

Five-Year Staffing Level/Forecast Study
Jefferson County Sheriff's Office
Port Hadlock, WA
Summer 2016

Abstract: The Jefferson County Sheriff's Advisory Committee in conjunction with Sheriff David Stanko and the Jefferson County Sheriff's Foundation began exploring the concept of an independent professional staffing study that would examine:

“...current calls for service to ensure that the JCSO responses conform to state law over the next decade. The study should be informed by best practices...to determine if the current staffing level is sufficient to meet the needs of the citizens of our County for the next decade.”

The Advisory Committee contacted Dr. Season Hoard from the Division of Governmental Studies and Services. Dr. Hoard provides technical support to law enforcement agencies in Washington and the Pacific Northwest at Washington State University. Dr. Hoard identified a doctoral student, Ms. Lan Luo in the Carson School of Business at Washington State University with an expertise in staffing to carry out the study. The Jefferson County Sheriff's Foundation offered a stipend to Ms. Lan Luo to conduct the staffing study to examine what is needed for our jurisdiction which encompasses 1800 square miles and 300 miles of waterways. Jefferson County is larger than the state of Rhode Island.

The study concludes that the current Jefferson County Sheriff's Office staffing levels are inadequate to meet the needs of Jefferson County's citizens. The study's results indicated that:

1. Two (2) more deputies should be added in 2016,
2. Two (2) more deputies for year 2017 -2019,
3. Two (2) additional supervisors should be added in 2016 to provide adequate supervision of the JCSO deputies during all shifts. It is a best practice law enforcement practice to have full supervisory coverage during all shifts. This recommendation will allow for adequate supervision during critical JCSO public safety and order responses such as use of force or other potentially sensitive incidents,
4. Staffing data should be run through the model to determine appropriate staffing levels for 2020-2021, and
5. Given the limitation of the data, possible demographic increases in the County and in order to improve maintain the accuracy of the staffing study, it is highly recommended that the JCSO re-run this model utilizing the most recent data every five (5) years to determine if staffing levels are sufficient to meet the public safety and order needs of Jefferson County's citizens.

The Jefferson County Sheriff's Advisory Committee recognizes that adding deputies and supervisory personnel inevitably carries with it the need for additional administrative support to ensure that the Jefferson County Sheriff's Office operates in an efficient and professional manner. We suggest that at least a .5 FTE administrative support person be added to meet this need.

Five-Year Staffing Level/Forecast Study

Prepared for the Jefferson County Sheriff's Office

In conjunction with

Jefferson County Sheriff's Advisory
Committee

And

Jefferson County Sheriff's Foundation

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INTRODUCTION

This study has been conducted at the request of the Jefferson County Sheriff's Advisory Committee and Jefferson County Sheriff's Foundation with the cooperation of the Jefferson County Sheriff's Office (JCSO). The study's goal was to examine the County's current calls for service to ensure that JCSO responses conform to the state law, best law enforcement practices and establish a baseline for budgeting purposes to meet the law enforcement and safety needs of Jefferson County over the next decade. The study has been conducted utilizing the literature's best practices for determining workload for a small rural law enforcement department (see below). Tables A and B in the conclusion portion of the study show the required minimal staffing levels in two schedules.

MODEL

• Methodology

Staffing Level

Following Wilson and Weiss (2015), we used a workload-based method to determine the staffing level for "small" department. Adjusted with the needs of Jefferson County a step-by-step approach for conducting a workload-based assessment is as following:

1. *Using the historical data to calculate the average number of calls at different time from different areas during a day.* This step helps to estimate the expected demand of workload.
2. *Examining the nature of calls for service.* We further categorize the calls into different types that need deputies' responses¹. Then we generate a time with 3 dimensions (Area * Time * Type)².
3. *Estimating time consumed on calls for service.* In order to get the estimated "create to close" time for an incoming call, weighted average method is applied in. First, we fill the 3-D table with average historical process time³. Then we use the numbers in Table 1 divided by the corresponding hourly total to generate the weight (probability) of each type of call coming from each location during different time in a day⁴. Taking Table 2 and Table 3 together, we have the estimated processing (create to close) time at different time in a day⁵.
4. *Estimating hourly demand on calls for service.* We use historical hourly sum of number of calls coming in divided by the grand total to get the percentage of calls that come in at a

¹ Based on the requirement of Jefferson County Sheriff's Office, deputies are responsible for handling those types of calls with up to 60% of their work time. The rest 40% of work time should be used for generating report, handling the rest types of calls and doing other services.

