September 2023

GIS Analysis

BONITA SPRINGS
Fire Control and Rescue District

Bonita Springs Fire Department
Bonita Springs, FL

Prepared by:

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ESTABLISHING BASELINE PERFORMANCE

The first step in completing GIS planning analyses is to establish the desired performance parameters. Measures of total response time can be significantly influenced by both internal and external influences. The dispatch time, defined as the time from call creation at the 911-center to the dispatching of units, was not available for this analysis. Another element in the total response time continuum is the turnout time, defined as the time from when the units are notified of the incident until they are responding. Turnout time can have a significant impact on the overall response time for the customer and is generally considered under management's control. However, the travel time, defined as the period from when the units are responding until arrival at the incident is a factor of the number of fire stations, the ability to travel unimpeded on the road network, the existing road network's ability to navigate the community, and the availability of the units. Largely, travel time is the most stable variable to utilize in system design regarding response time performance.

Therefore, these GIS planning analyses will focus on travel time capability as the unit of measure. Performance for travel time of first arriving Bonita Springs Fire Department (BSFD) units to emergency calls by program during the 2022 (January 1, 2022 – December 31, 2022) reporting period is provided below. Overall, travel time was 8.2 minutes or less for 90% of the incidents within the City. EMS-related incidents had a travel time of 7.9 minutes or less for 90% of the incidents, and fire service-related incidents had a travel time performance of 9.2 minutes or less for 90% of the incidents for incidents within the jurisdiction.

Table 1: 90th Percentile Performance Times by Program– First Arriving BSFD Units in BSFD's Jurisdiction

Program	Dispatch Time (Minutes)	Turnout Time (Minutes)	Travel Time (Minutes)	Response Time (Minutes)	Sample Size[1]
EMS	1.1	1.7	7.9	9.7	5,719
Fire	1.4	1.8	9.2	11.2	1,014
Hazmat	1.7	1.7	9.1	10.7	32
Rescue	1.6	1.6	10.7	12.5	40
Total	**1.2**	**1.7**	**8.2**	**10.0**	**6,805**

[1]Sample sizes reflect the number of responses to emergency calls made by first arriving primary front-line units assigned to BSFD; due to missing or excluded time data, sample sizes corresponding to individual table metrics may be smaller.

Comparison to National References

There are two notable references for travel time available to the fire service in National Fire Protection Association (NFPA) 1710[1] and the Commission on Fire Accreditation International (CFAI)[2]. NFPA 1710 suggests a 4-minute travel time at the 90th percentile for first due arrival of Basic Life Support (BLS) and fire incidents, and the CFAI recommends a 5 minute and 12 seconds travel time for first due arrival in an urban/suburban population density. In contrast the CFAI affords a 13-minute travel time for rural areas. The arrival of an Advanced Life Support (ALS) unit is recommended at 8 minutes travel time by NFPA 1710. It is important to note that the previous edition (9th edition) of the CFAI guidelines have de-emphasized response time and only reference the legacy standards with a separately provided companion document[3]. There is no reference for response times in the most recent publication.[4]

The following analysis evaluates the 4-minute travel time at the 90th percentile to evaluate the NFPA 1710 recommendations.

When referring to the marginal utility analyses provided in the tables on the following pages, ascending rank order is the station's capability to cover risk (incidents) for all calls in relation to the total historical call volume of the sample period CY 2022. Station is the identifier for the current BSFD station; station capture is the number of calls the station would capture within the specified travel time parameter; total capture is the cumulative number of calls captured with the addition of each station; and percent capture is the cumulative percentage of risk covered with the addition of each station.

The goal would be to achieve at least 90% capture. Figures depict drive time mapping for all incidents from stations Bonita Springs deploys.

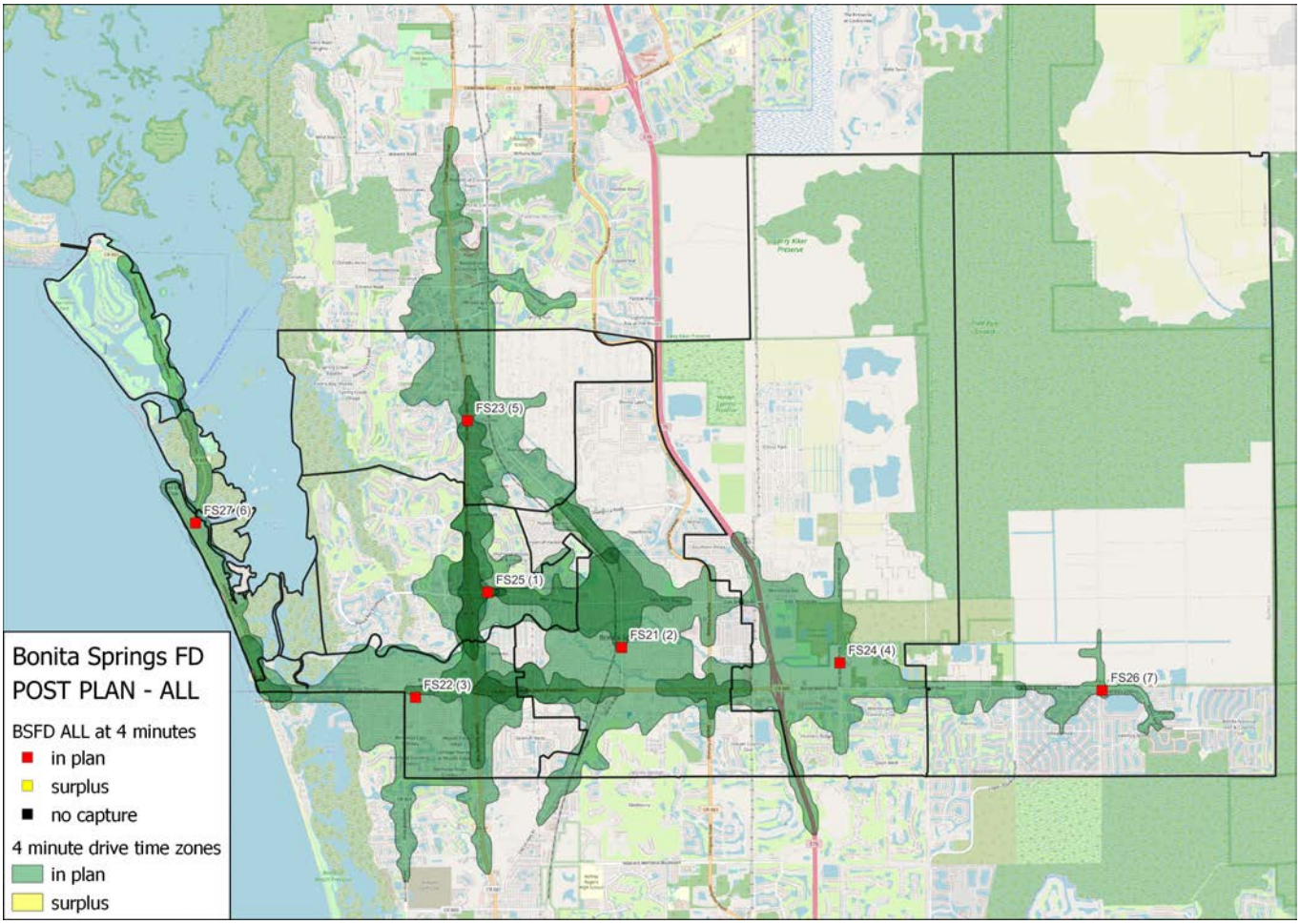
Results suggest that with 7-stations, approximately 57% of all calls could be responded to within 4-minutes or less travel time.

[1] National Fire Protection Association. (2010). NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*. Boston, MA: National Fire Protection Association.
[2] CFAI. (2009). Fire & emergency service self-assessment manual, (8th ed.). Chantilly, Virginia: Author. (page 71)
[3] CFAI. (2016). Fire & emergency service self-assessment manual, (9th ed.). Chantilly, Virginia: Author.
[4] CFAI. (2020). Quality improvement for the fire and emergency services. Chantilly, Virginia: Author.

Table 2: Marginal Station Contribution for 4-Minute Travel Time – All Calls

Rank	Station	Travel Time	Station Capture	Total Capture	Percent Capture
1	FS25	4	1,926	1,926	22.75%
2	FS21	4	1,244	3,170	37.45%
3	FS22	4	518	3,688	43.57%
4	FS24	4	516	4,204	49.66%
5	FS23	4	412	4,616	54.53%
6	FS27	4	150	4,766	56.30%
7	FS26	4	62	4,828	57.03%

Figure 1: Current Station Bleed Map for 4-Minute Travel Time – All Calls



Validation of Planning Analysis

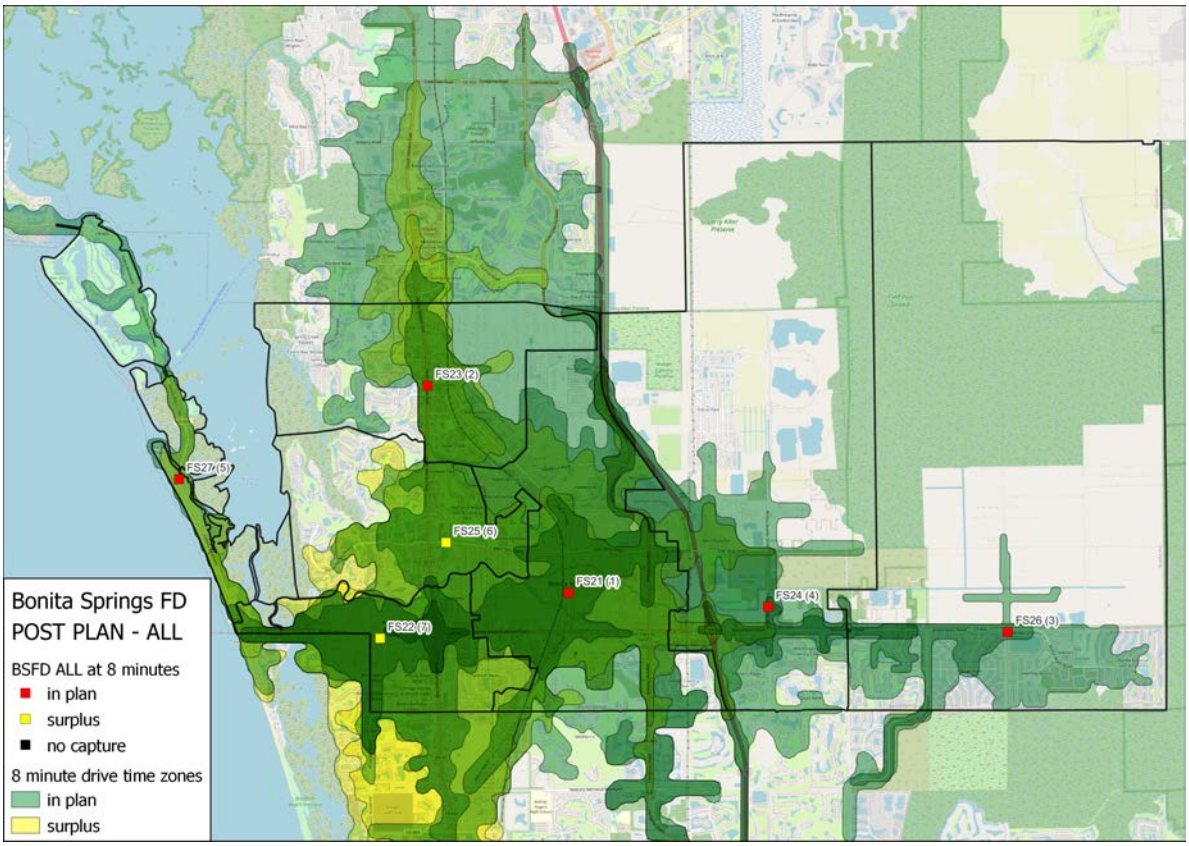
The first step in this validation analysis is to utilize the historical performance to validate the planning analyses utilized by the GIS system. The 2022 historical performance demonstrated an 8.2-minute overall department travel time performance at the 90th percentile. The planning assessments estimated 91.32% risk coverage by 7 stations within 8-minutes travel time.

The planning assessment utilizes average road speeds and impedance; therefore, it is not uncommon for the fire department to outperform the more conservative GIS modeling. Overall, there is a high degree of agreement between the historical performance and the GIS modeling.

