DEVELOPING A METHODOLOGY FOR NIGHT TIME SEAT BELT USAGE DATA COLLECTION

Vinod Vasudevan, Ph.D., P.E.
Associate Research Engineer & Program Manager
vinod.vasudevan@unlv.edu

Nirup Bandaru, M.S.E.
Graduate Research Assistant

Pushkin Kachroo, Ph.D., P.E.
Co-Director

Avinash Kaiparambil
Graduate Research Assistant

Transportation Research Center
University of Nevada, Las Vegas
4505 S. Maryland Parkway, Box 454007, Las Vegas, NV 89154-4007 USA
Tel.: (702) 895 1594; Fax: (702) 895 4401

Kaan Ozbay, Ph.D.
Professor, Department of Civil and Environmental Engineering,
Rutgers, The State University of New Jersey,
623 Bowser Road, Piscataway, NJ 08854 USA,
Tel: (732) 445-2792; Fax: (732) 445-0577

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Developing a Methodology for Night Time Seat Belt Usage Data Collection
Vinod Vasudevan¹, Nirup Bandaru², Pushkin Kachroo³, Avinash Kaiparambil⁴, Kaan Ozbay⁵

ABSTRACT
Estimating seat belt usage rates accurately is important in evaluating safety of an area. Traditionally, the seat belt usage is estimated based on day time usage rates. In recent years, importance of night time seat belt usage rate get attention and several states initiated efforts to evaluate night time usage rates. In the absence of guidelines, these states use data collection methodology similar to the one used for day time usages. Unlike in other places, in Las Vegas metropolitan area, night time seat belt usage data were observed for eight hour duration. These data showed that the seat belt usage vary by time of night. This suggests that following the current practices will not be sufficient for estimating night time seat belt usage. In this paper, a revised methodology for night time usage is developed. The revised methodology is different from the current practice. Based on the revised methodology, two sets of data collection per site is recommended. Duration of data collection vary depending on vehicle miles traveled.

INTRODUCTION
Seat belt usage is widely considered as one of the most important factors in reducing crash severity (1). Foss et al (2) showed that compared with drivers who were not intoxicated, legally intoxicated drivers were about a third less likely to be wearing a seat belt. Several literatures show an increasing trend in driving under influence during night. This is one of several factors which lead to the assumption that the usage rate at night is lower than the daytime usage rates. FARS states that the use of seat belts reduces the risk of fatal injury to front-seat passenger car occupants by 45 percent and the risk of moderate-to-critical injury by 50 percent (3). The use of seat belts has often been monitored in various study areas to express the effect of seatbelt usage on motor vehicle crashes. The National Occupant Protection Use Survey (NOPUS) (4) conducted by the NHTSA reports that the nationwide belt use exceeds 80 percent. It is important to note that all of the reported data are from daytime observations. Studies conducted in various states show that nighttime seat belt usage rates are lower than daytime usage. Nevada (5, 6) conducts several media and enforcement campaigns to improve seat belt usage rates. However, most of these are

¹ Transportation Research Center, University of Nevada, Las Vegas, 4505 S. Maryland Parkway, Las Vegas, NV 89154-4007, USA; Tel.: (702) 895-1393, Fax: (702) 895-4401, E-mail: vinod.vasudevan@unlv.edu
² Department of Electrical and Computer Engineering, University of Nevada, Las Vegas, 4505 S. Maryland Parkway, Las Vegas, NV 89154-4007, USA; Tel.: (702) 895-1393, Fax: (702) 895-4401, E-mail: bandarun@unlv.nevada.edu
³ Transportation Research Center, University of Nevada, Las Vegas, 4505 S. Maryland Parkway, Las Vegas, NV 89154-4007, USA; Tel.: (702) 895-4926, Fax: (702) 895-4401, E-mail: pushkin@unlv.edu
⁴ Transportation Research Center, University of Nevada, Las Vegas, 4505 S. Maryland Parkway, Las Vegas, NV 89154-4007, USA; Tel.: (702) 895-1393, Fax: (702) 895-4401, E-mail: kaiparambila@unlv.nevada.edu
⁵ Department of Civil & Environmental Engineering, Rutgers, The State University of New Jersey, 4505 S. Maryland Parkway, 623 Bowser Road, Piscataway, NJ 08854 USA; Tel.: Tel: (732) 445-2792; Fax: (732) 445-0577; E-mail: kaan@rci.rutgers.edu
evaluated only using day time seat belt usage observations. Vivoda et. al (7) state that the seat belt use among fatally injured front-seat passengers was less than 35 percent between the hours of 10:00 PM and 5:00 AM whereas belt use among fatality-injured passengers between 8:00 AM and 5:00 PM was about 55 percent in 2003. Chaudhary et. al (8) conducted a study to compare day and night time belt usage by means of night vision technology. The results from this study indicated that belt use during the day was 83.0 percent while belt use at night was 76.6 percent.

