) for serious emergencies. Making these deployment goal changes will strengthen the measures and meet the best practice recommendations of the Commission on Fire Accreditation International and the NFPA.

In earlier national recommendations, it was thought to take 1 minute for the company to receive the dispatch alert message and get the apparatus moving. However, as will be discussed later, even 1 minute for company turnout is unrealistic, given the need to don mandated protective safety clothing and to be seated and belted in before the apparatus begins to move. Other recommendations were that the 911 dispatch center processing should take no more than 1 minute for 90 percent of the incidents.

If up to 2.5 minutes for dispatch processing and crew "turnout" time is added to 4 minutes travel time over the streets, from the time of fire dispatch *receiving the call*, an effective deployment system is ***beginning*** to manage the problem within 6.5 minutes total response time. Even this only occurs when a "grid" type street system and close fire station spacing can support 4 minutes travel time. If the first unit can arrive from 6.5 to no more than 7.5 minutes, that is right before the point that brain death is becoming irreversible and the fire has grown to the point to leave the room of origin and become very serious. Yes, sometimes the emergency is too severe even before the Fire Department is called in for the responding company to reverse the outcome; however, given an appropriate response time policy and a system that is well designed, then only issues like bad weather, poor traffic conditions or a significant number of multiple emergencies

will slow the response system. Consequently, a properly designed system will give the citizens hope of a positive outcome for their tax dollar expenditure.

2.3 CITY OF SAN DIEGO FIRE RISK ASSESSMENT

Both newcomers to the community, as well as long-term residents, may not realize the community assets that are at risk today in such a vibrant and diverse community. San Diego Fire-Rescue is charged with responding to a variety of emergencies, from fires to medical calls to special hazards and cargo transportation emergencies on the highway.

SANDAG estimates employment in the City is approximately 800,000. In addition to the resident population and risk types listed earlier in section 1.4, the Department also has to deploy to emergencies for:

- 17 miles of coastline
- 4,600 acres around Mission Bay Park
- Major shifts in the City's population twice per workday
- Wide variance in population densities per square mile, which contribute to very different call for service occurrences
- Universities and colleges
- Health care centers of all sizes and types
- Sports and tourism venues
- An international border
- Aviation and shipping hazards
- Railroads, pipelines and trucking systems that transport hazardous materials
- High-tech semi-conductor and biotech research and manufacturing.

In addition to the above risks, the City contains a mix of single- and multi-family dwellings, small and larger businesses, and light or "high-tech" industrial park businesses. In addition, there are smaller warehouse and light manufacturing facilities, regional shopping malls, hotels, 205 high-rise business and residential buildings, the Sea World theme park, the San Diego Zoo, Balboa Park and the list of attractions and amenities becomes quite lengthy.

The significance of the above information is that the Department must be staffed, equipped and trained to deal with most any type of emergency faced by a United States fire department.

In order to understand the importance of response time in achieving satisfactory outcomes, the deployment of resources must be based upon assessment of the risks and the emergency outcome desired if something goes wrong. There are actually many different types of risks depending upon the nature of the emergency. At a very basic level, a fire in a single-family, detached home

is among the most frequent events with a measurable outcome. A *single*-patient medical emergency is a different event, and while it is the most frequent, it is normally not as threatening to life and property as the structure fire since the structure fire can spread from building to building and eventually become a conflagration.

The fire incident reporting system indicates a wide variety of events that can result in a call for service, but it is a reported fire in a building that is the essence of a fire department's deployment plan that drive the need for a "distribution" system of fire stations, apparatus and firefighters.

2.3.1 Building Fire Risk

In addition to risk types and community demographics cited above, in a Standards of Response Coverage study, building fire risk could be understood by looking at larger classes of buildings as well as the wildfire potential that surrounds the City.

In Map Set #2 in the mapping appendix to this study (found in Volume 2, separately bound), are displayed the locations of the larger *commercial* buildings that the Insurance Service Office (ISO) has sent an evaluation engineer into for underwriting purposes.

The ISO sends underwriters into commercial buildings to evaluate and collect demographic data for fire insurance underwriting purposes. This study obtained the current ISO data set for the City of San Diego, and it contains approximately 11,590 location records that range in size from a few hundred square feet up to 1.1 million square feet under one roof. There are 104 locations with buildings greater than 100,000 square feet.

One of the measures the ISO collects is called fire flow, or the amount of water that would need to be applied if the building were seriously involved in fire. The measure of fire flow is expressed in gallons per minute (gpm). In San Diego the ISO records list 1,813 buildings with a required fire flow of more than 3,000 gpm. These locations are shown on Map Set #2 in the attached map atlas. The table below breaks out the fire flow categories:

Fire Flow Categories

ISO Location Quantity	Required Fire Flow	% Of Whole
235	≥ 5,000	2%
316	4,000 – 4,999	3%
1,262	3,000 – 3,999	11%
9,776	< 3,000	84%

Fire flows above 3,000 gpm are a significant amount of firefighting water to deploy, and a major fire at any one of these buildings would result in a greater alarm fire. Using the generally accepted figure of fifty gallons per minute per firefighter on large building fires, a fire in a

building requiring 3,000 gallons per minute would require 60 firefighters, or a *four alarm* fire deployment effort given the Department's current staffing of a minimum of 17 firefighters on a first alarm structure fire response.

An effective response force is the deployment of multiple units (pumpers, ladder trucks and incident commander) so they can arrive close enough together to combat serious fires and keep them to less than greater alarm size. This refers back to the earlier points in this report on speed and weight of attack. The massing of units in a timely manner (weight) must be such that serious fires do not typically become larger. Since City zoning has placed these buildings throughout the City, this places additional pressure to have a multiple-unit effective response force of pumpers, and, also importantly, ladder trucks throughout the more built-up areas of the City.

2.3.2 Special Hazard Risks

The City has several hundred businesses that use or resell hazardous materials. Examples are gasoline stations and dry cleaners. These businesses are highly regulated by the building, fire and environmental codes. Other businesses in the industrial parks use chemicals in the fabrication of electronic and circuit board devices. The largest businesses using larger quantities of hazardous materials are called "target hazards" in that they receive a higher level of inspection activities and the responding firefighters have plans for their business and technical inventories.

San Diego Fire-Rescue and the County of San Diego are the lead agencies in a countywide Joint Powers Authority (JPA) regional hazardous materials response team for serious incidents. All San Diego Fire-Rescue firefighters are trained to the level of "first responder" for hazardous materials emergencies.

2.3.3 Wildland Fire Risk

The wildfire threat in the City of San Diego is significant, as the community is all too painfully aware. Many of the City's edge neighborhoods are exposed to wildland fuels and upslope terrain, all of which combine to pose a real danger. To combat this risk, the City works closely with its mutual aid partner fire departments while training and equipping its firefighters for wildland firefighting in San Diego County conditions.

The Department has extensively mapped and identified high hazard wildfire areas resulting in 90 plus percent of the City being in the Very High Fire Hazard Severity Zone for wildfire threat. This includes over 900 linear miles of canyon rim that traverse behind homes and businesses.

The City has adopted new, best practice codes for fuel reduction safety zones and fire resistant construction standards. Even so, given the risks and quantity of exposed homes, the City has to field an extensive and layered wildfire response system, including state of the art helicopters.

To provide ground-based firefighting resources for wildfires, the Department operates 12 brush fire apparatus and 2 water tenders capable of off-road travel. During normal fire weather conditions, these units are "cross staffed" by crews assigned to structure fire engines.

Occasionally, during extreme fire weather conditions the brush apparatus receive dedicated staffing with personnel on overtime.

2.3.4 Desired Outcomes

A response system can be designed with staffing and station locations to accomplish desired outcomes. An outcome example is, "confine a residential fire to the room of origin." That outcome requires a more aggressive response time and staffing plan than "confine the fire to the building of origin, to keep it from spreading to adjoining structures." As such, fire deployment planning takes direction from policy makers as to the outcomes desired by the community.

Given the Fire-Rescue Department's current response time goals revolving around the first-due unit having a travel time of 4 minutes and the first alarm having a travel time of 8 minutes and its Class 3 fire insurance classification rating, the City has, in effect, adopted a structure fire goal of deploying a significant force to building fires to contain the fire near the room, or compartment, of origin, if the fire is small to modest when first reported. By delivering paramedics via fire engines and ambulances, the City has committed to a higher level of emergency medical care that is typical in urban areas in California.

2.4 Staffing – What Must Be Done Over What Timeframe to Achieve the Stated Outcome Expectation?

The next step in the Standards of Response Cover process is to take the risk information above and review what the firefighting staffing is, and what it is capable of, over what timeframe.

Fires and complex medical emergencies require a timely, coordinated effort in order to stop the escalation of the emergency. Once the tasks and time to accomplish them to deliver a desired outcome are set, travel time, and thus station spacing, can be calculated to deliver the requisite number of firefighters over an appropriate timeframe.

2.4.1 Offensive vs. Defensive Strategies in Structure Fires Based on Risk Presented

Most fire departments use a strategy that places emphasis upon the distinction between offensive or defensive methods. These strategies can be summarized:

> It is important to have an understanding of the duties and tasks required at a structural fire to meet the strategic goals and tactical objectives of the Fire Department response. Firefighting operations fall in one of two strategies – **offensive or defensive.**
>
> Offensive strategy is characterized primarily by firefighters working **inside** the structure on fire. This strategy is riskier to firefighters but much more effective for performing rescues and attacking the fire at its seat.

Defensive strategy is characterized by firefighters working **outside** the structure on fire. This strategy is generally safer for firefighters; however, it also means no rescues can be performed and the building on fire is a total loss. Risks to firefighters take into account:

We may risk our lives a lot to protect savable lives.

We may risk our lives a little to protect savable property.

We will not risk our lives at all to save what is already lost.

Considering the level of risk, the Incident Commander will choose the proper strategy to be used at the fire scene. The Incident Commander must take into consideration the available resources (including firefighters) when determining the appropriate strategy to address any incident. The strategy can also change with conditions or because certain benchmarks are achieved or not achieved. For example, an important benchmark is "all clear," which means that all persons who can be saved have been removed from danger or placed in a safe refuge area.

Once it has been determined that the structure is safe to enter, an **offensive** fire attack is centered on life safety of the occupants. When it is safe to do so, departments will initiate offensive operations at the scene of a structure fire. Initial attack efforts will be directed at supporting a primary search – the first attack line will go between the victims and the fire to protect avenues of rescue and escape.

The decision to operate in a **defensive** strategy indicates that the offensive attack strategy, or the potential for one, has been abandoned for reasons of personnel safety, and the involved structure has been conceded as lost (the Incident Commander makes a conscious decision to write the structure off). The announcement of a change to a defensive strategy means all personnel will withdraw from the structure and maintain a safe distance from the building. Officers will account for their crews. Interior lines will be withdrawn and repositioned. Exposed properties will be identified and protected.

For safety, federal and state Occupational Health and Safety Regulations (OSHA) mandate that firefighters cannot enter a burning structure past the incipient or small fire stage without doing so in teams of 2, one team inside and one team outside, ready to rescue them. This totals a minimum of 4 firefighters on the fireground to initiate an interior attack. The only exception is when there is a known life inside to be rescued. This reason, along with the fact that a four-person company can perform more tasks simultaneously and 25 percent more efficiently than a three-person company, is why NFPA Deployment Standard 1710 for career fire departments recommends four-person company staffing on engines (pumpers) as well as on ladder trucks. For these reasons, this is also the staffing policy of San Diego Fire-Rescue.

Many fire department deployment studies using the Standards of Response Coverage process, as well as NFPA guidelines, arrive at the same fact – that an average (typically defined by the NFPA as a modest single-family dwelling) risk structure fire needs a minimum of 16 firefighters, *plus* one on-scene incident commander.

The NFPA 1710 recommendation is that the first unit should arrive on-scene within 6:20 minutes/seconds of call receipt (1-minute dispatch, 80-seconds company turnout, and 4-minute travel), 90 percent of the time. The balance of the units should arrive within 10:20 minutes/seconds of call receipt (8-minute travel), 90 percent of the time, if they hope to keep the fire from substantially destroying the building. (The NFPA recommendation of 1-minute dispatch time is generally attainable; the 80-second company turnout time is generally unattainable considering the time it takes firefighters to don the required full personal protective equipment.)

For an extreme example, to confine a fire to one room in a multi-story building requires many more firefighters than in a single-story family home in a suburban zone. The amount of staffing needed can be derived from the desired outcome and risk class. If the community desires to confine a one-room fire in a residence to the room or area of origin, that effort will require a minimum of 16 personnel plus incident commander. This number of firefighters is the minimum needed to safely conduct the *simultaneous* operational tasks of rescue, fire attack, and ventilation plus providing for firefighter accountability and incident command *in a modest, one fire hose line house fire*.

A significant fire in a two-story residential building or a one-story commercial or multi-story building would require, at a minimum, an additional two to three engines and an additional truck and chief officer, for upwards of 17 plus additional personnel. As the required fire flow water gallonage increases, concurrently the required number of firefighters increases. Simultaneously, the travel distance for additional personnel increases creating an exponential impact on the fire problem. A typical auto accident requiring multiple-patient extrication or other specialty rescue incidents will require a minimum of 10 firefighters plus the incident commander for accountability and control.

2.4.2 Daily Unit Staffing in the City

Below is the current and typical minimum daily unit firefighter staffing assignment in the City:

Units and Daily Firefighter Staffing Plan

Minimum Per Unit			Extended
47 Engines @	4	Firefighters/day	188*
12 Ladder Trucks @	4	Firefighters/day	48
1 Medium Rescue Unit @	4	Firefighters/day	4
3 Aircraft Fire Rescue @	3/2	Firefighters/day	8
1 Med. Lift Helicopter @	3	Firefighters/day	3
0 24-hr Ambulances @	0	Firefighter/paramedics	0
1 Shift Commander @	1	Per day for command	1
7 Battalion Chiefs @	1	Per day for command	7
		Total 24/hr Personnel:	259

** In February 2010 the Department had to close or brownout 8 engines per day due to economic challenges. This results in a reduction of up to 32 primary firefighters per day.*

To compliment the above "baseline" staffing for primary firefighting and rescue, the Department also staffs these specialty units 24/7/365 with dedicated staffing, or "cross-staffed" where the engine crew switches to the specialty unit when it is needed.

