RESULTS
The equivalent continuous noise levels \( (L_{eq}) \) in dBA were measured at Marredpally – a residential area; Trimulgherry – commercial & residential (mixed); Begumpet – commercial area and Jeedimetla – an industrial area in Hyderabad Telangana state, India. For this study, noise levels and vehicular count were measured at different zones are taken diurnal (6:00 - 5:00 hrs) sixty measurements were made for every hour duration (i.e. at one minute interval) for each month thrice at three different locations for a period of one year (November 2010- October 2011). The monthly averaged data is further classified into different Quarters and characterized into the following seasonal variations.

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Dates</th>
<th>Season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarter-1</td>
<td>November 2010 - February 2011</td>
<td>Winter</td>
</tr>
<tr>
<td>Quarter-2</td>
<td>March 2011 - June 2011</td>
<td>Summer</td>
</tr>
<tr>
<td>Quarter-3</td>
<td>July 2011 - October 2011</td>
<td>Rainy</td>
</tr>
<tr>
<td>Annual</td>
<td>November 2010 – October 2011</td>
<td></td>
</tr>
</tbody>
</table>

Noise descriptors are commonly used to predict sound pressure levels from various environmental noise sources. They are represented as \( L_{min} \), \( L_{max} \), \( L_{eq} \), \( L_{10} \), \( L_{50} \) and \( L_{90} \). Noise parameters i.e. TNI (Traffic Noise Index), NC (Noise Climate), \( L_{np} \) (Noise Pollution Level), day and night variations were computed to assess annoyance in the study area. Vehicular count of two wheelers, three wheelers, four wheelers and heavy vehicles at each study location is taken into consideration to calculate correlation coefficient analysis between vehicles and observed \( L_{eq} \). Calixto model is used to predict calculated \( L_{eq} \) and a regression equation is plotted between observed and calculated \( L_{eq} \) at each study location.

4.1 MARREDPALLY

4.1.1 \( L_{eq} \) Noise Levels in dB (A) at Study Location(s) of Marredpally

The study locations of Marredpally, a residential area, where the average noise levels \( L_{eq} \) were measured diurnal (6:00 - 5:00 hrs) from November 2010 to October 2011 is shown in Table 4.1.1. The monthly \( L_{eq} \) values recorded a maximum value of 81.4 dBA during morning from 9:00 – 10:00 hrs in the month of October and minimum of 49.6
dB (A) during early morning from 3:00 - 4:00 hrs in December 2010. The 24 hours average noise level recorded a minimum of 64.1 ± 5.9 dB (A) in the month of November 2010 and to a maximum of 68.5 ± 7.5 dB (A) in October 2011. The annual average noise level is recorded as 66.3 ± 6.7 dB (A). The analysis of variance (ANOVA) revealed that non-significant variation is existed between the mean average of data in different months ($p<0.05$).

4.1.2 Noise levels $L_{eq}$ during Different Quarters in dB (A) at Study Location(s) of Marredpally

The noise data measured in Marredpally as shown in Plate 1 was complied quarterly and the data is presented in Table 4.1.2 and Figure 4.1.1. The average noise levels in $L_{eq}$ for 24 hrs recorded a minimum of 40.5 dB (A) in quarter-1, 41.3 dB (A) in quarter-3 and 42 dB (A) in quarter-2 during early morning from 3:00 - 4:00 hrs for all the months. The maximum $L_{eq}$ recorded in quarter-1 (82.7 dB (A)) followed by 85.3 dB (A) in quarter-2 and 89.2 dB (A) in quarter-3 between 9:00 - 10:00 hrs for all months.

The quarterly diurnal $L_{eq}$ (24hrs) showed a minimum value of 50.7 dB (A) during early morning from 3:00-4:00 hrs in quarter-1 followed by 53 dB (A) and 53.1 dB (A) in quarter-2 and 3 respectively. The maximum diurnal $L_{eq}$ was recorded in quarter 3 (80.5 dB (A)) followed by 76.7 dB (A) and 73.7 dB (A) in quarter-2 and 1 respectively during morning hours between 9:00-10:00 hrs.