Table 3: Marginal Station Contribution for 8-Minute Travel Time – All Calls

Rank	Station	Travel Time	Station Capture	Total Capture	Percent Capture
1	FS21	8	6,070	6,070	71.71%
2	FS23	8	614	6,684	78.96%
3	FS26	8	511	7,195	85.00%
4	FS24	8	245	7,440	87.89%
5	FS27	8	221	7,661	90.50%
6	FS25	8	65	7,726	91.27%
7	FS22	8	4	7,730	91.32%

Figure 2: Current Station Bleed Map for 8-Minute Travel Time – All Calls



EVALUATION OF VARIOUS DISTRIBUTION MODELS

As previously discussed, these analyses utilized 2022 historical performance as the desired performance for system design. Various configurations of 4- to 9-minute travel times were completed to consider alternatives compared to the current performance.

Analyses are presented as follows:

1. BSFD stations responding to ALL calls at 4-, 6-, 7-, 8, and 9-minute travel times.
    a. 4-, and 8-minute travels times were previously presented

2. BSFD stations responding to EMS calls at 4-, 6-, 7-, 8, and 9-minute travel times.

Analyses are offered to compare the various potential distribution models.

BSFD Fire Stations – All Calls

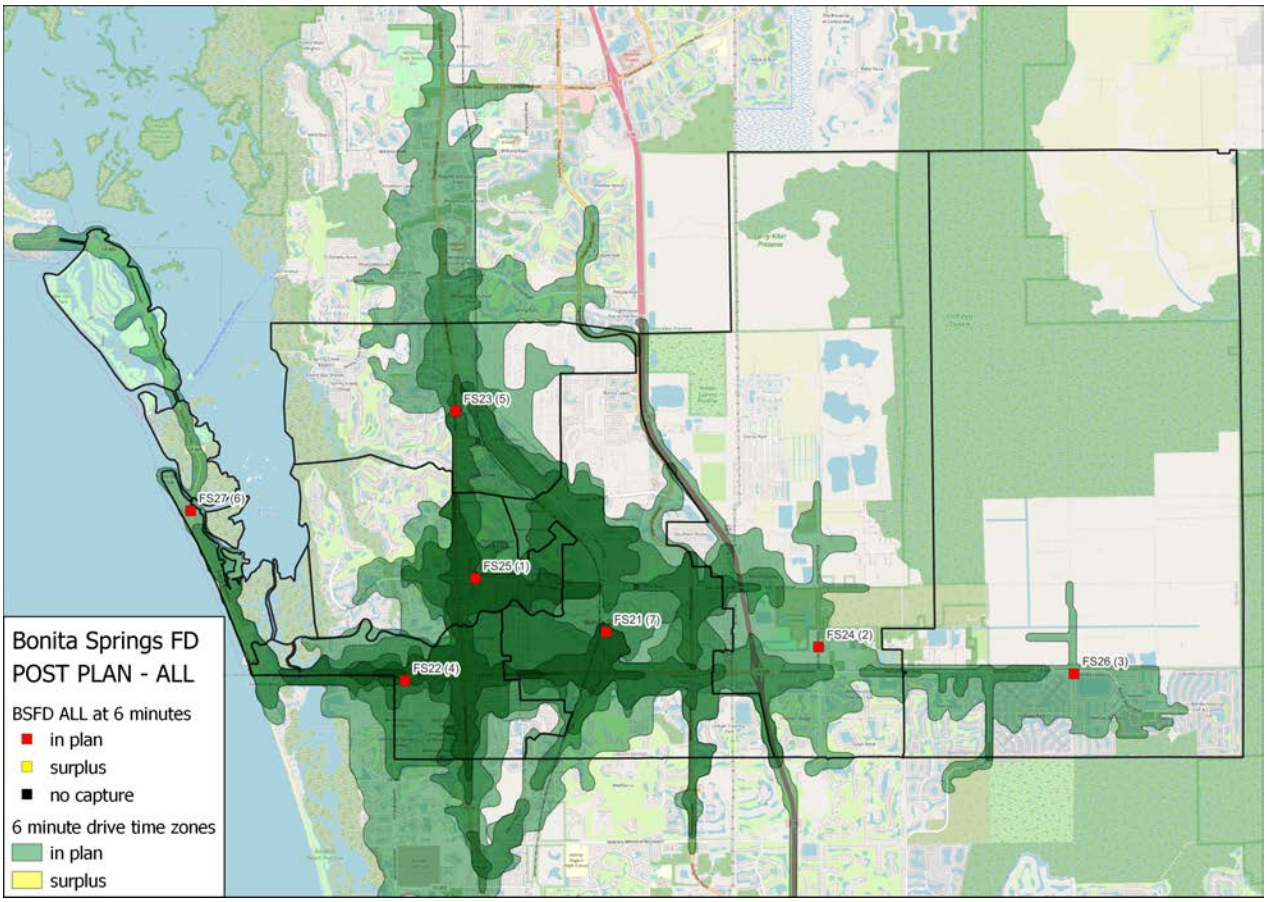
6-Minute Travel Time – All Calls

The planning assessments estimated 79.73% risk coverage by 7-stations within 6-minutes travel time.

Table 4: Marginal Station Contribution for 6-Minute Travel Time – All Calls

Rank	Station	Travel Time	Station Capture	Total Capture	Percent Capture
1	FS25	6	4,658	4,658	55.03%
2	FS24	6	1,050	5,708	67.43%
3	FS26	6	296	6,004	70.93%
4	FS22	6	262	6,266	74.02%
5	FS23	6	210	6,476	76.50%
6	FS27	6	138	6,614	78.13%
7	FS21	6	135	6,749	79.73%

Figure 3: Current Station Bleed Map for 6-Minute Travel Time – All Calls



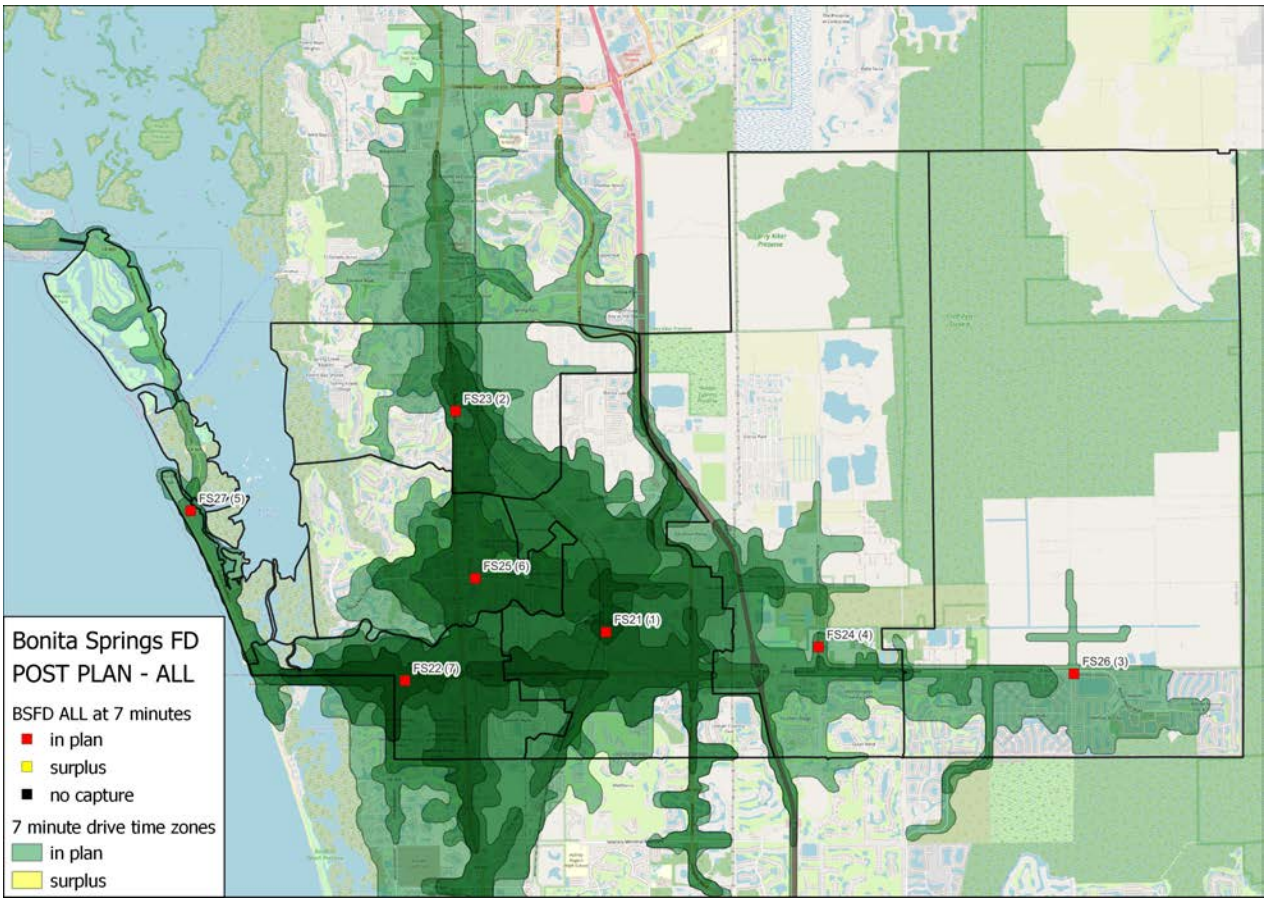
7-Minute Travel Time – All Calls

The planning assessments estimated 85.92% risk coverage by 7-stations within 7-minutes travel time.

Table 5: Marginal Station Contribution for 7-Minute Travel Time – All Calls

Rank	Station	Travel Time	Station Capture	Total Capture	Percent Capture
1	FS21	7	5,501	5,501	64.99%
2	FS23	7	532	6,033	71.27%
3	FS26	7	465	6,498	76.76%
4	FS24	7	373	6,871	81.17%
5	FS27	7	268	7,139	84.34%
6	FS25	7	120	7,259	85.75%
7	FS22	7	14	7,273	85.92%

Figure 4: Current Station Bleed Map for 7-Minute Travel Time – All Calls



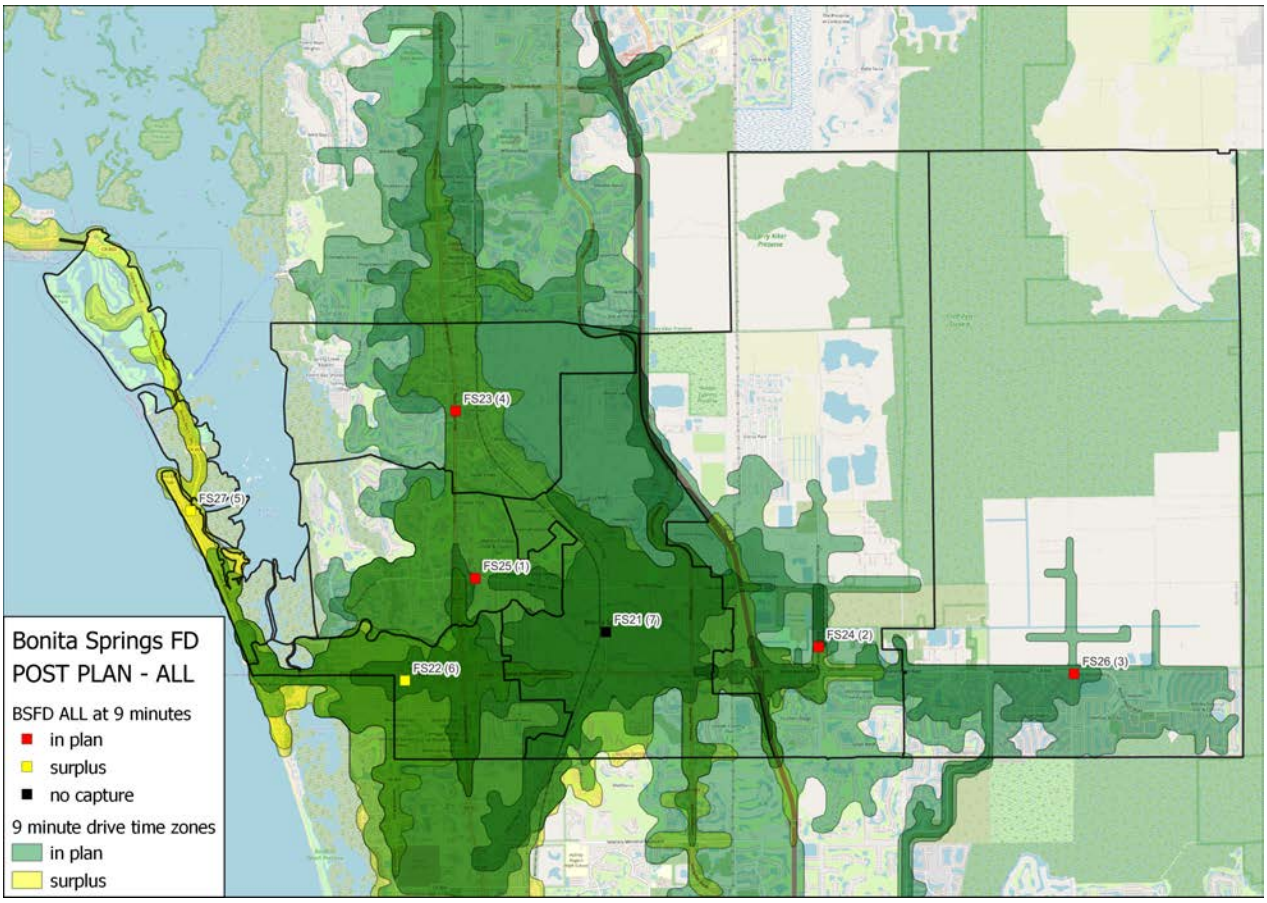
9-Minute Travel Time – All Calls

The planning assessments estimated 94.07% risk coverage by 7-stations within 9-minutes travel time. However, a four-station configuration can cover 91.98% of the incident density without consideration for geographic needs.