- Metro Arson Strike Team (MAST)
  - 1 Captain and 1 Engineer – dedicated 24/7/365
- Explosive Device Team (EDT)
  - 1 40-hour Technician, 10 other technicians from crossed-staffed units
- 24-hour ambulances
  - All non-Firefighter personnel
- 12-hour ambulances
  - All non-Firefighter personnel
- Hazardous Incident Response Team
  - Cross-staffed with 1 Engine crew
- STAR (Special Tactical and Response) Tactical Medic Team
  - Cross-staffed with 2 Firefighter-Paramedics
- Heavy Rescue
  - US&R 41 cross-staffed with E41 crew

- Swiftwater Team (OES/Cal EMA)
  - Life Guard and Firefighter cross-staffed.

In addition to the Department's daily staffing listed above, San Diego Fire-Rescue and the surrounding fire departments operate under an automatic aid and boundary drop "closest unit" agreement managed by five fire dispatch centers via a Regional computer interface beginning in Spring 2011. This policy means that edge area building fires receive a mix of City and automatic aid partner agencies. For modest fires in the edges areas of the City, this system not only helps by providing the units in the least amount of time without regard to jurisdiction, but also leaves other City units available for back-to-back or simultaneous calls for service in other areas.

2.4.3 Staffing Discussion

If the City provides fire services at all, safety of the public and firefighters must be the first consideration. Additionally, the chief officers, as on-scene incident commanders, must be well trained and competent, since they are liable for mistakes that violate the law. An under-staffed, poorly led, token force will not only be unable to stop a fire, it also opens the City up for real liability should the Fire Department fail.

As stated earlier in this section, national norms indicate that 16 or so firefighters, including an incident commander, are needed at significant building fires if the expected outcome is to contain the fire to the room of origin and to be able to simultaneously and safely perform all the critical tasks needed. The reason for this is that the clock is still running on the problem after arrival, and too few firefighters on-scene will mean the fire can still grow faster than the efforts to contain it. Chief officers also need to arrive at the scene in a timely manner in order to intervene and provide the necessary incident command leadership and critical decision making to the organization.

To meet its goal of sending an Effective Response Force of a minimum of 3 engines, 1 ladder truck and 1 battalion chief to modest building fires, the City has to send 17 personnel or 7 percent of its on-duty force. Then, to augment its staffing above 16, it has to send additional units via greater alarms and/or mutual aid. Given the occurrence of building fires in the City at approximately 421 per year, or about 35 per month, the City can typically field enough firefighters at a modest building fire. However, as the mapping portion of this study will show, delivering an effective first alarm in the northern City is very difficult as compared to the downtown core where the station spacing is tighter.

2.4.4 Company Critical Task Time Measures

In order to understand the time it takes to complete all the needed tasks on a moderate residential fire and a modest emergency medical rescue, the Department staff provided information using their standard operating procedures to demonstrate how much time the entire operations take.

The following tables start with the time of fire dispatch notification and finish with the outcome achieved. There are several important themes contained in these tables:

- These results were obtained under best conditions, in that the day was sunny and moderate in temperature. The structure fire response times are from actual incident records, showing how units arrive at staggered intervals in the core of the City. The actual drills were conducted in real buildings at the Department's Fire Training Center.
- It is noticeable how much time it takes after arrival or after the event is ordered by command to actually accomplish key tasks to arrive at the actual outcome. This is because it requires firefighters to carry out the ordered tasks. The fewer the firefighters, the longer some task completion times will be. *Critical steps* are highlighted in ***grey*** in the tables.
- The time for task completion is usually a function of how many personnel are ***simultaneously*** available so that firefighters can complete some tasks simultaneously.
- Some tasks have to be assigned to a minimum of two firefighters to comply with safety regulations. An example is that two firefighters would be required for searching a smoke filled room for a victim.

The following tables of unit and individual duties are required at a first alarm fire scene at a typical single-family dwelling fire. This set of duties is taken from Department operational procedures. This set of needed duties is entirely consistent with the usual and customary findings of other agencies using the Standards of Response Cover process and that found in NFPA 1710 or in CAL-OSHA regulations on firefighter safety. No conditions existed to override the OSHA 2-in/2-out safety policy.

Shown below are the critical tasks for a typical single-family house fire with a room burning on the second floor. The response force is three engines, one ladder truck, and one battalion chief responding for a total of 17 personnel:

Critical Tasks – Structure Fires

Structure Fire Incident Tasks	Time From Arrival 1st Engine	Total Reflex Time
Pre-arrival time of dispatch, turnout and travel time at desired goal point		07:00
1st engine on-scene	00:00	
Conditions report	02:37	
Supply line charged	03:00	
Charged line to 2nd Floor	03:48	
Rapid Intervention Team Established	04:40	11:40
Forced Entry	06:09	
Second engine arrival	03:38	
Third engine arrival	05:45	
Back-up attack line at door, charged	06:15	
Water on Fire	07:04	14:04
Ladder Truck arrival	07:56	
Primary Search for victims	08:10	15:10
Ladders positioned	11:05	
Utilities secured	12:45	
Positive pressure ventilation	12:32	
Secondary search complete	15:53	22:00
Check for fire extension in hidden spaces	15:58	
Fire out / **incident under control**	**16:45**	**23:45**

The above duties grouped together to form an *effective response force or first alarm assignment*. Remember that the above discrete tasks must be performed simultaneously and effectively to achieve the desired outcome. Just arriving on-scene does not stop the escalation of the emergency. Firefighters accomplishing the above tasks do, but as they are being performed, the clock is still running, and it has been since the emergency first started.

Fire spread in a structure can double in size during its free burn period. Many studies have shown that a small fire can spread to engulf the entire room in less than 4 to 8 minutes after open burning has started. Once the room is completely superheated and involved in fire (known as flashover), the fire will spread quickly throughout the structure and into the attic and walls. For this reason, it is imperative that fire attack and search commence before the flashover point occurs, if the outcome goal is to keep the fire damage in or near the room of origin. In addition, flashover presents a serious danger to both firefighters and any occupants of the building.

For comparison purposes, the critical task table below reviews the tasks needed on a typical auto accident rescue. The situation modeled was a one-car collision with one patient. The driver required moderate extrication with power tools and the vehicle was upright with no fuel hazards. One engine, one ladder truck, one ambulance and one battalion chief responded with a total of eleven (11) personnel.

Critical Tasks – Auto Incident – 1 Vehicle, 1 Patient

Vehicle Extrication Critical Tasks	Time From Arrival 1st Engine	Total Reflex Time
Pre-arrival time of dispatch, turnout and travel time at desired goal point		07:00
Engine on scene	00:00	
Size up and upgrade to rescue response	00:15	
Initial report	02:00	
Vehicle stabilization initiated	02:00	09:00
Protection firefighting line in place	02:25	
Ladder Truck arrival	02:00	
Patient assessed, vital signs obtained	03:48	10:48
Door forcibly opened and secured	04:48	
Patient on backboard and removed	05:40	13:40
Patient on gurney	06:00	
Patient under ambulance crew care and depart scene	07:00	**14:00**

The table above shows typical task times for good patient care outcomes. These patient care times and steps are consistent with San Diego County EMS Agency patient care protocols and would provide positive outcomes where medically possible.

2.4.5 Critical Task Measures Evaluation

What does a deployment study derive from a response time and company task time analysis? The total completion times above to stop the escalation of the emergency have to be compared to outcomes. We know from nationally published fire service "time vs. temperature" tables that after about 4 to 8 minutes of free burning a room fire will grow to the point of flashover where the entire room is engulfed, the structure becomes threatened and human survival near or in the fire room becomes impossible. We know that brain death begins to occur within 4 to 6 minutes of the heart having stopped. Thus, the effective response force must arrive in time to stop these catastrophic events from occurring.

The response and task completion times discussed above show that the residents of the City are able to expect positive outcomes and have a better than not chance of survival in a *modest* fire or medical emergency, when the first responding units *are* available in 7 minutes or less total response time.

The point of the tables above is that mitigating an emergency event is a team effort once the units have arrived. This refers back to the "weight" of response analogy. If too few personnel arrive too slowly, then the emergency will get worse, not better. Control of the structure fire incident still took 16:45 minutes/seconds after the time of the first unit's arrival, or 23:45 minutes/seconds from fire dispatch notification. The outcome times, of course, will be longer, with less desirable results, if the arriving force is later or smaller.

The quantity of staffing and the time frame it arrives in can be critical in a serious fire. As the risk assessment portion of this study identified, the City's building stock is diverse and includes large and multi-story buildings, any of which can slow the firefighting times as personnel and tools have to be walked to upper floors. Fires in these buildings could well require the initial firefighters needing to rescue trapped or immobile (the very young or elderly) occupants. If a lightly staffed force arrives, they cannot simultaneously conduct rescue and firefighting operations.

In EMS trauma incidents, the patient is initially being assessed within 10:48 minutes/seconds total reflex time and is able to be transported within 14 minutes. These times are good for trauma patients, when all the needed units can arrive by minute 7, which is not always possible at the outer perimeter areas of the City, or when multiple calls for service occur.

Fires and complex medical incidents require that the other needed units arrive in time to complete an effective intervention. Time is one factor that comes from ***proper station placement***. Good performance also comes from ***adequate staffing***. On the fire and rescue time measures above, the City can do a good job, in terms of time, on one or two moderate building fires and several routine medical calls at once. This is typical for metropolitan departments that staff 4-person companies for average, routine emergencies. However, major fires and medical emergencies where the closest unit is not available to respond ***will*** challenge the City response system to deliver good outcomes, so the City is co-dependent for severe emergency coverage with its neighbors. This factor **must** be taken into account when we look at fire station locations. Operating as a "single" regional system is a great, cost-effective idea, as long as all of the partners maintain their levels of service.

Previous critical task studies conducted by Citygate, the Standard of Response Cover documents reviewed from accredited fire departments, and NFPA recommendations all arrive at the need for 16+ firefighters plus a command chief arriving within 11 minutes (from the time of call) at a room and contents structure fire to be able to ***simultaneously and effectively*** perform the tasks of rescue, fire attack and ventilation.

If fewer firefighters arrive, what from the list of tasks mentioned would not be done? Most likely, the search team will be delayed, as will ventilation. The attack lines only have two firefighters, which does not allow for rapid movement above the first floor deployment. Rescue is done with only two-person teams; thus, when rescue is essential, other tasks are not done in a simultaneous, timely manner. Remember what this report stated in the beginning: effective deployment is about the **speed** *(travel time)* and the **weight** *(firefighters)* of the attack.

Yes, 17 initial firefighters (3 engines, 1 ladder truck, 1 battalion chief) can handle a moderate risk house fire (especially on the first floor). An effective response force of even 17 will be seriously slowed if the fire is above the first floor in a low-rise apartment building or commercial/industrial building.

When the on-duty staffing is stretched thin, the City can bring in greater alarms or automatic or mutual aid equipment, but from a distance and under the assumption that the aiding department is not already busy.

2.5 CURRENT STATION LOCATION CONFIGURATIONS

The City is served today by 47 fire stations.[1] As part of this fire services study, it is appropriate to understand what the existing stations do and do not cover, if there are any coverage gaps needing one or more stations, and what, if anything, to do about them as the City continues to evolve. In brief, there are two geographic perspectives to fire station deployment:

- Distribution – the spreading out or spacing of first-due fire units to stop routine emergencies.
- Concentration – the clustering of fire stations close enough together so that building fires can receive enough resources from multiple fire stations quickly enough. This is known as the Effective Response Force or commonly the "first alarm assignment" – the collection of a sufficient number of firefighters on-scene, delivered within the concentration time goal to stop the escalation of the problem.

To analyze first-due and first alarm fire unit travel time coverage for this study, Citygate used a geographic mapping tool called *FireView* that can measure travel time distance over the street network. Citygate ran several deployment map studies and measured their impact on various parts of the City.

The maps (found in Volume 2 of this study) display travel time using prior Department incident data to adjust the normal posted speed limits per type of street to those more reflective of slower fire truck travel times. The travel time measures used in this analysis are reflective of current City goals and national best practice recommendations. These are 4 minutes travel time for first-

[1] Does not include Lindberg Field, the helicopter base and assumes normal staffing for the eight stations without a fire engine crew due to brownouts.

due units for good suburban outcomes. For the first alarm, multiple-unit coverage, travel time is based on 8 minutes. When one minute is added for dispatch reflex time and two minutes for company notification times, the maps then effectively show the area covered within 7 minutes for first-due units and 10:30 minutes for a first alarm assignment from the time the 911-call is received in the fire dispatch center.

An additional measure used was the Insurance Service Office 1.5-mile recommendation for first-due fire companies and 2.5-mile service for second-due companies and ladder trucks. 1.5 miles driving distance equates to 3.5 to 4 minutes travel time over the road network.

The map set in this study does not show the coverage from the closest, nearby automatic aid fire stations from the career-staffed departments around the City of San Diego. The first goal is to determine if the City can substantially cover itself with its fire stations in appropriate response times. If so, then the automatic aid coverage is useful to fill in edge area gaps and be able to provide back-up unit response when City units are on other incidents. As Citygate's study for the County of San Diego determined, aid from other fire departments only replaces the need for initial San Diego City based coverage in very few, small locations on the City limits.

Note – given the size of the City, and to allow for greater local area detail, each map theme is done twice, once in a northern and once in a southern view.

Map Sets #1 through #16 are a view of the baseline or "as is" situation. These provide a basis for Map Sets #17 through #19 that show response coverage gaps. Finally, geographic measures of road miles covered will be reviewed in data table to understand mathematically in addition to the visual maps, what is and is not covered at different response time measures.

Map #1 – Existing Fire Station Locations

This first map shows the City and its current fire stations. This map view, then, is important to remember as later maps in the set display the fire station coverage areas. The different station symbols show the type of primary apparatus assigned to each station.

