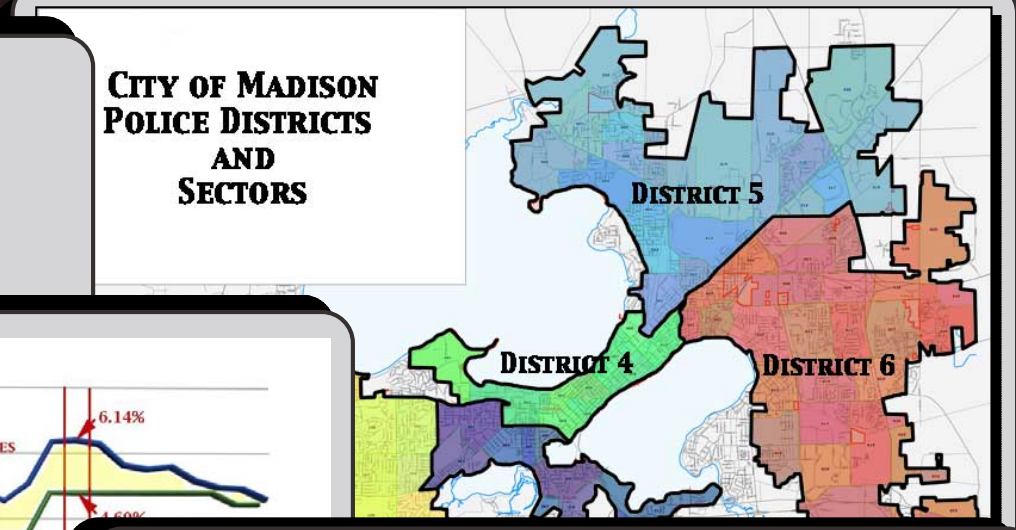
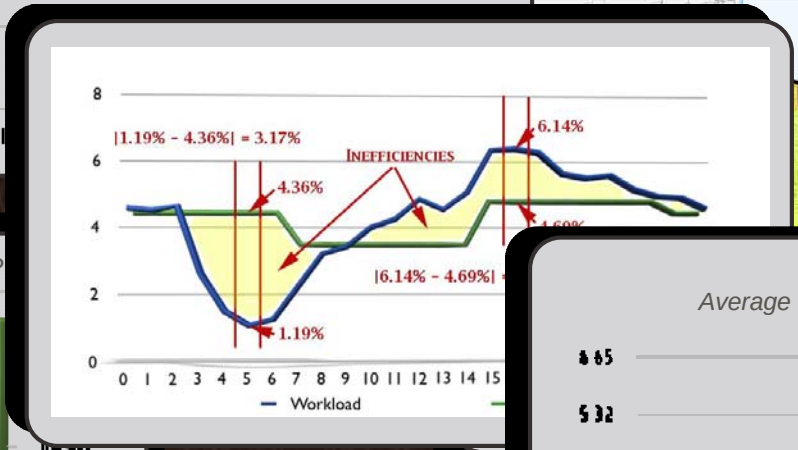
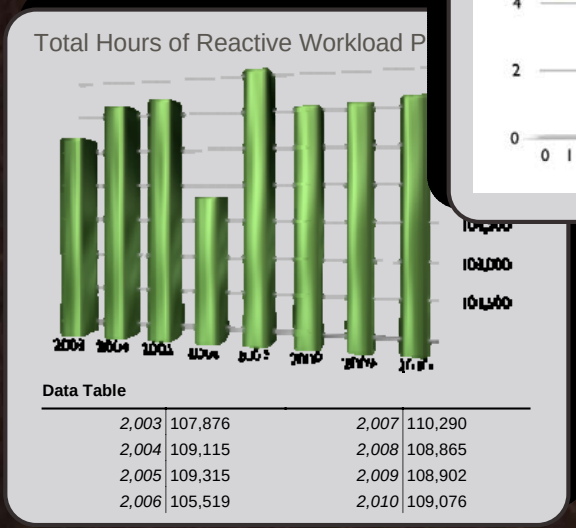
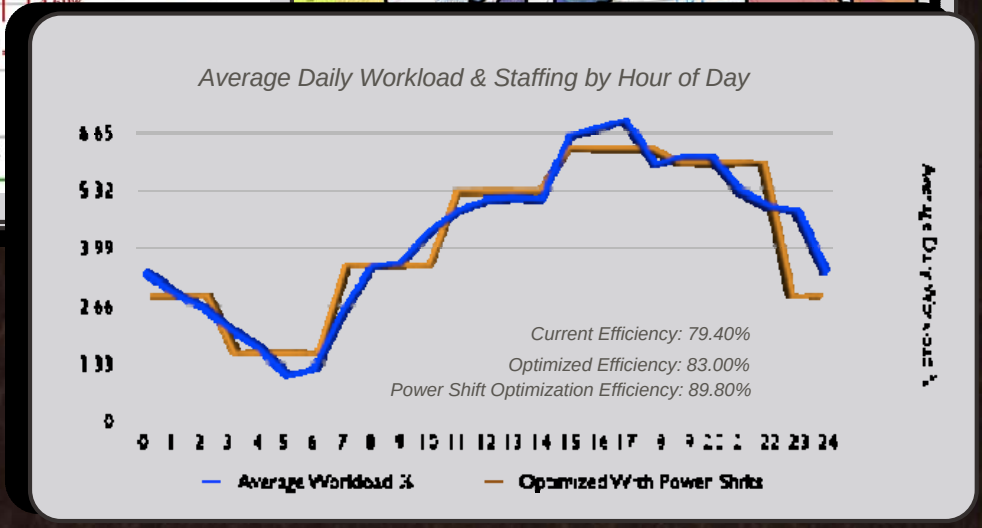
Etico Solutions, Inc.









Police Patrol Staffing Study

Madison Police Department

RFP 7856-0-2007 / MM

- ***Principle Researchers:***
  - Timothy J. Freesmeyer, MBA
  - Dr. William W. Stenzel, D.Sc.

- ***Study Time-Frame:***
  - September 2007 - July 2008

- ***Purpose of the study:***
  - Help determine the appropriate level of patrol staff for the department to meet its patrol requirements.
  - Help develop deployment strategies that use patrol staff in the most effective manner.
- ***Referenced Methodology:***
  - Police Allocation Manual (PAM), 1993, U.S. Department of Transportation, *National Highway Traffic Safety Administration*

- ***Approach taken:***

1. Analysis of current workload indicators for patrol to determine total reactive workload.

2. Analysis of leave time, non-patrol time, and shift schedule to determine officer availability.

3. Determination of current performance measures under existing staffing and deployment conditions.

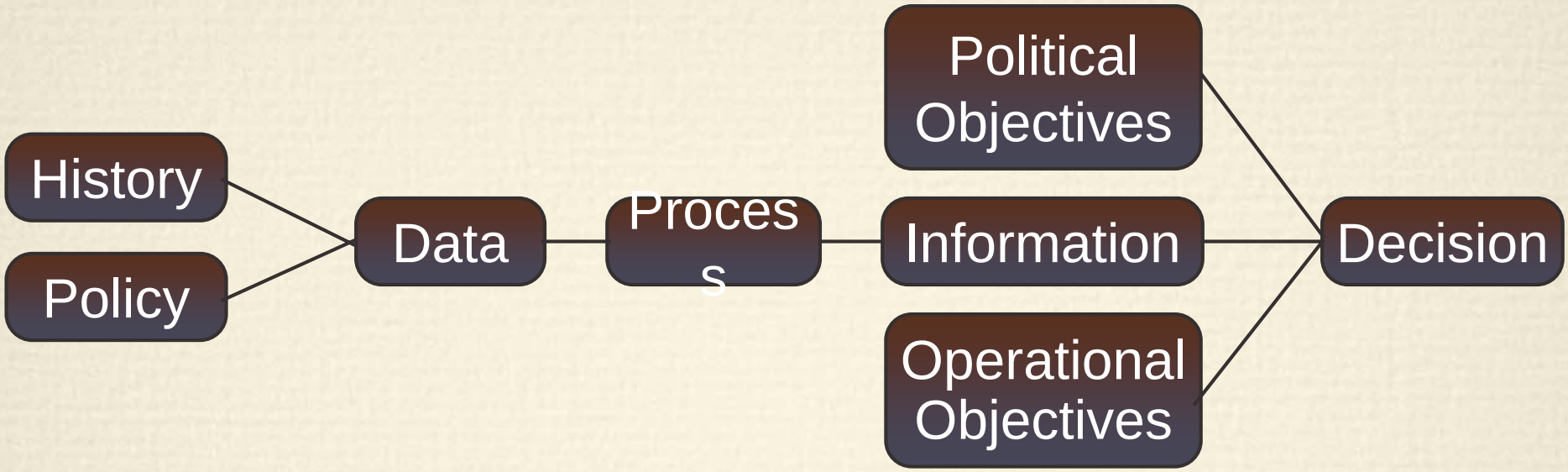
- ***Approach taken (continued):***

4. Determine expected performance changes based on alternative patrol staffing choices.

5. Analyze correlation between current workload patterns and current staffing patterns.

6. Provide recommendations on schedule modifications to improve staffing efficiencies.

- ***How should this study be viewed?***



- The methodology laid out in this study is a ***process*** for continued improvement.
- As policies are changed and new data is generated, the data improves and the process produces more reliable information for decision makers.

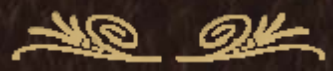
- ***What divisions are included in this study?***
  - Patrol Officers and Patrol Sergeants only.

- ***What divisions are not included in this study?***
  - All other divisions within the agency such as:
    - Community Policing Teams
    - Neighborhood Policing Officers
    - Emergency Response Team
    - Traffic and Support Services
    - Investigations
    - Personnel and Training
    - Records
    - Information Management and Technology
    - Professional Standards

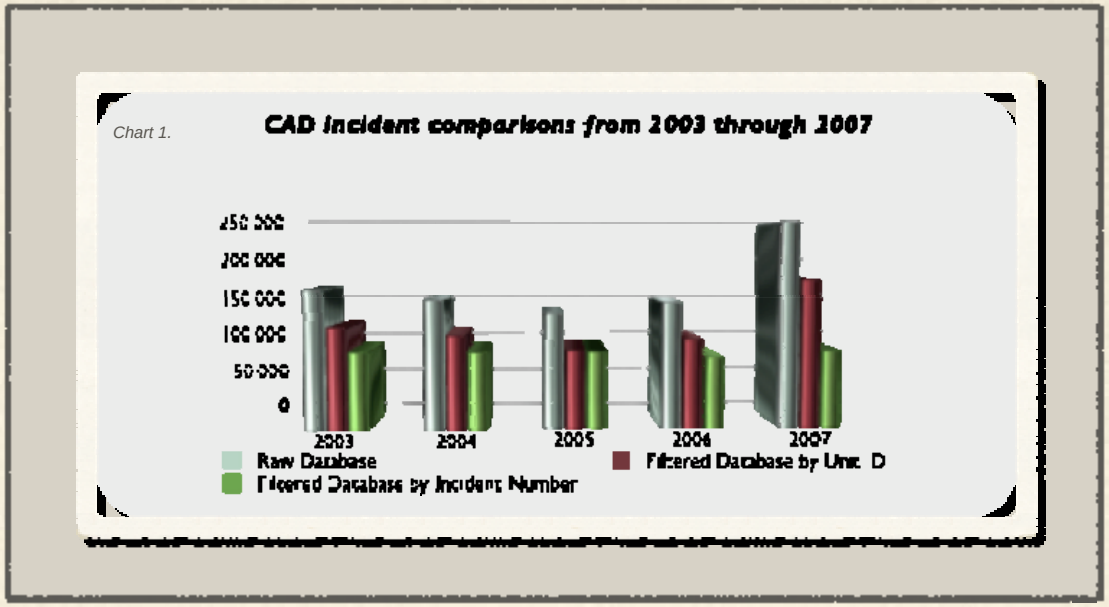
- ***Interpretation of results.***
  - Methodology represents best practices in the discipline of resource allocation and deployment.
  - Numbers derived from careful analysis of CAD data should be viewed as *information* for decision makers, not an *answer* in themselves.
  - Results are quantitatively driven and must be balanced with a qualitative perspective.
  - Deviation from study recommendations may be necessary based on factors outside of the scope of this study.

- ***Therefore, this study ...***
  - ...represents a careful analysis of the data available at the time the study was conducted.
  - ...is the first step in a continual process of improved data collection and analysis.
  - ...has initiated several changes for improved data gathering and data interpretation.
  - ...has set an example and laid a foundation for future studies to be conducted by MPD personnel.

Actions Taken



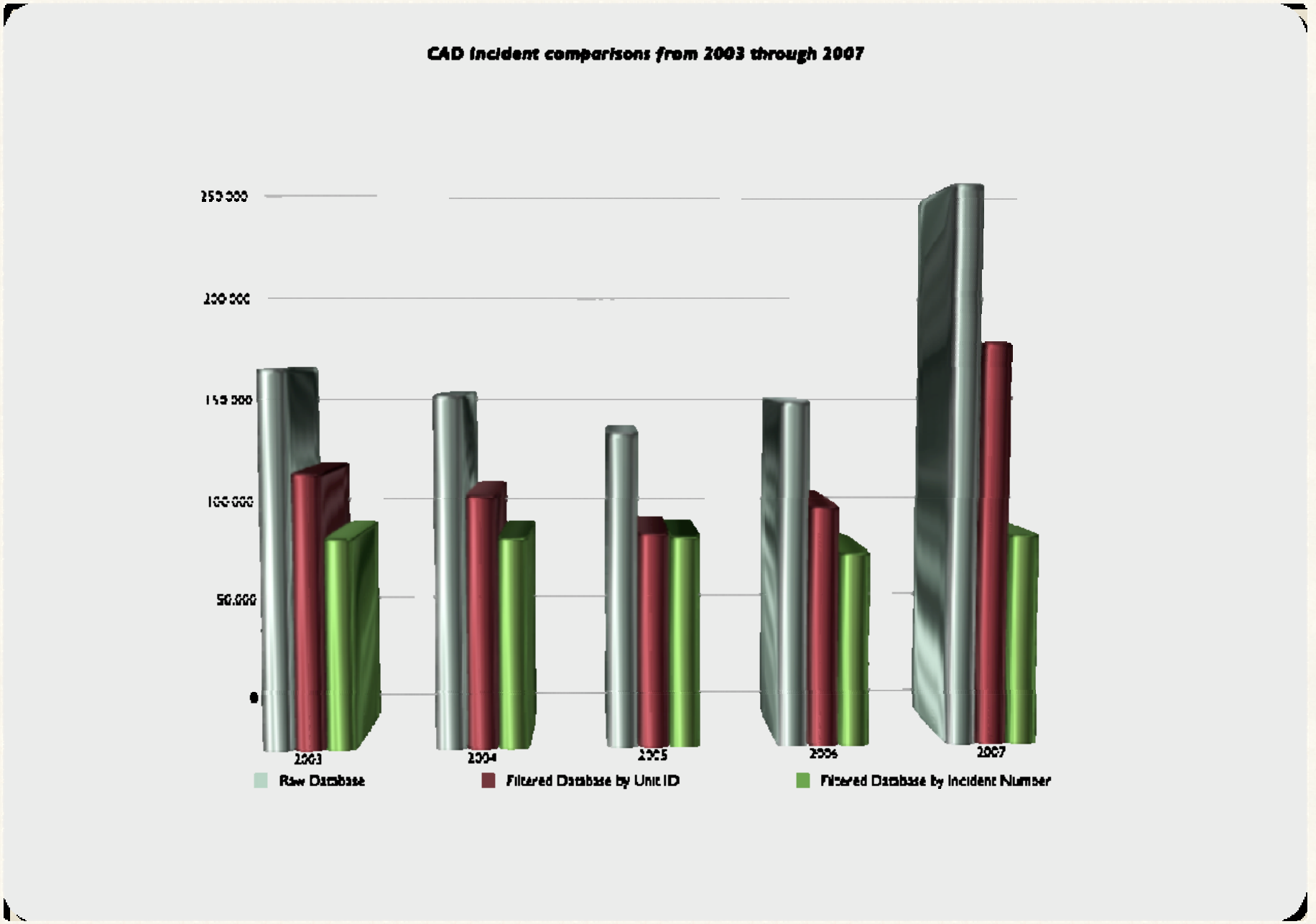
Resource Allocation



Analysis of current workload indicators for patrol to determine total reactive workload.