Table 6: Marginal Station Contribution for 9-Minute Travel Time – All Calls

Rank	Station	Travel Time	Station Capture	Total Capture	Percent Capture
1	FS25	9	6,535	6,535	77.20%
2	FS24	9	687	7,222	85.32%
3	FS26	9	390	7,612	89.92%
4	FS23	9	174	7,786	91.98%
5	FS27	9	167	7,953	93.95%
6	FS22	9	10	7,963	94.07%
7	FS21	9	0	7,963	94.07%

Figure 5: Current Station Bleed Map for 9-Minute Travel Time – All Calls



All BSFD Fire Stations – EMS Calls

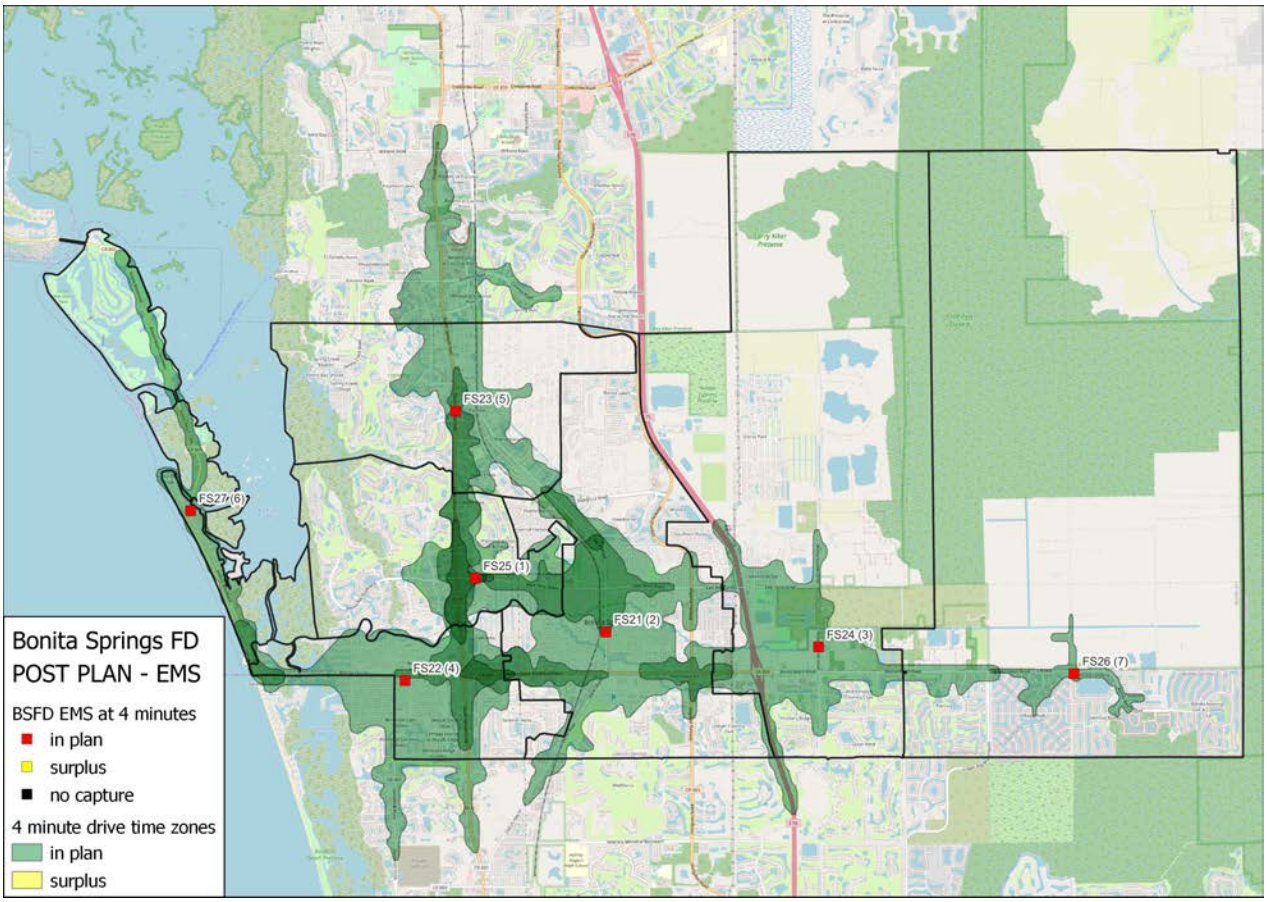
4-Minute Travel Time – EMS Calls

The planning assessments estimated 59.65% risk coverage by 7-stations within 4-minutes travel time.

Table 7: Marginal Station Contribution for 4-Minute Travel Time – EMS Calls

Rank	Station	Travel Time	Station Capture	Total Capture	Percent Capture
1	FS25	4	1,552	1,552	24.45%
2	FS21	4	989	2,541	40.03%
3	FS24	4	419	2,960	46.64%
4	FS22	4	362	3,322	52.34%
5	FS23	4	338	3,660	57.67%
6	FS27	4	83	3,743	58.97%
7	FS26	4	43	3,786	59.65%

Figure 6: Current Station Bleed Map for 4-Minute Travel Time – EMS Calls



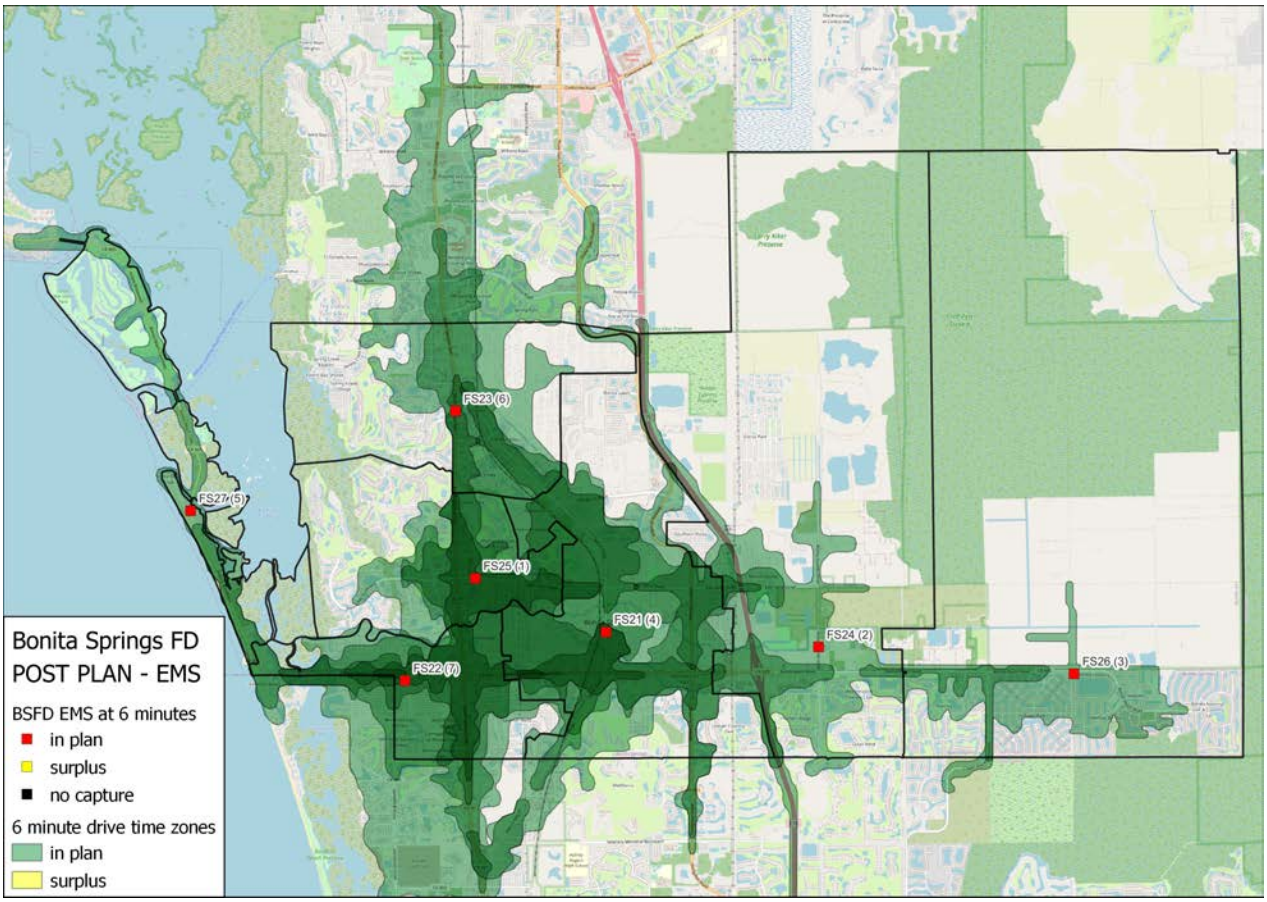
6-Minute Travel Time – EMS Calls

The planning assessments estimated 82.13% risk coverage by 7-stations within 6-minutes travel time.

Table 8: Marginal Station Contribution for 6-Minute Travel Time – EMS Calls

Rank	Station	Travel Time	Station Capture	Total Capture	Percent Capture
1	FS25	6	3,682	3,682	58.01%
2	FS24	6	845	4,527	71.33%
3	FS26	6	190	4,717	74.32%
4	FS21	6	183	4,900	77.20%
5	FS27	6	155	5,055	79.64%
6	FS23	6	110	5,165	81.38%
7	FS22	6	48	5,213	82.13%