Map #2 – Risk Assessment

Map Set #2A displays the locations of the higher fire flow buildings as calculated by the Insurance Service Office (ISO) over a broad measure of population density. Most of these buildings are along the major road corridors in commercial and industrial areas due to zoning. Many, but not all of the commercial areas are also in the urban population density zone. There are two exceptions to this in the north City where large business parks are in suburban population density areas. These higher fire flow sites are the buildings that must receive a timely effective first alarm force to serious fires.

Map Set #2B is a different measure of risk – wildland fire hazards severity zones. This map again shows the higher fire flow building sites along with the very high wildfire risk zones as determined by San Diego Fire-Rescue and CAL FIRE staffs. This view demonstrates that the

wildfire threat to be protected against is not just a danger to homes, but also businesses and business parks in several areas throughout the entire City.

Map #3 – First-Due Unit Distribution – Existing Stations (4-Minute Travel)

These maps show in green colored street segments the *distribution* or first-due response time for each current City fire station per a desirable response goal of 4 minutes travel time. Thus, the computer shows how far each company can reach within 7 minutes Fire Department *total* response time from the time of the fire communications center receiving the call. Therefore, the limit of color per station area is the time an engine could reach the 4-minute travel time limit, ***assuming*** they are in-station and encounter no unusual traffic delays. In addition, the computer uses speed limits per roadway type that are slowed by actual fire unit travel times. Thus, the projection is a very close modeling of the real world.

A goal for a city as developed as the City of San Diego could be to cover 90 percent of the geography containing the highest population densities with a first-due unit coverage plan based on a goal measure statement to deliver acceptable outcomes. This would only leave the very hard-to-serve outer edge areas with longer coverage times, and depending on the emergency, with less effective outcomes. There should be some overlap between station areas so that a second-due unit can have a chance of an adequate response time when it covers a call for another station. The outer perimeter areas are hard to serve, and in many cases, cost-prohibitive to serve for a small number of calls for service.

As can be seen in this measure, the shape of the City is very hard to serve; especially since a grid type road network does not exist. However, due to very challenging topography and the resultant non-grid street network in much of the City, many of the station areas only have partial coverage at 4 minutes of travel. This is especially true outside of the downtown core.

The message to be taken from this map is that it would be very challenging for the City to improve travel time coverage without adding fire stations. At the end of this set of map descriptions, the actual miles covered and the size of the response gaps will be discussed with a data table.

Map #4 – ISO Engine Coverage Areas – Existing City Stations

These map exhibits display the ISO requirement that stations cover a 1.5-mile distance response area. Depending on the road network in a department, the 1.5-mile measure usually equates to a 3- to 4-minute travel time. However, a 1.5-mile measure is a reasonable indicator of station spacing and overlap. As with the 4-minute drive time map, many, but not all of the developed road areas of the City are served within a 1.5-mile distance from the existing fire stations. As the 4-minute map projected, the areas in the difficult to serve street network/topography areas and newer growth areas are not.

Stated this way, the two models of 4-minute and 1.5-mile travel represent the best and least coverages likely and both state that some of the developed areas are just beyond these measures.

Map #5 – Concentration (Effective Response Force)

These map exhibits show the *concentration* or massing of fire companies for serious fire or rescue calls. Building fires, in particular, require 16+ firefighters arriving within a reasonable time frame to work together and effectively to stop the escalation of the emergency. Otherwise, if too few firefighters arrive, or arrive too late in the fire's progress, the result is a greater alarm fire, which is more dangerous to the public and the firefighters.

The concentration map exhibits look at the Department's ability to deploy a minimum of three of its engines, one ladder truck and one battalion chief to building fires within 8 minutes travel time (10:30 minutes/seconds total Fire Department response time from the 911-call receipt). This measure ensures that a minimum of 16 firefighters and one battalion chief can be deployed at the incident to work ***simultaneously*** and effectively to stop the spread of a modest fire in a house or small commercial building.

The green color in the map shows the area where the City's current fire deployment system should deliver the initial effective response force. Streets without the green highlights do not have three engines, one ladder truck or the battalion chief in 8 minutes travel time.

As can be seen, due to the spacing of the City fire stations, an effective response force can be gathered in much of the City core. This coverage is not possible in northern and southern areas unless a cluster of stations exists.

The next few maps will "take apart" the full first alarm Map #5 and show the coverages of the different types of units, which makes up an effective response force.

Map #6 – Multiple Engine Coverage

In Map Set #6, the coverage for the three needed engines is displayed at 8 minutes travel. As can be seen, this coverage is a little better than in Map Set #5. This occurs because the City has more primary fire engines than ladder trucks and chief officers. The lack of these specialty units in some areas limits the coverage area of the first alarm team as seen in Map Set #5.

Map #7 – Ladder Truck Coverage

Map Set #7a measures the ladder truck coverage at an 8-minute travel time goal. As can be seen in both northern and southern views, there are several pockets and in some cases, almost entire station areas that do not receive a ladder trick within 8 minutes.

Map Set #7b measures the ISO 2.5-mile driving *distance* measure for ladder trucks. The result is similar and correlates with the 8-minute time map in that not all of the developed road segments are covered within 2.5 miles of a ladder truck location.

Completing the coverage of ladder trucks at 8 minutes travel will require the addition of four (4) more trucks.

Map #8 – Battalion Chief Coverage

Measured here is the battalion chief coverage for the first alarm at 8 minutes travel. As with ladder trucks, outside of the urban core, battalion chief coverage is incomplete in several developed areas.

Completing the coverage of incident command battalion chiefs at 8 minutes travel will require the addition of two (2) more chief units.

Map #9 – All Incident Locations

This is an overlay of the exact location for all Fire Department incident types for two years from January 2008 through December 2009. It is apparent that there is a need for Fire Department services in all of the station areas of the City. It also should be noted that call for service volumes are higher where the population densities and human activity are the highest. This is normal, as people drive calls for service more than do open space areas. Also shown on this map are incidents on freeways and to neighboring fire departments. Wildfire responses are plotted to the nearest paved road address location.

Map #10 – EMS Incident Locations

This map further breaks out only the emergency medical and rescue call locations. Again, with the majority of the calls for service being emergency medical, almost all streets need Fire Department services in one year's time.

Map #11 – All Fire Type Locations

This map identifies the location of all fires in the City. All fires include any type of fire call from auto to rubbish to building. There are obviously fewer fires than medical or rescue calls. Even given few fires, it is evident that all first-due station areas experience fires with areas having the greatest population density, having the most fires.

Map #12 – Structure Fire Locations

This map is similar to the previous map, but only displays structure fires for one year. While the structure fire count is a smaller subset of the total fire count, there are two meaningful findings to this map. There are still structure fires in every first-due fire company area. The location of many of the building fires parallels the higher risk and older building type commercial areas in the more built-up areas of the City. Fires in the more complicated building types must be controlled quickly or the losses will be very large.

Map #13 – All Incident Location Hot Spots

This map set examines, by mathematical density, where clusters of incident activity occurred. In this set, all incidents are plotted by high-density workload. For each density measure, the darker the color, the greater the quantity of incidents in a small area. This type of map makes the

location of frequent workload more meaningful than just mapping the dots of all locations as done in Map Set #9.

Why is this perspective important? Overlap of units and ensuring the delivery of a good concentration for the effective response force. When we compare this type of map with the concentration map, we want the best concentration of unit coverage (first alarm) to be where the greatest density of calls for service occurs. For the City, this mostly occurs in the highest population density areas.

Map #14 – EMS Incident Location Densities

This map set is similar to Map Set #11, but only the medical and rescue hot spots of activity are plotted. The clusters of activity look very similar to the all-incident set in Map #13 because medical calls are such a large part of the total.

Map #15 – All Fire Location Densities

This map set shows the hot spot activity for all types of fires. While again the call-for-service density is highest where there is more population density, there are also fire incidents of some type in every populated area and on the roads connecting clusters of population activity. Even auto fires at the side of a freeway need to be suppressed quickly or the risk of the fire spreading to and causing a serious wildfire is very real.

Map #16 – Structure Fire Densities

This map only shows the structure fire workload by density. Here, the activity clusters are smaller given the lower number of incidents, but are still spread across many areas of the City.

2.5.1 Deployment Improvement Needs Analysis

As these baseline coverage maps were understood, Citygate worked with the Department staff to identify and test the impacts of possible deployment improvement scenarios. The next series of maps and data tables will explain the best-fit choices identified.

Citygate started by understanding the Department's existing fire station master plan for new or re-built sites. A few are already in the capital improvement budget pipeline. Given the very good fire station site identification work already done by fire management staff, we compared Citygate's response gap model to possible fire station locations. In some cases where more than one site per gap area was possible, Citygate choose the best-fit site that provided the most road miles of coverage in the fewest minutes of travel. In some cases, we did not use a fire-identified site as we determined the area was just too small for a fire station when compared to other options. This will be explained in detail below.

Map #17 – 4 and 5-minute First-Due Unit Gap Analysis – Existing Stations

This map set changes the streets color to red to better contrast against response time areas. The green streets are the current 4-minute travel time coverage. The blue street segments extend the travel time coverage into the gaps by one additional minute, or the 5th minute of travel. As can be seen, even by a 5th travel minute not all the streets are covered. Smaller gaps are backfilled by the 5th minute.

A natural question becomes, at what minute of travel does the existing station network reach 90 percent coverage? The table below shows the public (not military or private) road miles covered for each measure:

Public Road Miles Covered for Each Measure

	Existing Station Coverage	
Travel Time	**Miles**	**Percent Covered**
4 Minute	2,329	60.32%
5 Minute	3,146	81.50%
6 Minute	3,544	91.80%
Total	**3,860**	**100.00%**

As can be seen, the 5th minute of travel does increase coverage 21.5 percent which is significant. Stated this way, if an area is outside the green coverage on the map, is the gap a 1-minute or 5- or 10-minute gap? The answer is that many areas are just beyond the 5th minute of coverage.

More complete 90 percent coverage is not attained until the 6th minute of travel. The road network outside of the urban core with a traditional, "right angle" grid street network is very hard to efficiently serve. In addition to many newer, post-war areas being designed with curvilinear streets, and dead end one-way in/out subdivisions, there are many natural barriers in the City due to the mesa and canyon topography in coastal southern California.

Map #18 – Prioritization of Filling the Gaps Identified

This pair of maps displays the gaps beyond the 4th and 5th minute, with priority to improve numbers placed in black on the top 15 gaps. The **added** station coverage is shown as dark and light blue. A number of factors went into this prioritization and they will be discussed in several sections of this report, including the prior incident response statistics analysis.

Using just geographic coverage measures, this table displays how much more road mile coverage each future fire station site adds cumulatively to the citywide coverage measure. The priority numbers take the data from this table into consideration, but later in the report will be further refined and re-sorted with response statistics insights.

Added Road Mile Coverage Per Additive Station

Station Site	Added Miles @ 4 Minutes	% Covered Increase
Skyline	31.62	61.16%
Serra Mesa	34.09	62.04%
Mission Bay / Pacific Beach	37.63	63.01%
Paradise Hills	31.79	63.84%
Home Ave	24.79	64.48%
Navajo	23.64	65.09%
Encanto	18.93	65.58%
Mission Valley	13.04	65.92%
Torrey	31.24	66.73%
USCD	23.51	67.34%
Liberty Station	24.41	67.97%
West Mission Vly	18.76	68.46%
College	16.07	68.87%
Stresemann / Governor	23.81	69.49%
Tierrasanta	14.03	69.85%
Scripps Miramar	21.35	70.41%
Linda Vista	8.56	70.63%
Research Park	10.58	70.90%
Mira Mesa	13.55	71.25%
University City	10.33	71.52%
South Park	8.75	71.75%
Kensington	3.68	71.84%
Black Mountain Ranch	3.75	71.94%
San Pasqual	7.68	72.14%
East Village	0.84	72.16%
East Otay	6.28	72.32%
Rancho Encantada	3.00	72.40%
Bayside	0.00	72.40%

The road miles covered per added fire station in the table above shows a very difficult situation facing the City. After about 17 or so stations are added, each remaining site only adds 10 miles of coverage or less at the 4th minute. This occurs as the added stations also overlap coverage of existing stations and do not add more coverage to "gap" miles. The best example of this is the

Bayside station downtown west of the railroad tracks, which improves response time due to traffic disruption and availability for simultaneous calls, but it is not needed to cover miles beyond the 4th minute of coverage from other stations.

In fact, even if 27 more stations were added to increase coverage at the 4th minute of travel, only 72 percent of the road network is covered. The reason for this is that serving all of the curvilinear, dead end neighborhood street system outside of the urban core, is too expensive, as the last added stations produce almost no increase in coverage.

An analogy would be that if the coverage problem was the shape of a human hand or blood vessels in the body, a few stations could easily cover the palm or core areas. Pushing into the fingers or legs covers more, but only partway out. To cover to the finger tips or toes requires many more stations to cover increasingly small areas.

As in the previous table, how does the coverage look if more stations are added **and** the travel time goal is increased one-minute to five travel minutes, reflecting the topography challenge in the San Diego region?

The table below shows the marked difference in additive coverage. First, the existing stations cover more in the 5th minute of travel, as do the added stations. By pushing out the existing coverage one minute and then filling in the largest remaining gaps, coverage to near 90 percent is possible for a more effective number of stations.