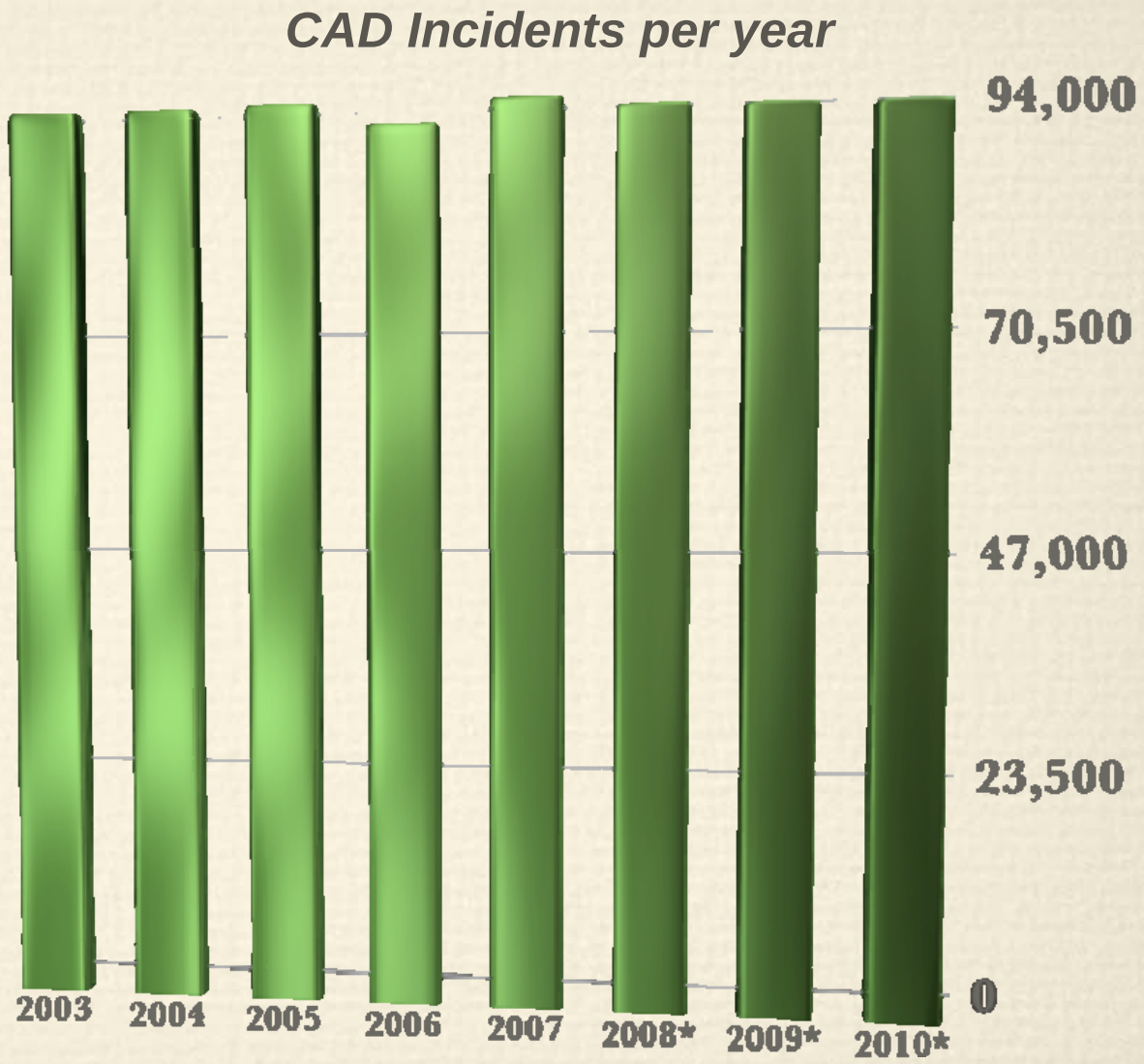
Computer Aided Dispatch (CAD) Analysis

- Five years of past data was analyzed
- First filter: Unit ID to isolate patrol only
- Calculation of time variables
  - Processing Times
  - Travel Times
  - Response Times
  - Time on Calls
- Aggregation of key variables
- Collapsed database to single record per event to calculate patrol activity frequency


CAD Incident comparisons from 2003 through 2007
250,000
200,000
150,000
100,000
50,000
0
2003
2004
2005
2006
2007
Raw Database
Filtered Database by Unit ID
Filtered Database by Incident Number

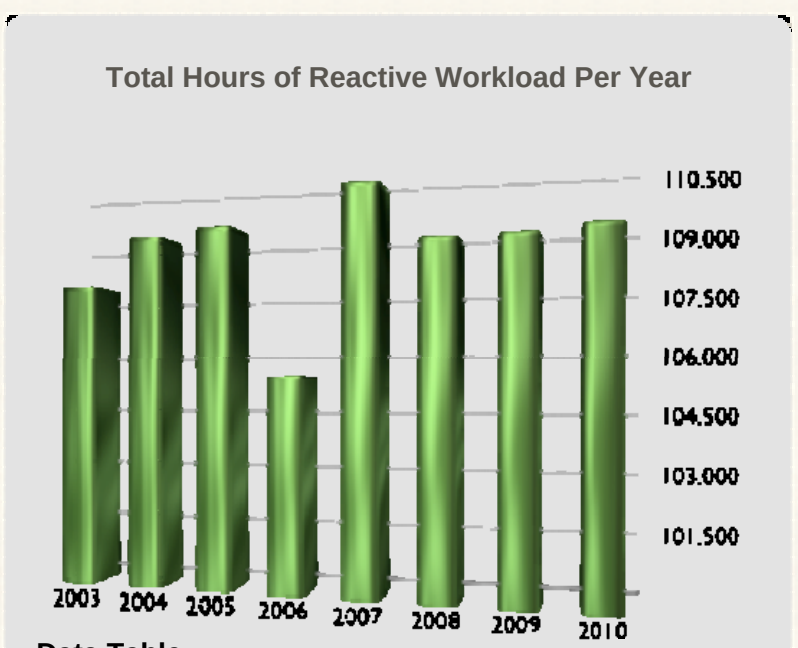
CAD Incidents per year excluding traffic stops	
2003	92,742
2004	92,704
2005	92,945
2006	90,673
2007	93,044
2008*	92,016
2009*	91,863
2010*	91,761

* Forecasted Estimates



Total Reactive Workload

- Patrol activities were categorized as “reactive” or “proactive”
- Average times were calculated for each patrol activity
- Average times were multiplied by activity frequency
- Time was summed for all reactive patrol activities



Data Table

2003	107,876	*2007*	110,290
2004	109,115	*2008*	108,865
2005	109,315	*2009*	108,902
2006	105,519	*2010*	109,076

Average Time Off Patrol per Year per Officer

Time Off Category	Days	Hours
Regularly Scheduled Days	121.67	973.33
Admin & Benefit Time	27.02	216.16
Non-Patrol Time	22.14	177.12
Net Comp Time	2.5	20
Total	173.33	1386.61

Analysis of leave time, non-patrol time, and shift schedule to determine officer availability.

Shift Relief Factor

$$\left(\begin{array}{c}\textit{Shift}\\ \text{Re}\textit{lief}\\ \textit{Factor}\end{array}\right) = \frac{\left(\begin{array}{c}\text{Total Number of Hours Required}\\ \text{To Cover One Shift Position Every}\\ \text{Day for One Year}\end{array}\right)}{(365 \text{ x Shift Length}) - \left(\begin{array}{c}\text{Average Hours Off}\\ \text{Patrol per Year}\\ \text{per Officer}\end{array}\right)}$$

- Defined as the number of officers required to field one shift-unit per day, every day of the year.
- Dependent on three variables
  - Amount of Benefit Time Off per year
  - Amount of Non-Patrol Time per year
  - Number of Regularly Scheduled Days Off per year

Benefit Time Off

- Data obtained from the TeleStaff Scheduling Software maintained by the Police Department
- Two-year data sample representing 129 officers.
- Times on the right reflect the average days of leave used by the average officer in patrol.

Admin & Benefit Time Off

Leave Type	Days
Administrative Leave	0.274
Bereavement Leave	0.43
Family Leave	1.699
FTO	0.791
Holiday Leave	1.644
Injured	0.1
Jury Duty	0.004
MPPOA Earned	0.065
Military Leave	0.686
Sick Leave	5
Vacation Leave	15.654
Workers Comp Time Off	0.674
Total	27.02

Non-Patrol Time

- Data obtained from the TeleStaff Scheduling Software maintained by the Police Department
- Same two-year data sample representing 129 officers.
- Times on the right reflect the average non-patrol time for the average officer in patrol.

Non-Patrol Time

Leave Type	*Days*
Light Duty	*3.979*
Event	*1.514*
Special Assignment	*0.648*
Training	*15.794*
Miscellaneous	*0.199*
Total	*22.135*

Regularly Scheduled Days Off

- Patrol works a Duty Cycle Schedule of 6 on-duty days followed by 3 off-duty days (6 on - 3 off)

$$\text{Regularly Scheduled Days Off} = \frac{\text{Duration} \times \text{Off-Duty Days per Duty Cycle Schedule}}{\text{Duty Cycle Length}}$$

$$= \frac{365 \times 3}{9} = 121.67 \text{ days}$$

- Each officer receives 121.67 days off per year.

Average Time off Patrol/Year/Officer

- Net Comp time is calculated as the difference between additional hours worked by patrol and the amount of compensatory time taken by patrol.
- The average officer worked 10.94 hours of overtime in patrol each year and used 13.55 hours of comp leave.
- Average time off patrol per year per officer was 1,386.61 hours.

Average Time Off Patrol per Year per Officer

Time Off Category	Days	Hours
Regularly Scheduled Days	121.67	973.33
Admin & Benefit Time	27.02	216.16
Non-Patrol Time	22.14	177.12
Net Comp Time	2.5	20
Total	173.33	1386.61

Shift Relief Factor

- For every unit that the agency needs to field, per shift, they must have 1.904 officers assigned to the patrol division.
- To staff one more patrol unit around the clock, the agency would need 5.712 officers assigned to the patrol division.

$$\left(\begin{array}{c}\textit{Shift}\\ \text{Re}\textit{lief}\\ \textit{Factor}\end{array}\right) = \frac{\left(\begin{array}{c}\text{Total Number of Hours Required}\\ \text{To Cover One Shift Position Every}\\ \text{Day for One Year}\end{array}\right)}{(365 \text{ x Shift Length}) - \left(\begin{array}{c}\text{Average Hours Off}\\ \text{Patrol per Year}\\ \text{per Officer}\end{array}\right)}$$

$$\text{SRF} = \frac{(365 \text{ x Shift Length})}{(365 \text{ x Shift Length}) - \left(\begin{array}{c}\text{Average Hours Off}\\ \text{Patrol per Year}\\ \text{per Officer}\end{array}\right)}$$

$$\text{SRF} = \frac{(365 \text{ x } 8 \text{ hours})}{(365 \text{ x } 8 \text{ hours}) - (1387.69)}$$

$$\text{SRF} = 1.904$$

Example: Using the Total Reactive Time from 2007

302 hrs/day

$$\frac{\textbf{110,290 hours per year}}{\textbf{365 days per year}} = \textbf{302.164 hours per day}$$

For each 8-hour shift, officers spend 73.25 minutes on administrative duties. Therefore, the average officer spends 6.779 hours per day on reactive and proactive patrol.

6.779 hrs/unit

$$\frac{\textbf{302 hours per day}}{\textbf{6.779 hours per unit}} = \textbf{44.55 units per day}$$

This represents the minimum number of units that must be fielded each day in the patrol division if all units were to run call-to-call for the entire length of every shift.

Example: Using the Total Reactive Time from 2007

Daily On-duty Staff

X

Shift Relief Factor

=

Total Patrol Staff

Assuming that a minimum of 44.55 units, each working one shift, must be fielded each day

and ...

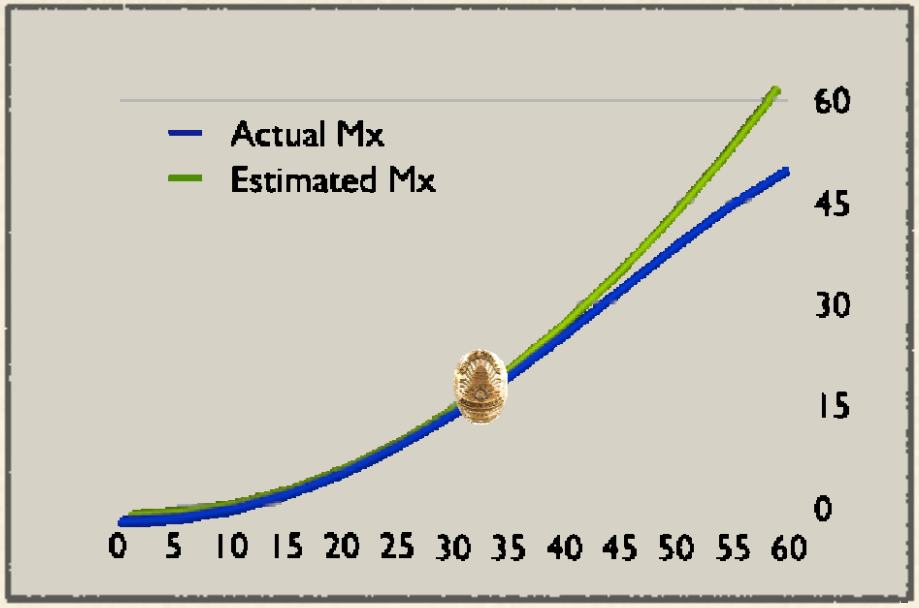
The Shift Relief Factor dictates that for every unit fielded per day the agency must assign 1.904 officers to the patrol division,

then ...

The Police Department would require a minimum of 84.82 officers assigned to the Patrol Division with each officer running call-to-call for the entire length of every shift.

Improving Patrol Performance with Proactive Time

- Reduce Officer Burnout
- Incident Follow-up
- Community Oriented Policing
- Problem Oriented Policing
- Maintain beat integrity
- Reduce Cross-beat Dispatching
- Reduce Response Times
- Improve Officer Safety
- Improve Citizen Safety

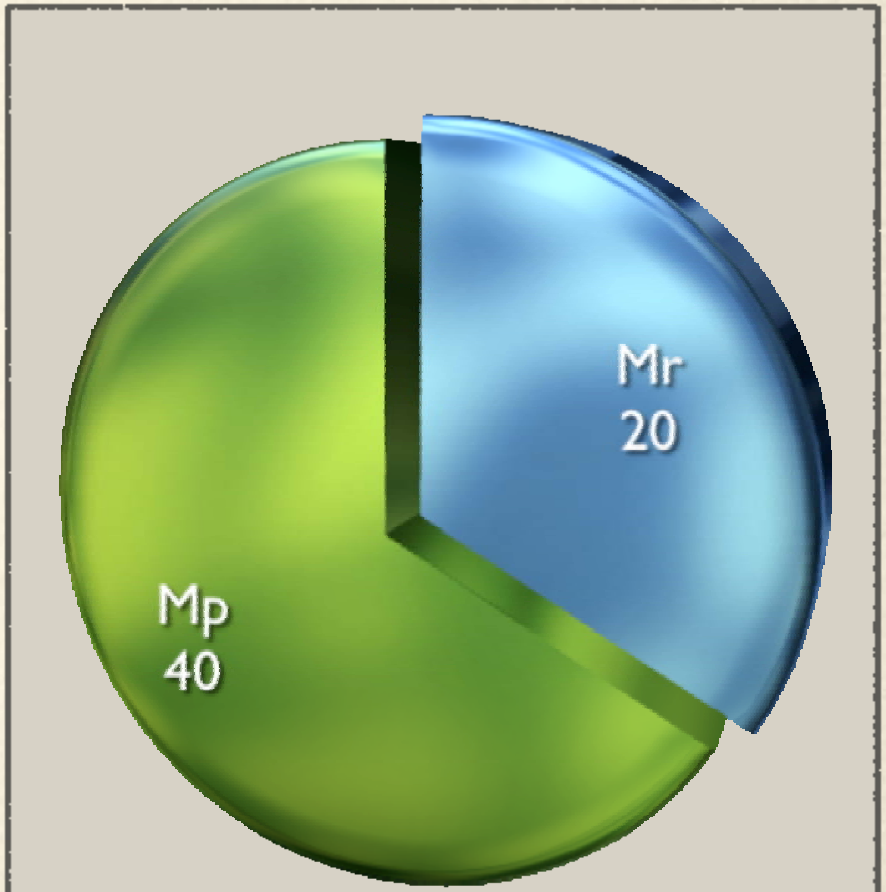


Determination of current performance measures under existing staffing and deployment conditions.