The mean value of $L_{eq}$ for quarter-1 is 64.6 ± 6.5, 66.6 ± 6.6 and 67.8 ± 7.1 dB (A) for quarter-2 and 3 respectively. The percentage mean variation among the quarters is only 10 %. The differences between the noise levels in different quarter periods were found to be statistically insignificant ($p<0.05$). While the allowed limit value of 55 dB (A) for residential area was exceeded 91.8 % in quarter-3, 91.6 % in quarter-2 and 87.4 % in quarter-1 respectively. All the values in Marredpally are above the permissible limits and the percentage mean variation classification of noise levels ($L_{eq}$) for different quarters and annual for study location of Marredpally is given below
<table>
<thead>
<tr>
<th>Noise Range( L_{eq} )</th>
<th>Quarter-1</th>
<th>Quarter-2</th>
<th>Quarter-3</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;50</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>50-54</td>
<td>12.5</td>
<td>8.3</td>
<td>8.3</td>
<td>8.3</td>
</tr>
<tr>
<td>55-59</td>
<td>8.3</td>
<td>0.0</td>
<td>0.0</td>
<td>8.3</td>
</tr>
<tr>
<td>60-64</td>
<td>20.8</td>
<td>33.3</td>
<td>25.0</td>
<td>25.0</td>
</tr>
<tr>
<td>65-69</td>
<td>37.5</td>
<td>25.0</td>
<td>29.2</td>
<td>25.0</td>
</tr>
<tr>
<td>70-74</td>
<td>20.8</td>
<td>25.0</td>
<td>16.7</td>
<td>25.0</td>
</tr>
<tr>
<td>75-79</td>
<td>0.0</td>
<td>8.3</td>
<td>16.7</td>
<td>8.3</td>
</tr>
<tr>
<td>&gt;80</td>
<td></td>
<td></td>
<td></td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

From the table above, we can classify the various noise levels in dB (A) into different categories based upon human health factors, with \(<55\) dB (A) at residential areas is the permissible limit which is less harmful when \(>80\) dB (A), it is considered as high risk. In the present study in all quarters the noise is above permissible limit and especially in Quarter-3 the noise is reaching to high risk compared to moderate risk at other two quarters.

4.1.3 Noise Indices \( L_{10}, L_{50} \) and \( L_{90} \) at Study Location(s) of Marredpally

The average values of all Indices such as \( L_{10}, L_{50} \) and \( L_{90} \) were studied for 24 hrs at the residential area of Marredpally is shown in Figure 4.1.2. The average \( L_{10} \) values for 24 hrs showed maximum value of 71.1 dB (A) during quarter-3 followed by 69.7dB (A) during quarter-2 and a minimum value of 67.8 dB (A) during quarter-1 and annual average of 69.5 dB (A).

The \( L_{50} \) values for 24 hrs show the same trend with minimum during quarter-1 and a maximum during quarter-3 recorded a value of 61.5 dB (A) and 64.6 dB (A) respectively and an annual average of 63.1 dB (A).
In case of background noise $L_{90}$ values for 24 hrs shows that both quarter-2 and quarter-3 have values of 56.5 dB (A) and 56.4 dB (A) respectively and a minimum of 55.6 dB (A) was seen during quarter-1 and the annual average of 56.2 dB (A).

4.1.4 Noise Parameters TNI, NC and $L_{np}$ at Study Location(s) of Marredpally

The different noise parameters such as TNI, NC and $L_{np}$ at the study location of Marredpally is shown in Figure 4.1.3. Traffic Noise Index (TNI) is a parameter which indicates the degree of variation in a traffic flow expressed in dB (A) and depends upon the different noise Indices. The TNI values were computed to estimate the annoyance response due to traffic noise and the Value of TNI over 74 dB (A) is defined as the threshold of over criterion. The average TNI showed a minimum value of 74.3 dB (A) during quarter-1 and maximum of 85.1 dB (A) during quarter-3 while the quarter-2 showed a value of 79.3 dB (A) and annual average showed a value of 79.6 dB (A).

The Noise Climate (NC) provides the range over which the sound levels fluctuate in an interval of time and expressed in dB(A) which also depends upon noise indices. The average NC varied between 12.2-14.7 dB (A) during quarter-1 and quarter-3 respectively while the quarter-2 showed a value of 13.2 dB (A) and annual average showed a value of 13.4 dB (A).

The Noise Pollution Level ($L_{np}$) has a threshold value of 72 dB (A) (Scholes and Sargent, 1971). The average $L_{np}$ showed a minimum value of 76.1 dB (A) during quarter-1 and maximum of 82.9 dB (A) during quarter-3 while quarter-2 and annual average showed a value of 79.4 dB (A) and 79.5 dB (A) respectively. From the study it is clear that both TNI and $L_{np}$ showed higher values when compared to the threshold values.