Additive Coverage Measures Using 5 Minutes Travel Time

GIS Priority	Locations	5-Minute Travel Added Miles	Coverage % Increase	5-min Gap Population	5-min Gap Incidents	Gap Avg Pop Density
1	Mission Bay/Pacific Beach	38.77	83.87%	19,011	1,935	5-25,000
2	Torrey	31.40	84.69%	11,946	567	5-10,000
3	Serra Mesa	31.11	85.49%	15,646	1,553	5-10,000
4	Stresemann/Governor	24.07	86.12%	8,670	597	5-10,000
5	Encanto	17.35	86.57%	9,715	710	0-10,000
6	Skyline	16.22	86.99%	19,803	1,384	**10-20,000**
7	UCSD	15.45	87.39%	10,248	1,283	10-15,000
8	Paradise Hills	12.78	87.72%	11,486	787	**10-20,000**
9	Mira Mesa	11.13	88.01%	1,437	393	5-10,000
10	Liberty Station	9.90	88.26%	2,117	1,127	10-20,000
11	University City	9.84	88.52%	4,753	456	0-10,000
12	San Pasqual	9.51	88.76%	21	130	0-5,000
13	Home Ave	8.45	88.98%	10,271	683	**5-20,000**
14	College	8.08	89.19%	6,729	403	**5-25,000**
15	Scripps Miramar	7.01	89.37%	4,867	160	0-5,000
16	East Otay	6.80	89.55%	634	140	0-5,000
17	Linda Vista	3.53	89.64%	6,371	501	5-10,000
18	Black Mountain Ranch	3.35	89.73%	1,384	51	0-10,000
19	Mission Valley	3.04	89.81%	16,174	1,517	**5-25,000**
	Totals:	**267.79**		**161,283**	**14,377**	

However, even with this 5-minute travel model, the additive miles covered per station drops quickly after the first nine stations are added.

More analysis measures were added to this model, to better understand what besides road miles were to be covered by each added station. The geographic model allowed the measurement of how many prior year incidents from the data set were in the gap area, beyond the 4th travel minute from the existing stations. Also measured were the total population in the gap area and what each area's population density per square mile was. These allow different comparative rankings to determine site weighting priority and the additive impacts of several sites. For example, if all 19 gaps were filled:

- Coverage at the 5th minute increases to 90 percent, a gain of 1-minute over the existing system 6th minute coverage;

- Another 161,283 residents are covered within 5 minutes of a neighborhood resource, which is the equivalent of adding into coverage more than the population of Escondido.
- Another 14,377 calls for service are reached in the 5th minute, not the 6th or longer. This is more incidents than found in some suburban cities.

As can also be seen, five gap areas have urban to metropolitan population densities per square mile with high call for service counts. If only the first nine geographically largest gaps were filled with a station, the results would be:

- Coverage at the 5th minute increases to 88 percent.
- Another 107,962 residents are covered within 5 minutes of a neighborhood resource, which is the equivalent of adding into coverage more than the population of Carlsbad.
- Another 9,209 calls for service are reached in the 5th minute. This is more incidents than found in smaller suburban cities and, when averaged daily, increases service 25 times per day, or once per hour.

The addition of nine well-placed resources, along with a model balanced to deliver 5 minutes of travel time coverage, significantly increases public service.

After the review of response statistics in the next section of this report, these geographic coverage facts will be considered with current workload issues to determine the final site priorities as shown on Map Set #18.

Map 19 – Gaps to Population Density Analysis

This set of maps allowed the Citygate and Department management team to review the population densities within each 4+ minute response gap. As the data table discussed above measured, there is quite a divergence of population densities across the gap areas. When these are compared to the incidents not covered in the 5th minute of travel in the same table, the relationship of population density to calls for service is shown. For the most part, people, not things, generate the need for emergency services.

2.6 MAPPING MEASURES EVALUATION

Based on the above mapping evaluation, Citygate offers the following findings:

Finding #2:	The City of San Diego is very difficult to cover efficiently with a cost-effective quantity number of fire stations due to the non-grid street network and very difficult coastal topography with canyons, mesas and other natural barriers.

Finding #3:	Much of the City is substantially developed and is of urban and suburban population densities. Given the populations and diverse risks in the developed areas, the City should have fire service deployment goals to deliver an urban level of first-due fire unit coverage, which would be 4 minutes of travel time for the best possible outcomes in the most populated areas and 5 minutes travel in the less populated and lighter risk zones.
Finding #4:	Increasing coverage at the 4th minute of travel would require 27 additional fire stations increasing total station coverage to 72 percent of the public road network.
Finding #5:	If the policy choice were to implement a deployment model balanced to provide the entire City 5 minutes of travel time coverage from a neighborhood response resource, then 19 additional stations would extend coverage to 90 percent of the public road network. While adding one minute to the travel time places it one minute above the NFPA 1710 national best practice recommendation, it is a reasonable adjustment given the City's complex road network and difficulty in achieving 4-minute travel time coverage, even with an extraordinary expense in fire stations that would only cover just a few miles of roads past the 4th minute.
Finding #6:	In addition to the need for multiple neighborhood based first-response units, based on the first alarm concentration gap analysis of ladder truck and battalion chief coverage, improving citywide first alarm effectiveness at 8 minutes travel to 90 percent of the public road network will also require the addition of 4 ladder trucks and 2 battalion chief units.

After the historical response statistics are analyzed in the next section of this report, then an integrated set of deployment recommendations will be made to further prioritize the filling of response gaps and what alternative deployment strategies may be considered.

2.7 CURRENT WORKLOAD STATISTICS SUMMARY

In this section of the Standards of Response Cover process, prior response statistics are used to determine what percent of compliance the existing system delivers. In other words, if the geographic map measures say the system will respond with a given travel time, does it actually deliver up to expectations? A detailed analysis of in-depth statistics was separately provided to

the Department senior staff. What follows is a summary of those comprehensive measures and findings.

The sections of this report that focused on mapping the distribution and concentration of fire stations used geographic mapping tools to estimate travel time over the street network. Thus, the maps show what ***should*** occur from the station placements. However, in the real world, traffic, weather, and units being out of quarters on other business such as training or fire prevention duties affect response times. Further, if a station area has simultaneous calls for service, referred to as "call-stacking," the cover unit to the second or third call in the same area must travel much farther. Thus, a complete Standards of Response Coverage study looks at the actual response time performance of the system from incident records. Only when combined with map measures can the system fully be understood and configured.

As a review of actual performance occurs, there are two perspectives to keep in mind. First, the recommendations of NFPA 1710 only require that a ***department-wide*** performance measure of 90 percent of the historical incidents (not geography) be maintained. This allows the possibility that a few stations in the core of a city with great response time performance can "mask" the performance of stations with poorer travel times.

In the Accreditation philosophy for the Standards of Response Coverage approach, and in Citygate's opinion, it is recommended that the performance of each ***station area*** also be determined to ensure a balance or **equity** of coverage to the degree economically possible. However, even this approach is not perfect – a station area may well have less than 90 percent performance, but serves lower-risk open space areas with limited buildings thereby not having an economic justification for better performance. In addition, the study must discuss just what is measured within the under-performing statistic. For example, a station area with a first-due performance of 88 percent with only 50 calls in the 88th to 90th percentile is far different from an area with 500 calls for service in that 88th to 90th percentile.

All measures, then, must be understood in the complete context of geography, risk, and actual numbers of calls for service that exceed the City's performance measure. A balanced system will avoid such extremes and strive for equity of service within each category of risk.

Fire departments are required to report response statistics in a format published by the U.S. Fire Administration called the National Fire Incident Reporting System (NFIRS). The private sector develops software to do this reporting according to state and federal specifications.

Data sets for this section of the study were extracted from the San Diego Fire-Rescue Communications center that provides dispatching and NFIRS records services for the Department and other contracting area fire departments.

Total response time in this study is measured from the time of receiving the call at the Fire Communications center to the unit being on-scene. This time does not include the time it takes to receive a 911-call at the City's Police Dispatch Center and transfer the call to the regional fire

communications center. While the computer systems are not linked to track this data, the call answer and transfer process typically takes less than 30 seconds.

For suburban and urban population density areas, NFPA 1710 recommends a 4-minute fire unit travel time, which when a more realistic 1.5 minutes is added for turnout time and 1 minute for dispatch processing, aggregates to a 6.5-minute total reflex (customer) measure. For multiple-unit calls, the outer NFPA 1710 recommended measurement is 8 travel minutes, plus 1.5 for turnout and 1 minute for dispatch, which is a 10.5-minute total reflex measure. These measures are also consistent with good outcomes for urban/suburban risks as identified in the Standards of Response Cover Process.

The primary 4- and 8-minute travel time measures are also consistent with current City of San Diego General Plan and Fire Department measures.

Data sets in this study were "cleaned" to eliminate records without enough time stamp records or records with impossible times, such as a 23-hour response. The data sets were modeled in the "*NFIRS 5 Alive*" fire service analysis tool for fire service deployment statistics. Later, this study will integrate all the Standards of Cover study elements to propose refined deployment measures that best meet the risk and expectations found in the City.

The San Diego Fire-Rescue Department furnished NFIRS 5 data for 274,325 incidents dated for the 36-month period from 7/1/2007 through 12/31/2009. This NFIRS 5 incident data included 609,114 Apparatus records and 1,642,009 fire fighter responder records for the same period. This quantity of records provides a statistically significant and robust measure of response times in the City.

2.7.1 Incident Types and Distribution Over Time

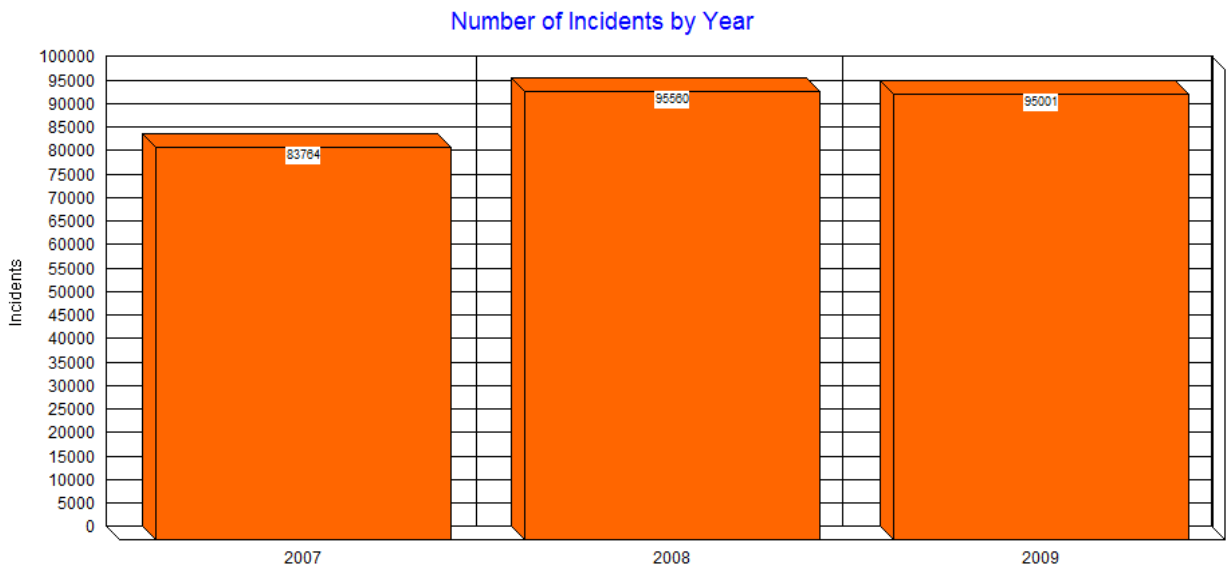
Below is a list of "Nature of Call" counts for **2009**. These counts are based on first apparatus arrivals so they represent incidents as opposed to apparatus responses. Only call categories of 200 or more were included.

Incident Type	Count
321 EMS call, excluding vehicle accident with injury	67,206
322 Vehicle accident with injuries	7,320
611 Dispatched & canceled en route	2,929
700 False alarm or false call, other	2,005
743 Smoke detector activation, no fire - unintentional	805
745 Alarm system sounded, no fire - unintentional	801
740 Unintentional transmission of alarm, other	791
735 Alarm system sounded due to malfunction	707
651 Smoke scare, odor of smoke	695
300 Rescue, emergency medical call (EMS) call, other	502
131 Passenger vehicle fire	469
730 System malfunction, other	458
600 Good intent call, other	444
331 Lock-in (if lock out , use 511)	412
113 Cooking fire, confined to container	409
353 Removal of victim(s) from stalled elevator	392
733 Smoke detector activation due to malfunction	362
111 Building fire	346
744 Detector activation, no fire - unintentional	308
118 Trash or rubbish fire, contained	299
151 Outside rubbish, trash or waste fire	297
150 Outside rubbish fire, other	237
622 No incident found on arrival of incident address	213

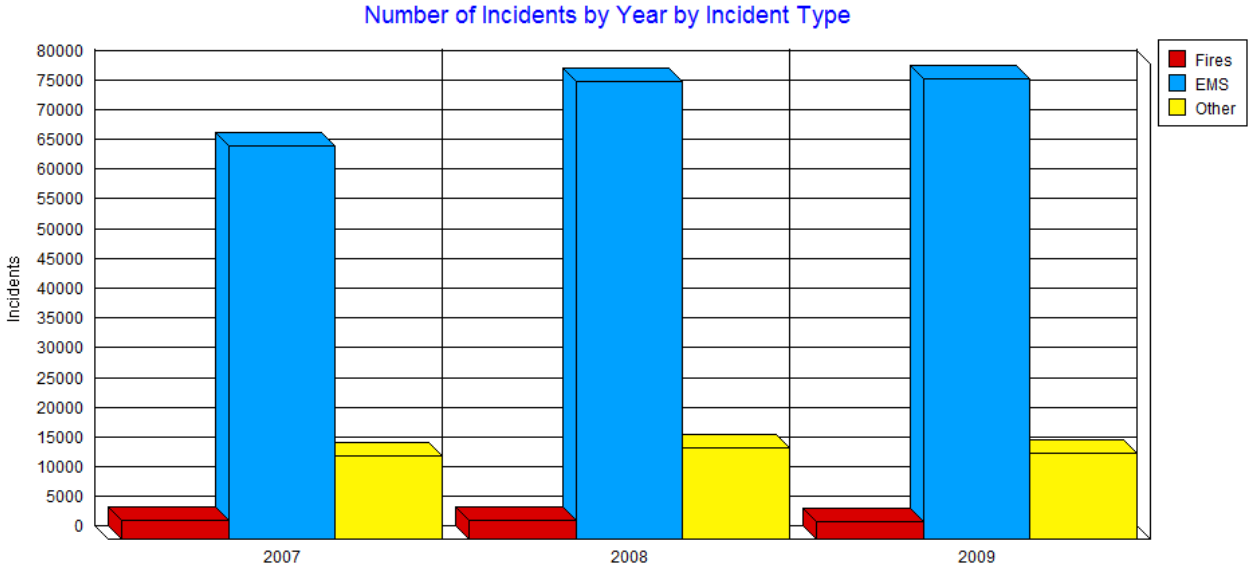
This chart shows the top types of property receiving services from the Department 2009. Property types with fewer than 200 responses were eliminated from the list.