Cross-beat Dispatching

Average Patrol Hour

- M_r = Minutes of reactive time
- M_p = Minutes of proactive time
- $M_r + M_p = 60$ minutes



Based on an M_r value of 20 minutes/hour

Cross-beat Dispatching

Average Patrol Hour

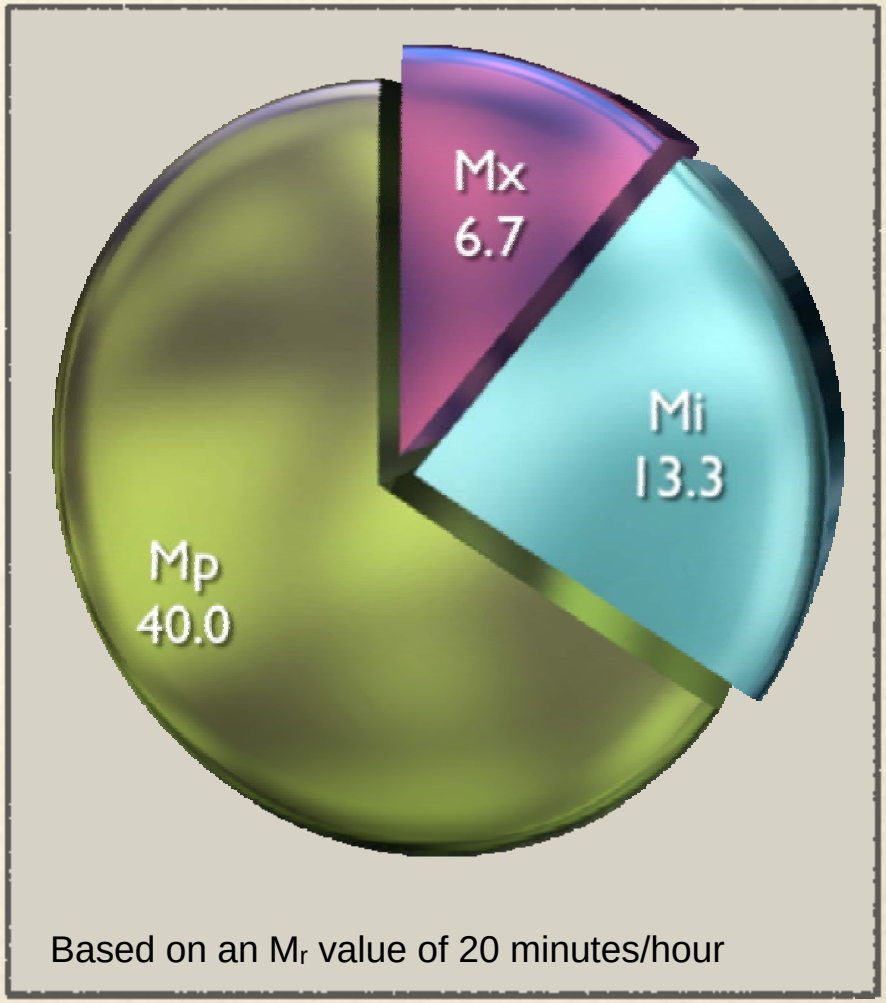
M_p = Minutes of proactive time

M_r = Minutes of reactive time

$M_r = M_x + M_i$

M_x = Minutes of cross-beat dispatching

M_i = Minutes of reactive time spent inside the beat



Based on an M_r value of 20 minutes/hour

Cross-beat Dispatching

Cross-beat Dispatching Formula

$$\frac{m_o^{\,2}}{60}\left(1-\frac{1}{n}\left(\frac{m_o}{60}\right)^{(n-1)}\right)$$

Or, a simpler estimation.....

$$\frac{(m_o)^2}{60}$$

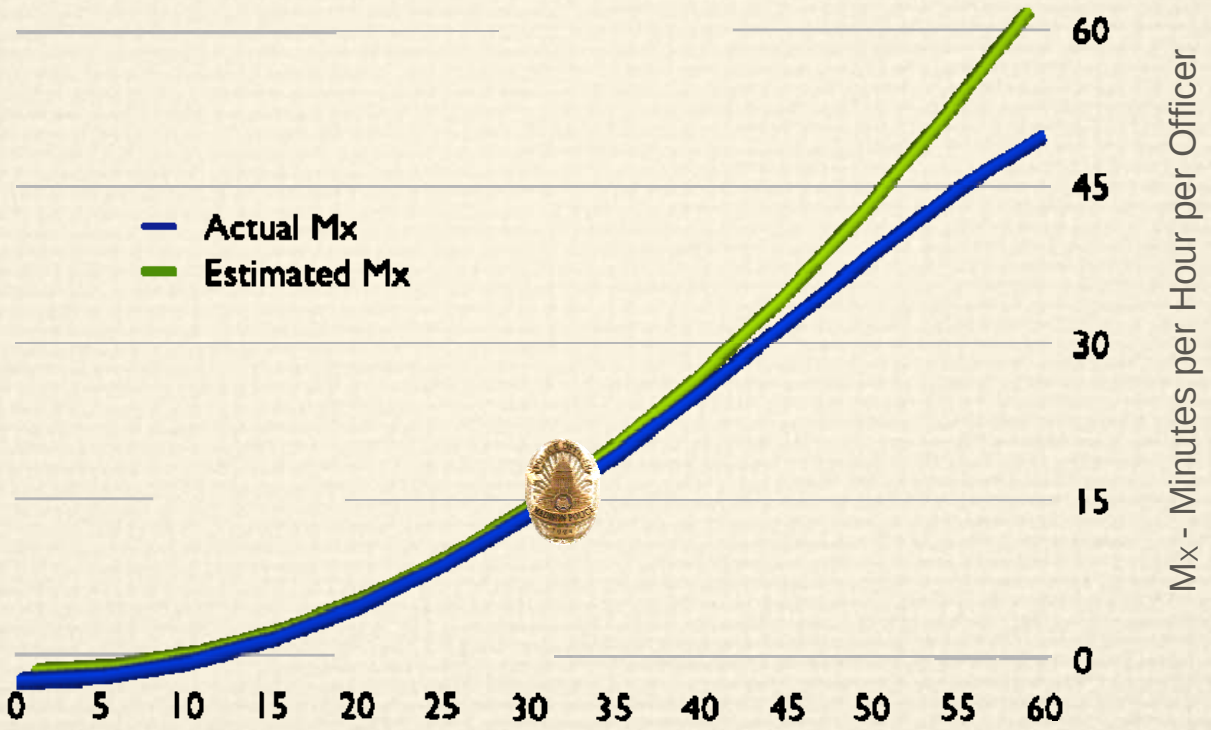
Exponential Effect of M_X

M_O	Actual M_X
20	6.7
25	10.4
30	14.80
35	19.9
40	25.6
45	31.6
50	37.6
55	43.3
60	48

Cross-beat dispatching based on a 5-Beat Plan

Exponential Effect of M_X

Cross-beat Dispatch Levels as a Function of Reactive Time per Hour



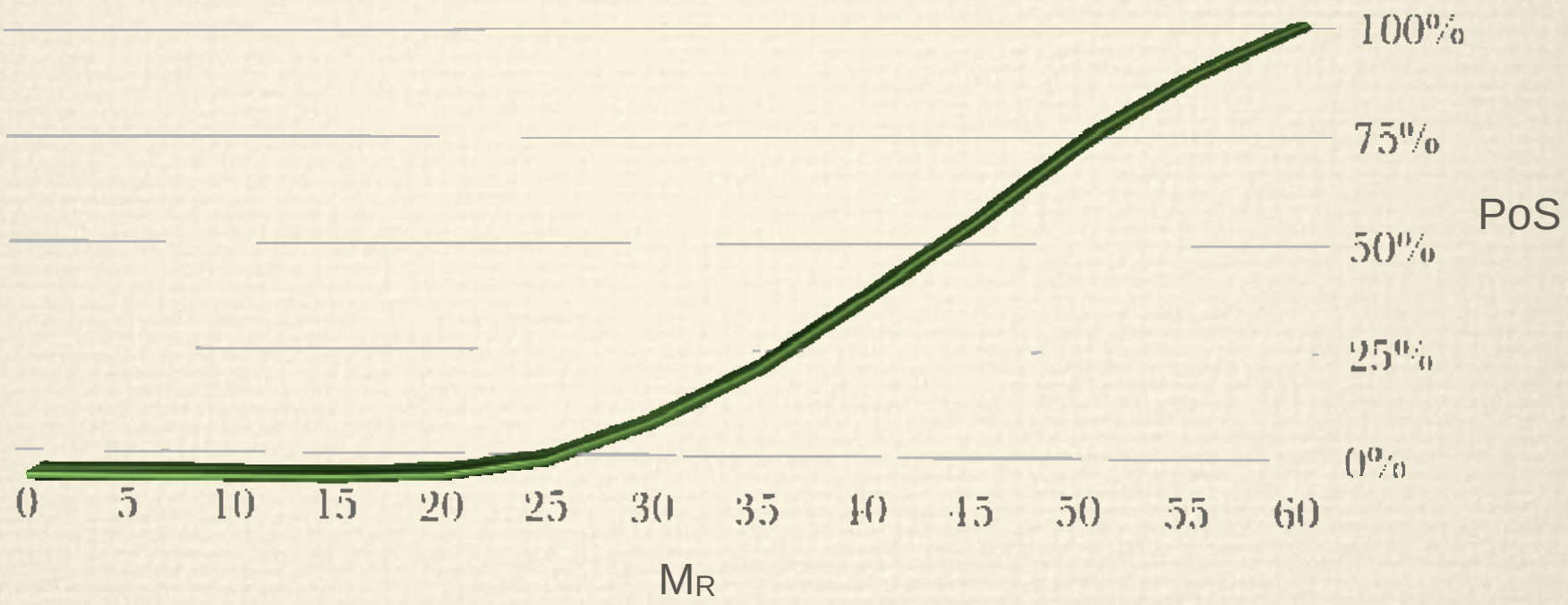
Probability of Saturation

- The probability that when the next call for service comes into the dispatch center, there will be no units available to answer that call immediately.

M_R	PoS
20	0.7%
25	4.1%
30	12.8%
35	24.6%
40	40.4%
45	56.8%
50	74.8%
55	89.0%
60	100%

Sample values taken from South District, Second Detail

Probability of Saturation



Sample values taken from South District, Second Detail

Patrol Interval

- The average time a stranded motorist will have to wait for an officer to come by while on random patrol on proactive time.
- The value depends on:
  - the street miles in the jurisdiction,
  - the average patrol speed,
  - the number of units fielded,
  - the current Mp value.

Patrol Interval

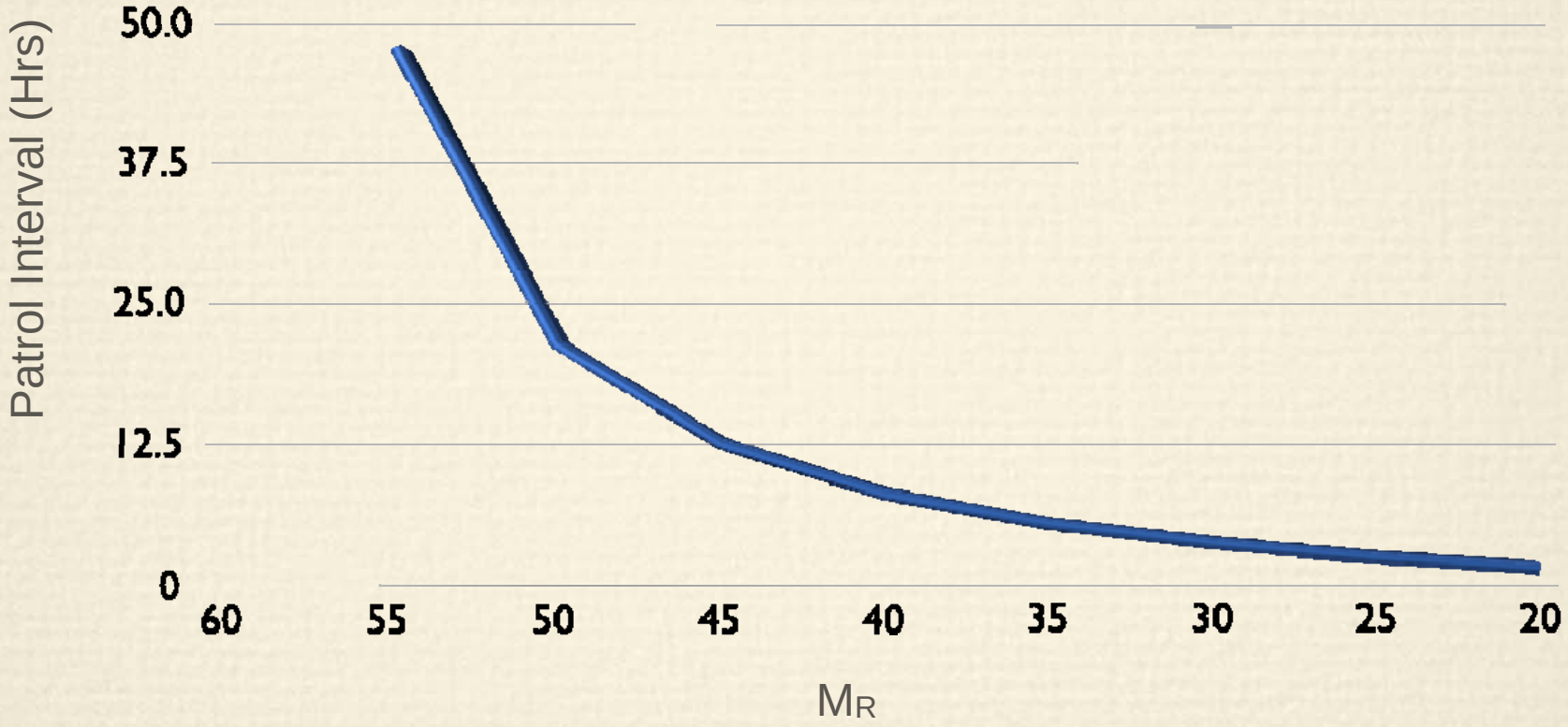
$$PI = \frac{Street\ \ miles\ \ in\ \ the\ \ jurisdiction}{Average\ \ patrol\ \ speed * \left(\frac{M_P}{60}\right) * Units\ \ fielded}$$

Patrol Interval

M_R	(hours)	(gained hrs)
20	2.1	
25	3.0	0.9
30	4.2	1.2
35	5.8	1.6
40	8.3	2.5
45	12.5	4.2
50	20.7	8.2
55	45.5	24.8
60	Infinite	Infinite

Sample values taken from South District, Second Detail

Patrol Interval



Sample values taken from South District, Second Detail

Improving Patrol Performance with Proactive Time

- Reduce Officer Burnout
- Incident Follow-up
- Community Oriented Policing
- Problem Oriented Policing
- Maintain beat integrity
- Reduce Cross-beat Dispatching
- Reduce Response Times
- Improve Officer Safety
- Improve Citizen Safety

- ***How much proactive time should the patrol division have?***
  - This is a policy decision, not a calculated decision. It is based on a desired level of performance and what the citizens are willing to fund.
  - As M_P is increased, performance and cost both increase. By increasing the amount of available proactive patrol, the city is purchasing a “level of service.”
  - At the time of this study, Patrol Officers were averaging 27.3 minutes of proactive time per hour per officer.

- ***Do national averages or standards exist for an appropriate M_R or M_P value?***
  - To our knowledge, there are no documented national standards or averages.
  - Past practice has been to determine an agency's current baseline and then to provide expected performance levels for various M_P values within a short range of their existing baseline.
  - When feasible, recommendations typically target an M_R value of 25 to 35 minutes per hour.
  - The spreadsheet accompanying this report and the tables included in the final report allow department administrators to designate a desired M_R value.

Performance Factor

- Once an M_R value is chosen for the agency, a corresponding performance factor is determined.
- The performance factor is then used to determine the Total Patrol Time for the patrol division.
- The Total Patrol Time includes proactive time for the patrol officers.