² See Appendix Table 1.

³ See Appendix Table 2.

⁴ See Appendix Table 3.

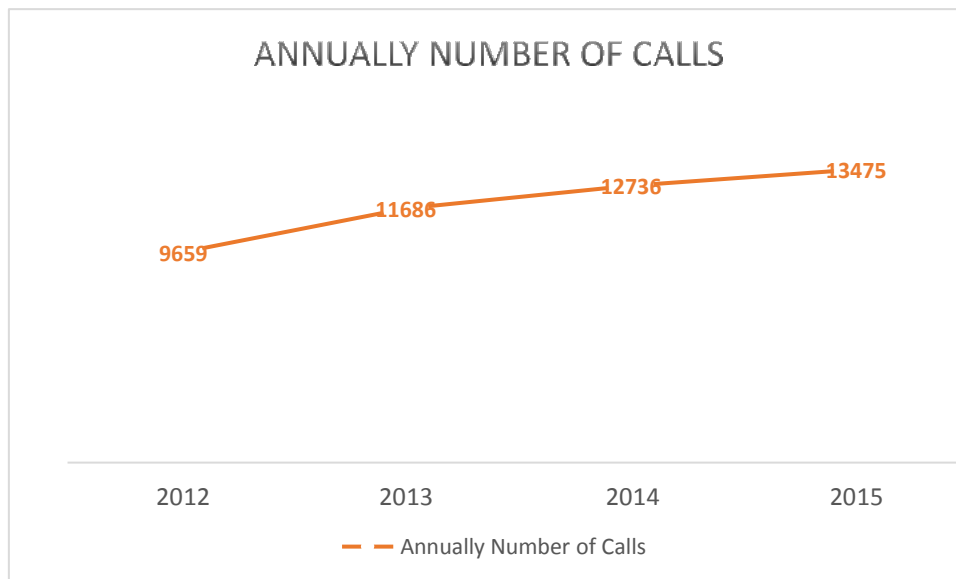
⁵ See Appendix Table 4.

given time⁶. By estimating the daily number of calls, which we will introduce in the next section, we get the estimation of hourly demand.

5. *Calculating agency shift-relief factor.* The shift-relief factor shows the relationship between the maximum numbers of days that an officer can work and *actually* works. In JCSO, deputies work 10 hours per day and 4 days per week. So, after finding out the required daily staffing level, we need to transfer it into weekly staffing level, which means that we need to time the factor with 7/4.
6. *Establishing performance objectives.* The objective of this study is to provide an optimized staffing arrangement that satisfies the calling demands with 60% work time while minimizing the total deputies needed per day.
7. *Providing staffing estimates.* Then we could use a Linear Optimization Model to find out the proper staffing level. However the staffing needs will vary by time of day, day of week, and month of year. Thus agencies should distribute their officers accordingly.

Forecasting Number of Calls

Graph 1: Annually Number of Calls from 2012 to 2015.



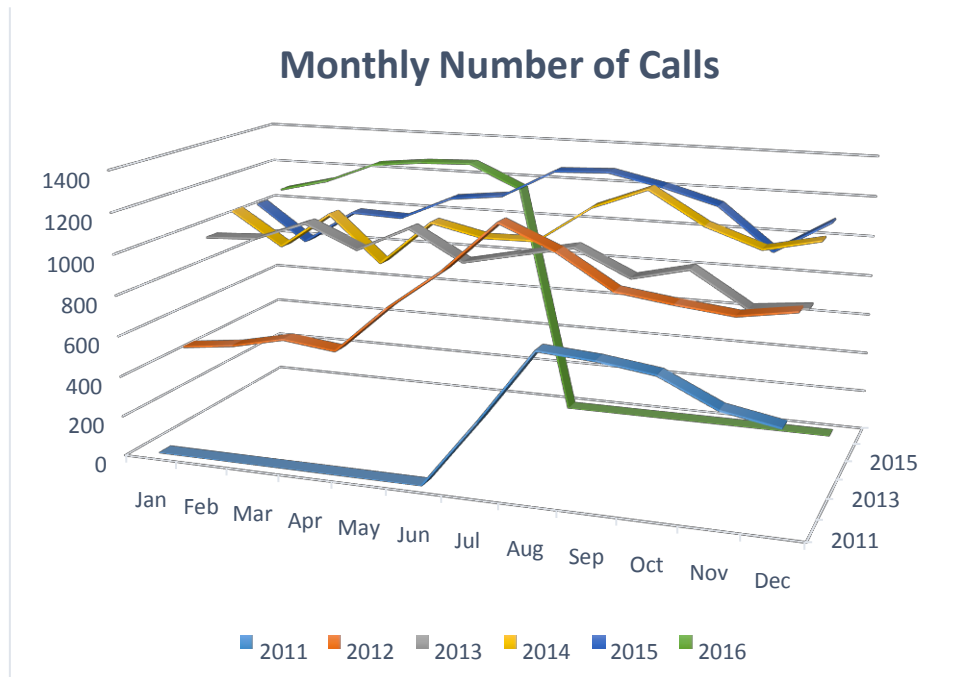
The above plot shows the linear trend of annual number of calls. We use linear regression to forecast the annual demand on calls for services for next 5 to 6 years based on the historical data.