Property Type		Count
419	1 or 2 family dwelling	27,042
429	Multifamily dwellings	15,025
963	Street or road in commercial area	9,647
962	Residential street, road or residential driveway	4,343
960	Street, other	3,594
961	Highway or divided highway	3,111
311	24-hour care Nursing homes, 4 or more persons	2,319
599	Business office	2,056
340	Clinics, Doctors offices, hemodialysis centers	1,978
449	Hotel/motel, commercial	1,937
439	Boarding/rooming house, residential hotels	1,596
965	Vehicle parking area	1,209
150	Public or government, other	951
931	Open land or field	815
519	Food and beverage sales, grocery store	619
882	Parking garage, general vehicle	597
322	Alcohol or substance abuse recovery center	596
161	Restaurant or cafeteria	590
171	Airport passenger terminal	581
215	High school/junior high school/middle school	545
400	Residential, other	512
937	Beach	492
341	Clinic, clinic-type infirmary	488
331	Hospital - medical or psychiatric	473
500	Mercantile, business, other	415
888	Fire station	392
241	Adult education center, college classroom	380
213	Elementary school, including kindergarten	375
900	Outside or special property, other	322
131	Church, mosque, synagogue, temple, chapel	290
361	Jail, prison (not juvenile)	267
160	Eating, drinking places	250
936	Vacant lot	211
300	Health care, detention, & correction, other	209

The above information describes where the bulk of the demand for service occurs – emergency medical issues and in the predominant building type – homes. There was a significant rise in incidents between 2007 (83,764) and 2008 (95,560). There was a very slight decrease in incidents between 2008 (95,560) and 2009 (95,001):



Here is the same 3-year incident set broken down by incident type:

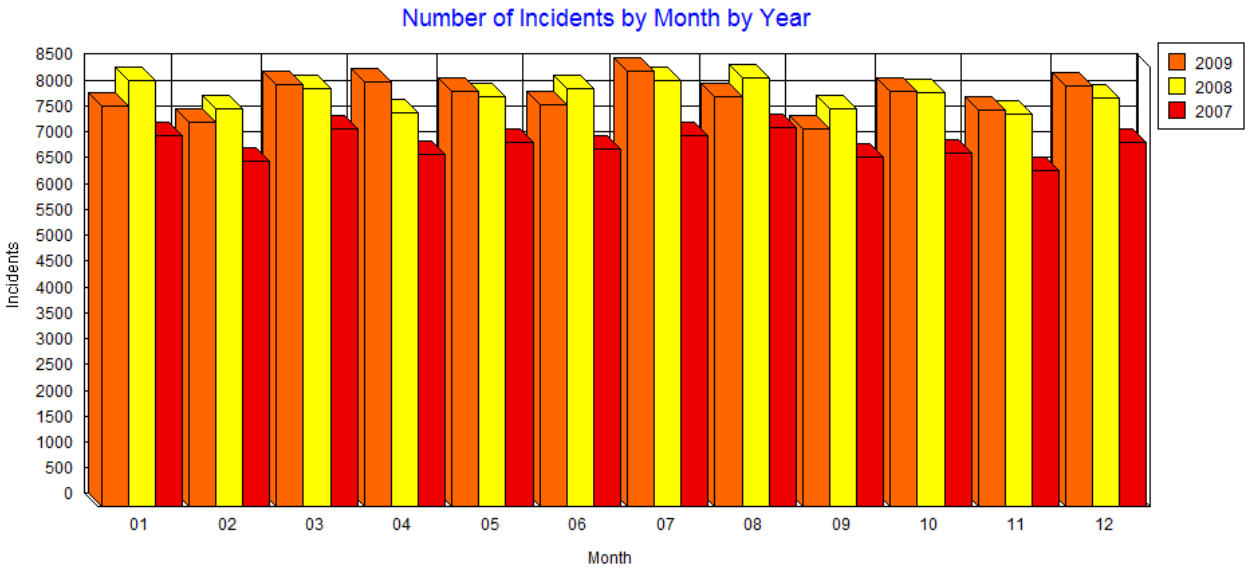


Here are the numbers for the graph above:

	2007	2008	2009
Fire	3,364	3,194	3,084
EMS	66,218	76,986	77,444
Other	14,182	15,380	14,472

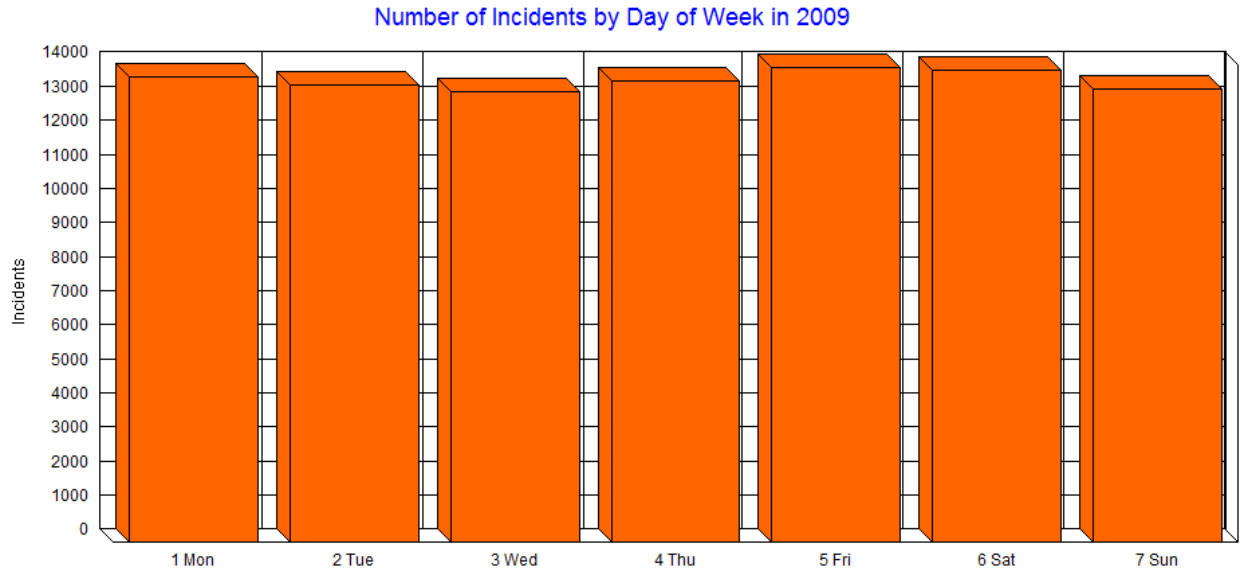
Distribution by Month

The graph below illustrates the number of incidents by month for the 3-year dataset. Monthly incident numbers are not highly volatile remaining within a range from 6,500 – 8,500 over a 36-month period:



Distribution by Day of Week

The next graph illustrates incident activity by day of week for 2009. Daily incident count remains in the range of 13,000 to 14,000 incidents:



Finding #7: Emergency incident requests are evenly distributed over the months, week of the year and day of week. This means that the deployment model should not have widely different staffing patterns. The Department needs a constant baseline of response resources.

2.7.2 Peak Demand for Service Patterns

Unlike the monthly and day of week patterns, there is a slight variance of workload by hour of day. The following temporal activity graph measures activity by hour of day and day of week in 2009. High activity hours are shown in red with low activity hours shown in green:

	1 Mon	2 Tue	3 Wed	4 Thu	5 Fri	6 Sat	7 Sun	Total
00:00-00:59	371	375	319	336	362	492	570	2,825
01:00-01:59	347	332	291	326	357	566	597	2,816
02:00-02:59	241	268	269	257	320	495	552	2,402
03:00-03:59	239	263	245	239	252	320	361	1,919
04:00-04:59	211	208	198	217	187	269	253	1,543
05:00-05:59	227	236	209	244	277	238	284	1,715
06:00-06:59	348	306	316	324	333	320	279	2,226
07:00-07:59	499	503	494	504	450	392	323	3,165
08:00-08:59	587	594	577	613	552	463	463	3,849
09:00-09:59	726	721	700	683	679	590	500	4,599
10:00-10:59	779	772	758	747	746	659	647	5,108
11:00-11:59	798	813	768	774	729	669	644	5,195
12:00-12:59	852	749	787	766	838	688	711	5,391
13:00-13:59	777	809	760	772	776	761	685	5,340
14:00-14:59	768	811	766	782	829	759	657	5,372
15:00-15:59	828	815	770	782	746	729	638	5,308
16:00-16:59	792	759	764	788	773	653	728	5,257
17:00-17:59	831	701	802	781	858	723	723	5,419
18:00-18:59	708	733	692	740	702	713	723	5,011
19:00-19:59	720	657	696	723	685	724	658	4,863
20:00-20:59	620	630	649	622	676	705	659	4,561
21:00-21:59	548	539	576	595	670	700	638	4,266
22:00-22:59	486	456	468	510	590	646	530	3,686
23:00-23:59	381	394	367	408	536	603	476	3,165
Total	13,684	13,444	13,241	13,533	13,923	13,877	13,299	95,001

Finding #8: There is tapering off of emergency incident demand from midnight to 7 AM. As the day becomes busy the hourly demand for service is fairly high and constant from 10 AM to 7 PM. Peak activity units on partial day staffing such as the paramedic ambulances are already deployed on assist areas at peak hours experiencing high simultaneous calls for service.

Simultaneous Incident Loading

Simultaneous incidents are incidents that occur when other incidents are underway. As a metropolitan fire department San Diego rarely has a break from simultaneous activity. The table below shows the number of incidents underway when new incidents occur:

# of Incidents	Percent
2 or more incidents underway	98.69%
3 or more incidents underway	96.41%
4 or more incidents underway	92.78%
5 or more incidents underway	87.87%
6 or more incidents underway	81.98%
7 or more incidents underway	74.95%
8 or more incidents underway	66.93%
9 or more incidents underway	58.20%
10 or more incidents underway	49.05%
11 or more incidents underway	39.88%
12 or more incidents underway	31.26%
13 or more incidents underway	23.60%
14 or more incidents underway	17.11%
15 or more incidents underway	11.94%
16 or more incidents underway	08.00%
17 or more incidents underway	05.15%
18 or more incidents underway	03.23%
19 or more incidents underway	01.97%
20 or more incidents underway	01.18%

We see by this chart San Diego's median simultaneous incident activity is 10 incidents.

2.7.3 San Diego Fire-Rescue Response Times

While many fire departments track *average* response time, it is not highly regarded as a performance measurement. One of the most commonly used criteria to measure response effectiveness is fractile analysis of response time. A fractile analysis splits responses into time segments and provides a count and percentage for each progressive time segment.

Here is a fractile response time breakdown for *citywide* fire department first arriving unit for 2009:

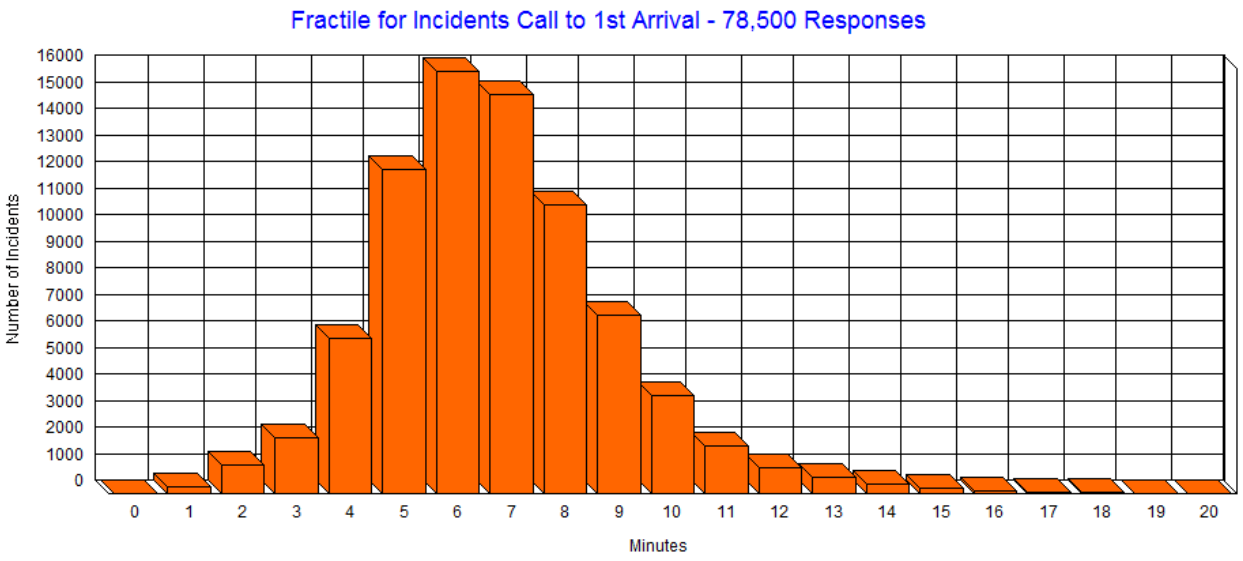
For Priority 1 incidents, the following fractile results for total response time are:

Measure	90% Minute Goal	Goal Source	Actual Performance
Fire Receipt to Arrival	<= 06:00	Current City of SD	49.7%
Fire Receipt to Arrival	<= 07:30	Citygate Recommendation	77.2%
Fire Receipt to Arrival	<= 08:50	City of SD Actual Compliance	90.2%

The current City goal is 6 minutes total response time. This is 1-minute dispatch, 1-minute crew turnout and 4 minutes travel time.