Performance Factor (F_{perf})

$$F_{perf} = \frac{60}{M_R} = \frac{60}{60 - M_P}$$

Total Patrol Time (TPT)

TPT = F_{perf} x Total Reactive Time

Total Proactive Time

$$\frac{\text{Total Patrol Time} - \text{Total Reactive Time}}{\text{Total Proactive Time}}$$

Table 9. ***Relationship Between Proactive Time and Patrol Performance Measures***

M_R	M_P	M_x	Officers/Day	Total Patrol Staff
60	0	48.0	44	84
59	1	47.2	45	86
58	2	46.3	46	87
57	3	45.3	46	89
56	4	44.3	47	90
55	5	43.3	48	92
54	6	42.2	49	94
53	7	41.1	50	95
52	8	40.0	51	97

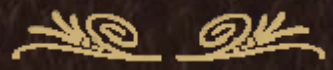
Determine expected performance changes based on alternative patrol staffing choices.

- Three tables are contained in the report (Tables 9-11) that provide performance expectations based on various M_R values chosen by the MPD administration.

- It is recommended that the MPD attempt to lower their M_R value from the current 32.7 minutes/hour to 30 minutes/hour.

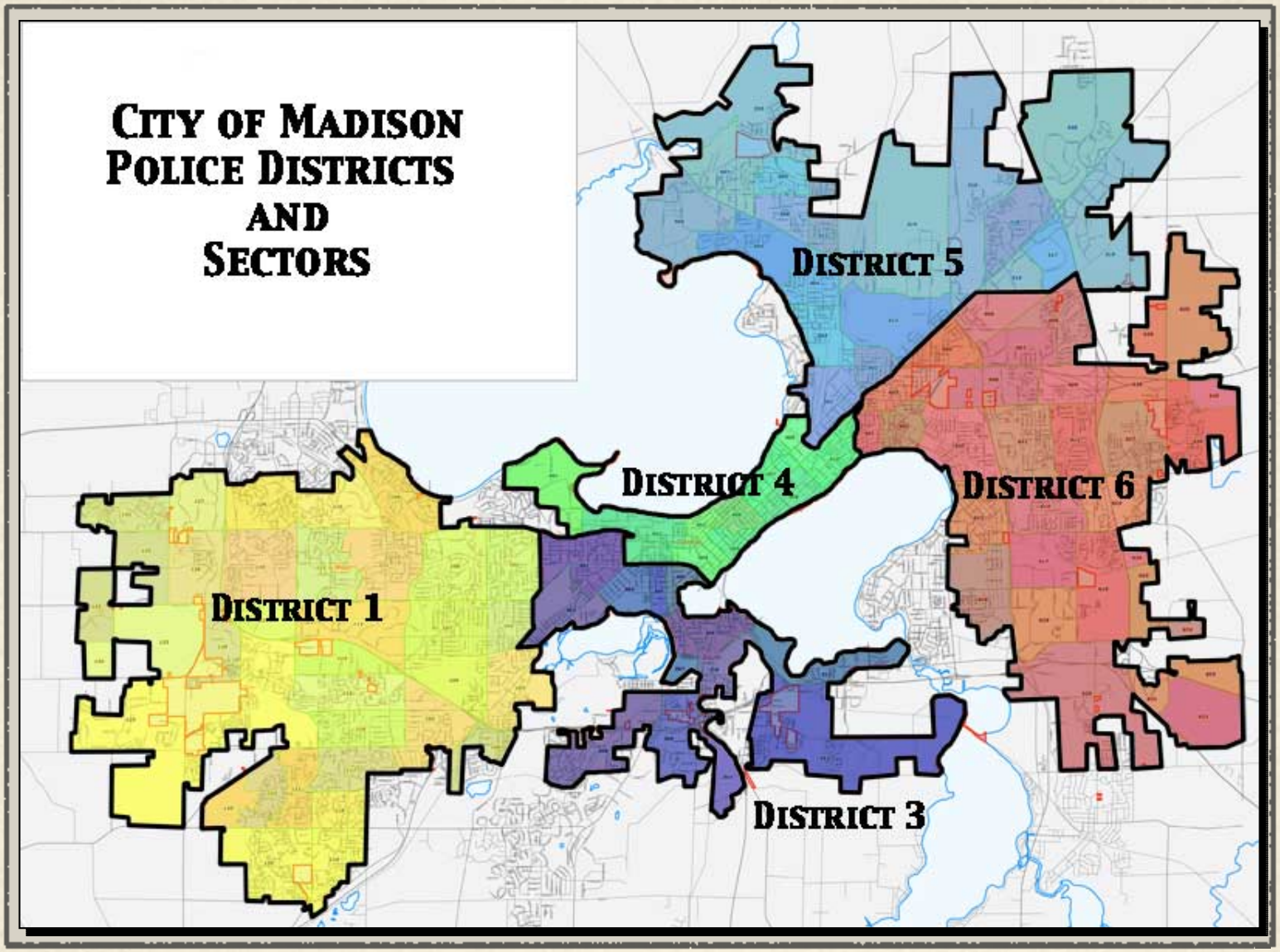
- To account for limitations in the current workload data collection practices, the agency may wish to consider a targeted M_R value of 28 minutes/hour.

Actions Taken



Resource Deployment

Analyze correlation between current workload patterns and current staffing patterns.



District Deployment

Current District Statistics

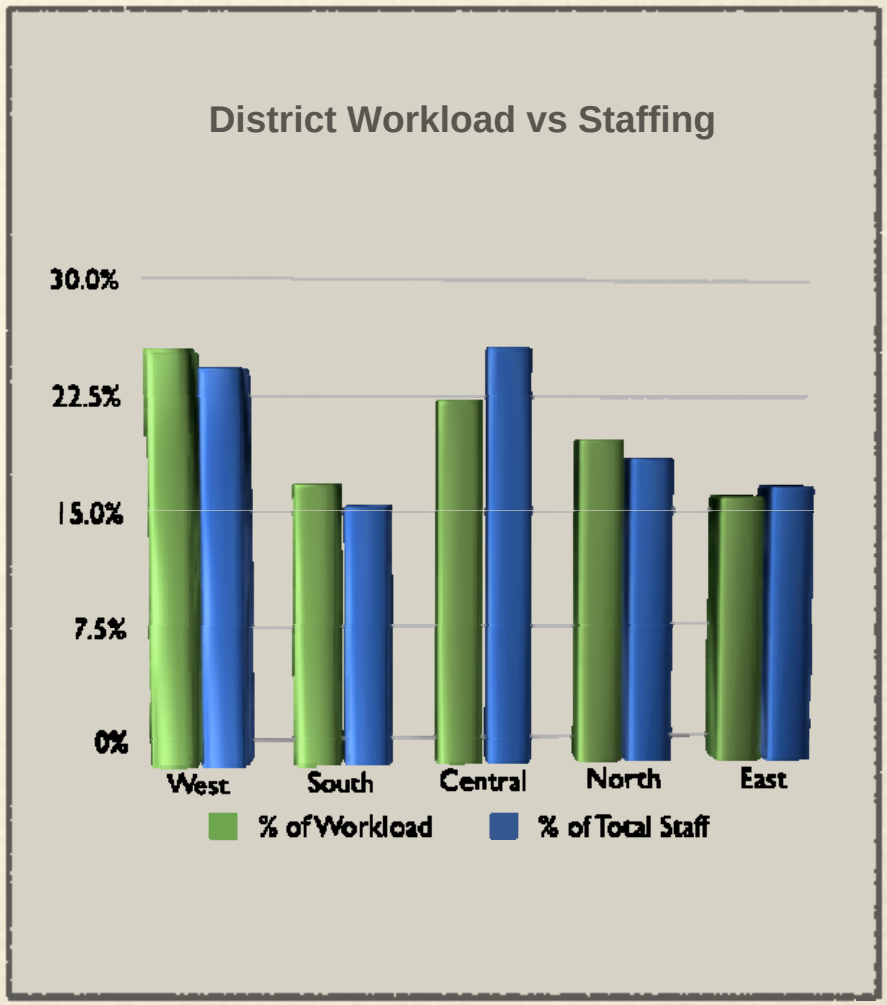
District	Location	Street Miles in District	Number of Sectors	Hours of Work in CAD	Assigned Officers
1	West	325.2 miles	35	24,106 hours	40
3	South	118.2 miles	13	16,382 hours	26
4	Central	72.0 miles	10	21,293 hours	42
5	North	155.8 miles	20	19,038 hours	31
6	East	238.5 miles	26	15,527 hours	28

- Due to physical substations located throughout the various districts, changes to district boundaries were not considered.
- The alternative was to examine the ratio between officer assignments among districts and district workload percentages.

Current District Statistics

- Current personnel were reallocated across the five districts based on their percentage of total workload.
- Recommended changes based on current staffing

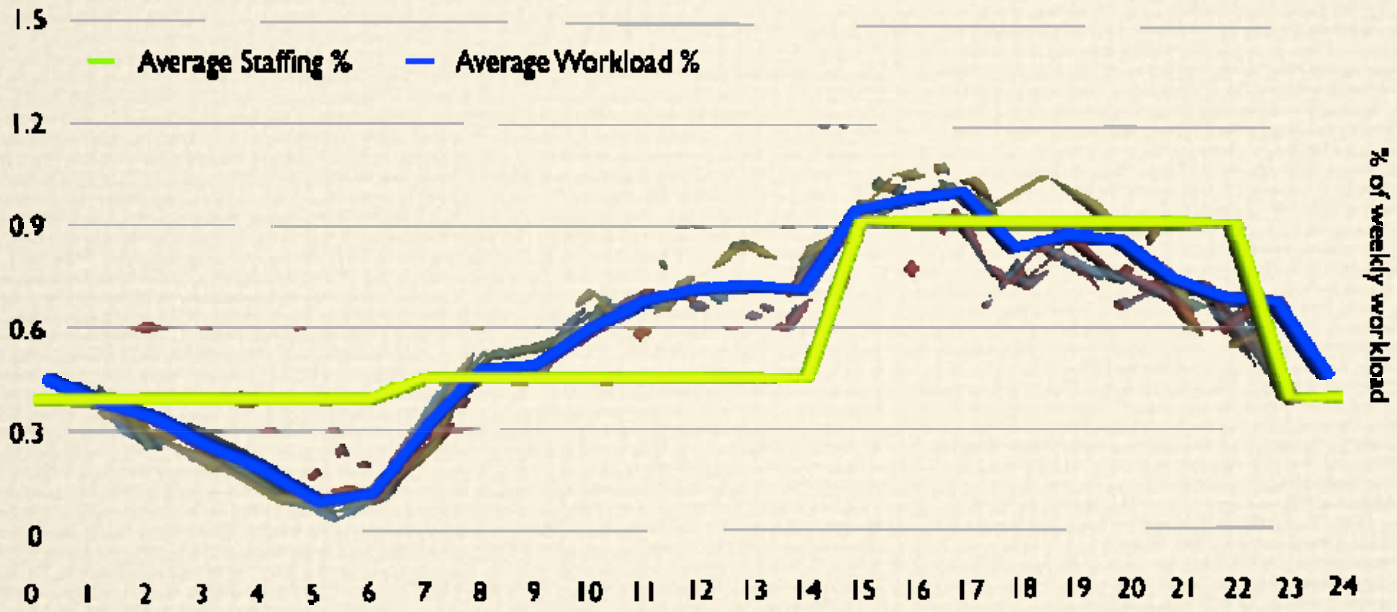
District	Change
West	+2
South	+3
Central	-4
North	+1
East	-2

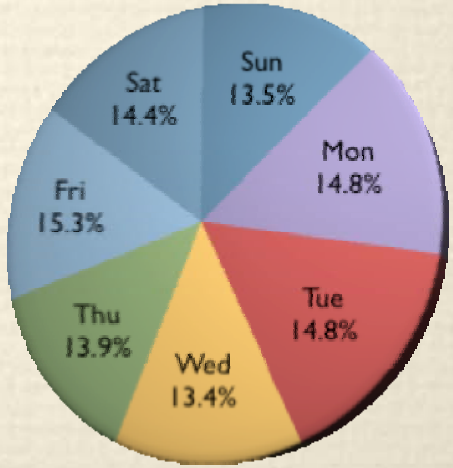


- ***Workload Curve:***
  - Time-weighted curve based on calls-for-service only. (Current CAD limitation)
  - Charted as a percentage of work by hour of day
  - Workload by day of week was consistent (Central District exception)
  - Workload by hour of day was nonuniform but predictable.

District 1: West

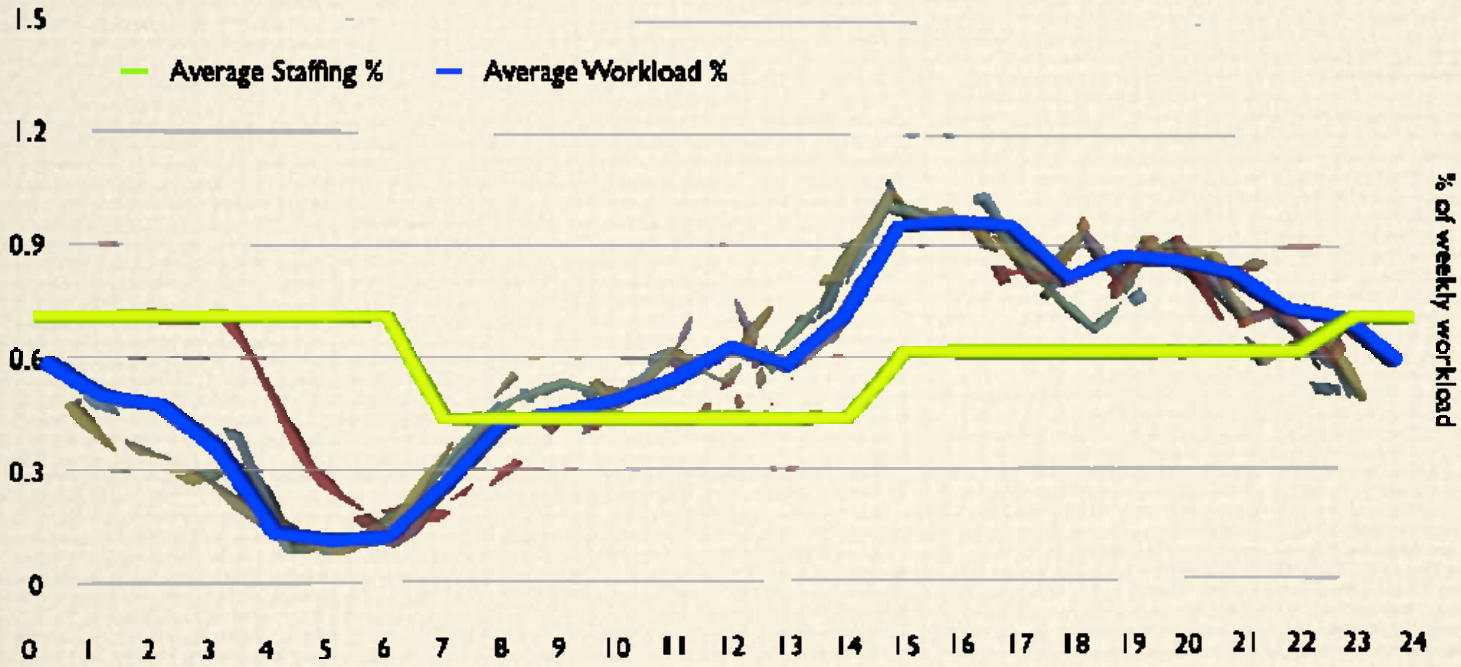
District 1: Workload Percentages by Hour of Day