LITERATURE REVIEW
Four major studies were found with details of the observations illustrated from the states of Connecticut, Indiana, Pennsylvania, and New Mexico. Summary from each of these studies are provided below.

Connecticut
Connecticut’s night-time statewide seat belt survey was conducted for 100 sites and was conducted from 9:00 PM until 3:59 AM (8). Each site was observed for 45 minutes. Sophisticated night vision equipment was used for night-time observations when roadway lighting was insufficient to make the observations. To supplement this equipment, handheld infrared spotlights, visible only with the use of the night-vision goggles and not to the naked human eye, further illuminated the roadway, making vehicle occupants visible for belt observations even in total darkness. Night-time procedures were consistent with daytime procedures, with some changes. Because of the equipment, observations were done by a two-person team, with one person observing traffic and the other recording the results as stated by the observer.

Indiana
Indiana conducted night-time seat belt surveys at 113 sites for a period of 55 minutes each (7). A pair of observers was used to conduct the survey in each site. One person in each data collection team conducted observations, while the other entered data into the PDA. Night vision goggle and infrared spotlight was used to enhance the visibility during night times. The night-time survey was conducted between 9:30 PM and 5:45 AM Wherever possible (61 of 113 sites), direct day-to-night matching of sites was achieved (i.e., data was collected from a specific site the same night as when the daytime data collection occurred). For the sites where it was not possible to collect data the same night, the same day of week was matched from the first week (daytime collection) to the second week (night-time collection) whenever possible.

Pennsylvania
In Pennsylvania two cities, Reading and Bethlehem were selected for night-time seat belt surveys with 20 sites in each city (7). Reading served as the treatment site and Bethlehem (in North Hampton County) served as the comparison location. Observations (day and night) were conducted for 45 minutes at each site. Daytime observations occurred from 9:00 AM until 3:59 PM. Night observations took place from 9:00 PM until 3:59 AM. 20 sites in each city were selected for the survey. Military grade night vision equipment was used for night-time observation when lighting on the roadway was inadequate to make the observations. These near-military grade night vision goggles function in both light and dark conditions. Because of the equipment, night-time observations were done by a pair of observers, with one person observing
traffic (with the equipment) and the other recording verbalized results from the observer. Selection of observation sites were made from three functional classes of roadway: Principal Arterial Roadways, Minor Arterial Roadways and Urban Collectors.

**New Mexico**
The Annual Statewide Survey of Seat Belt Use is conducted by the New Mexico Department of Health during the month of June (9). 108 sites were selected which represents the State’s population demographics and roadway travel. Day time observations lasted 20 minutes each and were conducted between 7 a.m. and 7 p.m. whereas night-time observations occurred between 9:00 PM and 3:59 AM at the same locations as daytime observations and usually on the night following the day observation. Night-time observation periods lasted 45 minutes in order to sample a sufficient number of vehicles given the lower traffic volume at night. Observations at night were made by two observers.

Table 1 summarizes night time seat belt observational studies conducted. This shows that overall, the difference between daytime and nighttime usage rate does not show a notable difference, except for the Connecticut pre-campaign and Indiana post-campaign data. It is also important to note that none of these studies looked at the significance of time of data collection.

<INSERT TABLE 1 here>

**Summary of Literature Review**
Review of literature shows that collecting night-time seat belt usage rates is a challenging process. In the absence of a guideline from NHTSA or any other governing body, each of the states developed and followed its own process for data collection. Most of these states used similar data collection process as that of daytime data collection, collecting data for specific time periods at all the sites identified for the daytime observations. These data collection processes assumed that the seat belt usages do not vary with time of the night. That is, by collecting seat belt usage data for a site for a short duration, at any time of the night, overall estimates of night time usage rate for that site is estimated.