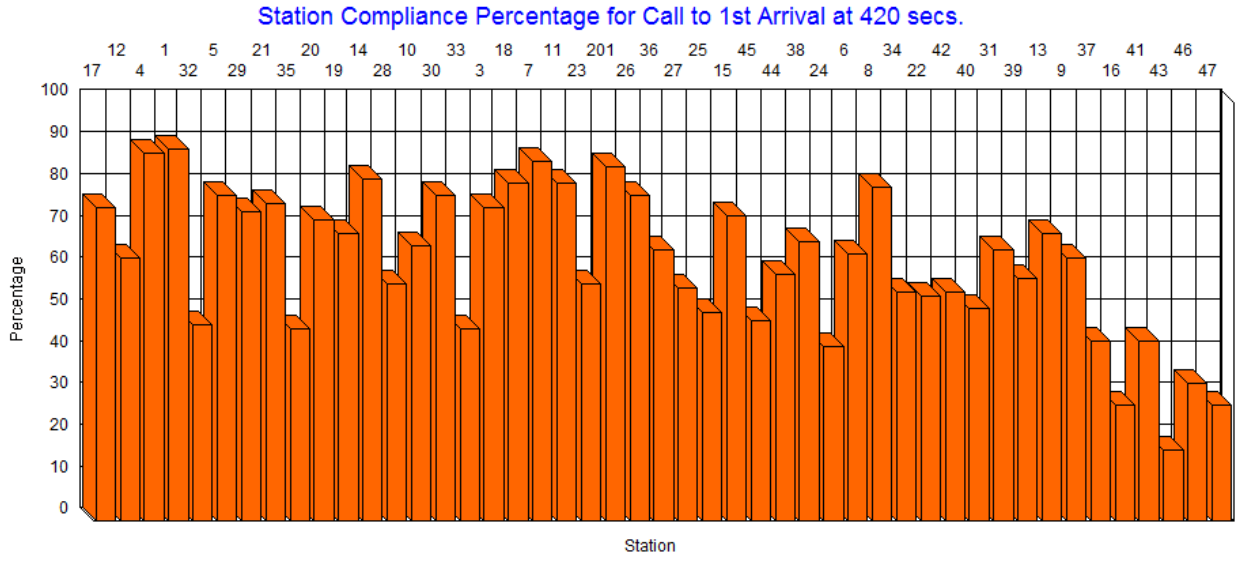
Once on-scene, the crew must identify the emergency, in a medical call gain access to the patient, and then begin emergency intervention procedures. In the best of situations, this takes 2-3 more minutes after arrival. Therefore, for good outcomes in urban/suburban areas, Citygate typically recommends to our clients that they plan for a 90 percent arrival near the 7th minute of total response. The additional minute past the City goal of 6 minutes reflects a more realistic crew turnout time of 1.5 minutes and allows for some set-up time prior to actual intervention.

The graph below illustrates **Call to Arrival** performance using the same dataset of all Priority 1 incidents in 2009.



In the above graph having a maximum incident count at 6 minutes is normal. However, having a very slow drop-off at 7, 8 and 9 minutes is not normal for a well-deployed metropolitan fire department. As the data by station district will show, many of the station areas are too large and have lengthy response times.

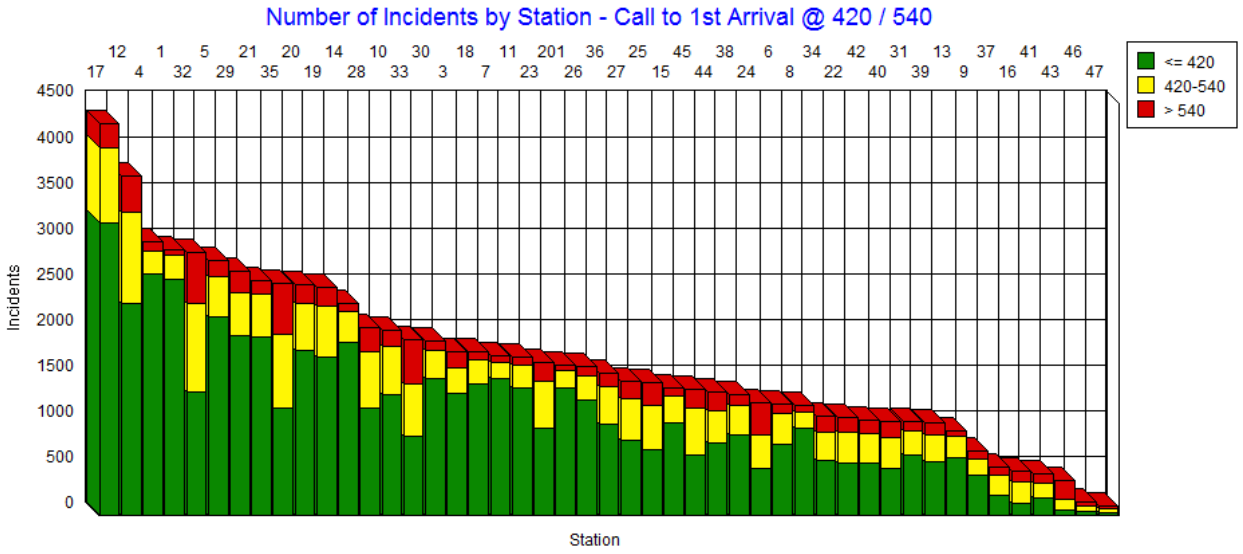
The next graph shows how total response time performance varies significantly by fire station area due to size and not enough fire stations in some areas. In the graph 420 seconds equals 7 minutes:



While overall total response time performance does not achieve 90 percent to all incidents, incidents closer to fire stations *do* receive service within the City's adopted goal.

This **next graph** measures the length of call to arrival delays. Here green incidents are less than or equal 420 seconds (Citygate goal point of 7 minutes), yellow incidents are greater than 420

and less than or equal to 540 seconds (9 minutes) and finally red incidents are greater than 540 seconds. Stations 32, 35 and 33 show a high number of incidents with delayed first arrivals beyond 9 minutes.



Structure Fires Alone

The following fractile breaks down responses to **structure fires** that occurred during **2009**.

Measure	90% Minute Goal	Goal Source	Actual Performance
Fire Receipt to Arrival	<= 06:00	Current City of SD	49.7%
Fire Receipt to Arrival	<= 07:30	Citygate Recommendation	71.2%
Fire Receipt to Arrival	<= 08:50	City of SD Actual Compliance	90.2%

2.7.4 Response Time Component Measurements

The next step is to evaluate all response time components by breaking down "Total Reflex Time" into its three component parts of:

- Call-handling time – time of call until time of dispatch. Only dispatch records showing a call-handling time greater than 0 seconds and less than 3 minutes were used in this analysis.
- Turnout time – time of dispatch until time unit is responding. Only dispatch records showing a turnout time greater than 0 seconds and less than 4 minutes were used in this analysis.

- Travel time – time unit is responding until time the unit arrives on the scene. Only dispatch records showing a travel time greater than 0 seconds and less than 10 minutes were used in this analysis.

Call-handling time – the national recommendations are that 90 percent of the calls should be processed to dispatch within 1 minute, 90 percent of the time. In the City of San Diego, given high call volumes, the dispatch center triages the call to send the right resource. While this is done in many metro centers across the county to save scare resources, it does slow call processing past the older ideal goal. The City of San Diego system places emphasis on first alerting the ambulance crew where necessary, as these are the fewest resources of all. For ambulance dispatches in 2009:

Measure	90% Minute Goal	Goal Source	Actual Performance
Call Processing	<= 01:00	Desired NFPA Goal Point	66.5%
Call Processing	<= 01:40	City of SD Actual Compliance	89.9%

For the first-due fire engine:

Measure	90% Minute Goal	Goal Source	Actual Performance
Call Processing	<= 01:00	Desired NFPA Goal Point	10.5%
Call Processing	<= 02:50	City of SD Actual Compliance	89.0%

Finding #9: San Diego Fire-Rescue's ambulance call processing times are consistent with national call sorting practices. The Department needs to place greater emphasis on procedures to get the first-due engine dispatched in less time, closer to the ambulance performance point.

Company turnout time – the time from company notification to donning protective clothing to getting underway.

Measure	90% Minute Goal	Goal Source	Actual Performance
Turnout	<= 00:80	Desired Goal Point in NFPA 1710	86.1%
Turnout	<= 00:90	City of SD Actual Performance	90.3%
Turnout	<= 02:00	Citygate Recommendation	96.6%

Older national recommendations were for turnout time to take 1 minute. Over the last five plus years of increasing protective clothing regulations by OSHA and the NFPA, complete data studies have shown this to be a near impossible goal to accomplish safely. The NFPA for structure fires now recommends 80 seconds, but Citygate finds a more realistic goal is to complete the company notification and turnout process in 1:30 minutes or less, 90 percent of the time. Attention to this critical time element can help reduce the time.

Finding #10: For crew turnout time performance, San Diego Fire-Rescue excels in this area and is the largest department Citygate has seen to perform this well at the 90-second point for structure fire turnout time.

Travel time – here are the citywide travel time measures for 2009 to Priority 1 EMS incidents. While not inclusive of fires, given the high number of EMS incidents, this measure is the most descriptive of citywide performance:

Measure	90% Minute Goal	Goal Source	Actual Performance
Travel	<= 04:00	Desired Goal Point in NFPA 1710 & SDFD Goal	55.2%
Travel	<= 06:20	City of SD Actual Compliance	90.9%

This table shows the travel time performance as a percent of the City's 4-minute travel time goal:

Travel Time Performance (At City's 4-Minute Travel Time Goal)

Station	4-Minute % Travel Compliance	Station	4-Minute % Travel Compliance
17	64.40%	25	31.90%
12	46.10%	27	35.30%
4	83.50%	44	43.90%
35	32.80%	45	28.30%
1	81.60%	24	29.10%
5	65.10%	15	60.20%
32	30.50%	38	49.80%
21	62.10%	8	63.80%
20	55.90%	6	46.60%
29	61.30%	34	39.60%
19	55.40%	22	44.00%
14	67.70%	39	34.20%
28	37.70%	42	43.40%
10	50.60%	40	32.80%
33	37.70%	31	45.70%
3	58.30%	13	55.60%
201	81.70%	9	46.80%
30	61.60%	41	26.60%
18	66.20%	37	26.30%
11	68.50%	16	16.40%
23	42.20%	43	13.10%
7	74.30%	46	20.50%
26	63.60%	47	23.40%
36	43.40%		

Finding #11: The citywide and individual fire station area *travel* times correlate with the geographic model travel time predictions, in that there are not enough fire stations in some areas to achieve the City's 4-minute *travel* time to 90 percent of the incidents in urban areas. This is due to a combination of not enough fire stations combined with the effects of a non-grid street network in other areas.

2.7.5 First Alarm Fractile Compliance

This report section focuses on concentration or massing of units for the first alarm arrival units.

Most Standards of Response Cover studies along with NFPA 1710 recommend that for urban/suburban areas that all of the necessary fire units for an effective response force (first alarm) arrive on-scene within 8 minutes travel time, and when 2.5 minutes are added for dispatch and turnout time, this equals 10:30 minutes, 90 percent of the time. A normal first alarm response for San Diego Fire-Rescue is 4 engines, 1 ladder truck and 1 battalion chief. However, given the mapping coverage result that the Department does not have enough engine companies, this study looked at the performance with 3 engines, as the minimum staffing necessary, which is that considered typical for medium density populations in NFPA 1710.

In the 2009 data set, there were 2,257 occurrences (6 times per day on average) where 3 engines and 1 ladder truck had to arrive. The performance citywide was:

Measure	90% Minute Goal	Goal Source	Actual Performance
Fire Receipt to Arrival	<= 10:00	Current City of SD	49.8%
Fire Receipt to Arrival	<= 10:30	Citygate Recommendation	55.4%
Fire Receipt to Arrival	<= 15:00	City of SD Actual Compliance	89.7%

As with other measures of deployment, there is a wide diversity of first alarm compliance across the different station areas as the next table describes. Some areas had *no* events with a complete 4-unit response even when rounded up to minute 11:

Station	Percent by 11 Minutes	Station	Percent by 11 Minutes
4	95.34%	22	45.94%
11	91.66%	44	44.44%
7	90.90%	25	43.58%
15	88.00%	16	40.00%
14	86.36%	6	39.13%
201	86.15%	39	35.00%
1	85.91%	32	31.03%
17	85.38%	37	29.41%
19	84.52%	35	29.23%
5	82.35%	42	25.00%
3	80.85%	38	22.72%
10	80.70%	40	22.22%
18	78.57%	13	21.42%
8	74.57%	27	16.66%
30	74.19%	31	10.52%
26	73.52%	43	8.33%
12	71.29%	41	5.88%
23	62.79%	34	0.00%
28	59.72%	9	0.00%
20	56.86%	24	0.00%
21	55.00%	33	0.00%
45	53.48%	46	0.00%
29	50.00%		
36	46.42%		

As the next table shows, many of the station areas had the complete first alarm firefighting force arrive from 1 to 11 minutes past the City's desired goal point:

First Alarm Total Response Time Measures by Station Area

Station	Minutes at 90%	Station	Minutes at 90%
4	9.50	39	14.42
11	10.33	12	14.67
7	10.50	28	14.92
14	11.17	33	15.00
15	11.25	24	15.08
8	11.58	32	15.17
1	11.75	25	15.42
19	11.83	22	15.42
18	12.08	40	15.92
201	12.17	16	16.33
5	12.25	41	17.58
17	12.42	35	17.67
26	13.00	13	17.75
30	13.17	38	18.00
20	13.25	34	18.42
10	13.33	6	18.83
45	13.33	43	18.92
23	13.67	9	19.58
44	14.08	42	19.58
3	14.17	27	20.58
21	14.25	29	21.83
31	14.33	37	21.92
36	14.42	46	22.92

Finding #12: The incident response measures for a Full Effective Response Force show that outside of three fire station areas in the downtown core, none of the other 44 fire station areas can deliver 3 engines and 1 ladder truck to 90 percent of building fires within a desired goal point of 10:30 minutes total response time, of which 8 minutes is travel time. The fire station areas are too large, there are not enough stations, and some units are busy and unavailable at peak hours of the day.