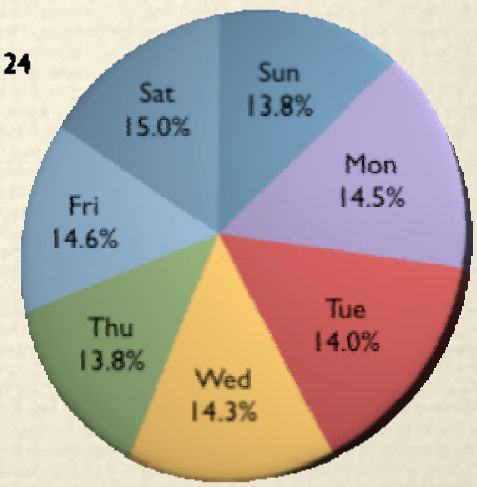




District 2: South

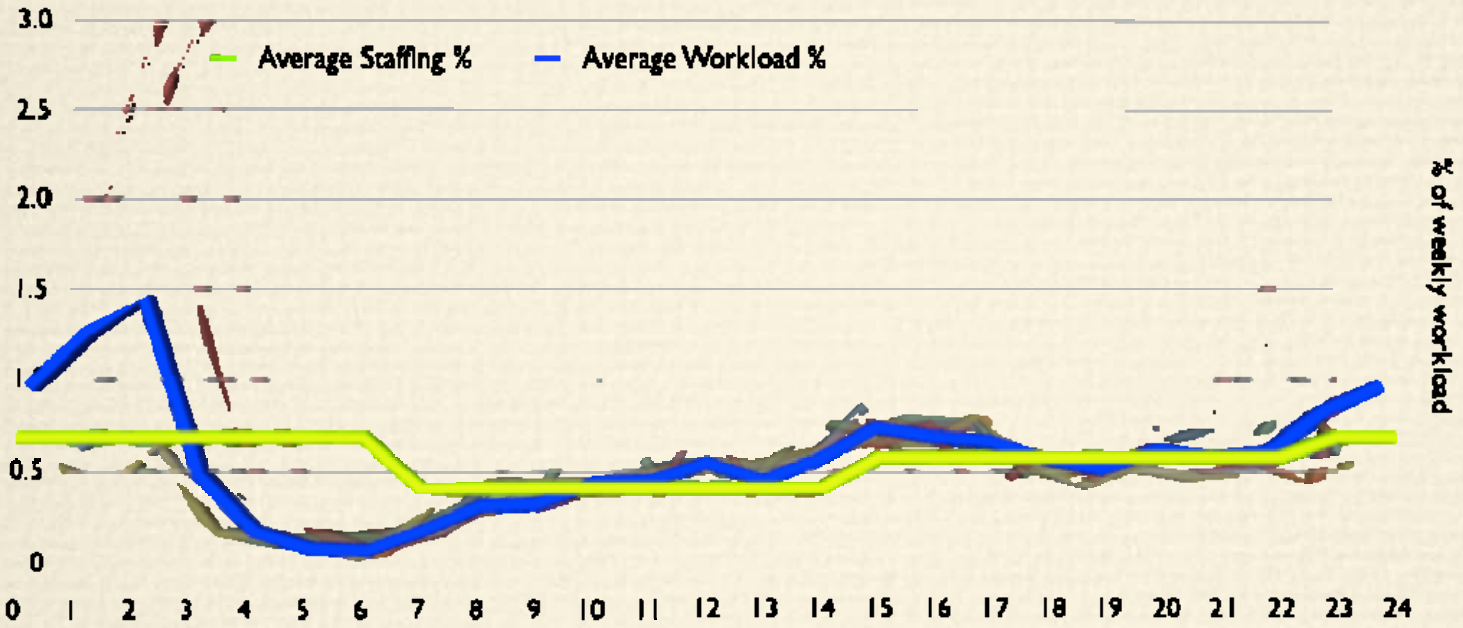
District 3: Workload Percentages by Hour of Day

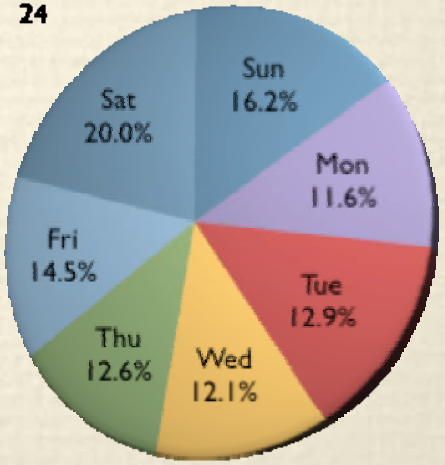




District 4: Central

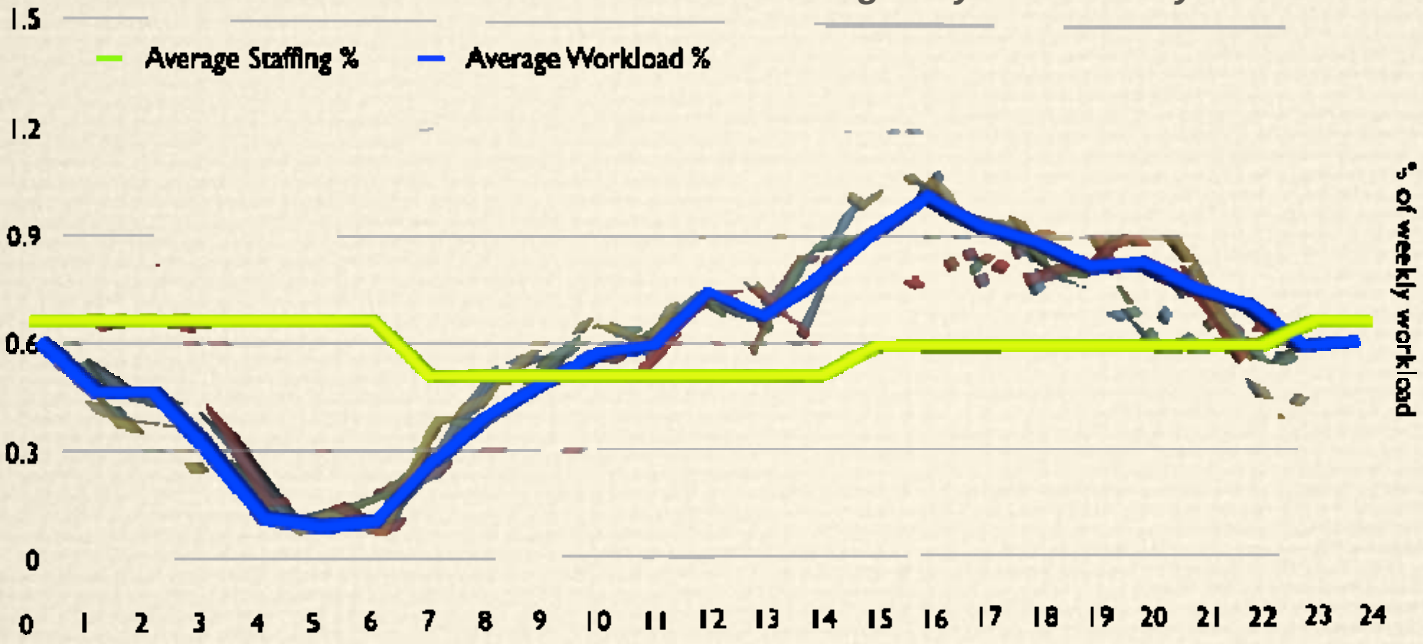
District 4: Workload Percentages by Hour of Day

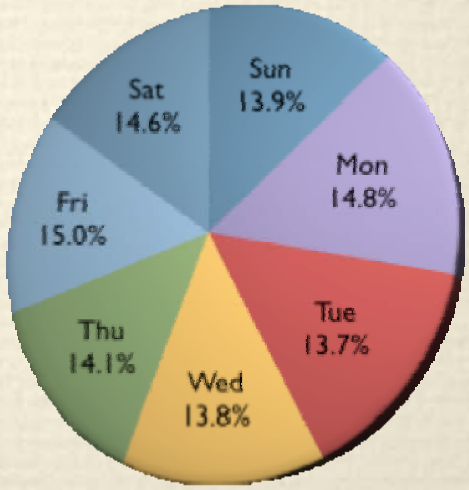




District 5: North

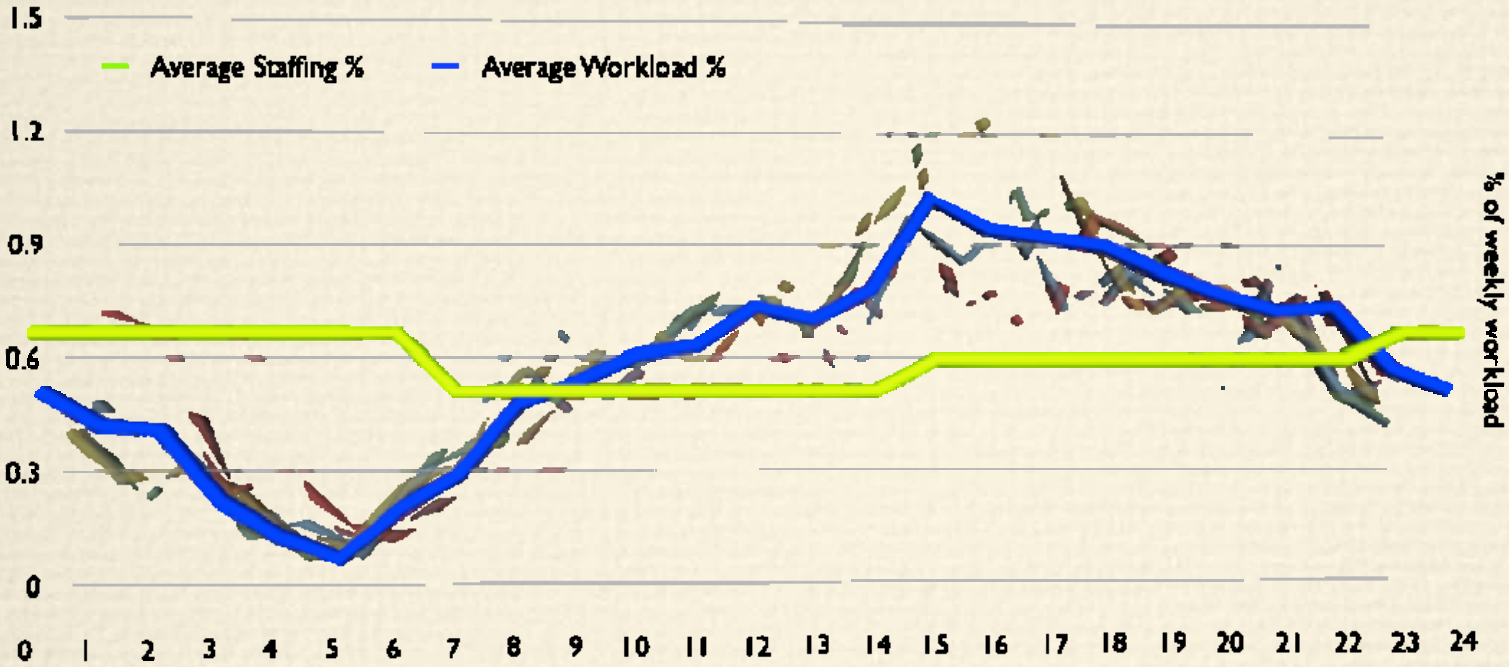
District 5: Workload Percentages by Hour of Day

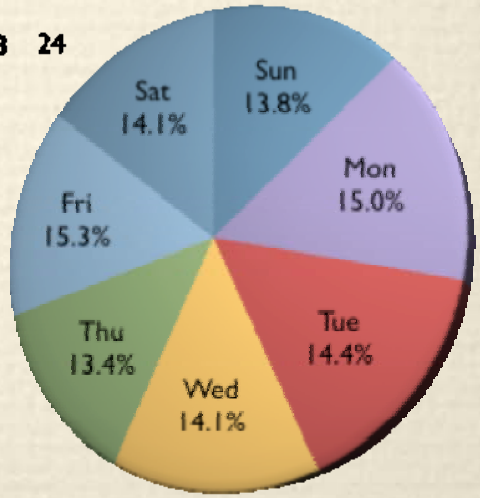


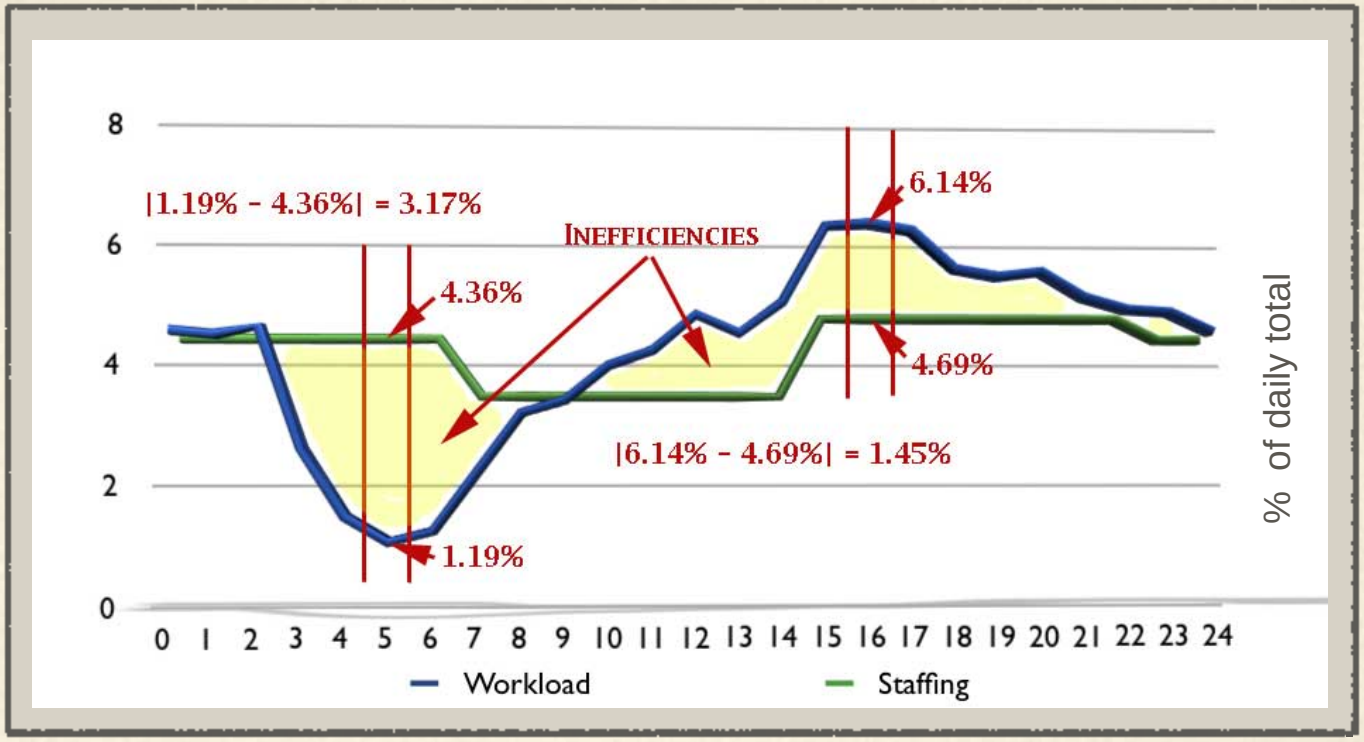


District 6: East

District 6: Workload Percentages by Hour of Day







Provide recommendations on schedule modifications to improve staffing efficiencies.