**LAS VEGAS NIGHT TIME SEAT BELT USAGE STUDY**
The Nevada Department of Public Safety-Office of Traffic Safety contracted UNLV Transportation Research Center to estimate night-time seat belt usage rates for the Las Vegas metropolitan area. This was determined by conducting seat belt usage observations during the months of December and January, 2008/09, at 6 locations across the Las Vegas metropolitan area (10).

**Site Selection**
In the absence of site selection criteria, daytime usage surveys are considered as the starting point for site selection. Nevada redesigned the entire survey methodology in 2007, to meet the Code of Federal Requirements (CFR) specified in 23 CFR Part 1340 (also known as Section 157 surveys). Based on the daytime seat belt usage survey methodology, Clark County houses 29 observation sites. Because of time constraints conducting observations at all of the 29 sites in Clark County was impossible. Efforts to acquire night vision equipments were failed because of military policy in acquiring equipments from their approved vendors. Due to unavailability of night vision equipments observation sites were limited to urban areas. Based on field visits, sites
with better lighting and those providing better views of the vehicle occupants were selected. Efforts were made to ensure that sites in various categories are selected and that they are well distributed within the Las Vegas metropolitan area. The final selected sites are:

1) I 15 and Blue Diamond Rd
2) Lake Mead Blvd and Jones Blvd
3) Pecos Rd and Sunset Rd
4) Spring Mountain Rd and Torrey Pines Dr
5) Washington Ave and Nellis Blvd
6) Wigwam Pkwy and Arroyo Grande Blvd

Figure 1 shows daytime seat belt usage observation sites and sites selected for nighttime seat belt usage observations in the Las Vegas metropolitan area.

Data Collection
The research team felt that it is important to study the seat belt usage pattern of each of the sites. Therefore night time observations were conducted for 8-hour duration from 8:30 PM – 4:30 AM. Additionally, daytime observations were made at these sites on the same day for comparison purposes.

Results of the Observations
The overall night-time seat belt usage rate (for 8-hour time periods for all the six sites), without considering weighted average is 81.3 for all occupants (drivers 80.4 percent and passengers 84.9 percent). These usage rates are about 10 percent value lower than the daytime average usage rates. Figures 2 and 3 show the usage rate distributions of drivers and all occupants for each of the 6 sites. From these figures, it is clear that the usage rate vary considerably over time of night.

OBJECTIVE
Results from night seat belt usage observations shows that the usage rate varies by time of the night. This means that based on time of the night the data were collected at a particular site, the observed data would vary significantly. None of the existing documents addressed these concerns. The objective of this study is to develop a methodology for night time data collection using data collected from Las Vegas metropolitan area in Nevada.

METHODOLOGY
Overall methodology for developing guideline could be divided into two steps: determining data collection frequency and estimating data collection duration each time. Each of these steps is discussed in the following sections.

Determining Data Collection Frequency
In order to determine seat belt usage data collection frequency, Discrete Fourier Transform (DFT) is used. During this analysis, it is assumed that a continuous time domain signal sampled at Nyquist rate results in discrete time domain data. Nyquist rate is the minimum frequency at which the signal is sampled in order to reconstruct the original signal without any loss of information. This is extremely important for night time seat belt usage rate since figures 2 and 3
showed variations of seat belt usage rates over time of the night. The purpose of this step is to help identify the minimum data collection frequency that is required to reconstruct the original usage rates for all time periods. If the highest frequency \( F \) in the original signal is known, the Nyquist–Shannon sampling theorem gives the lower bound on the sampling frequency for signal to be restored. The lower bound to the sampling frequency, \( 2F \), is called the Nyquist rate.

DFT is the most used method to analyze the frequencies contained in sampled data, to solve partial differential equations, and to perform other operations such as convolutions. In practice Fast Fourier Transform (FFT) algorithm is used to compute DFT efficiently. As the sampled data is discrete and finite in time domain, in this study, we used Discrete Fourier Transform (DFT) to transform time domain function to a frequency domain.