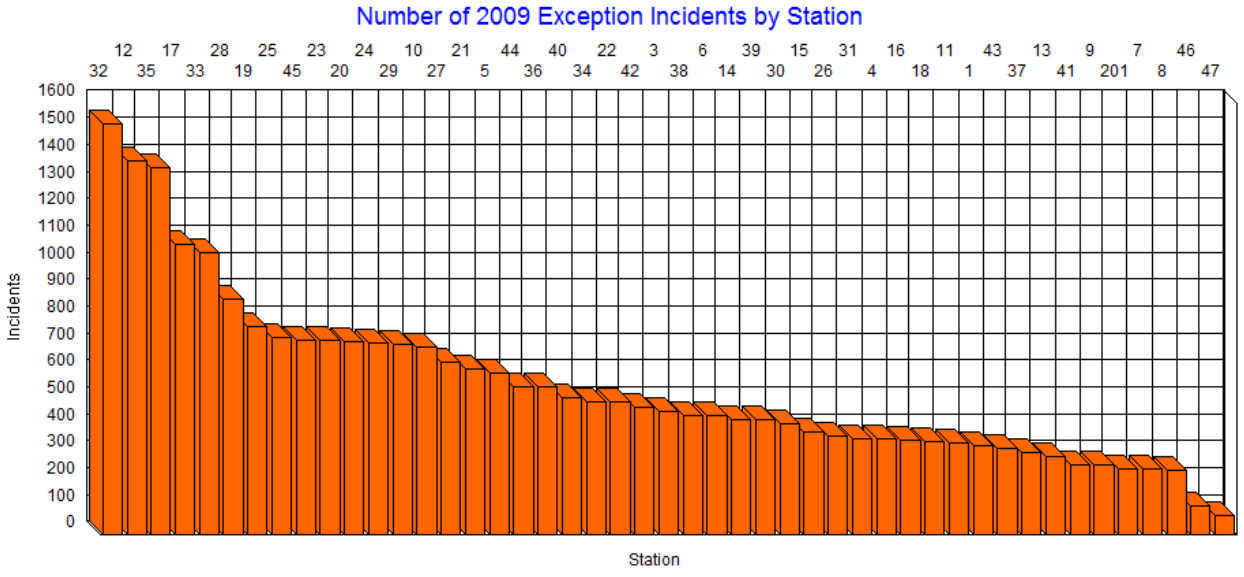
2.7.6 Gap Analysis of Response Time Deficiencies

While many of the measures discussed above review percent of performance against a desired goal point, the *quantity* of calls in the gap between current performance and the desired goal need to be understood and what factors other than geography might create delayed response time performance. The table below shows the number of calls in 2009 that were not reached by a first unit within 7 minutes total response time:

Response Time Deficiencies

	Incident Count	Percentage of Incidents Inside City
2009 Incident NFIRS Records	95,001	
Incidents Inside City Limits	94,065	
Call to Arrival > 7 minutes	33,107	35.1%
Deficiencies to any Priority 1 Incident	**25,834**	**24.46%**
Deficiencies to All Types of Fires	1,261	1.34%
Deficiencies to All EMS Types	24,573	26.12%

Thus, 24.46 percent of the priority calls inside the City limits received the first-due San Diego Fire-Rescue unit in greater than the desired goal point of 7 minutes. This next graph shows the deficiencies or exceptions to policy by station area:



As the geographic mapping and simultaneous incident statistics showed, there are *both* response gap and high workload reasons for the diversity of deficient response times across a 47-station system.

By hour of the day, the deficient response times exist every hour, but peak from 10 AM through 6 PM, at a constant rate across all seven days of the week:

2009 Exception Incidents > 7 Minutes Total Response Time

	1 Mon	2 Tue	3 Wed	4 Thu	5 Fri	6 Sat	7 Sun	Total
00:00-00:59	121	117	106	102	100	152	139	837
01:00-01:59	123	116	107	102	132	210	205	995
02:00-02:59	80	105	89	95	116	183	200	868
03:00-03:59	90	106	86	87	86	108	151	714
04:00-04:59	87	80	89	81	77	115	93	622
05:00-05:59	81	91	94	106	106	106	115	699
06:00-06:59	119	102	113	137	118	113	99	801
07:00-07:59	174	175	159	177	161	115	108	1,069
08:00-08:59	151	176	158	162	137	112	98	994
09:00-09:59	198	191	190	164	169	152	115	1,179
10:00-10:59	246	248	229	212	228	193	178	1,534
11:00-11:59	234	243	206	199	176	178	146	1,382
12:00-12:59	196	174	193	135	200	153	162	1,213
13:00-13:59	193	212	193	189	174	185	148	1,294
14:00-14:59	198	209	163	183	196	187	143	1,279
15:00-15:59	237	247	220	206	190	174	142	1,416
16:00-16:59	222	210	194	227	195	147	156	1,351
17:00-17:59	216	174	222	219	207	176	149	1,363
18:00-18:59	167	163	166	174	149	156	151	1,126
19:00-19:59	153	150	161	159	150	180	148	1,101
20:00-20:59	115	143	159	153	161	166	138	1,035
21:00-21:59	135	124	148	144	156	182	153	1,042
22:00-22:59	124	122	121	118	165	174	150	974
23:00-23:59	113	117	117	108	186	173	132	946
Total	3,773	3,795	3,683	3,639	3,735	3,790	3,419	**25,834**

Next is the same table by hour of the day, but only for the deficiencies that exceed 9 minutes:

Exceptions > 9 Minutes Call to Arrival

	1 Mon	2 Tue	3 Wed	4 Thu	5 Fri	6 Sat	7 Sun	Total
00:00-00:59	38	43	29	34	30	55	49	278
01:00-01:59	36	42	36	33	41	80	61	329
02:00-02:59	27	39	22	35	46	55	66	290
03:00-03:59	31	35	32	29	24	42	48	241
04:00-04:59	26	31	30	31	31	38	37	224
05:00-05:59	26	35	29	33	41	28	35	227
06:00-06:59	38	33	36	44	40	28	26	245
07:00-07:59	43	50	52	53	46	29	24	297
08:00-08:59	39	59	55	49	43	26	29	300
09:00-09:59	58	51	60	47	52	48	40	356
10:00-10:59	93	96	74	73	78	58	63	535
11:00-11:59	82	82	63	79	61	55	51	473
12:00-12:59	64	45	51	39	62	43	49	353
13:00-13:59	58	67	58	60	59	59	50	411
14:00-14:59	74	61	60	58	62	72	38	425
15:00-15:59	84	83	82	74	66	59	39	487
16:00-16:59	81	78	68	85	52	39	36	439
17:00-17:59	82	58	73	65	72	41	43	434
18:00-18:59	45	47	51	48	46	48	48	333
19:00-19:59	41	41	47	59	44	56	58	346
20:00-20:59	36	45	50	59	52	52	37	331
21:00-21:59	35	31	51	35	39	53	43	287
22:00-22:59	27	36	37	31	55	53	49	288
23:00-23:59	31	39	34	23	58	53	36	274
Total	1,195	1,227	1,180	1,176	1,200	1,170	1,055	**8,203**

Finding #13: The message from the deficient response time analysis tables is that within the 24.46 percent or 25,834 Priority 1 calls with response times exceeding City goals, there are 8,203 that exceed 9 minutes and *this occurs every hour somewhere, every day*. In the nine peak hours where performance is the most deficient, every hour period for all 365 days, has at least one Priority 1 incident with the first due unit arriving *2 minutes later* than the desired goal point.

Finding #14: Due to very high call for service volumes in the downtown core, and the vertical (high-rise) building populations, multiple units and stations will be always be needed to cover not just geographic travel time, but to provide enough units at peak demand hours to maintain adequate customer service to all incidents.

Finding #15: The current technology to alert fire stations crews of what and where to respond is 21 years old, technically obsolete and, in many cases, inserts unnecessary time delays into the crew dispatching process.

2.7.7 Integrated Fire Station Deployment Recommendations

Discussion

While no one city (even a metropolitan one) can stand by itself and handle everything and any possibility without help, a desirable goal is to field enough of a response force to handle a community's day-to-day responses for primary single-unit response needs equitably to all neighborhoods, as well as be able to provide an effective initial response force (first alarm) to moderately serious building fires.

The City of San Diego has adopted fire deployment measures consistent with its risks, outcome expectations and national best practice recommendations for urban-suburban areas.

As the mapping coverage and response statistics analysis in this study have shown, deploying a best practice mix of fire crews across the challenging topography of the City of San Diego cost-effectively is *very difficult* to achieve. This is likely why over many decades; the fire station spacing did not keep pace with City growth.

When the deployment gaps are also understood in the context of the current and foreseeable economic challenges, the question becomes how best to deploy any new resources as the City can afford to make changes.

Citygate used the comprehensive data sets built for this study to identify patterns in the deployment system of:

- Overuse of resources;
- High density call for service areas;
- Identifying where response time gaps are as large or larger than an entire typical fire station area;
- Trying to balance the push-pull of improving neighborhood equity of service availability versus the need to handle multiple incidents per hour in smaller areas.

2.7.8 Integrated Analysis to Determine Priorities and Alternative Approaches

The study team reviewed detailed data on the quantity of calls per hour on some units, the locations of high demand areas which generate simultaneous calls, and then in combination, where did high workloads combine with response time gaps (missing stations) to create small, perfect storms of weak response time performance.

By using a multiple measures approach, instead of just road miles covered by a new fire station, or just fixing a simultaneous incident issue in an existing fire station area, the team could make integrated and prioritized recommendations.

Further as this analysis showed the need for more than a fixed fire station deployment model, alternative deployment approaches were considered.

The results described in this section are the result of this integrated work.

The first step in the priority analysis was to compare in-depth data on three factors summarized in the following table. The factors are:

- Station areas with the highest rate of simultaneous incident rates;
- Individual engines that had the highest workload rates, known as Unit Hour Utilization;
- Locating station areas that had the most responses to other station areas (helpers);
- Cross-identifying where an impacted for workload station area meet two or three of these criteria to be known as a workload impacted area.

Dist's Giving Most Outside Aid >300/yr	Engines w/ highest UHU >12%	Stations with highest Simoul >20%
E201	E17	17
E14	E12	12
E11	E32	32
E1	E5	4
E26	E35	29
E5		35
E7		1
E4		19
E12		5
E19		20
E8		21
E17		14
E18		33
E27		28
		10

As can be seen in the summary table above, several engines are in more than one category. Three engines – 5, 12 and 17 – are in all three categories.

Next the analysis considered the geographic mapping results that adding stations to meet a 4-minute travel time goal was not feasible given San Diego City's unique topography. However, a 5-minute travel time model to achieve 90 percent coverage equitably across the developed city was more feasible and that with some additional in-fill stations, much of the long response time issues could be improved. While adding one minute to the travel time places it one minute above the NFPA 1710 national best practice recommendation, it is a reasonable adjustment given the City's complex road network and difficulty in achieving 4-minute travel time coverage, even with an extraordinary expense in fire stations that would only cover just a few miles of roads past the 4th minute.

The geographic data model was used to rank order the 5-minute fire station gaps by how under-covered road miles could be improved with each station addition. For each station addition, the current incident loads and population densities were also measured:

Ranking of Future Station Sites by Road Miles of Additive Coverage

GIS Priority	Sites @ 5-min to 90%	Additive Per Gap 5-min Population	Additive Per Gap 5-min Incidents	Avg Pop Density
1	Mission Bay / Pacific Beach	19,011	1,935	5-25,000
2	Torrey	11,946	567	5-10,000
3	Serra Mesa	15,646	1,553	5-10,000
4	Stresemann/Governor	8,670	597	5-10,000
5	Encanto	9,715	710	0-10,000
6	Skyline	19,803	1,384	10-20,000
7	UCSD	10,248	1,283	10-15,000
8	Paradise Hills	11,486	787	10-20,000
9	Mira Mesa	1,437	393	5-10,000
10	Liberty Station	2,117	1,127	10-20,000
11	University City	4,753	456	0-10,000
12	San Pasqual	21	130	0-5,000
13	Home Ave	10,271	683	5-20,000
14	College	6,729	403	5-25,000
15	Scripps Miramar	4,867	160	0-5,000
16	East Otay	634	140	0-5,000
17	Linda Vista	6,371	501	5-10,000
18	Black Mountain Ranch	1,384	51	0-10,000
19	Mission Valley	16,174	1,517	5-25,000
	Total:	**161,283**	**14,377**	

Understanding that the station gap areas were very different when reviewed for long response time workloads and populations, and that gaps #10-19 all only added more than 10 new road miles of coverage each, the high workload areas were added to the priority analysis table. Then Citygate placed priorities on adding service to an area based on these "weighting" factors:

- New station areas (gaps) that are next to high workload areas. These are the areas in the table on page 75 having the most to least yellow, orange and red negative workload impacts. A number in a color cell in the following table on page 77 means that more than one station area had this measure in the gap area under consideration;
- Serving the highest under-served population densities;
- Serving areas with most 5-minute population and long response times;

- Additive road miles the gap station covered.