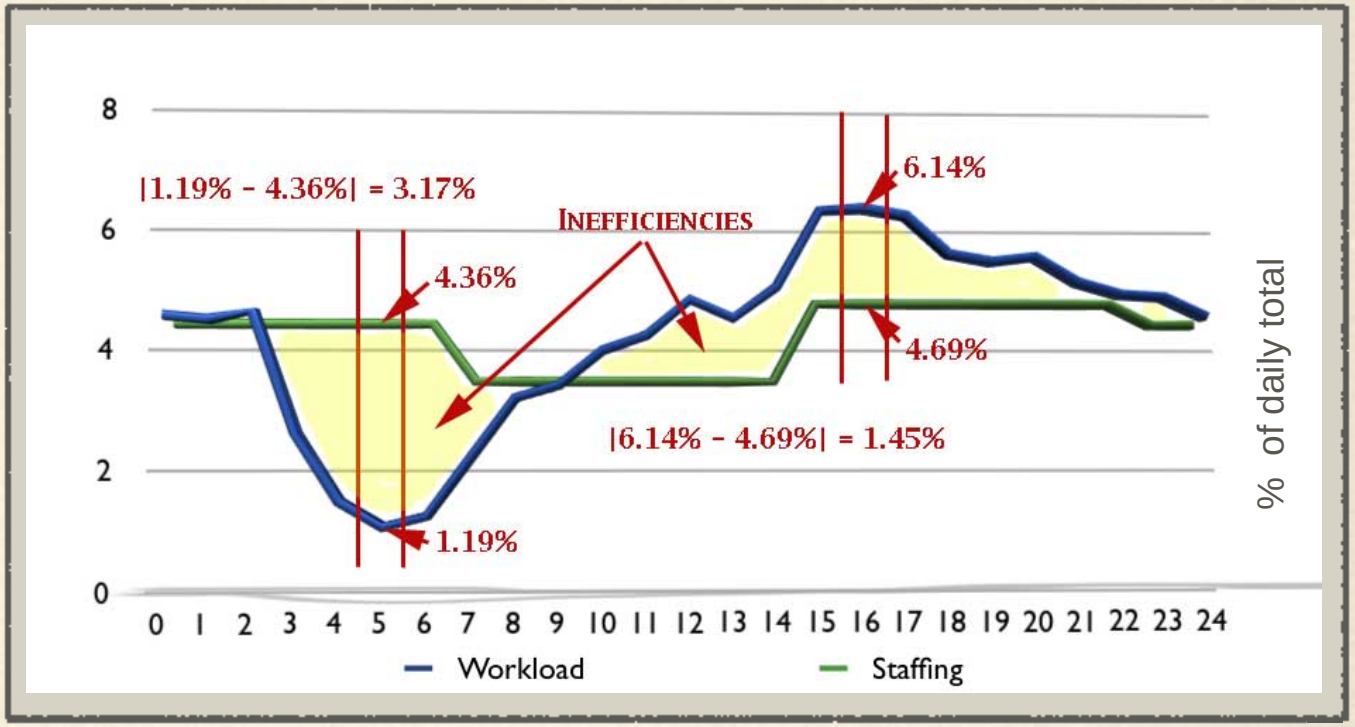
Schedule Efficiency Index

Efficiency Index =

$$\sum_{i=1}^{24} |C_W - C_S|_i$$

where,

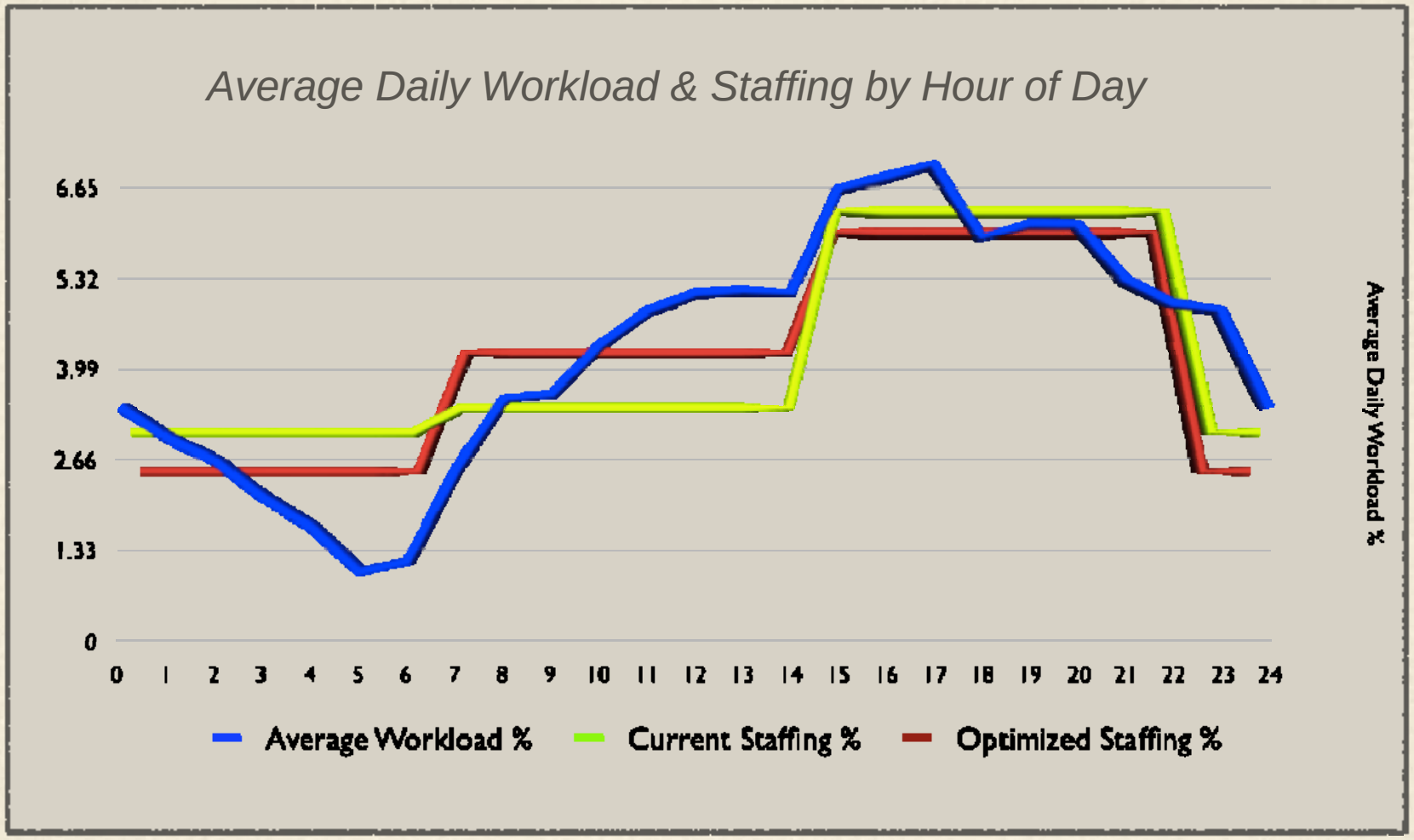
C_W = Workload Curve
C_S = Staffing Curve



- Any areas existing between the workload curve and the staffing curve represent an opportunity for increased efficiency.
- Measures “closeness of fit” with existing officers, does not indicate if the correct amount of officers are being scheduled.

- First Schedule Optimization Recommendation:
  - Redeploy officers across Districts based on workload percentages.
  - Redeploy officers across existing details based on workload percentages.
  - Least obtrusive change which does not change existing detail starting or stopping times.
  - Maintains existing number of details.