The discrete Fourier series representation of a periodic sequence \( x[n] \) with fundamental period \( N \) is given by:

\[
x[n] = \sum_{k=0}^{N-1} C_k e^{j\Omega_0 n}
\]  

(1)

\[
\Omega_0 = \frac{2\pi}{N}
\]  

(2)

Where \( C_k \) are the Fourier coefficients and are given by

\[
C_k = \frac{1}{N} \sum_{n=0}^{N-1} x[n] e^{-j\Omega_0 n}
\]  

(3)

**DFT Analysis**

The night time seat belt usage data collection period is divided in 16 periods, each period of 30 minutes (from 8:30 PM to 4:30 AM). This means that the number of data points in the sampled data \( x[n] \) is constant i.e., \( N = 16 \). \( N \) values of 1, 2, 3, ..., and 16 represents the time 8:30 -9:00 PM, 9:00 – 9:30 PM, 9:30 -10:00 PM, ..., and 4:00 – 4:30 AM respectively. Therefore, 16 - point FFT is used to determine the frequency spectrum of the signal. The frequency spectrum gives the magnitude of each Fourier coefficients as a function of frequency \( f \).

The total energy of the spectrum is computed by the equation:

\[
E = \sum_{i=0}^{N-1} |C_i|^2
\]  

(4)

Where \( C_i \) is the energy corresponding to the \( i^{th} \) point and \( E \) is the total energy in arbitrary units.

In order to determine the frequency of data collection for a site, night time seat belt usage data from that particular site is used. Magnitude of Fourier coefficients are estimated for each of the data points. For each of the frequency diagrams there will a data point with peak magnitude. This peak magnitude data point is called the \( dc \) component. The corresponding energy at ‘\( dc \)’ component is represented as \( E(dc) \). Once the \( dc \) component is identified, the next step is to estimate proportion of the energy contained in the \( dc \) component to the total energy is given by:

\[
\text{Proportion of } E \text{ at } dc = \frac{E_{dc}}{E}
\]  

(5)
Where $E_{dc} = |C_0|^2$

The proportion of the energy contained in the DC component along with the combined energy of the points equidistant from the DC component to the total energy is determined by:

$$\text{Proportion of } E \text{ at } dc \text{ including two points equidistant} = \frac{E_1}{E} \quad (6)$$

Where, 

$$E_1 = \sum_{k=0}^{k+1} |C_k|^2$$

For better analysis of the sample data, the original signal can be divided into two halves and their corresponding DFT’s (8-point FFT) can be determined using the same steps that is used for 16-point FFT.

**Results of DFT**

In order to explain the process illustrated in the previous steps, night time seat belt usage data from Site 1 is used. Figure 4 shows the frequency spectrum for Site 1 (for 16-point DFT). Figure 4 shows that DFT of discrete time bound signal is symmetric. Figure 4 also shows that the peak magnitude is at $N = 9$, which corresponds to the period 12:30 – 1:00 AM, i.e., $dc$ component and the spectrum is symmetric around this point.

The total energy of the spectrum was calculated using the equations (5) and (6). Upon calculating the percentage share of $dc$ component’s energy to the total energy ($E$), and the percentage share of $E_1$’s energy to the total energy ($E$), it is evident that the most of the signal’s energy is due to $dc$ component. The same process is repeated for all six sites. Table 2 shows the summary of these calculations for both drivers and all occupants. This shows that for each of the sites the peak magnitude is obtained at data point ($dc$ point) corresponding to 12:30 PM – 1:00 AM.

In order to gain more in-depth analysis of the signal’s behavior with respect to frequency, the sample data was divided into two halves with $N_1$ and $N_2$ being the number of data points respectively (both equal to 8). Here $N_1$ and $N_2$ represent time periods from 8:30 PM – 12:30 AM and 12:30 AM – 4:30 AM respectively. Figures 5 and 6 show corresponding DFT’s spectrum plots of $N_1$ and $N_2$ series respectively for Site 1. These show that peak magnitude is at $N_1 = N_2 = 5$, which corresponds to 10:30 PM – 11:00 PM for $N_1$ and 2:30 AM – 3:00 AM for $N_2$. Similar analyses are conducted for this revised for all six sites independently and the results are tabulated in Table 3. This shows that at each of the sites, peak magnitude is at data point 5 for both $N_1$ and $N_2$. This means that in order to capture night time seat belt usages with confidence, two sets of data collection is recommended. One time between period between 8:30 PM and 12:30 AM and the other one between 12:30 AM and 4:30 AM. Duration of data collection is estimated in the next step.
Selecting Data Collection Duration

Previous section illustrated that in order to capture night time usage pattern, observations need to be conducted in two time periods. The next step is to estimate minimum duration of each of these data collection efforts to ensure that a statistically significant sample is collected.