4.1.5 Day and Night Noise Level Variations at Study Location(s) of Marredpally

The noise levels during day time (6:00 – 22:00 hrs) more residential activity and vehicular flow is seen during day time compared to night time (22:00 – 6:00 hrs) in residential area of Marredpally.
4.1.5.1 Analysis of noise levels during day time

The day time (6:00 – 22:00 hrs) observed more residential and urban activity and vehicular flow compared to night time (22:00 – 6:00 hrs). The average day time variations of L\textsubscript{eq} for the residential area of Marredpally showed a maximum value of 71.0 dB (A) and all the other indices were almost high during the quarter-3 (July - Oct 2011). These higher values are due to increase in vehicular flow and a minimum value of 68.1 dB (A) during quarter-1 (Nov-10 - Feb-11), whereas the annual average L\textsubscript{eq} value of 69.7 dB (A) and the other indices were also high values as shown in Figure 4.1.4 which is exceeding the permissible range during the day time of 55 dB (A) as given by CPCB India 2000.

4.1.5.2 Analysis of noise levels during night time

The average night time variations of L\textsubscript{eq} for the residential area of Marredpally showed a minimum value of 57.5 dB (A) during quarter-1(Nov-10 - Feb-11) due to cold weather conditions in Hyderabad city during the night time whereas during quarter-2 (March - Jun2011), the value is 60.2 dB (A) and during quarter-3 (July - Oct 2011) also showed a high of 61.5 dB (A) and the annual average value of 59.7 dB (A) and other indices as shown in Figure 4.1.5 which is exceeding the permissible range of 45 dB (A) during night time as given by CPCB India, 2000. The analysis of variance (ANOVA) analysis revealed that non-significant variation (\(\rho<0.05\)).

4.1.6 Quarterly and Annual Average Noise Levels at Study Location(s) of Marredpally during Morning and Evening Peak Hours

The Table 4.1.3 shows the morning and evening peak hours for the residential area of Marredpally. The average values of L\textsubscript{eq} showed a maximum value of 76.4 dB (A) during morning (8:00 - 11:00) hrs and 77.2 dB (A) during evening (17:00 - 20:00) hrs during peak hours for quarter-3 and quarter-1 showed a minimum value of 71.7 dB (A) for both morning and evening peak hours and other indices such as L\textsubscript{10}, L\textsubscript{50} and L\textsubscript{90} the other parameters TNI, NC and L\textsubscript{np} for all quarters and annual also showed higher values. This high values are due to fact that more number of vehicles all types plying during the peak hours of morning and evening resulting increase traffic noise.
4.1.7 Total Vehicle Composition

The Figure 4.1.6 shows the total vehicle density of 2 wheelers, 3 wheelers, 4 wheelers light vehicle and heavy vehicle for different quarters and annual for the residential area of Marredpally. It is clearly evident that the 2 wheelers are predominant in this area and 3 wheeler and 4 wheelers light vehicles are of almost equally distributed and 4 wheeler heavy vehicle count is less due to fact that it is a residential area.

4.1.8 Vehicle Type vs L\textsubscript{eq}

Table 4.1.4 shows the annual total sum of 2 wheelers and 3 wheelers, 4 wheeler light vehicle and heavy vehicle count were plotted with the observed L\textsubscript{eq} and regression equations were found using linear regression for the residential area of Marredpally. The regression coefficients (R\textsuperscript{2}) were found to be very good and showed a high significant correlation between the different types of vehicle with L\textsubscript{eq} is shown in Figure 4.1.7(a-d) and good value of “r” is also shown. From this we can conclude that the L\textsubscript{eq} depends more on heavy vehicles as they produce more sound compared to other vehicles and also other hand the two wheelers and three wheelers are equally responsible in the increase in L\textsubscript{eq} especially in the residential area of Marredpally.

4.2 TRIMULGHERRY

4.2.1 L\textsubscript{eq} Noise Levels in dB (A) at Study Location(s) of Trimulgherry

The study location of Trimulgherry, a commercial and residential (mixed) area, where the average noise levels L\textsubscript{eq} were measured diurnal (6:00 - 5:00 hrs) from November 2010 to October 2011 is shown in Table 4.2.1. The monthly L\textsubscript{eq} values recorded a maximum value of 86.1 dB (A) during evening from 18:00 - 19:00 hrs in July and minimum of 53.8 dB (A) during early morning from 3:00 - 4:00 hrs in December 2010. The 24 hours average noise levels showed a minimum value of 70.6 ± 9.0 dB (A) recorded in the month of December 2010 to a maximum value of 74.0 ± 9.3 dB (A) during October. The annual average noise level is 72.4 ± 8.5 dB (A). The analysis of variance (ANOVA) analysis revealed that non-significant variation is existing between the mean average of data in different months (p<0.05).
4.2.2 Noise levels $L_{eq}$ during Different Quarters in dB (A) at Study Location(s) of Trimulgherry

The noise data was measured in Trimulgherry as shown in plate 2 was compiled for all quarters and the data is presented in Table 4.2.2 and Figure 4.2.1. The average noise levels in $L_{eq}$ for 24 hrs recorded a minimum of 43.0 dB (A) in quarter-1, 46.5 dB (A) in quarter-2 and 47.8 dB (A) in quarter-3 during early morning from 3:00 - 4:00 hrs in all the months. The maximum $L_{eq}$ recorded in quarter-1 (93 dB (A)) followed by 95.8 dB (A) in quarter-2 and 100.4 dB (A) in quarter-3 between 10:00 - 11:00 hrs for all months.