Figure 7: Current Station Bleed Map for 6-Minute Travel Time – EMS Calls



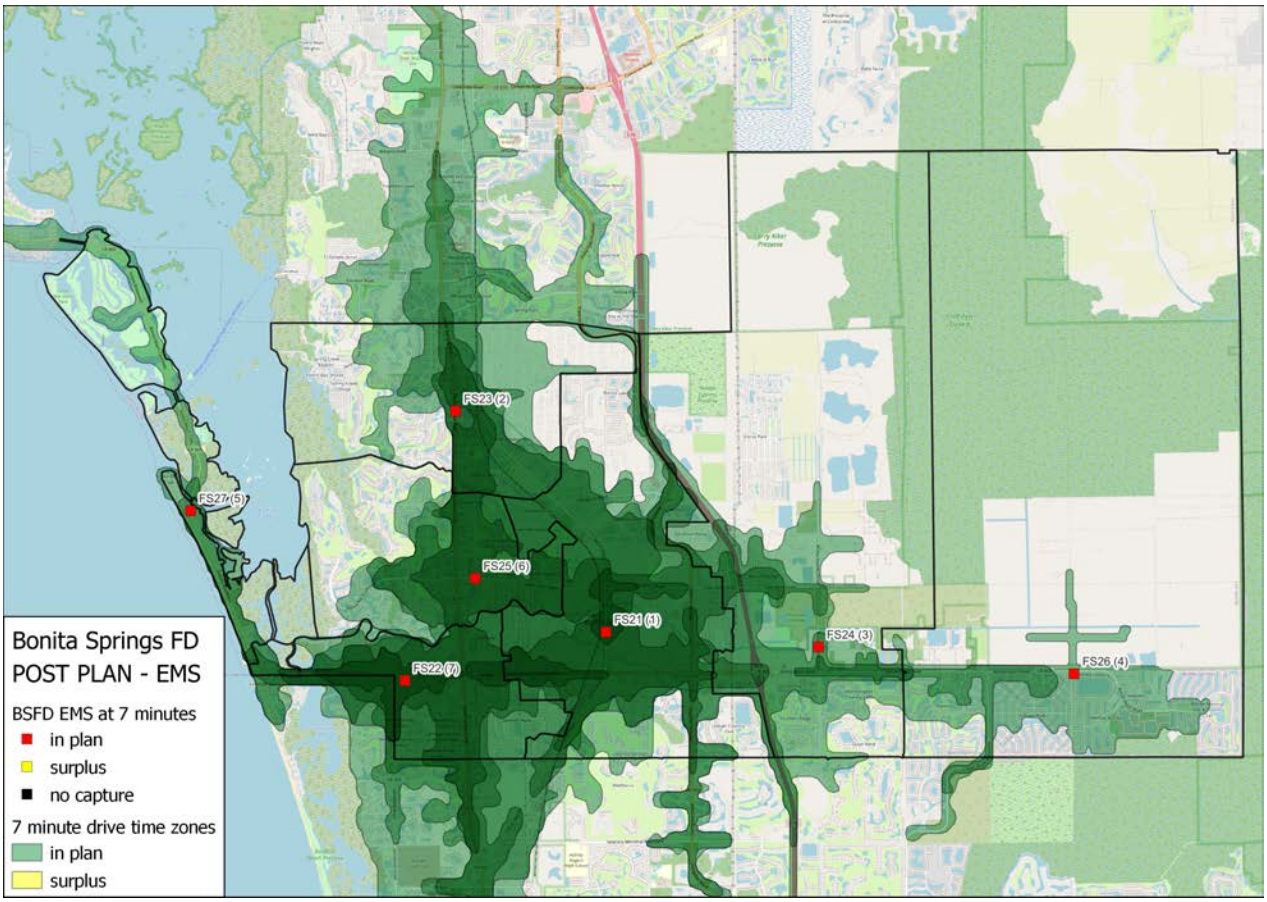
7-Minute Travel Time – EMS Calls

The planning assessments estimated 87.98% risk coverage by 7-stations within 7-minutes travel time.

Table 9: Marginal Station Contribution for 7-Minute Travel Time – EMS Calls

Rank	Station	Travel Time	Station Capture	Total Capture	Percent Capture
1	FS21	7	4,377	4,377	68.96%
2	FS23	7	376	4,753	74.89%
3	FS24	7	363	5,116	80.61%
4	FS26	7	235	5,351	84.31%
5	FS27	7	158	5,509	86.80%
6	FS25	7	69	5,578	87.88%
7	FS22	7	6	5,584	87.98%

Figure 8: Current Station Bleed Map for 7-Minute Travel Time – EMS Calls



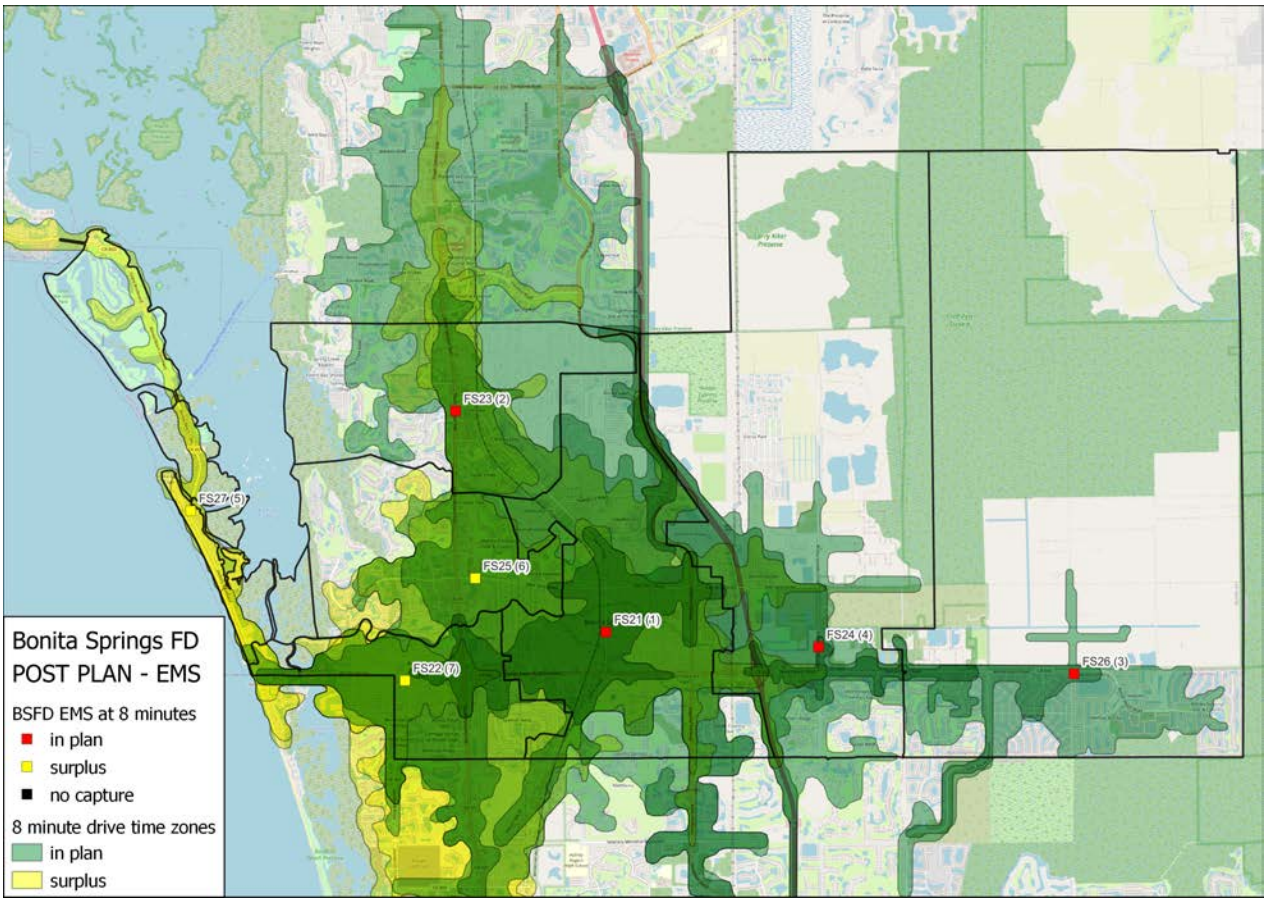
8-Minute Travel Time – EMS Calls

The planning assessments estimated 92.91% risk coverage by 7-stations within 8-minutes travel time. However, a 4-station configuration can cover 90.39% of the incident density without consideration for geographic needs.

Table 10: Marginal Station Contribution for 8-Minute Travel Time – EMS Calls

Rank	Station	Travel Time	Station Capture	Total Capture	Percent Capture
1	FS21	8	4,803	4,803	75.67%
2	FS23	8	408	5,211	82.10%
3	FS26	8	341	5,552	87.47%
4	FS24	8	185	5,737	90.39%
5	FS27	8	119	5,856	92.26%
6	FS25	8	39	5,895	92.88%
7	FS22	8	2	5,897	92.91%

Figure 9: Current Station Bleed Map for 8-Minute Travel Time – EMS Calls



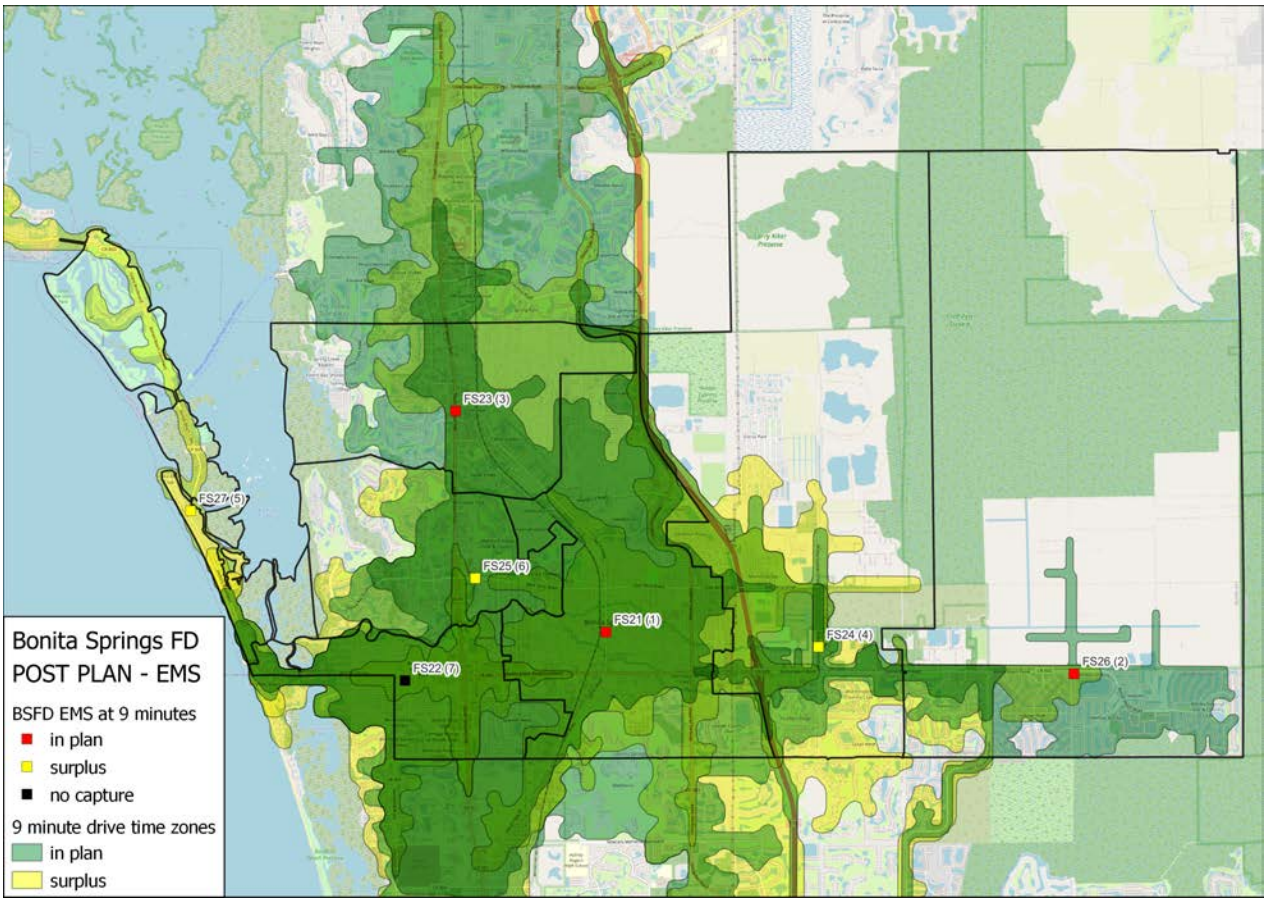
9-Minute Travel Time – EMS Calls

The planning assessments estimated 95.42% risk coverage by 7-stations within 9-minutes travel time. However, a 3-station configuration can cover 91.02% of the incident density without consideration for geographic needs.