As noted in Graph 2 the demand varies by month. The plot below shows that there is an obvious seasonality in demand of service. Thus, adjustments should be applied to the monthly demand accordingly. In order to get the weight for each month, we use the historical sum of the

⁶ See Appendix Table 5.

number of calls in a month divided by the grand total of all calls. We then multiply the estimated annual demand with monthly weight to obtain the prediction of the monthly number of calls for next 5 to 6 years. By assuming 30 days a month, we easily get the daily demand.

Graph 2: Monthly Number of by year from July 2011 to June 2016. N.B., the 2016 line drops to zero after June 2016 since data was only available until the end of that month for the study.

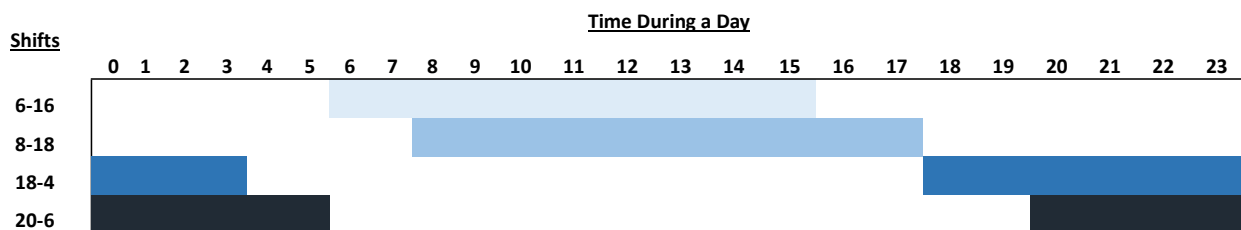


• **Data**

The Jefferson County Sheriff's Office provided the following data:

The current Schedule and Staffing Level

Graph 3: Currently Schedule of Jefferson County Sheriff's Office.



JCSO currently has 12 road deputies, 2 west end deputies and 4 supervisors. They apply the above four shifts excluded supervisors' shift: 6-16, 8-18 and 20-6. Currently supervisors

are also responsible for responding to calls for service as well as fulfilling the minimum staffing level requirement, requiring at least 2 deputies to be on duty at all times.

Historical Data for Number of Calls during a Day

This data set covers the number of calls from July 2011 to June 2016. The first layer category is the time within a day (24 hours). The calls for service have been put into 8 different areas: Brinnon, Chimacum, Nordland, Port Hadlock, Port Ludlow, Port Townsend, Quilcene and Sequim. Then the numbers of calls are further categorized into 55 types that need deputies' response.