District 1: West

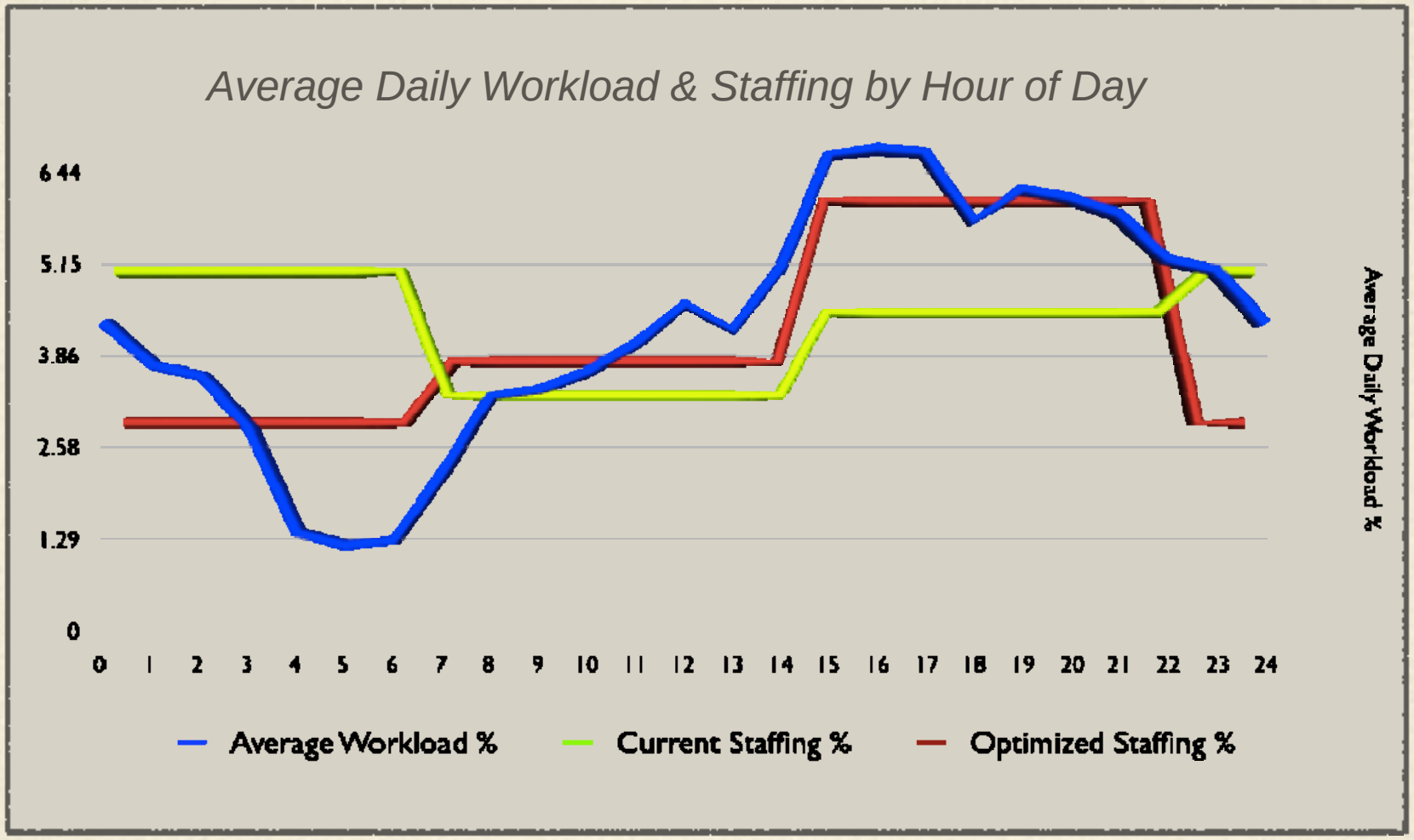


Current Efficiency Index: 79.40%

Optimized Efficiency Index: 83.00%

+3.6%

District 3: South

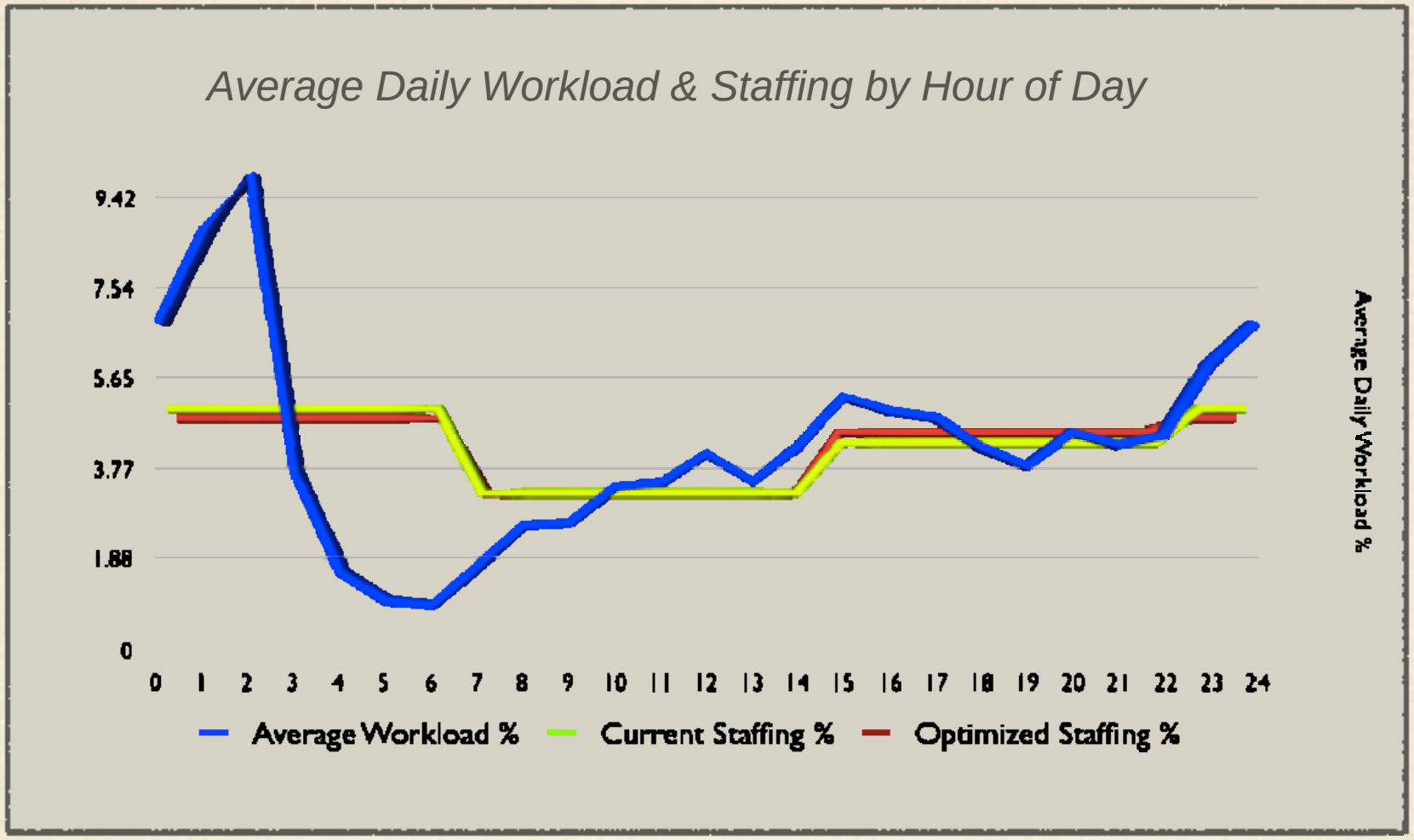


Current Efficiency Index: 66.19%

Optimized Efficiency Index: 82.68%

+16.49%

District 4: Central

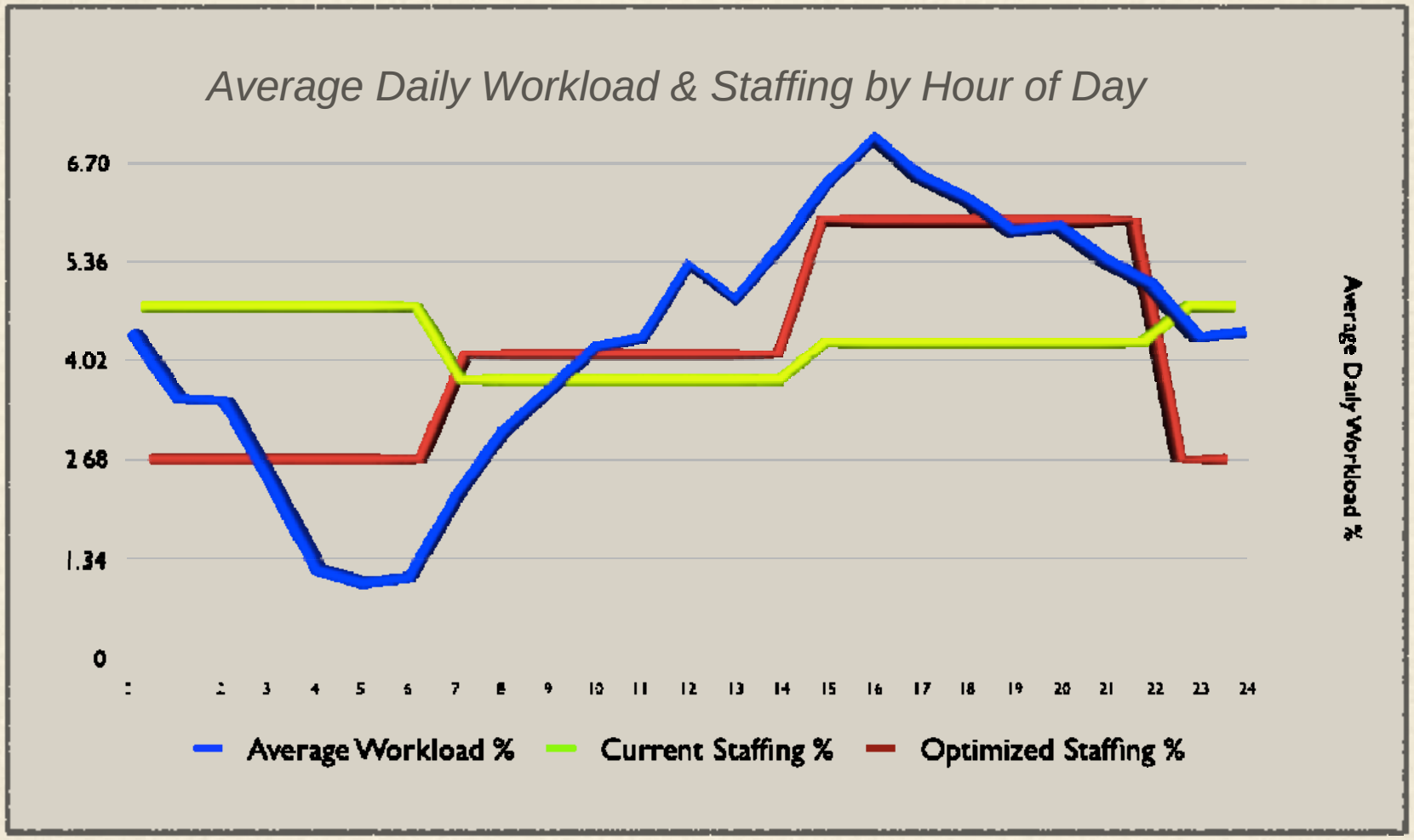


Current Efficiency Index: 70.17%

Optimized Efficiency Index: 70.34%

+.17%

District 5: North

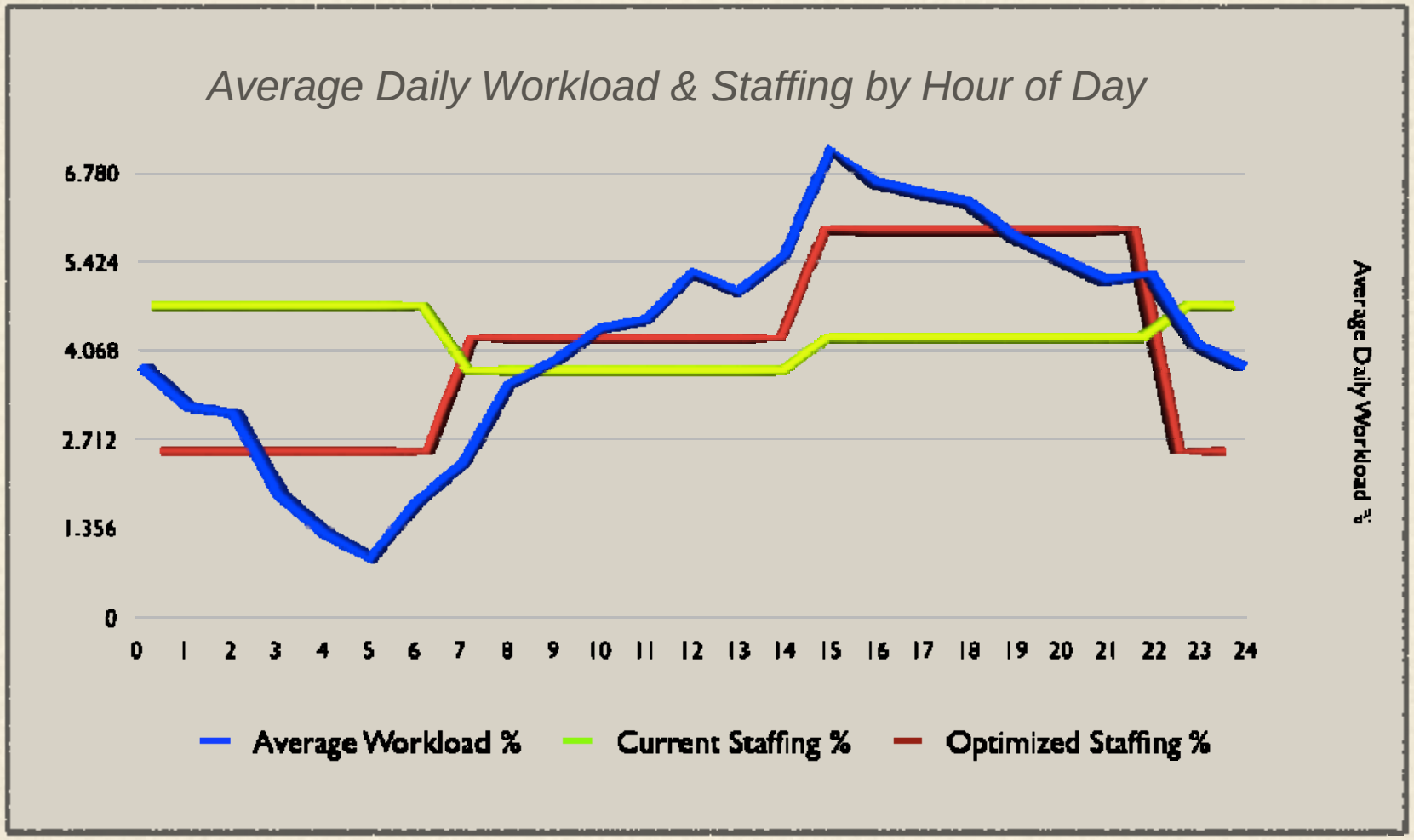


Current Efficiency Index: 64.46%

Optimized Efficiency Index: 80.52%

+16.06%

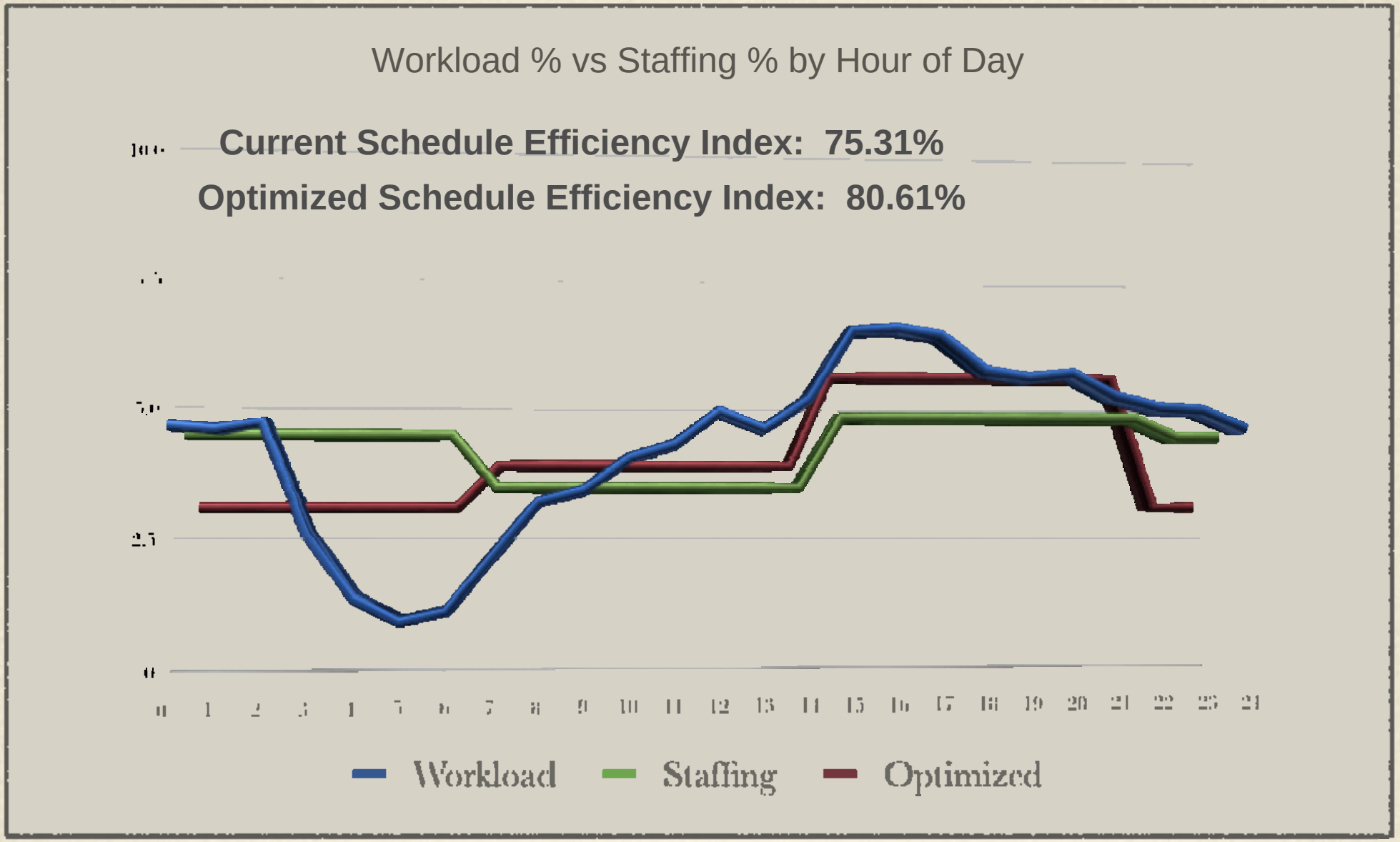
District 6: East



Current Efficiency Index: 63.42%

Optimized Efficiency Index: 81.94%

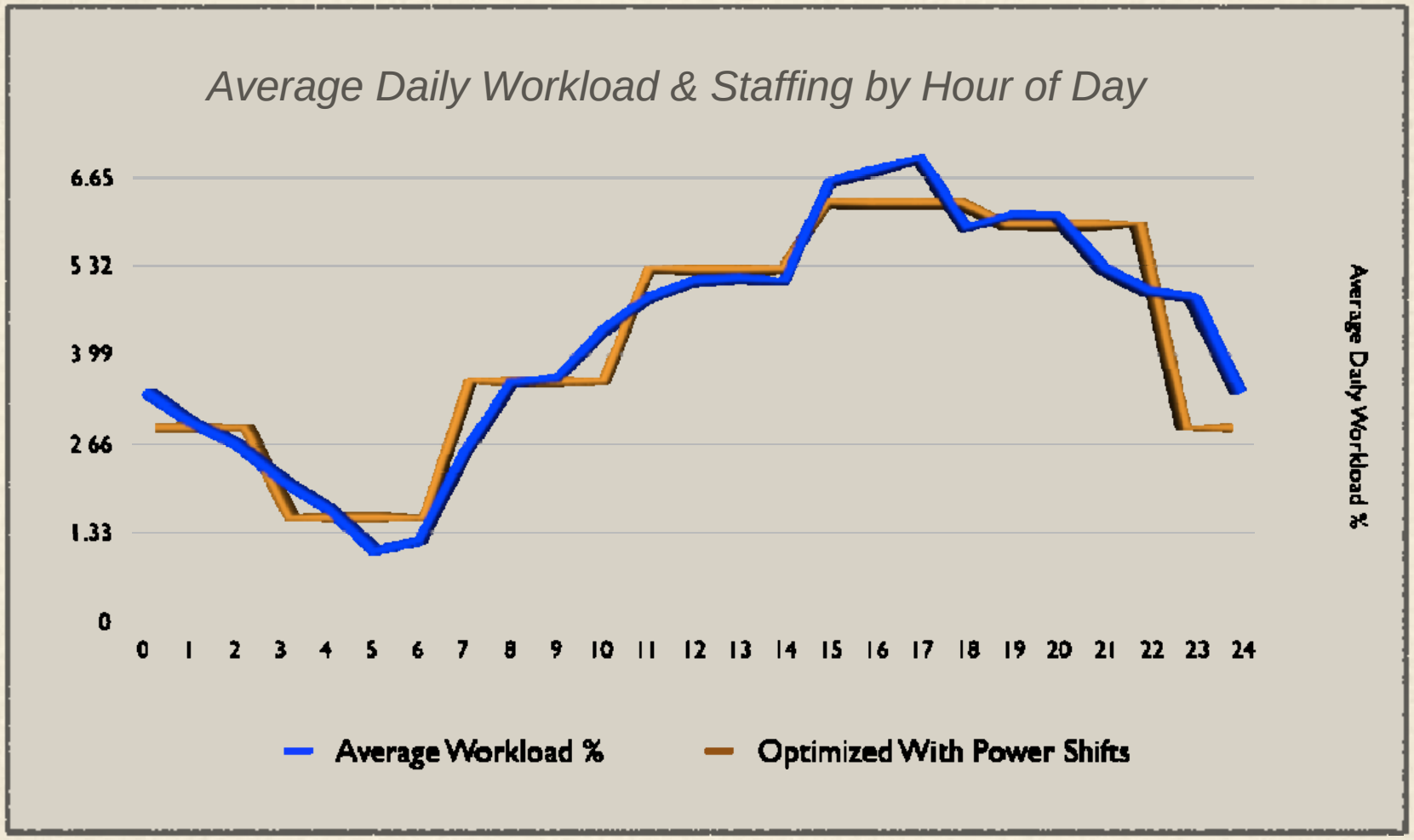
+18.52%



Current Schedule Efficiency

- Second Schedule Optimization Recommendation:
  - Redeploy officers across Districts based on workload percentages.
  - Add two additional “Power Shifts” working from 11a - 7p and 7p - 3a.
  - Redeploy officers across 5 details based on workload percentage.
  - May require additional equipment (patrol cars, radios, etc.).
  - Dedicated supervisors to each shift would be highly recommended.