Traffic follows Poisson distribution \( (11) \). Therefore, Poisson distribution is used to estimate minimum duration of data collection for each of the time periods.

Poisson distribution is defined as:

\[
f(n; \lambda) = \frac{\lambda^n e^{-\lambda}}{n!}
\]

for \( n = 0, 1, 2, \ldots \).

Cumulative probability distribution is given by:

\[
F(n; \lambda) = \sum_{k=0}^{n} f(k; \lambda)
\]

Let \( \omega \) be the basic time interval considered, \( \lambda_0 \) be the number of vehicles pass during \( \omega \) time, \( \theta \) be the minimum number of observations required, and \( P \) be the probability of having \( \theta \) number of observations. Now, given \( \lambda_0, \omega, \theta, \) and \( P \), and taking \( \lambda = n\lambda_0 \), we have

\[
\Delta T = \omega n,
\]

where \( n = \min\{\eta \in \mathbb{N}\} \) such that \( F(\theta, n\lambda_0) > P \). Here, \( F(\cdot, \cdot) \) is the cumulative Poisson distribution function and \( \mathbb{N} \) is the set of natural numbers.

In this study, assume value of \( \omega \) as 5 minutes and corresponding \( \lambda_0 \) is estimated from vehicle miles travelled (VMT) data. It varies from site to site. In Nevada, VMT data is published by Nevada Department of Transportation \((12)\). Table 4 shows hourly traffic volume, and \( \lambda_0 \). For the central limit theorem to take effect during post data process of data, a minimum of \( \theta = 30 \) observations are required. Assuming that in this study to have a probability of at least 80 percent to have \( \theta \) observations, values of \( n \) and \( \Delta T \) are calculated using steps illustrated previously. The results are shown in Table 5 along with corresponding values of \( P \).

\[<\text{INSERT TABLE 4 here}>\]

\[<\text{INSERT TABLE 5 here}>\]

Table 5 shows that observation duration at each site varies from time period. For each of the sites, duration to observe at least 30 vehicles is estimated. Duration also depends on the traffic volume. Comparing values from Tables 4 and 5 show that, as expected, the sites with higher traffic volume require lesser time duration to collect minimum sample size.

SUMMARY OF FINDINGS

Values from tables 2 and 3 show, based on night time observations from Las Vegas metropolitan area, that two sets of data collection would be sufficient to represent the entire seat belt usage distribution of night time for these sites. It is interesting to note that for all the three cases of \( N \), \( N_1 \), and \( N_2 \) all the sites showed the same data collection period. Table 5 shows that for most sites, the data collection duration for early half of night time period is much shorter than that required during the second half of later night. For example, at site 1 a 5 minute duration observation from 10:30 – 11:00 PM would collect representative sample for early part of night and a 15 minute
interval during the period 2:30 -3:00 AM would collect representative sample for later part of night. When duration is over 30 minute, the remaining duration should be made as close to that time period as possible.

CONCLUSIONS AND DISCUSSIONS
The objective of this study was to develop a methodology to collect night time seat belt usage data. Using the night time usage data collected from Las Vegas metropolitan area, analyses shows that the usage varies depending on time of night. Following the current practices would not collect representative sample of data for representing night time usage rates for each site. This paper illustrates a revised methodology for conducting night time seat belt usage observational studies. The revised method shows that, based on data collected in Las Vegas metropolitan area, at each site, sample needs to be collected between 10:30 PM – 11:30 PM and 2:30 AM – 3:00 AM respectively. Time duration of data collection varies from each other based on traffic volume. These results are based on night time observed usage rates from the Las Vegas metropolitan area. However, the methodology illustrated in this paper could be used to determine design data collection efforts for any sites. Similarly, this revised methodology is recommended to perform a similar analysis for collecting day time usage studies as well.