Historical Monthly Data for Number of Calls

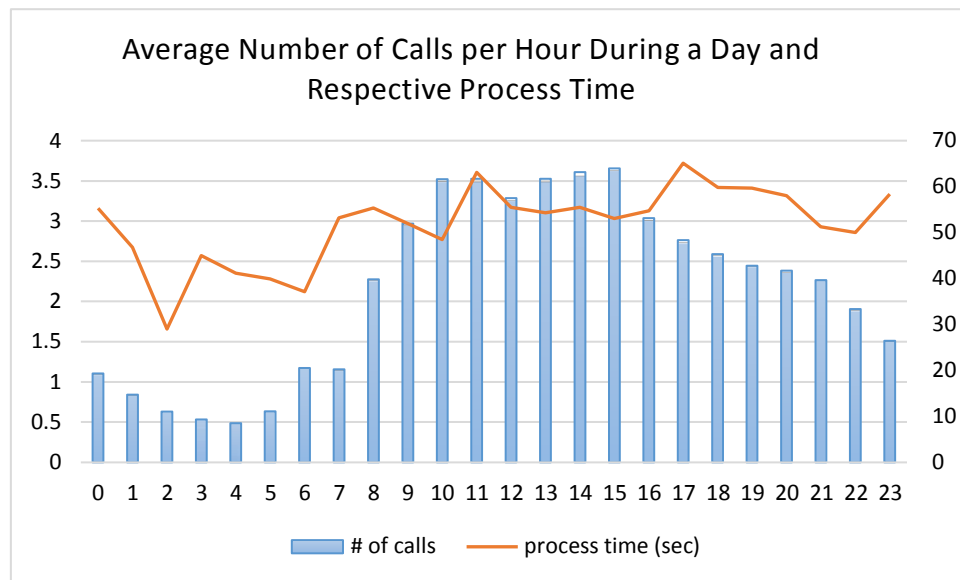
The monthly data covers the same time range that from July 2011 to June 2016 for the eastern part of the county.

Historical Data for Create to Close Times

Time data set also has been put into a 3-dimension table labeled: Type of Calls and Time of a Day and Area. Thus we are able to match the time data with the number of calls to calculate the weighted average time for an incoming call at any given time.

After processing the known data, the graph below presents how the call numbers and processing time vary within a day.

Graph 4: Average Number of Calls per Hour during a Day and Respective Process Time (left vertical axis represents the number of calls, the right vertical axis represents the time needed in minutes).



• **Assumptions Using a Work-Based Approach**

Our methodology is subject to the following assumptions/parameters:

- 1) There is no significant sudden increase or decrease in the population,
- 2) There is a very little chance to have unusual accidents that boost the needs sharply,
- 3) The evolution of technology or transportation methods would not have a big impact on processing time,
- 4) There is no individual difference among deputies regarding to the processing time, and
- 5) Based on current deputies' experience, it is reasonable to assume that 40% work time is enough for handling the rest types of calls and generating the report.

• **Main Model**

Linear Optimization Model for Staffing Level

Decision Variables:

Let X be the deputies needed for shift 6-16, X1 be the amount of time spending during T1 (6-8), X2 be the amount of time spending during T2 (8-16),

Let Y be the deputies needed for shift 8-18, Y1 be the amount of time spending during T2 (8-16), Y2 be the amount of time spending during T3 (16-18),

Let W be the deputies needed for shift 18-4, W1 be the amount of time spending during T4 (18-20), W2 be the amount of time spending during T5 (20-4), and

Let Z be the deputies needed for shift 20-6, Z1 be the amount of time spending during T5 (20-4), Z2 be the amount of time spending during T6 (4-6).

Objective function:

Minimize the total staff needed per day = $X+Y+W+Z$

Constraints:

- 1) Satisfy the demand on calls for service during the day:

Estimated workload (in terms of time) during T1 $\leq X1$

Estimated workload (in terms of time) during T2 $\leq X2+Y1$

Estimated workload (in terms of time) during T3 $\leq Y2$

Estimated workload (in terms of time) during T4 $\leq W1$

Estimated workload (in terms of time) during T5 $\leq W2+Z1$

Estimated workload (in terms of time) during T6 $\leq Z2$

- 2) The responding time could not exceed 60% of work time per deputy:

$$X1+X2 \leq 6 * X$$

$$Y1+Y2 \leq 6 * Y$$

$$W1+W2 \leq 6 * W$$

$$Z1+Z2 \leq 6 * Z$$

3) Satisfy the minimum staffing requirement:

If supervisors are not responsible for fulfilling the minimum requirement:

$$X \geq 2$$

$$Y \geq 2$$

$$W \geq 2$$

$$Z \geq 2$$

If supervisors are responsible for fulfilling the minimum requirement:

$$X \geq 1$$

$$Y \geq 1$$

$$W \geq 1$$

$$Z \geq 2$$

4) Non-negative and integer constraints:

$X, Y, W, Z \geq 0$ and integer

Linear Regression Model for Forecasting the Number of Calls

Let $X=5, 6, 7, 8, 9, 10$ (Representing year 2016,2017,2018,2019, 2020 and 2021).