Table 11: Marginal Station Contribution for 9-Minute Travel Time – EMS Calls

Rank	Station	Travel Time	Station Capture	Total Capture	Percent Capture
1	FS21	9	5,134	5,134	80.89%
2	FS26	9	345	5,479	86.32%
3	FS23	9	298	5,777	91.02%
4	FS24	9	153	5,930	93.43%
5	FS27	9	102	6,032	95.04%
6	FS25	9	24	6,056	95.42%
7	FS22	9	0	6,056	95.42%

Figure 10: Current Station Bleed Map for 9-Minute Travel Time – EMS Calls



Geographic Coverage without Consideration for Call Distribution

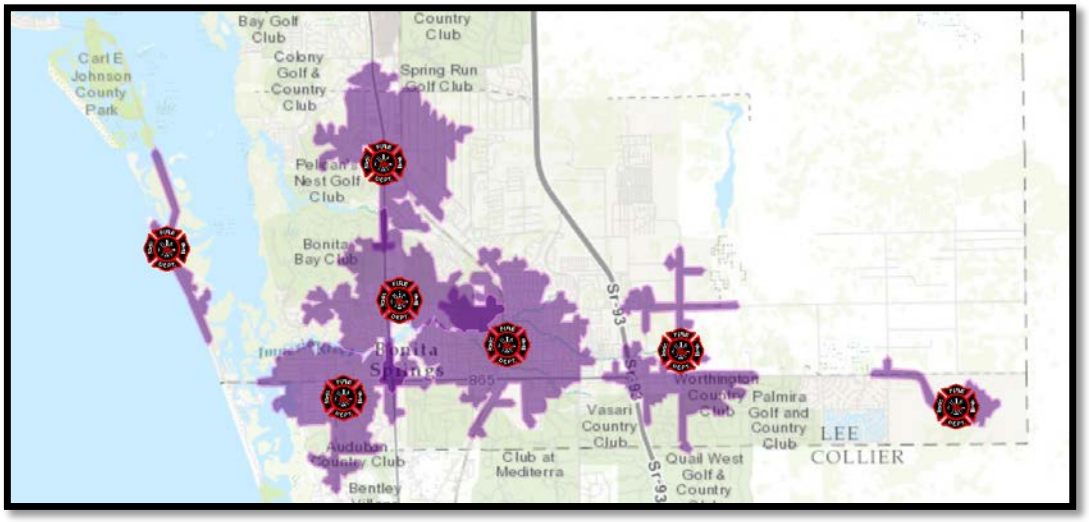
While there are multiple deployment strategies that may be adopted, two clear policy positions emerge in communities. First, position stations that are best prepared to meet the community's historical distribution of calls or demand for services. The advantage to this approach is that it is a more efficient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

A second strategy is to provide station response coverage purely on a geographic lens without any consideration for how calls are distributed throughout the community. The following analyses utilized distance without consideration of the relative impedance and/or the robustness of the road network. For example, when time is the unit of measure, a station's units could travel a farther distance on a highway than through a school zone, but this approach caps the coverage area at 1.5 miles (i.e., for engines) regardless of available travel speeds. This strategy more closely follows the recommendations of insurance rating services. Therefore, these analyses examined current coverage areas by utilizing a 1.5-mile engine polygon and 2.5-mile station locations. Analyses confirmed that all stations are within a 5-miles contiguous road system.

Engine Coverage

Analysis confirm that the stations are further apart than the WSRB recommendation of 1.5 miles.

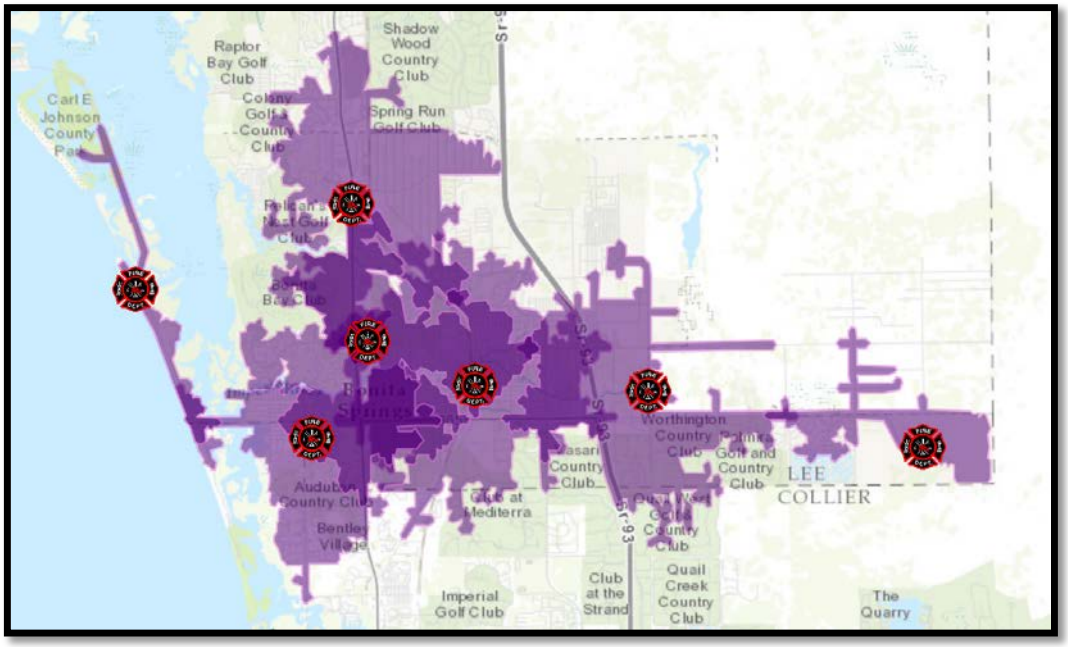
Figure 11: 1.5-Mile Engine Polygons – All Current Stations



Ladder Truck Coverage

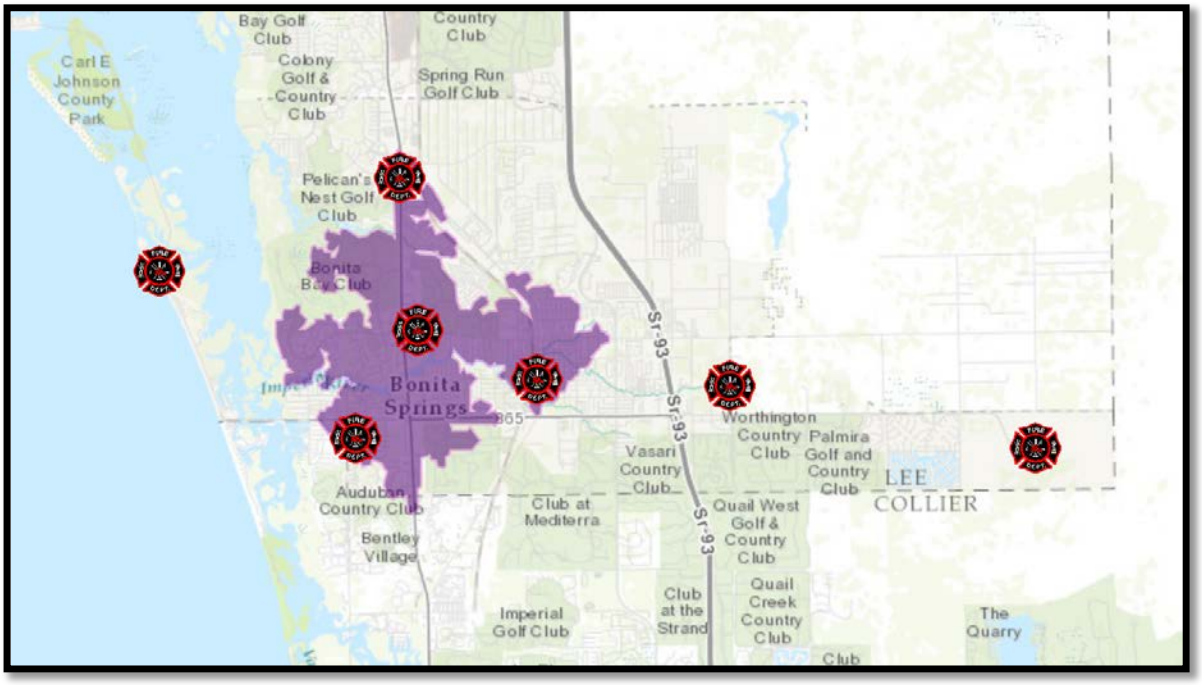
The current configuration provides the great coverage through the core of the city based on geography.

Figure 12: 2.5-Mile Station Ladder Truck Configuration – Current and Proposed Deployment – Quint Concept



The following map is the ladder truck coverage for 2.5 miles from Station 25.

Figure 13: Current Ladder Truck Deployment - ISO 2.5 Mile



All stations are within the ISO recommended 5-mile contiguous road network should be fully considered and rated.

DISTRIBUTION OF RISK ACROSS THE JURISDICTION

Distribution of Demand by Program Areas

Heat maps were created to identify the concentration of the historic demand for services overall and by program area (i.e., EMS, Fire, Hazmat, and Rescue). The blue areas have the lowest concentration of demand, and the dark red areas have the highest concentration of demand.