District 1: West

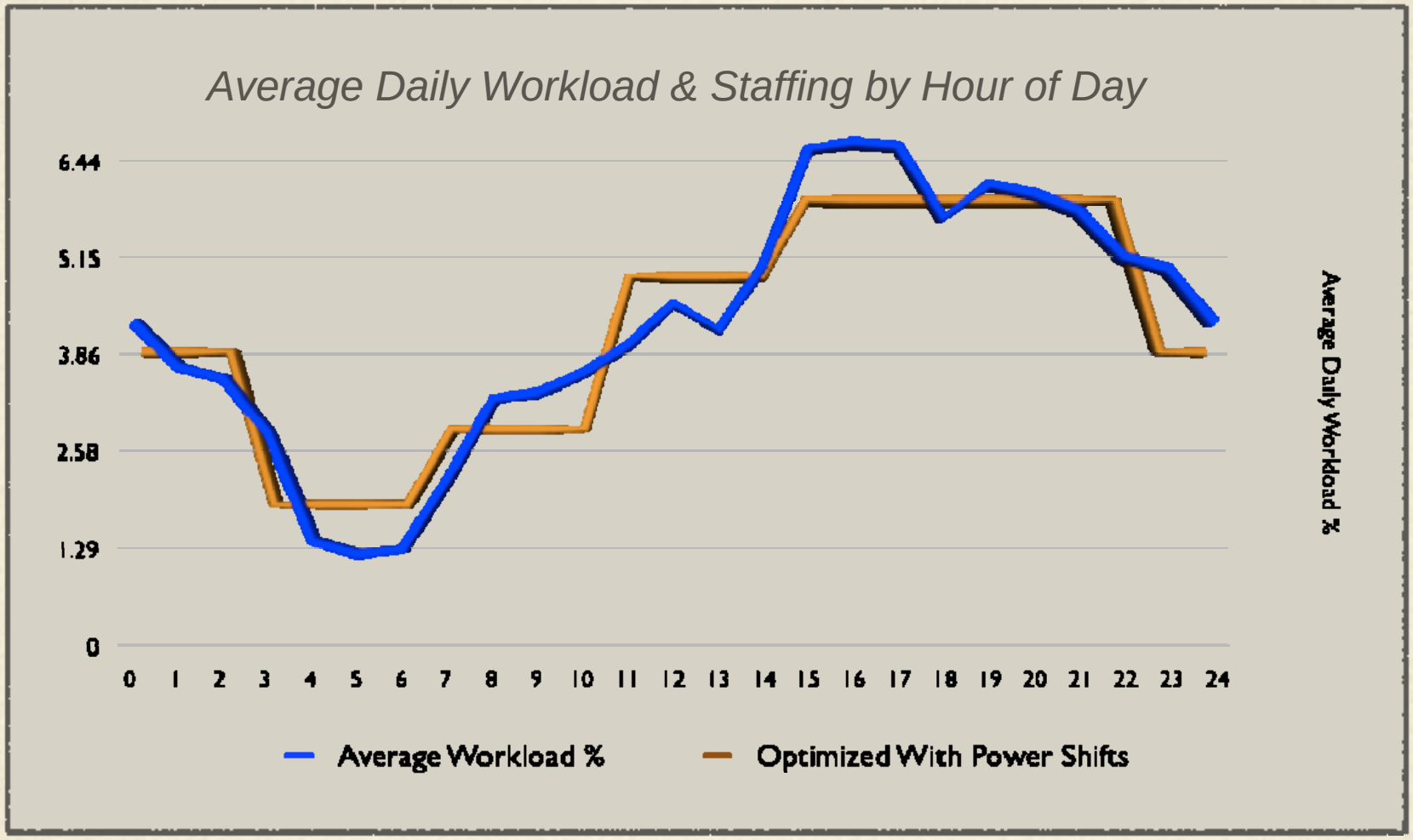


Current Efficiency Index: 79.40% **+3.6%**

Optimized Efficiency Index: 83.00% **+10.4%**

2nd Optimized Efficiency Index: 89.80%

District 2: South

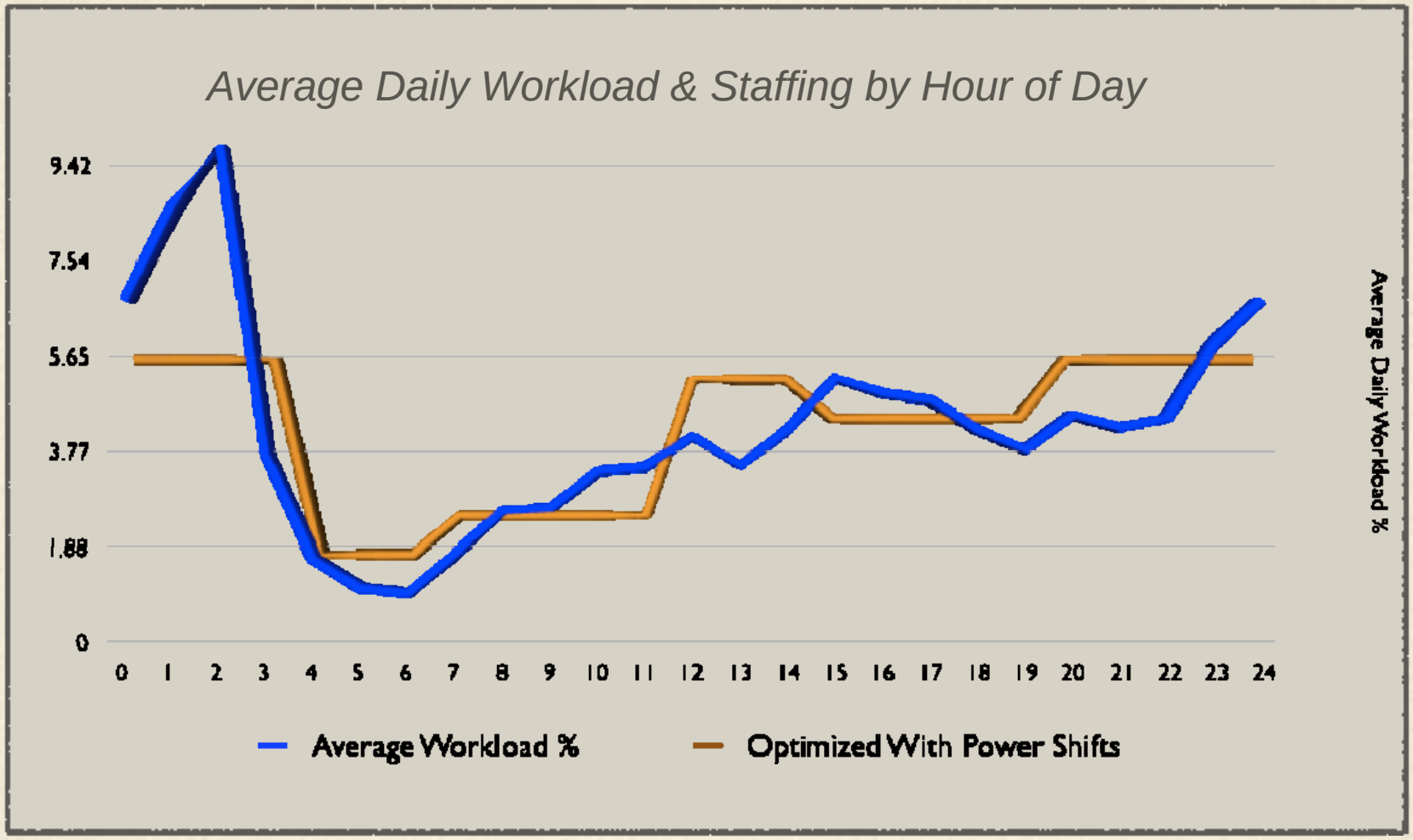


Current Efficiency Index: 66.19% **+16.49%**

Optimized Efficiency Index: 82.68% **+21.96%**

2nd Optimized Efficiency Index: 88.15%

District 4: Central

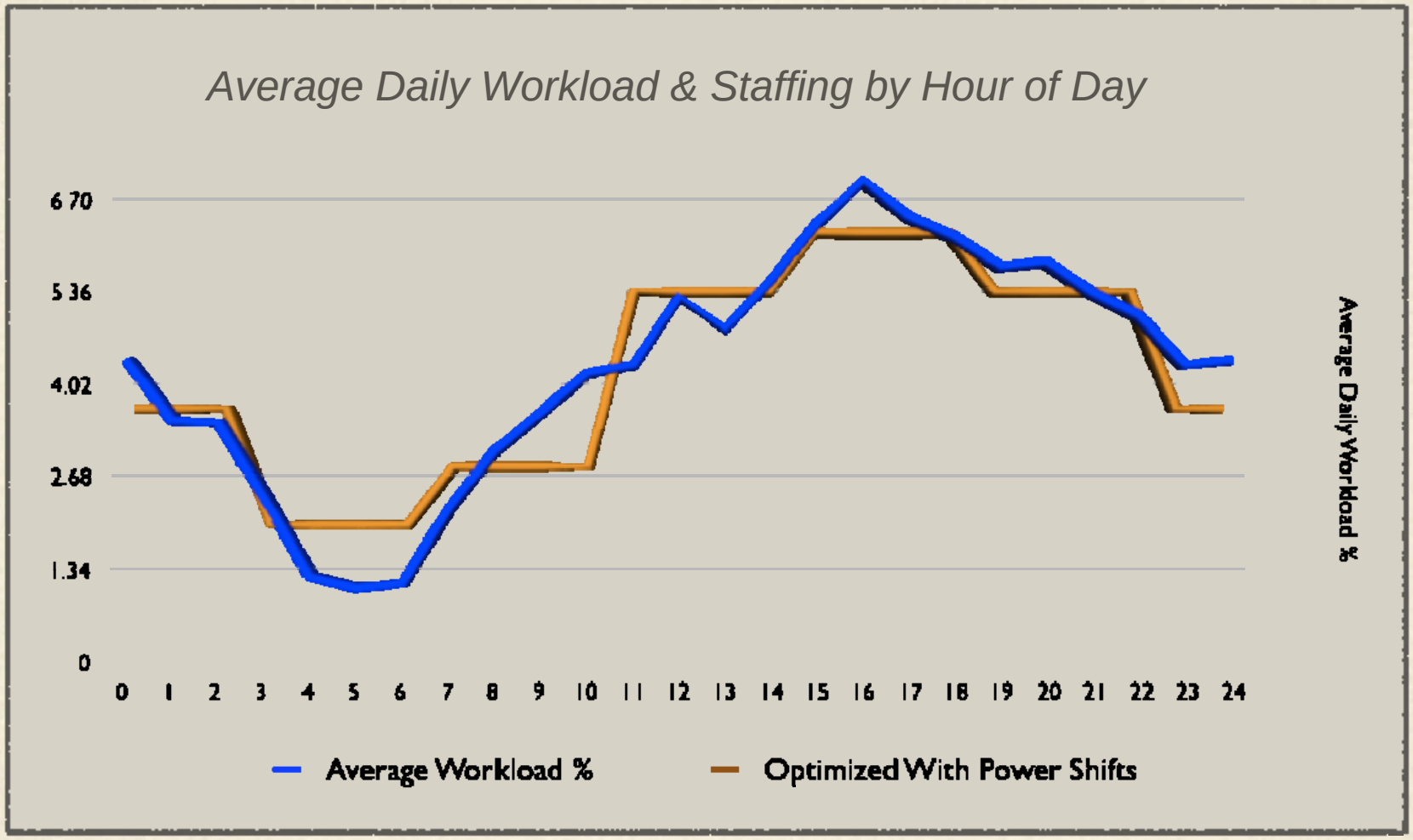


Current Efficiency Index: 70.17% **+.17%**

Optimized Efficiency Index: 70.34% **+6.57%**

2nd Optimized Efficiency Index: 76.74%

District 5: North

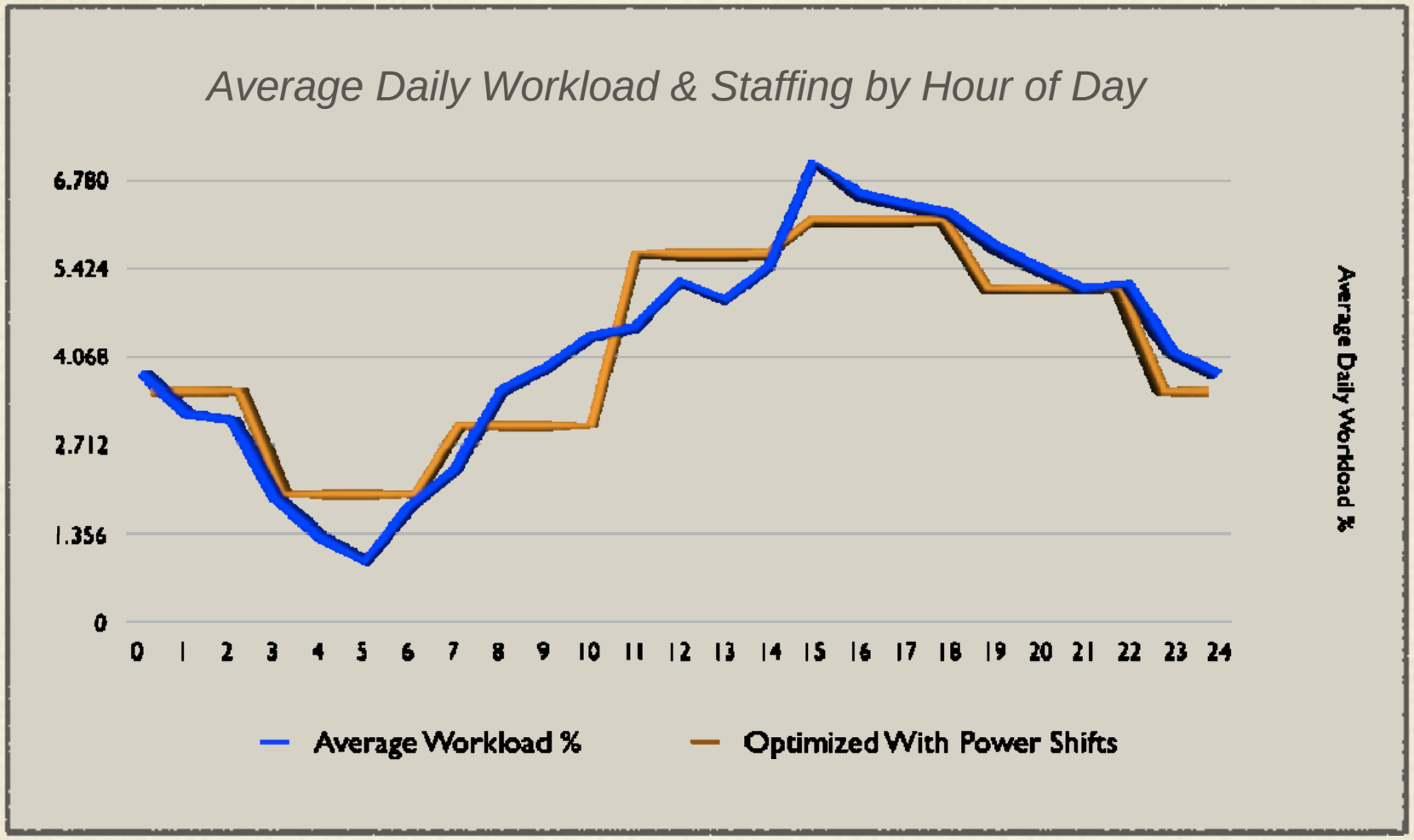


Current Efficiency Index: 64.45% **+16.07%**

Optimized Efficiency Index: 80.52% **+24.56%**

2nd Optimized Efficiency Index: 89.01%

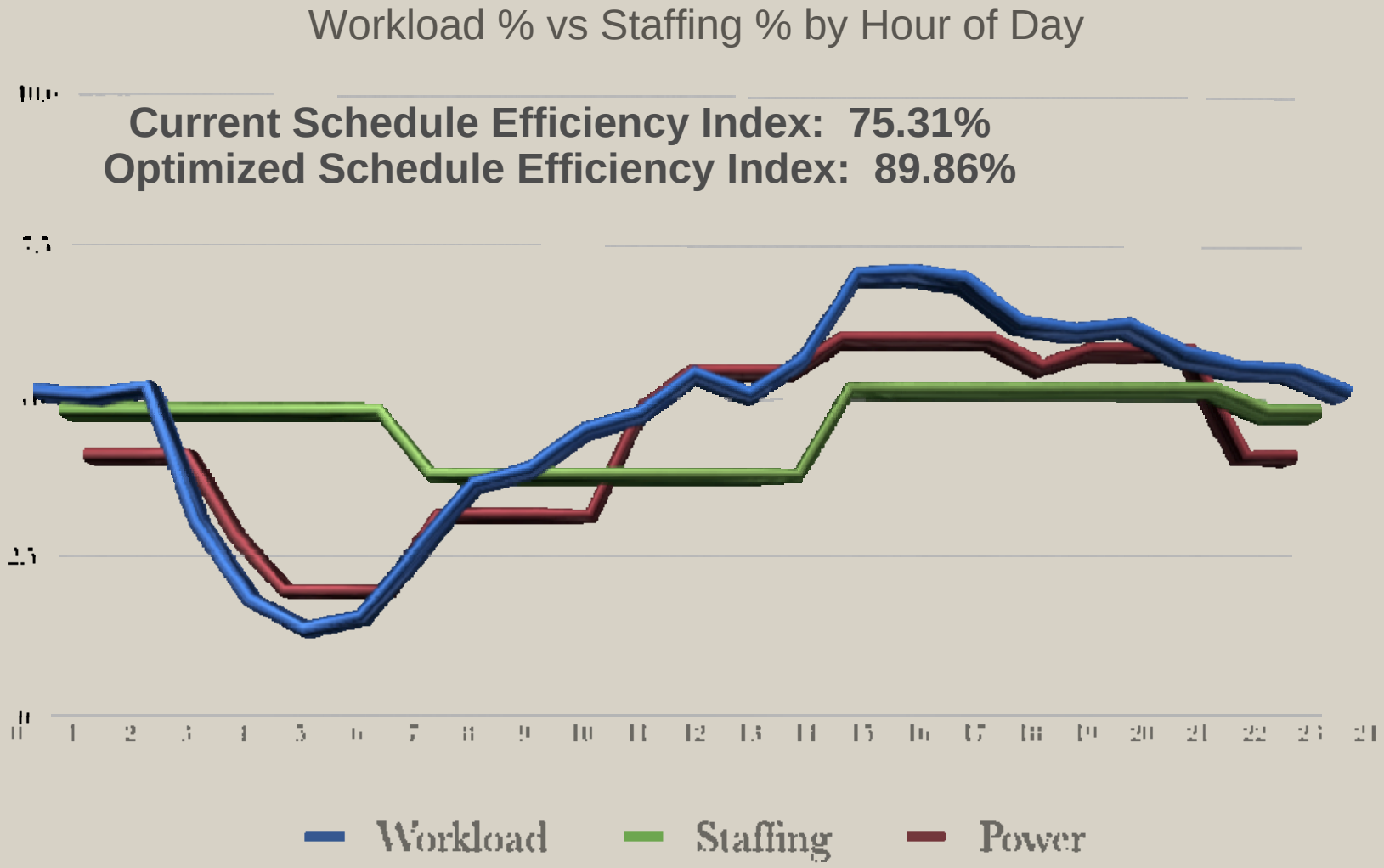
District 6: East



Current Efficiency Index: 63.42% **+18.52%**

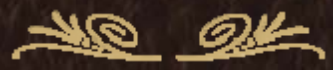
Optimized Efficiency Index: 81.94% **+25.39%**

2nd Optimized Efficiency Index: 88.81%



Current Schedule Efficiency

Recommendations



Data Collection

- Collection of Workload Data
  - Dispatch Policies - Collect all activities in the future
  - Officer Training - Heighten awareness of the need to document work
  - CAD Code Review - Ensure that all activities are included
  - Report Writing Times - Establish process for collection
  - “Priority Calls Only” Documentation
  - “Injury and Blockage Only” Documentation
  - Collection of Officer Availability Data – Continue

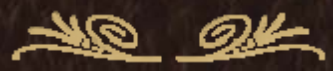
Patrol Staffing

- Reduce current M_R of 32.7 min/hr to within 28 - 30 min/hr. This change will require 13-25 additional officers in patrol.
- Increase the number of first line supervisors to ensure full coverage on each detail. This change will require 5 additional first line supervisors in patrol.

Patrol Deployment

- Based on the improved efficiencies that could be gained by the additional “Power shifts”, it is recommended that the second optimization plan be implemented at the next shift bid period.
- If equipment costs and supervisory costs become prohibitive, it is recommended that officers be redeployed based on the first schedule optimization plan.
- Consideration of two-officer units on selected details and sectors may relieve some economic burden on additional equipment needs.

Etico Solutions, Inc.



Macomb, IL
www.eticosolutions.com
217-641-3205