The forecast equation based on regression is:

$$\text{Annually number of calls} = 1249.8 * X + 8764.5$$

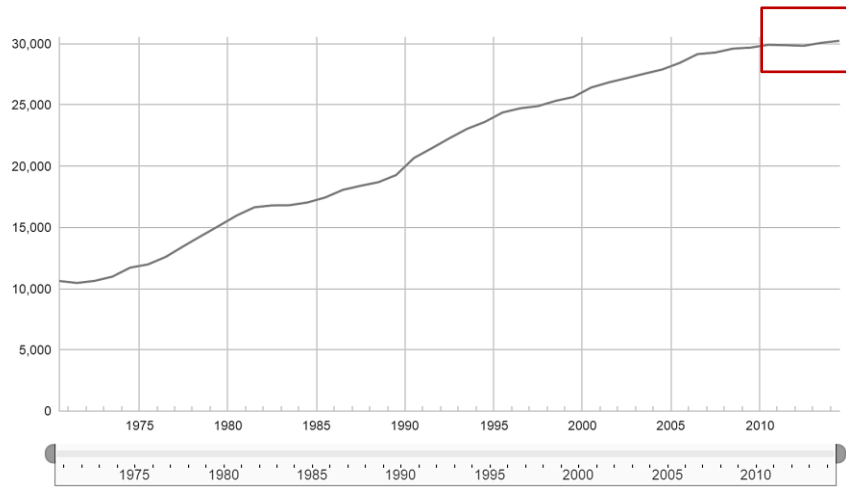
The interpretation is that the average yearly incensement is 1249.8 starting from 8764.5 at year 0 (year 2011).

- **Analysis**

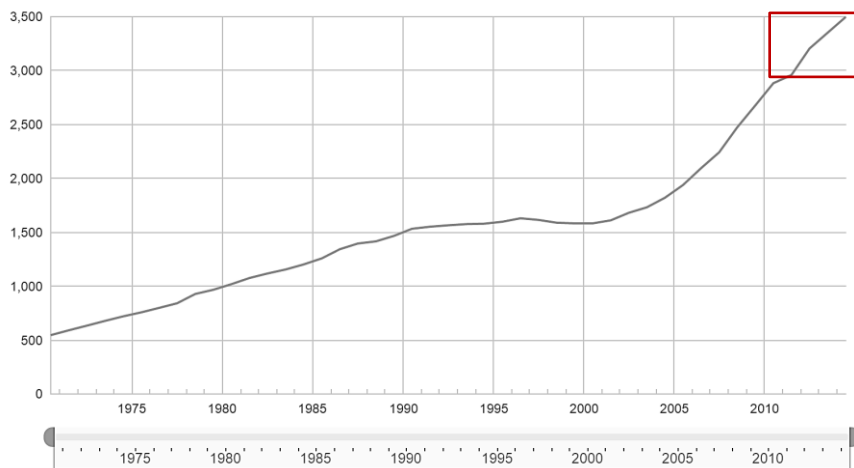
The growth in Jefferson County's population in terms of the retiree and non-retiree communities

Based on U.S. Census Bureau's data for Jefferson County, we found that the population of age range from 0 to 19 is decreasing and population in age from 20 to 39 is slightly increasing. However the population between 40 and 59 is decreasing. There is a marked increase in terms of retiree community. The following two graphs show the historical population of Jefferson County and its population aged from 65 to 70. We can see that the growth rate for retirees is increasing. At the same time, the younger population cohort remains flat to slightly decreasing. The rectangular in each graph marked the most valuable period that is from 2011 to 2015, which is consistent with our data period and trend. Obviously there is no significant turning point that disallows using our linear regression methodology to predict the number of calls for service.