The quarterly diurnal $L_{eq}$ (24hrs) showed a minimum value of 55.6 dB (A) during early morning from 3:00 - 4:00 hrs in quarter-1 followed by 59.3 dB (A) and 59.6 dB (A) in quarter-2 and 3 respectively. The maximum diurnal $L_{eq}$ was recorded in quarter- 3 (85.6 dB (A)) followed by 84.4 and 82.2 dB (A) in quarter-2 and 1 respectively during evening hours between 18:00-19:00 hrs.

The mean value of $L_{eq}$ for quarter-1 is $71.0 \pm 8.5$, $72.7 \pm 8.3$ and $73.6 \pm 8.9$ dB (A) for quarter-2 and 3 respectively. The percentage mean variation among the quarters is only 11%. The differences between the noise levels in different quarter periods were found to be statistically insignificant (P<0.05). While the allowed limit value of 60 dB (A) for mixed area was exceeded 95.7 % in quarter-3, 95.3 % in quarter-2 and 91.7 % in quarter-1 respectively. All the values in Trimulgherry are above the permissible limits and the percentage mean variation classification of noise levels ($L_{eq}$) for different quarters and annual for study location of Trimulgherry is given below:
### 4.2.3 Noise Indices $L_{10}$, $L_{50}$ and $L_{90}$ at Study Location(s) of Trimulgherry

The average values of all Indices such as $L_{10}$, $L_{50}$ and $L_{90}$ were studied for 24 hrs at Trimulgherry is shown in Figure 4.2.2. The average $L_{10}$ values for 24 hrs showed maximum of 77.4 dB (A) during quarter-3 followed by 76.2 dB (A) during quarter-2 (March- Jun2011) and a minimum of 74.5 dB (A) during quarter-1 and an annual of 76.0 dB (A).

The $L_{50}$ values for 24 hrs shows the same trend with minimum during quarter-1 and a maximum during quarter-3 showing a value of 68.4 dB (A) and 70.9 dB (A) respectively and whereas the annual average shows a value of 69.8 dB (A).

In case of the $L_{90}$ values for 24 hrs shows that both quarter-2 and quarter-3 have values of 63.1 dB (A) and 64.2 dB (A) respectively and a minimum of 61.5 dB (A) was seen during quarter-1 and an annual average of 62.9 dB (A).

### 4.2.4 Noise Parameters TNI, NC and $L_{np}$ at Study Location(s) of Trimulgherry

The different noise parameters such as TNI, NC and $L_{np}$ at study location of Trimulgherry are shown in Figure 4.2.3. The average TNI values showed a range of 83.5 -
86.9 dB (A) for quarter-1 and quarter-3 respectively, while quarter-2 showed a value of 85.6 dB (A) and annual average recorded a value of 85.3 dB (A). These high average values of TNI annual show the annoyance caused due to traffic noise.

The average NC showed a minimum value of 13.0 dB (A) during quarter-1 and maximum of 13.2 dB (A) while both quarter-2 and annual average showed the same value of 13.1 dB (A).

The average $L_{eq}$ showed a range of 84.2-87.1 dB (A) for quarter-1 and quarter-3 respectively while the quarter-2 showed a value of 86.0 dB (A) and annual average showed a value of 85.8 dB (A).

4.2.5 Day and Night Noise Level Variations at Study Location(s) of Trimulgherry

The noise levels during day time (6:00 – 22:00 hrs) more residential and commercial activity and vehicular flow is seen during day time compared to night time (22:00 – 6:00 hrs) in mixed (commercial and residential) area of Trimulgherry.

4.2.5.1 Analysis of noise levels during day time

The average day time variations of $L_{eq}$ for the commercial and residential (mixed) area of Trimulgherry showed a value of 78.7 dB (A) and all the other indices were almost high during the quarter-3 these higher values are due to increase vehicular flow and minimum value of 76.1 dB (A) during quarter-1, Whereas the quarter-2 and annual average $L_{eq}$ both showed the same value of 77.4 dB (A) and the other indices were also on a high which is exceeding the permissible range of 60 dB (A) during the day time as given by CPCB India 2000 which is shown in Figure 4.2.4.