Figure 14: Heat Map for All Calls

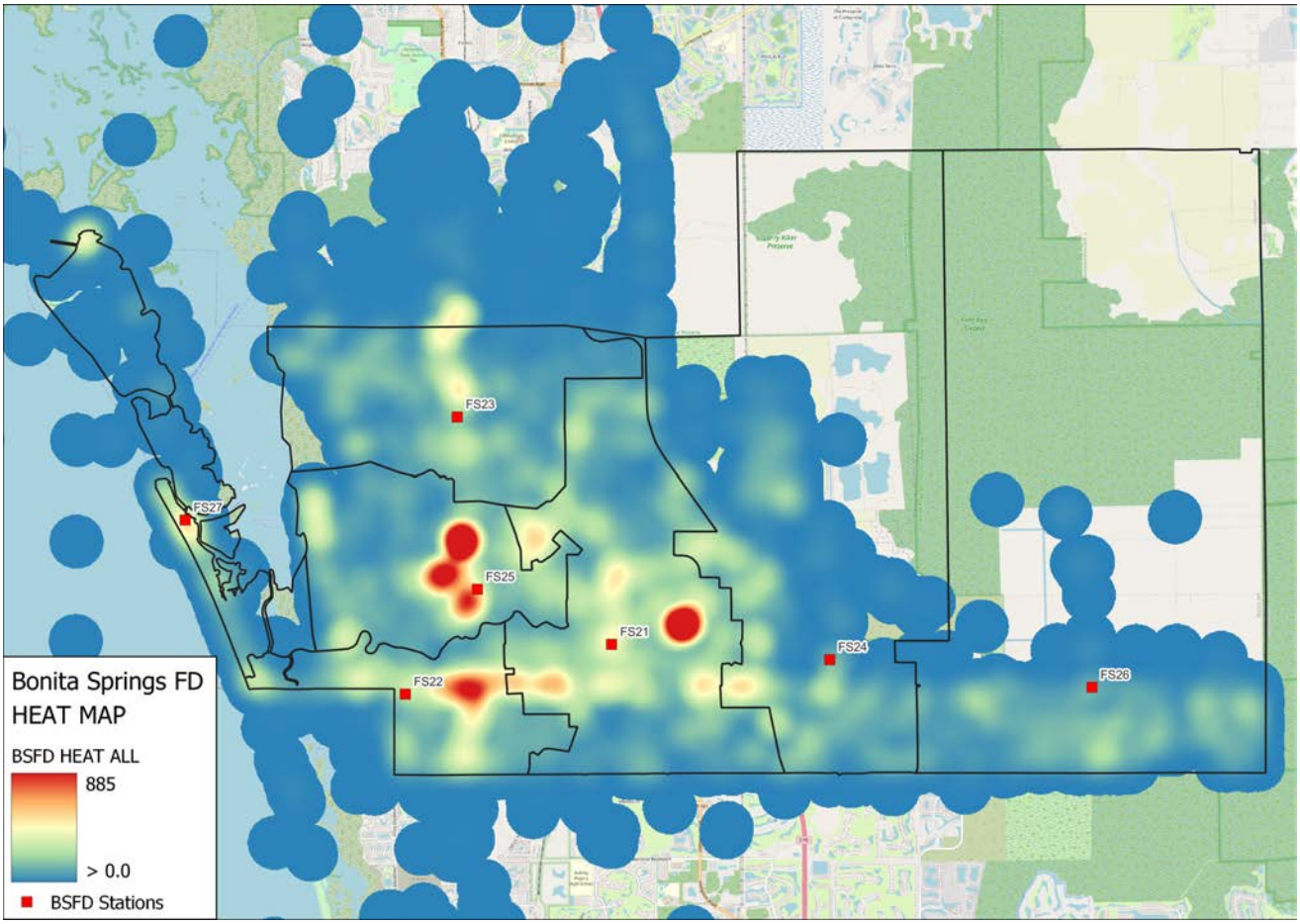


Figure 15: Heat Map for EMS Calls

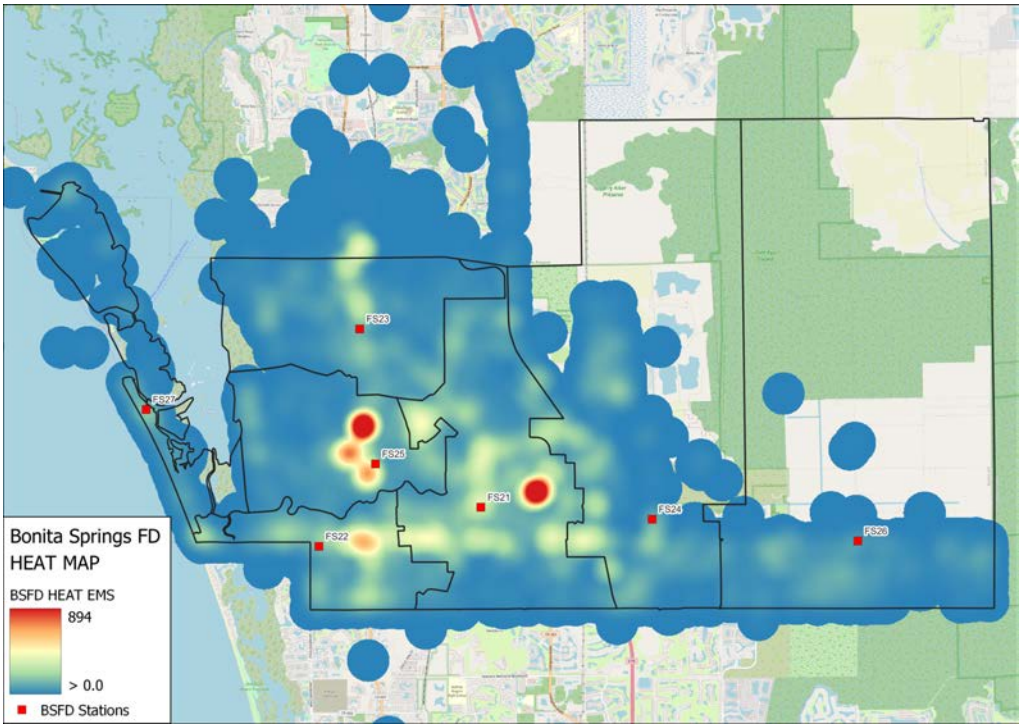


Figure 16: Heat Map for Fire Service Calls

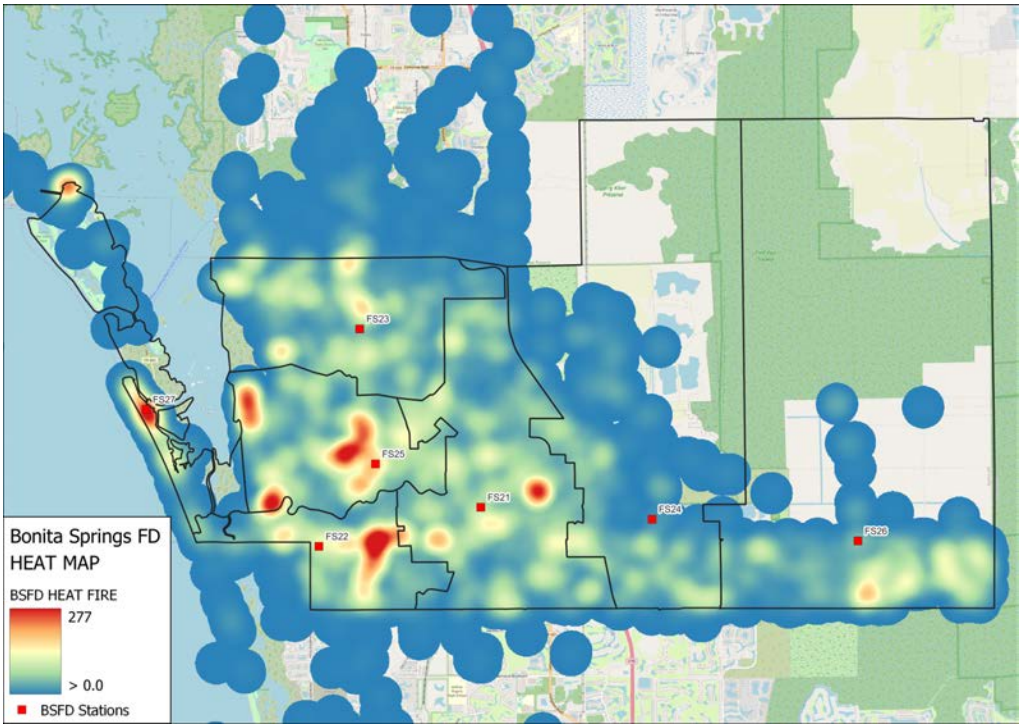


Figure 17: Heat Map for Hazmat Calls

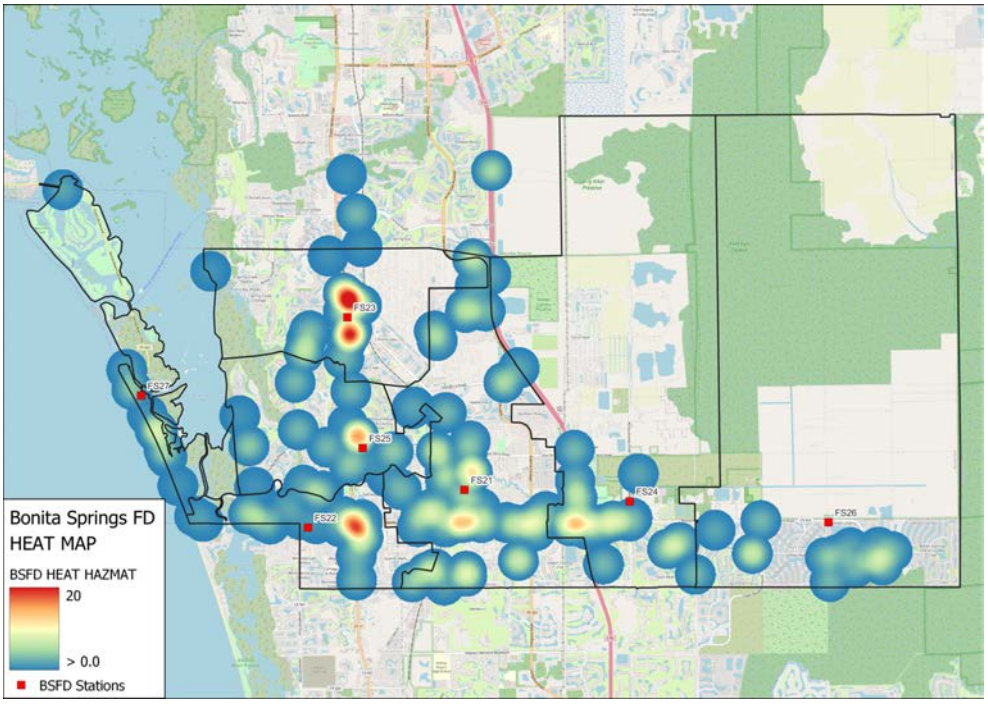


Figure 18: Heat Map for Rescue Calls

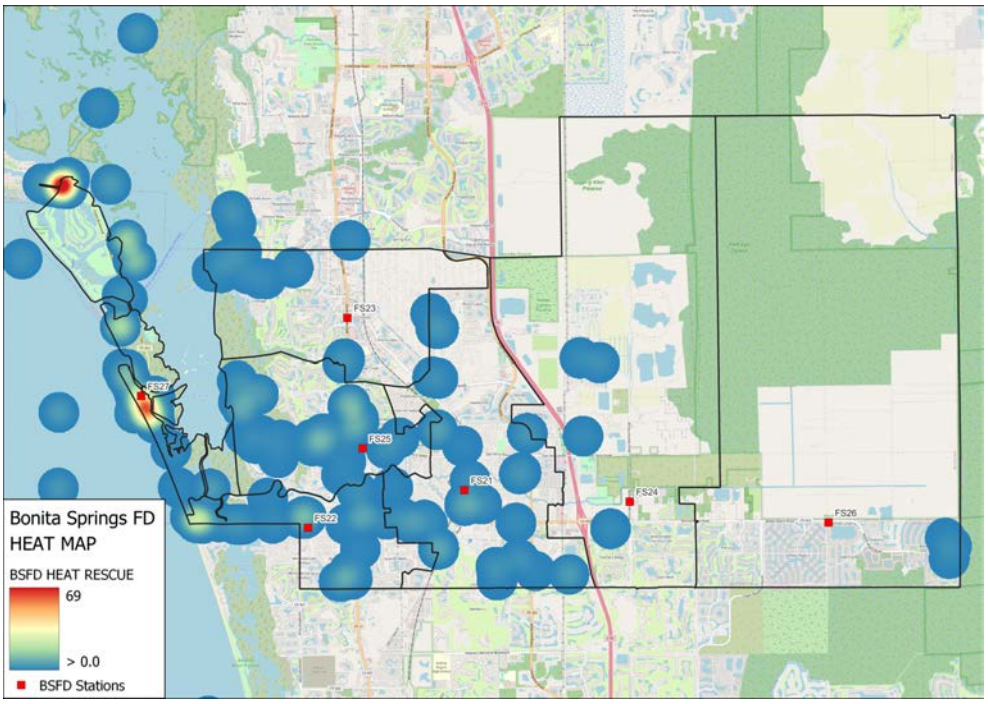
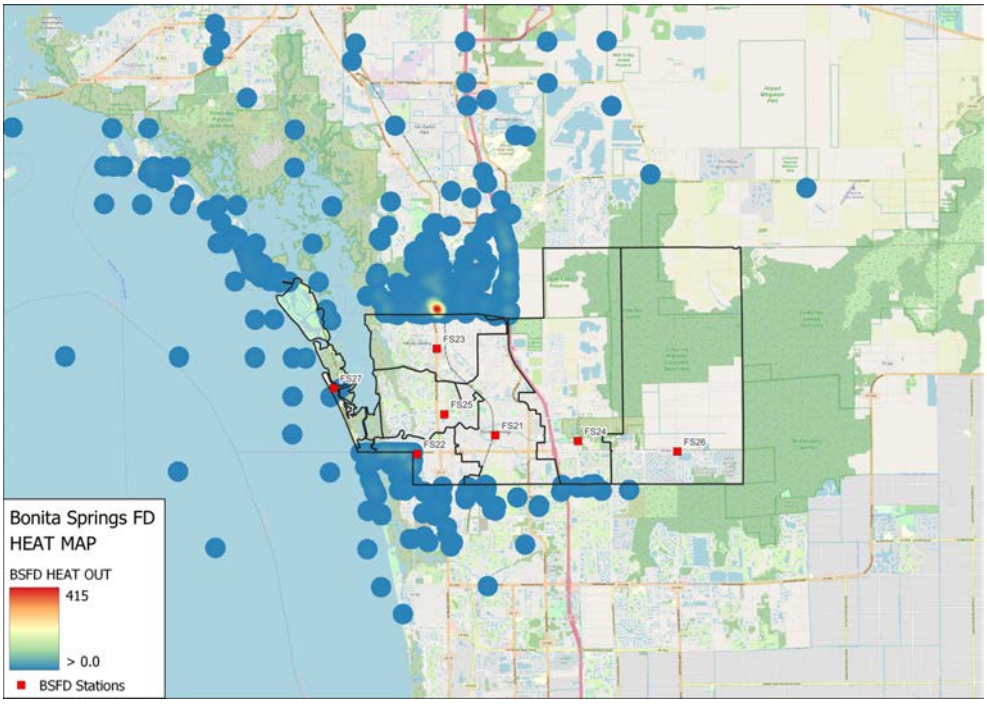
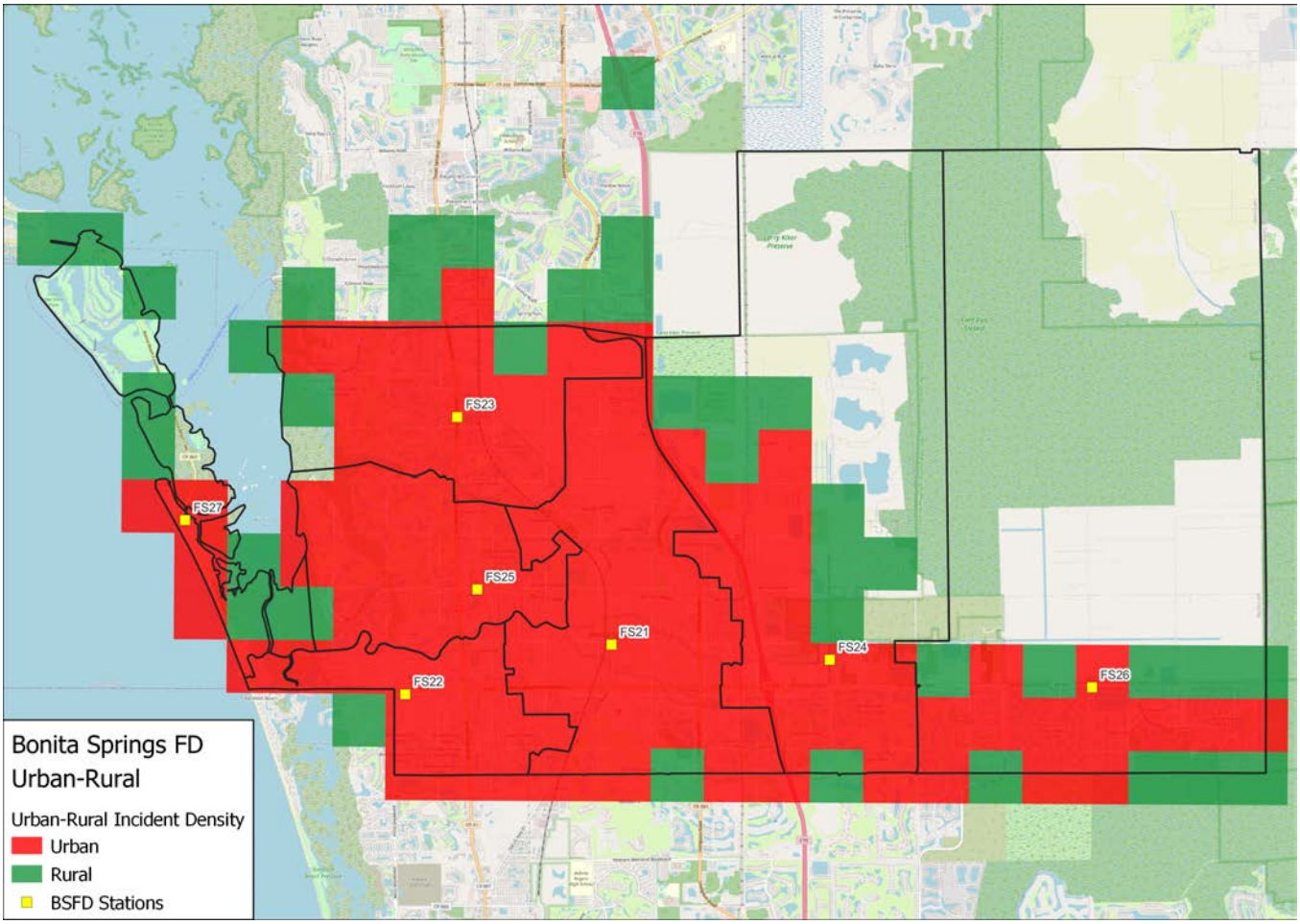