ACKNOWLEDGMENTS
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DISCLAIMER
The material for this paper is based on a study that benefited from funding provided by the NV-OTS. The opinions, findings, conclusions or recommendations expressed in the paper are those of the authors and do not necessarily reflect the views of University of Nevada, Las Vegas or Nevada OTS.
FIGURE 1: Seat belt Observation Sites
A. Site 1: I-15 and Blue Diamond Rd

B. Site 2: Lake Mead Blvd/Jones Blvd

C. Site 3: Pecos Rd/ Sunset Rd

D. Site 4: Spring Mountain Rd/Torrey Pines Dr

E. Site 5: Washington Ave /Nellis Blvd

F. Site 6: Wigwam Pkwy/Arroyo Grande Blvd

FIGURE 2: Night time seat belt usage of Drivers
FIGURE 3: Night Time Seat Belt Usage of All Occupants
FIGURE 4: N-point DFT of % Seat Belt Usage for Site 1

FIGURE 5: N₁-point DFT of % Seat Belt Usage for Site 1
FIGURE 6: N₂-point DFT of % Seat Belt Usage for Site 1

TABLE 1: Summary of reported night time seat belt usage studies

<table>
<thead>
<tr>
<th>Item</th>
<th>Connecticut</th>
<th>Indiana</th>
<th>Pennsylvania</th>
<th>New Mexico</th>
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</thead>
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<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Observation period</td>
<td>May-04</td>
<td>Apr-06</td>
<td>Jun-06</td>
<td>Aug-04</td>
</tr>
<tr>
<td>Number of sites</td>
<td>17</td>
<td>100</td>
<td>113</td>
<td>113</td>
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<tr>
<td>Number of observations</td>
<td>872</td>
<td>9,075</td>
<td>3,896</td>
<td>5,003</td>
</tr>
<tr>
<td>Observation time per site</td>
<td>45 min</td>
<td>45 min</td>
<td>55 min</td>
<td>55 min</td>
</tr>
<tr>
<td>Night vision equipment used</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Day time seat belt usage (%)</td>
<td>78.7%</td>
<td>80.6%</td>
<td>79.7%</td>
<td>84.3%</td>
</tr>
<tr>
<td>Night time seat belt usage (%)</td>
<td>66.5%</td>
<td>73.6%</td>
<td>79.0%</td>
<td>74.0%</td>
</tr>
<tr>
<td>Difference</td>
<td>12.2%</td>
<td>7.0%</td>
<td>0.7%</td>
<td>10.3%</td>
</tr>
</tbody>
</table>
### TABLE 2: $E_{dc}/E$ and $E_{1}/E$ Values of $dc$ for all Sites for $N$ Data Points

<table>
<thead>
<tr>
<th>Site #</th>
<th>Location</th>
<th>$dc$</th>
<th>$E_{dc}/E$</th>
<th>$E_{1}/E$</th>
<th>$E_{dc}/E$</th>
<th>$E_{1}/E$</th>
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<tr>
<td></td>
<td></td>
<td>12:30 AM - 1:00 AM</td>
<td>97.22</td>
<td>99.32</td>
<td>97.31</td>
<td>99.34</td>
</tr>
<tr>
<td>1</td>
<td>I-15/Blue Diamond Rd</td>
<td>12:30 AM - 1:00 AM</td>
<td>94.98</td>
<td>98.23</td>
<td>94.29</td>
<td>98.22</td>
</tr>
<tr>
<td>2</td>
<td>Lake Mead Blvd/Jones Blvd</td>
<td>12:30 AM - 1:00 AM</td>
<td>95.79</td>
<td>95.94</td>
<td>95.59</td>
<td>95.86</td>
</tr>
<tr>
<td>3</td>
<td>Pecos Rd/Sunset Rd</td>
<td>12:30 AM - 1:00 AM</td>
<td>99.34</td>
<td>99.39</td>
<td>99.47</td>
<td>99.51</td>
</tr>
<tr>
<td>4</td>
<td>Spring Mtn Rd/Torrey Pines Dr</td>
<td>12:30 AM - 1:00 AM</td>
<td>98.48</td>
<td>99.46</td>
<td>98.04</td>
<td>99.29</td>
</tr>
<tr>
<td>5</td>
<td>Washington Ave/Nellis Blvd</td>
<td>12:30 AM - 1:00 AM</td>
<td>96.71</td>
<td>98.95</td>
<td>96.74</td>
<td>98.74</td>
</tr>
<tr>
<td>6</td>
<td>Wigwam Pkwy/Arroyo Grande Blvd</td>
<td>12:30 AM - 1:00 AM</td>
<td></td>
<td></td>
<td></td>
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</table>