Graph 5: Population of Jefferson County⁷



Graph 6: Population of Jefferson County⁸ (Age range: 65-70)



The growth in Jefferson County's population in terms of proposed Pleasant Harbor Resort in Brinnon

Given the possibility of a major resort being considered in Brinnon it is difficult to reasonably project the law enforcement demands created by such a resort. However a reasonable estimation is that the Pleasant Harbor Resort would definitely increase the demand for additional law enforcement calls for service. The resort would bring more people to Brinnon for short-term stays, tourism and employment. There would also be an increase the transient and non-t of population as well as the variety of nature of seasonal and full-time number of residents. A very likely outcome of the planned Pleasant Harbor resort

⁷ Source: Google Public Data Explore: Population in U.S., WA, Jefferson County

⁸ Source: Google Public Data Explore: Population in U.S., WA, Jefferson County, Age 65-70

would be an increase in commercial activity in this portion of Jefferson County. What's more, the resort's seasonal law enforcement impact would by its very nature fluctuate. Hence the number of tourists would vary by seasons, holidays, and commercial growth/offering associated with the resort. Thus the study can still provide us insights about the required staffing level and its corresponding schedule.

FORECASTING CONCERNS AND LIMITATIONS

1. The data was recorded manually into the system, so there are some minor input errors. We replaced those extreme time points in the data with the respective average value.
2. Based on the historical data, we expect to have a best estimation, but the issue of uncertainty cannot be avoided.
3. There is no other county with a similar resort that we can refer to so that we cannot predict what exactly would going on after completing the planned resort and corresponding nexus of commercial enterprises.
4. The time range of data is from July 2011 to June 2016. Thus it limits the study's predictive power when using a Linear Regression method. Hence it is better to continually update the staffing study with updated JCSO data and this will require adjusting the prediction every five (5) years.

FORECAST SCENARIO SUMMARY TABLES

Staffing Table A: (If supervisors are responsible for fulfilling minimum staffing level):

| Scenario (total calls per month) | 900-1183 | 1184-1479 | 1480-1774 | 1775-1811 | 1812-2000 |
|---|-----------------|------------------|------------------|------------------|------------------|
| <i>staff needed per day</i> | 7 | 8 | 9 | 10 | 11 |
| <i>Staff needed per month</i> | 13 | 14 | 16 | 18 | 20 |
| <i>6-16</i> | 3 | 4 | 4 | 1 | 1 |
| <i>8-18</i> | 1 | 1 | 2 | 6 | 6 |
| <i>18-4</i> | 1 | 1 | 1 | 1 | 2 |
| <i>20-6</i> | 2 | 2 | 2 | 2 | 2 |

Staffing Table B: (If supervisors are NOT responsible for fulfilling minimum staffing level):

| Scenario (total calls per month) | 900-1183 | 1184-1479 | 1480-1774 | 1775-1811 | 1812-2000 |
|---|-----------------|------------------|------------------|------------------|------------------|
| <i>Staff needed per day</i> | 8 | 8 | 9 | 10 | 11 |
| <i>Staff needed per month</i> | 14 | 14 | 16 | 18 | 20 |
| <i>6-16</i> | 2 | 4 | 4 | 1 | 1 |
| <i>8-18</i> | 2 | 1 | 2 | 6 | 6 |
| <i>18-4</i> | 2 | 1 | 1 | 1 | 2 |
| <i>20-6</i> | 2 | 2 | 2 | 2 | 2 |

Monthly Number of Calls Forecasting Table: (the darker the red color is, the higher the estimated number of calls for service is)

| MONTH | YEAR | | | | | |
|-------|------|------|------|------|------|----------|
| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| 1 | | 1289 | 1388 | 1487 | 1586 | 1684.797 |
| 2 | | 1221 | 1315 | 1409 | 1503 | 1596.528 |
| 3 | | 1393 | 1500 | 1607 | 1714 | 1821.045 |
| 4 | | 1293 | 1392 | 1492 | 1591 | 1690.291 |
| 5 | | 1493 | 1608 | 1723 | 1837 | 1952.167 |
| 6 | | 1467 | 1580 | 1692 | 1805 | 1917.738 |
| 7 | 1259 | 1364 | 1469 | 1574 | 1679 | 1783.687 |
| 8 | 1387 | 1503 | 1618 | 1734 | 1849 | 1964.986 |
| 9 | 1320 | 1430 | 1540 | 1650 | 1760 | 1870.124 |
| 10 | 1258 | 1363 | 1468 | 1573 | 1677 | 1782.222 |
| 11 | 1098 | 1189 | 1281 | 1372 | 1464 | 1555.141 |
| 12 | 1161 | 1257 | 1354 | 1451 | 1547 | 1643.776 |