Figure 19: Heat Map for Mutual/Automatic Aid – Outside of Jurisdiction



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

Figure 20: Urban and Rural Call Density Map – All Incidents



CONCENTRATION STUDY

Effective Response Force Capabilities

The capability of an ERF to assemble in a timely manner with the appropriate personnel, apparatus, and equipment is important to the success of a significant structure fire event. Therefore, it is important to measure the capabilities of assembling an ERF. In most fire departments, the distribution model performs satisfactorily, but it is not uncommon to be challenged to assemble an ERF in the recommended time frames. Several factors affect the capabilities to assemble an ERF, such as the number of fire stations, number of units, and number of personnel on each unit. Each of these policy decisions should be made in relation to the community's specific risks and the willingness to assume risk.

Similar to the previous discussion, there are two prevailing recommendations for the time to assemble an ERF for structure fires. First, NFPA 1710 suggests that the ERF should arrive in eight minutes travel time or less. Second, the CFAI provides a baseline travel time performance objective of 10 minutes and 24 seconds 90% of the time or less as well as a 13-minute travel time ERF for suburban areas. ERF times between 8-, and 20-minute travel times were created to demonstrate the relative coverage throughout the jurisdiction.

Under the current model configuration, with 7 stations, approximately 54% of the **total** geography can be served with a 17-person ERF within 20-minutes with the current staffing strategy. However, the mapping will be much more informative to the reader due to the large undeveloped area in the east.

Table 12: Comparisons of Effective Response Force Configurations

Travel Time Objective	ERF 17 (NFPA 1710)
8-Minute	10.85%
10-Minute	23.86%
12-Minute	35.14%
14-Minute	41.56%
16-Minute	46.12%
18-Minute	51.36%
20-Minute	54.32%

Overall, the ERF coverage is more robust in the center of the jurisdiction where the greatest historical demand exists and the greater concentration of concentric response zones.