### TABLE 3: $E_{dc}/E$ and $E_{1}/E$ Values of $dc$ for all Sites for $N_1$ and $N_2$ Data Points

<table>
<thead>
<tr>
<th>Site #</th>
<th>Location</th>
<th>$E_{dc}/E$</th>
<th>$E_{1}/E$</th>
<th>$E_{dc}/E$</th>
<th>$E_{1}/E$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>10:30 - 11:00 AM</td>
<td>99.92</td>
<td>99.92</td>
<td>99.92</td>
</tr>
<tr>
<td>1</td>
<td>I-15/Blue Diamond Rd</td>
<td>12:30 AM - 1:00 AM</td>
<td>98.44</td>
<td>99.06</td>
<td>99.06</td>
</tr>
<tr>
<td>2</td>
<td>Lake Mead Blvd/Jones Blvd</td>
<td>10:30 - 11:00 AM</td>
<td>95.22</td>
<td>97.51</td>
<td>95.22</td>
</tr>
<tr>
<td>3</td>
<td>Pecos Rd/Sunset Rd</td>
<td>10:30 - 11:00 AM</td>
<td>94.89</td>
<td>95.55</td>
<td>94.89</td>
</tr>
<tr>
<td>4</td>
<td>Spring Mtn Rd/Torrey Pines Dr</td>
<td>10:30 - 11:00 AM</td>
<td>99.8</td>
<td>99.2</td>
<td>99.8</td>
</tr>
<tr>
<td>5</td>
<td>Washington Ave/Nellis Blvd</td>
<td>10:30 - 11:00 AM</td>
<td>98.38</td>
<td>98.76</td>
<td>98.38</td>
</tr>
<tr>
<td>6</td>
<td>Wigwam Pkwy/Arroyo Grande Blvd</td>
<td>10:30 - 11:00 AM</td>
<td>97.97</td>
<td>98.53</td>
<td>97.97</td>
</tr>
</tbody>
</table>
## TABLE 4: Average Hourly Traffic Volume and $\lambda_0$ Values

<table>
<thead>
<tr>
<th>Site #</th>
<th>Site Description</th>
<th>Average Hourly Traffic Volume</th>
<th>$\lambda_0$ Value (5 min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>8:00 PM - 9:00 PM</td>
<td>9:00 PM - 10:00 PM</td>
</tr>
<tr>
<td>1</td>
<td>I 15 and Blue Diamond Rd</td>
<td>897</td>
<td>797</td>
</tr>
<tr>
<td>2</td>
<td>Lake Mead Blvd and Jones Blvd</td>
<td>706</td>
<td>567</td>
</tr>
<tr>
<td>3</td>
<td>Pecos Rd and Sunset Rd</td>
<td>813</td>
<td>626</td>
</tr>
<tr>
<td>4</td>
<td>Spring Mountain Rd and Torrey Pines Dr</td>
<td>1,027</td>
<td>806</td>
</tr>
<tr>
<td>5</td>
<td>Washington Ave and Nellis Blvd</td>
<td>1,613</td>
<td>1,383</td>
</tr>
<tr>
<td>6</td>
<td>Wigwam Pkwy and Arroyo Grande Blvd</td>
<td>558</td>
<td>364</td>
</tr>
</tbody>
</table>

1. Vasudevan, Bandaru, Kachroo, Kaiparambil, & Ozbay
TABLE 5: Values of $n$, $\Delta T$, and $P$

<table>
<thead>
<tr>
<th>Site #</th>
<th>Site Description</th>
<th>8:30 PM - 12:30 AM</th>
<th>12:30 AM - 4:30 AM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$n$</td>
<td>$\Delta T$ (min.)</td>
</tr>
<tr>
<td>1</td>
<td>I 15 and Blue Diamond Rd</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Lake Mead Blvd and Jones Blvd</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>Pecos Rd and Sunset Rd</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>Spring Mountain Rd and Torrey Pines Dr</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>Washington Ave and Nellis Blvd</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>Wigwam Pkwy and Arroyo Grande Blvd</td>
<td>3</td>
<td>15</td>
</tr>
</tbody>
</table>

REFERENCES