As the priorities became clearer, it was apparent that the smallest gaps were not next to high workload areas and were not of enough priority in the immediate future to need a 24-hour, fixed location engine company. Thus, the gaps were also sorted for consideration for alternative deployment units, or Fast Response Squads (FRS) to be explained below. The weighted priorities became:

Final Citygate Integrated Ranking of Additional Fire Station Sites

Citygate Priority	FRS Eligible	Stats Weight			GIS Priority	Sites @ 5-min to 90%	Additive Per Gap 5-min population	Additive 5-min calls	Avg Pop Density
7	NO				1	Mission Bay / Pacific Beach	19,011	1,935	5-25,000
11	NO				2	Torrey	11,946	567	5-10,000
12	NO				3	Serra Mesa	15,646	1,553	5-10,000
6	NO				4	Stresemann / Governor	8,670	597	5-10,000
5	YES				5	Encanto	9,715	710	0-10,000
4	NO	2			6	Skyline	19,803	1,384	10-20,000
8	NO				7	UCSD	10,248	1,283	10-15,000
2	NO			2	8	Paradise Hills	11,486	787	10-20,000
13	NO				9	Mira Mesa	1,437	393	5-10,000
9	YES				10	Liberty Station	2,117	1,127	10-20,000
10	YES				11	University City	4,753	456	0-10,000
16	YES				12	San Pasqual	21	130	0-5,000
1	NO	3	2	2	13	Home Ave	10,271	683	5-20,000
3	NO			2	14	College	6,729	403	5-25,000
15	YES				15	Scripps Miramar	4,867	160	0-5,000
14	YES				16	East Otay	634	140	0-5,000
17	YES				17	Linda Vista	6,371	501	5-10,000
18	YES				18	Black Mountain Ranch	1,384	51	0-10,000
19	YES				19	Mission Valley	16,174	1,517	5-25,000
	9 FRS's					**Total:**	**161,283**	**14,377**	

Thus, the sites in Citygate's priority order to improve service in the identified gap areas are:

Citygate Priority Order of Additional Fire Station Sites

Citygate Priority	FRS Eligible	Sites @ 5-min to 90%	Additive Per Gap 5-min Population	Additive 5-min Calls
1	NO	Home Ave	10,271	683
2	NO	Paradise Hills	11,486	787
3	NO	College	6,729	403
4	NO	Skyline	19,803	1,384
5	YES	Encanto	9,715	710
6	NO	Stresemann/Governor	8,670	597
7	NO	Mission Bay / Pacific Beach	19,011	1,935
8	NO	UCSD	10,248	1,283
9	YES	Liberty Station	2,117	1,127
10	YES	University City	4,753	456
11	NO	Torrey	11,946	567
12	NO	Serra Mesa	15,646	1,553
13	NO	Mira Mesa	1,437	393
14	YES	East Otay	634	140
15	YES	Scripps Miramar	4,867	160
16	YES	San Pasqual	21	130
17	YES	Linda Vista	6,371	501
18	YES	Black Mountain Ranch	1,384	51
19	YES	Mission Valley	16,174	1,517
	9 FRS's	**Total:**	**161,283**	**14,377**

Improving response capability to all 19 gaps using a 5-minute travel time model achieves the following:

- 161,283 residents receive improved coverage by at least 1-minute travel time;
- 14,377 incidents receive improved service;
- A mix of 19 resources also adds weight of attack to first alarm coverage as well as depth of capacity in high workload areas;
- Sites 11 through 19 only add 10 miles of new coverage each;

- Of these 19 sites, Citygate believes 6 are the most critical, taking into consideration all the factors. Just these 6 sites would improve service to 66,674 residents and 4,564 delayed response time incidents. They are:
  - Home Avenue
  - Paradise Hills
  - College
  - Skyline
  - Encanto
  - Stresemann/Governor.
- For improved ladder truck and battalion chief coverage, the geographic and workload analysis concluded that the system needs:
  - Four (4) additional ladder trucks
  - Two (2) additional field battalion chief units.

2.7.9 Fast Response Squads and Engine Staffing Discussion

Given the competing needs of a cost-effective deployment increase, the fact that some response time gaps are actually very small and near other units, and that incident demands move during the day between the urban core and the suburbs, Citygate believes a cost-to-service effective solution is to implement 2 firefighter "Fast Response Squads" that would have these capabilities, which are more than adding just an ambulance:

- 2 firefighter crews, one of which is a paramedic
- Smaller, more agile unit, capable of:
  - EMS assessment
  - 1-patient transport when no ambulance is available
  - Providing "recon" at serious emergencies to tell dispatch what is really needed and what is not, which saves valuable resources at peak demand hours
  - Carrying a small quantity of water/foam for small fires – "knock down" capability pending the arrival of an engine company
  - Increasing first alarm staffing, multiple FRS's can be assigned to a first alarm feeing up at least one engine company
  - Can be part- or full-time staffed (12-hour or 24-hour schedule)

- If 24-hour staffed, placed in smaller buildings, like converted homes and commercial suites
- Can be moved to areas of need, following the population and call trends per hour of day. A 24-hour FRS could have two "posts," one in a high workload urban core in the daytime, and in the evening and weekends, in a suburban area response time gap.

Discussion

The Citygate team and Fire-Rescue senior staff discussed this option at length. It is not thrown out lightly. The joint team agrees there are solid needs driving this issue. There is no reason that serious emergencies cannot *also* be responded to with more, lesser-staffed units as part of a complete mix of units. A good analogy would be a deployment system that can "swarm" a resource mix to the emergency.

However, these units, for the most part, do not exist in the fire service. As such, this recommendation is experimental and not an off-the-shelf solution where the apparatus can be purchased immediately. This would need to be a pilot project that will take the combined talent of San Diego Fire-Rescue managers, labor representatives and apparatus manufacturers to accomplish. There are issues to be met and conferred on with the Fire Union. As the study team and apparatus builders determine what can be cost-effectively built, not all of the mission goals listed above may end up being feasible. But at the outset, the pilot program needs to consider all options.

As with any pilot program as it is implemented, data has to be collected and the Department has to be willing and be given the flexibility to make incremental adjustments. Even with all this to be done, Citygate and the Fire Chief believe this option needs to be strongly considered as part of the solution set.

The joint study team then considered the 3- versus 4-firefighter-per-unit issue. There is no question from Citygate, the Department, or City elected official leadership, that a 4-firefighter unit is more effective and safer for the firefighter and the public. However, if an agency has light workload on some or all of its units and cannot afford 4 firefighters, many agencies from suburban communities to the Los Angeles County Fire Department, operate 3-firefighter engines.

Citygate used the analysis tools in this study to answer this question, "Given the deployment gaps in the City of San Diego, how many engines, if any, could have staffing reduced from 4 to 3?"

The reality is that very few engines can have staffing reduced. With 19 or more fire station gaps in the system, in many areas the second-due unit is not close-by so a 3-firefighter crew cannot start interior fire attack if the 2-in/2-out rule has to be complied with. We also had to take into

account where call for service demands are high which creates delays for a second- or third-due unit to be available. Thus, we identified these criteria and results to the question:

- Areas that are under-deployed, with little to no overlap from an adjoining unit at 4 minutes travel.
- Areas that are very busy and drop calls to other units.
- Either of the above means a 3-firefighter unit is less effective than a 4-firefighter unit, as the first arriver, ***if*** the second-due unit is farther away.
- Analysis finds only 12 engines that have significant overlap from adjoining units with modest workloads, and that are not next to one or more major gap areas, that could allow their staffing to be at 3-firefighters/unit, which is a 25 percent efficiency loss per unit.
- Thus, 12 re-deployed firefighters per day would equal:
  - 3 more engines at 4-firefighters each, or
  - 4 more engines at 3-firefighters each, or
  - 6 new FRS units.

Given the efficiency and safety advantages of 4-firefighter units, San Diego's leadership preference for 4-firefighter units, and the number of deployment gaps in the system, Citygate and the Fire Chief prefer to see the Fast Response Squads units tried before unit staffing is reduced.

2.7.10 Integrated Deployment Recommendations

Given the complete analysis of the data elements in this study, combined with the knowledge of the very good San Diego Fire-Rescue senior staff, and of Citygate's extensive knowledge of the conditions in the City of San Diego, Citygate makes the following recommendations to deal with the findings of this study:

Recommendation #1: **Adopt Revised Deployment Measures:** The City should adopt revised performance measures to direct fire crew planning and to monitor the operation of the Department. The measures should take into account a realistic company turnout time of 1:30 minutes and be designed to deliver outcomes that will save patients medically salvageable upon arrival; and to keep small, but serious fires from becoming greater alarm fires. Citygate recommends these measures be:

1.1 **Distribution of Fire Stations:** To treat medical patients and control small fires, the first-due unit should arrive within 7:30 minutes, 90 percent of the time from the receipt of the 911 call in fire dispatch. This equates to 1-minute dispatch time, 1:30

minutes/seconds company turnout time and 5 minutes drive time in the most populated areas.

1.2 **Multiple-Unit Effective Response Force for Serious Emergencies:** To confine fires near the room of origin, to stop wildland fires to under 3 acres when noticed promptly and to treat up to 5 medical patients at once, a multiple-unit response of at least 17 personnel should arrive within 10:30 minutes/seconds from the time of 911-call receipt in fire dispatch, 90 percent of the time. This equates to 1-minute dispatch time, 1:30 minutes/seconds company turnout time and 8 minutes drive time spacing for multiple units in the most populated areas.

Recommendation #2: **Adopt Fire Station Location Measures:** To direct fire station location timing and crew size planning as the community grows, adopt fire unit deployment performance measures based on population density zones in the table below. The more specific, measurable and consistent the policy is, the more it can be applied fairly to all uses and easily understood by a non-fire service user.

Proposed Deployment Measures for San Diego City Growth

By Population Density Per Square Mile

	Structure Fire Urban Area	Structure Fire Rural Area	Structure Fire Remote Area	Wildfires Populated Areas
	>1,000-people/sq. mi.	**1,000 to 500 people/sq. mi.**	**500 to 50 people/sq. mi. ***	**Permanent open space areas**
1st Due Travel Time	5	12	20	10
Total Reflex Time	7.5	14.5	22.5	12.5
1st Alarm Travel Time	8	16	24	15
1st Alarm Total Reflex	10.5	18.5	26.5	17.5

* Less than 50 people per square mile there is acknowledgment that fire and EMS services are going to be substandard.

Recommendation #3: **Aggregate Population Definitions:** Where more than one square mile is not populated at similar densities, and/or a contiguous area with different zoning types aggregates into a population "cluster,"

these measures can guide the determination of response time measures and the need for fire stations:

Area	Aggregate Population	First-Due Unit Travel Time Goal
Metropolitan	> 200,000 people	4 minutes
Urban-Suburban	< 200,000 people	5 minutes
Rural	500 - 1,000 people	12 minutes
Remote	< 500	> 15 minutes

Recommendation #4: **Near Term Deployment Options:** As the City struggles with the economic downturn, it should consider this phasing of deployment changes:

- Do nothing
- Add back the 8 brownout engines
- Add back some of the 4-firefighter brownout engines as peak hour demand units*
- Implement gap area engines and/or Fast Response Squads.**

* *Meet and confer on impacts, work schedules, position compensation.*

Recommendation #5: **Adopt the Priority Criteria of this Study for Where to Add Resources:** Use of the tools and methods in this study would result over time as resources allow the addition of:

- 10 additional 4-firefighter staffed engine companies
- 9 new "Fast Response Squads"
- 4 additional aerial ladder trucks
- 2 additional field battalion chiefs.

Recommendation #6: **Fire Engine Dispatch Process:** The Department has to improve the procedures to achieve a decrease of the dispatch queue time for the first responding engine company.

Recommendation #7: **Fast Response Squads:** The Department should immediately begin detailed planning to fully design and cost a pilot program of two-firefighter Fast Response Squads to assist in smaller deployment gaps

where there are high simultaneous incident workloads. Unit type and capabilities are defined in Section 2.7.9.

Recommendation #8: **Replace In-Station Alerting System:** The City should make it a priority to replace the 21-year-old fire crew in-station alerting system at an approximate cost of $3.4 million. This will improve response times via a one-time capital expense without adding any more response crews.

SECTION 3—FISCAL IMPACTS

Section Intent: This chapter presents order-of-magnitude costs identified for the recommendations contained in this study. These are sufficient to permit the understanding of costs in current dollars so future long-range fiscal planning for fire and other City needs can occur when the economy recovers. Then, illustrative general timelines for implementing improvements are demonstrated.

Detailed costing is not possible until City leadership approves fire service deployment measures with Standards of Response Cover recommendations and sees enough of an economic recovery to plan for fire service enhancements. Even when the economy recovers, the City will likely have sustained damage to its existing service levels and fiscal reserves. As such, Fire Department needs may or may not be of sufficient priority to receive funding early in a recovery. The Mayor and Council will have to understand the entire City's under-met needs and make the appropriate fiscal allocation decisions. Additionally, the facility needs mentioned need more detailed planning and cost estimation based on City fire station standards and specific site costs.

If the City decides to add these enhancements as recommended by Citygate, the table below provides an *illustration* or sample of how this might be phased in over several years and the associated annual estimated cost in FY 10-11 dollars:

Operating Macro Costs

Resource – Staff & Operating	Cost in $ Millions	Quantity for 5-Minute Coverage @ 90%	Totals
2-FF Fast Response Squads	1.0	9	9.0
Single engine staffed station	2.2	6	13.2
Double staffed station	4.4	4	17.6
Batt Chief	0.53	2	1.1
Total			**$40.9**

Capital Macro Costs

Resource	Cost in $ Millions	Quantity for 5-Minute Coverage @ 90%	Totals
Engine	0.78	10	7.8
Ladder	1.1	4	4.4
Fast Response Squad	0.4	9	3.6
Single station	7	6	42.0
Double station	8	4	32.0
Fast Response Squad Station	.5	9	4.5
Replace Fire Station Crew Alert System	3.4	-	3.4
Total			**$97.7**

3.1 PRIORITIES AND TIMING

Some of the recommendations in this planning effort requiring minimal additional resources can be worked on in parallel. Others will take several fiscal years, both in time and funding. Given these two realities, Citygate recommends two short-term priorities and one long-term priority:

3.1.1 Short-Term Priority One

- Absorb the policy recommendations of this fire services study and adopt revised Department performance measures to drive the deployment of firefighting and emergency medical resources.
- Create a task force to fully study the Fast Response Squad concept. Bring forward an implementation pilot project and costs.

3.1.2 Short-Term Priority Two

- Add back brownout engines per the priority methodology used in this study.
- Identify revenues to replace the failing fire station alerting system to ensure timely incident notification to emergency responders.
- Identify revenue sources to increase the Department's deployment system.
- Add additional primary engine and Fast Response Squads as revenues allow.

3.1.3 Long-Term Priority

- Monitor the performance of the deployment system using adopted deployment measures and the methods in this study.