Figure 21: ERF at 8-Minutes

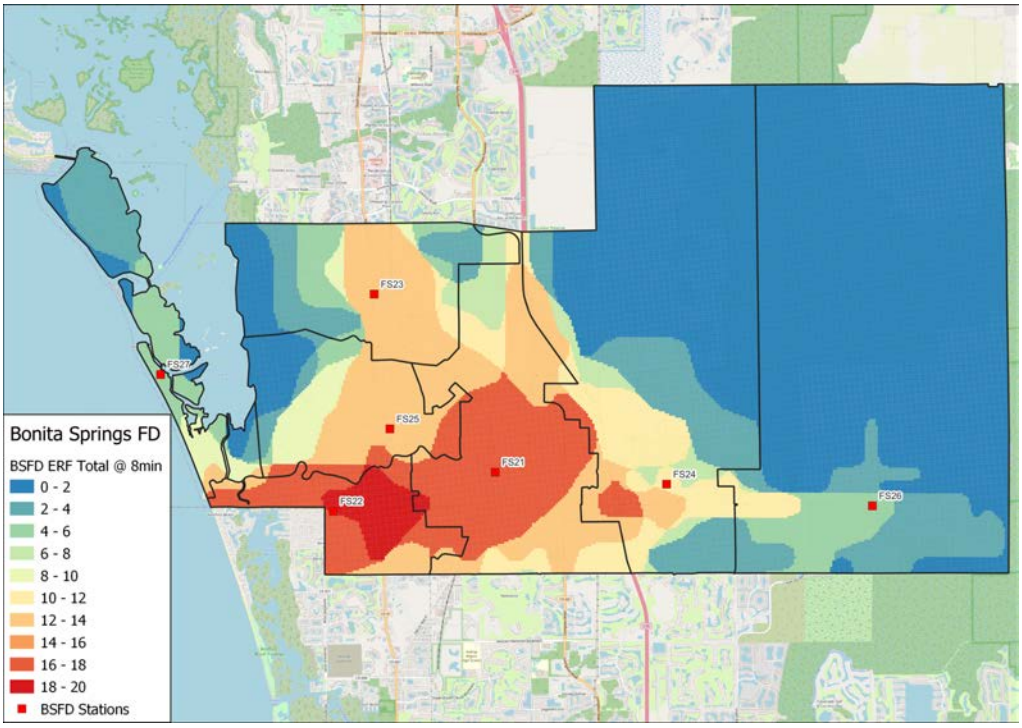


Figure 22: ERF at 10-Minutes

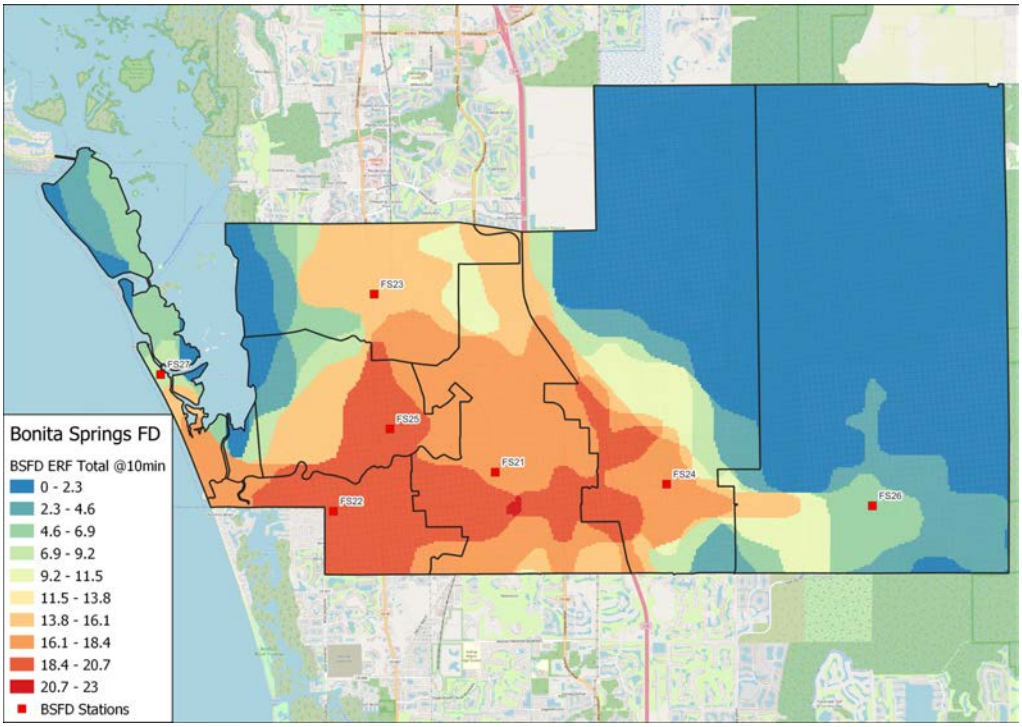


Figure 23: ERF at 12-Minutes

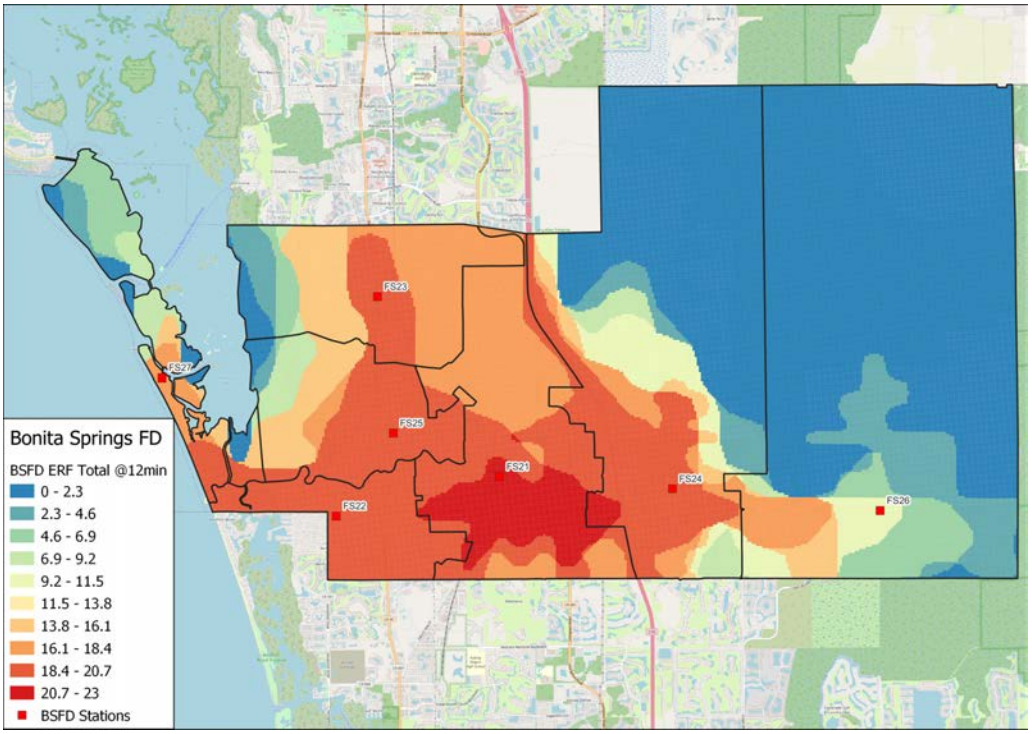


Figure 24: ERF at 14-Minutes

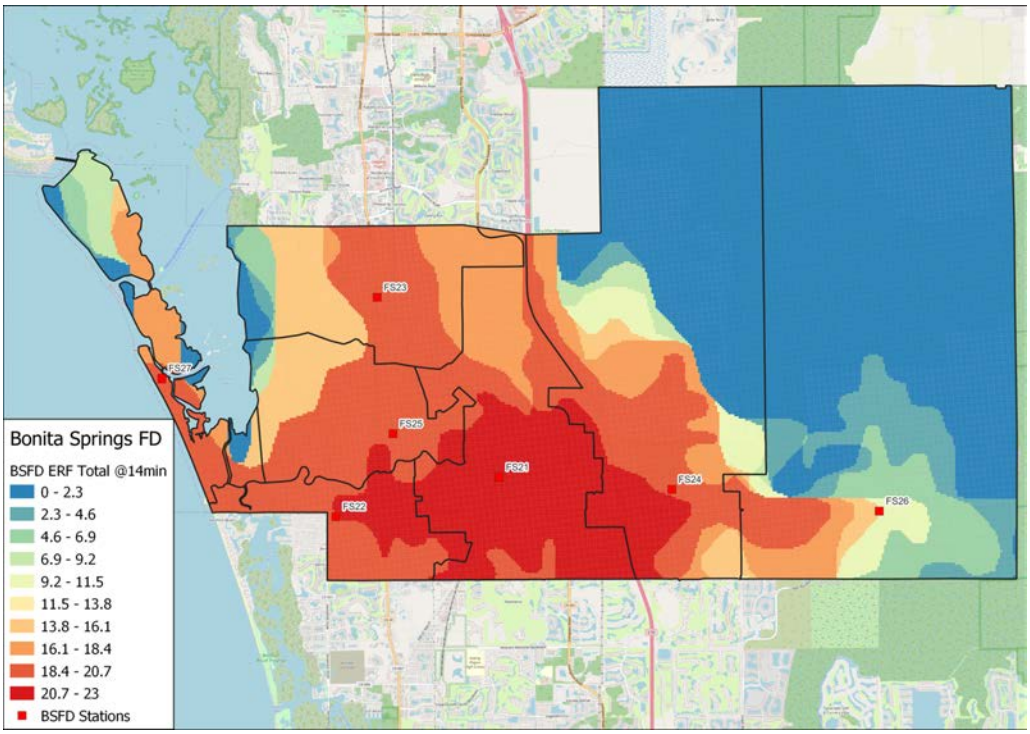


Figure 25: ERF at 16-Minutes

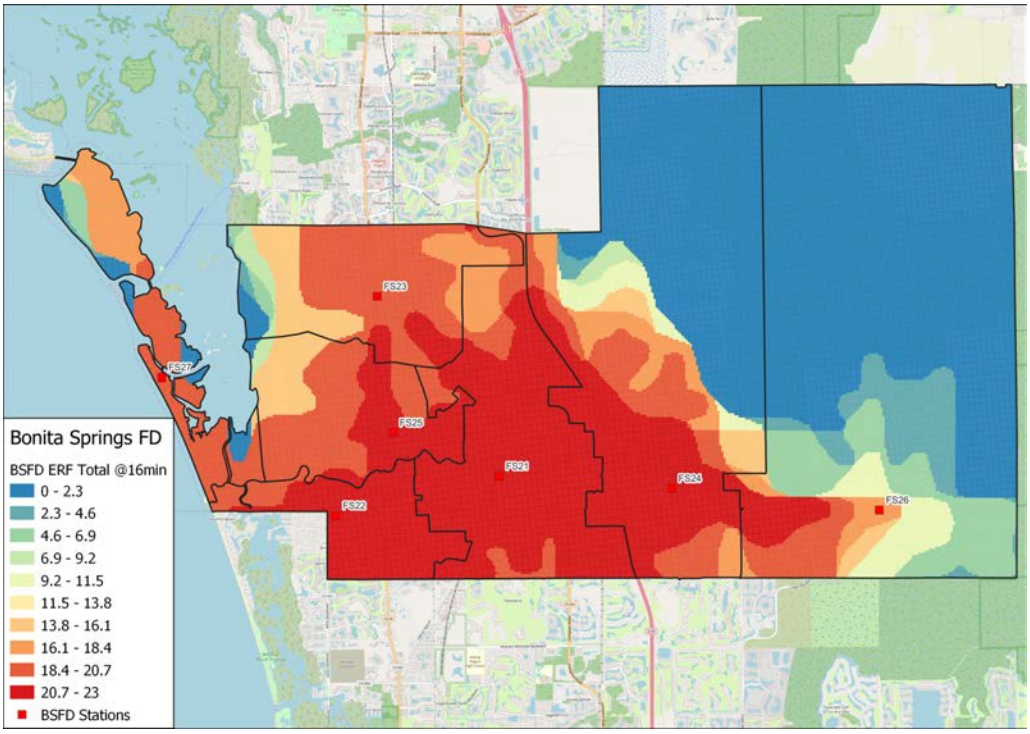


Figure 26: ERF at 18-Minutes

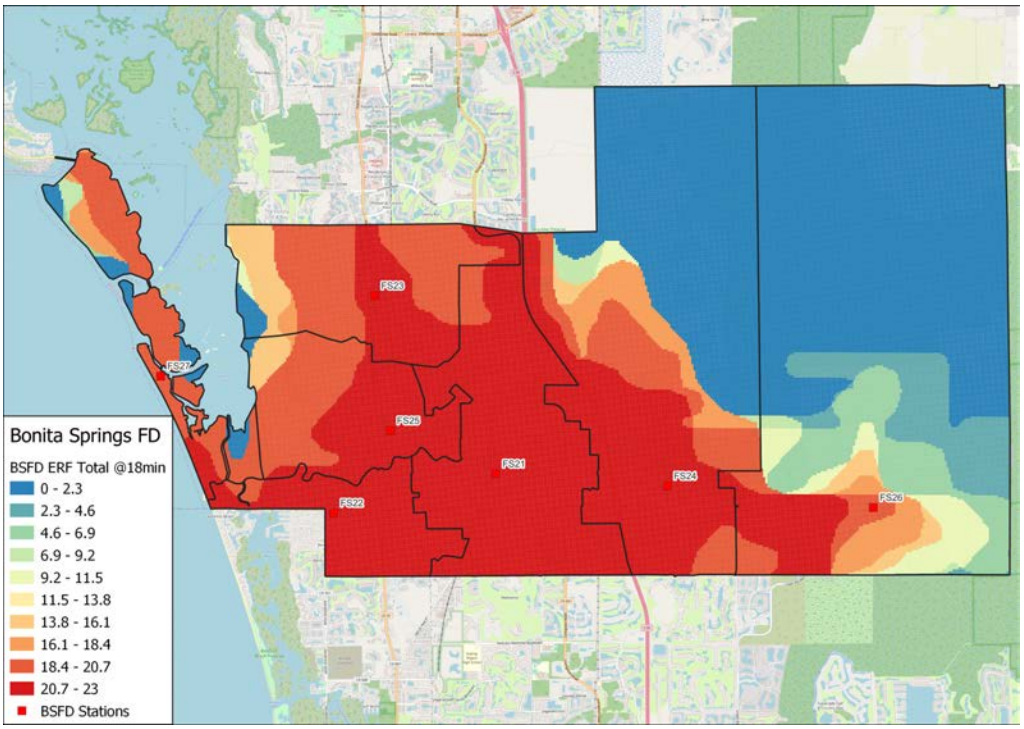
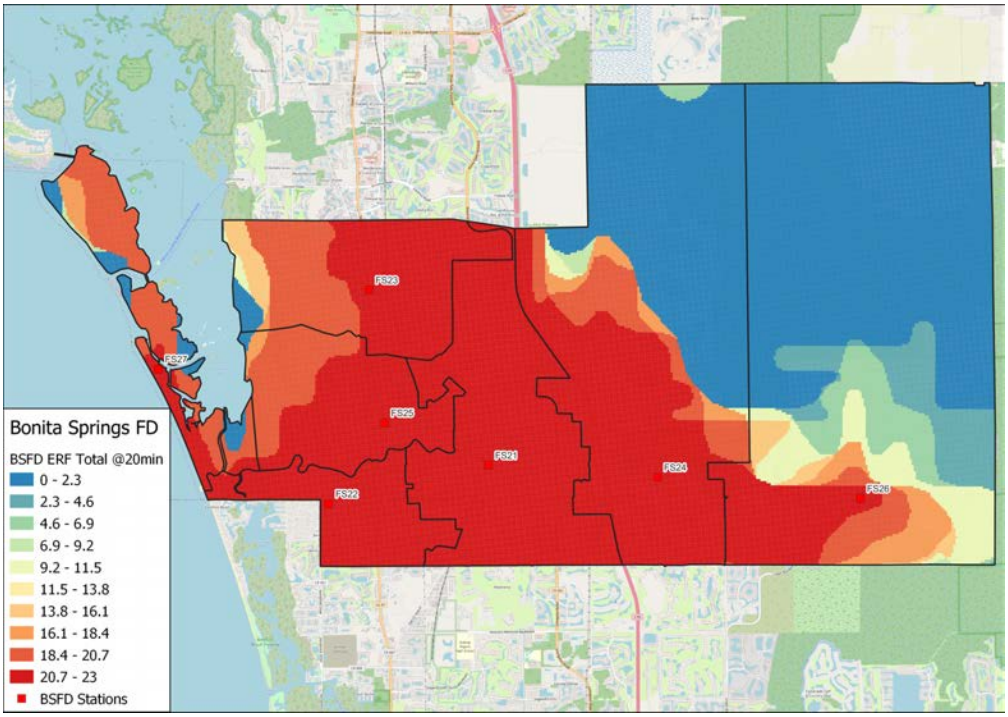


Figure 27: ERF at 20-Minutes



Long-Term Sustainability of the Models Presented

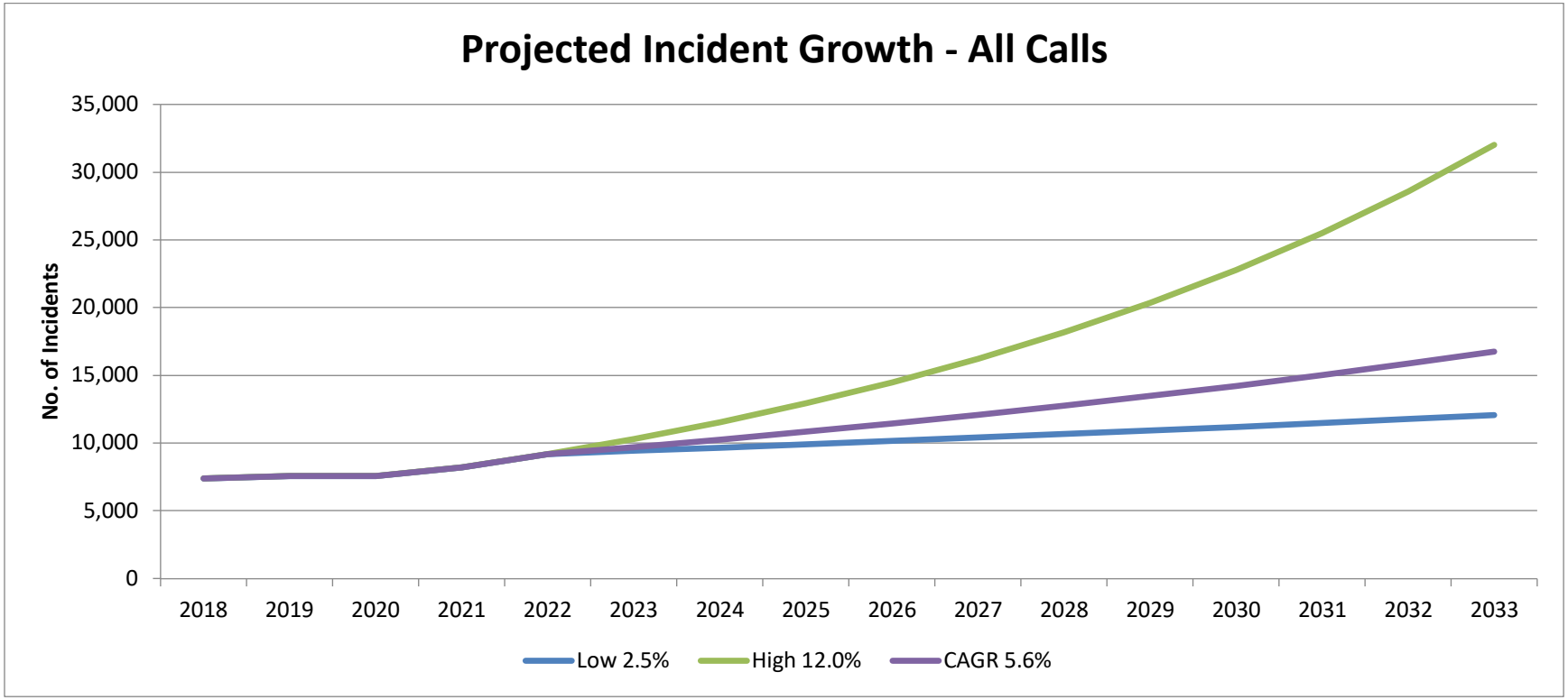
It is important to understand that the distribution models are restricted to the geographic limitations of the jurisdiction and the historical demand for services. Therefore, the number of stations is descriptive of the number of fixed facilities required from which to deploy resources. These analyses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

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

Projected Growth

The available data set included five reporting periods of data, representing 2018 - 2022. From 2018 to 2022, calls for BSFD services increased from 7,395 to 9,204, with Compound Annual Growth Rate (CAGR) of 5.6% per year. It is notable that during Covid-19, there was a year of negative growth, so the 5.6% average growth over the reporting period may be understated, especially if the more recent growth of greater than 12.0% continues. The figure below depicts observed call volume during the last five-year reporting periods and various hypothetical growth scenarios through 2033. These projections should be used with caution due to the variability in growth observed across prior calendar years. In all cases, data should be reviewed annually to ensure timely updates to projections and utilize a five-year rolling average.

Figure 28: Observed and Hypothetical Growth in Call Volume



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