CONCLUSION

Using the prediction for monthly demand in the above **Monthly Number of Calls Forecasting Table** combined with staffing tables; we generated the estimate for the required staffing level and the corresponding schedule, which is shown as follows:

Results Table A. (If supervisors are responsible for fulfilling minimum staffing level):

| | | PER DAY PER MONTH 6-16 8-18 18-4 20-6 | | | | | | |
|-------------|-----|---------------------------------------|----|----|---|---|---|---|
| | | | | | | | | |
| 2016 | max | 1387 | 8 | 14 | 1 | 4 | 1 | 2 |
| | min | 1098 | 7 | 13 | 1 | 3 | 1 | 2 |
| 2017 | max | 1503 | 9 | 16 | 1 | 5 | 1 | 2 |
| | min | 1189 | 8 | 14 | 1 | 4 | 1 | 2 |
| 2018 | max | 1618 | 9 | 16 | 1 | 5 | 1 | 2 |
| | min | 1281 | 8 | 14 | 1 | 4 | 1 | 2 |
| 2019 | max | 1734 | 9 | 16 | 1 | 5 | 1 | 2 |
| | min | 1372 | 8 | 14 | 1 | 4 | 1 | 2 |
| 2020 | max | 1849 | 11 | 20 | 1 | 6 | 2 | 2 |
| | min | 1464 | 8 | 14 | 4 | 1 | 1 | 2 |
| 2021 | max | 1965 | 11 | 20 | 1 | 6 | 2 | 2 |
| | min | 1555 | 9 | 16 | 1 | 5 | 1 | 2 |

Results Table B. (If supervisors are NOT responsible for fulfilling minimum staffing level):

| | | | PER DAY | PER MONTH | 6-16 | 8-18 | 18-4 | 20-6 |
|-------------|-----|------|---------|-----------|------|------|------|------|
| 2016 | max | 1387 | 9 | 16 | 2 | 3 | 2 | 2 |
| | min | 1098 | 8 | 14 | 2 | 2 | 2 | 2 |
| 2017 | max | 1503 | 10 | 18 | 2 | 4 | 2 | 2 |
| | min | 1189 | 9 | 16 | 2 | 3 | 2 | 2 |
| 2018 | max | 1618 | 10 | 18 | 2 | 4 | 2 | 2 |
| | min | 1281 | 9 | 16 | 2 | 3 | 2 | 2 |
| 2019 | max | 1734 | 10 | 18 | 2 | 4 | 2 | 2 |
| | min | 1372 | 9 | 16 | 2 | 3 | 2 | 2 |
| 2020 | max | 1849 | 11 | 20 | 2 | 5 | 2 | 2 |
| | min | 1464 | 9 | 16 | 3 | 2 | 2 | 2 |
| 2021 | max | 1965 | 11 | 20 | 2 | 5 | 2 | 2 |
| | min | 1555 | 10 | 18 | 2 | 4 | 2 | 2 |

The above results table reflect that there is a need for two (2) more deputies in 2016, another two (2) additional deputies for year 2017 -2019, and by 2020-2021 there is a need for twenty (20) road deputies. Results Table B was utilized since best span of control practices as per Lane (2006) for law enforcement agencies necessitates the need for a supervisor to be present in order to observe, provide adequate supervision, and to report during critical incidents such as the use of force. As a result, two (2) additional supervisors need to be added in 2016. This is based on two (2) deputies on call with one (1) supervisor per shift. This will enable the JCSO to have adequate supervision during each shift. As per Lane (2006), supervisors should not be responsible for maintaining minimum staffing levels in order to have adequate supervision during all shifts. A reasonable observer can easily conclude that current JCSO staffing levels constrains the ability of the agency to respond and adequately supervise incidents in a reasonable amount of time.

Last but not least, based on the results in the table, we can not only find the optimal staffing levels within the corresponding schedule, but the JCSO can also use the above table as a reference point when planning for deputies training and vacation time.

Finally, given the previously noted time frame of the data, in order to improve the accuracy of the study, it is better to re-run the model periodically with the updated information, especially when considering a long-run 5 – 10 years staffing plan that meets the law enforcement and public safety needs of Jefferson County's citizens.