4.2.5.2 Analysis of noise levels during night time

The average night time variations of $L_{eq}$ for the commercial and residential (mixed) area of Trimulgherry showed a minimum value of 61.0 dB (A) during quarter-1 due to cold weather conditions in Hyderabad city and lesser urban activity during the night time whereas during quarter-2 the value is 63.1 dB (A) and during quarter-3 also showed a high of 63.4 dB (A) and the annual average value of 62.5 dB (A) which is exceeding the permissible range of 50 dB (A) as given by CPCB India, 2000. Similarly all
the other indices also showed higher values as shown in Figure 4.2.5. The analysis of variance (ANOVA) analysis revealed that non-significant variation ($p<0.05$).

4.2.6 Quarterly and Annual Average Noise Levels at Study Location(s) of Trimulgherry during Morning and Evening Peak Hours

The Table 4.2.3 shows the morning 9:00 - 12:00 hrs and evening 17:00 - 20:00 hrs are the peak hours for Trimulgherry. The morning peak average values of $L_{eq}$ has minimum of 79.6 dB (A) during quarter-1 and a maximum of 83 dB (A) during quarter-3 while the evening peak showed a minimum of 81.5 dB (A) during quarter-1 and maximum of 84.7 dB (A) during quarter-3 and other indices such as $L_{10}$, $L_{50}$ and $L_{90}$ the other parameters TNI, NC and $L_{eq}$ for all quarters and annual showed higher values. It is clearly seen that noise levels during peak hours are very high when compared to permissible range given by CPCB India, 2000. This high values are due to the fact that more number of vehicles all types plying during the peak hours of morning and evening and more urban activity resulting increase traffic noise.

4.2.7 Total Vehicle Composition

The Figure 4.2.6 shows the total vehicle density of 2 wheelers, 3 wheelers, 4 wheelers light vehicle and heavy vehicles for different quarters and annual for the commercial and residential (mixed) area of Trimulgherry. It is clearly evident that the 2 wheelers are predominant in this area and 3 wheeler and 4 wheelers are of almost equally distributed and heavy vehicle count also contributes to increase in noise levels in this area compared to all the other areas.

4.2.8 Vehicle Type vs $L_{eq}$

Table 4.2.4 shows the annual total sum of 2 wheelers and 3 wheelers, 4 wheeler light vehicle and heavy vehicles count were plotted with the observed $L_{eq}$ and regression equations were found using linear regression for the commercial and residential (mixed) area of Trimulgherry. The regression coefficients ($R^2$) were found to be very good and showed a significant correlation between the different types of vehicle with $L_{eq}$ is shown
in Figure 4.2.7(a-d) and good value of “r” is also shown. From this we can conclude that the L_{eq} depends more on heavy vehicles as they produce more sound compared to other vehicles and also other hand the 2 wheelers and 3 wheelers are equally responsible in the increase in L_{eq} especially in the commercial and residential (mixed) area of Trimulgherry.

4.3 BEGUMPET

4.3.1 L_{eq} Noise Levels in dB (A) at Study Location(s) of Begumpet

The study location of Begumpet a commercial area where the average noise levels L_{eq} were measured diurnal (6:00 - 5:00 hrs) from November 2010 to October 2011 is shown in Table 4.3.1. The monthly L_{eq} values recorded a maximum value of 89.5 dB (A) during 10:00 - 11:00 hrs in October and a minimum of 60 dB (A) during early morning from 3:00 - 4:00 hrs in December 2010. The 24 hours average noise levels showed a minimum value of 74.1 ± 8.1 dB (A) recorded in the month of December 2010 to a maximum of 78.4 ± 8.4 dB (A) value recorded during October 2011. The annual average noise level is 76.2 ± 8.0 dB (A). The analysis of variance (ANOVA) analysis revealed that non-significant variation is existing between the mean average of data in different months (p<0.05).

4.3.2 Noise levels L_{eq} during Different Quarters in dB (A) at Study Location(s) of Begumpet

The noise data was measured in Begumpet as shown in plate 3 was compiled for all quarters and the data is presented in Table 4.3.2 and Figure 4.3.1. The average noise levels in L_{eq} for 24 hrs recorded a minimum of 50.5 dB (A) in quarter-1, and 51.7 dB (A) in quarter-2 during early morning from 3:00 - 4:00 hrs and 51.0 dB (A) in quarter-3 during early morning from 5:00 - 6:00 am. The maximum L_{eq} recorded in quarter-3 (106.2 dB (A)) followed by 104.2 dB (A) in quarter-2 and 97.1 dB (A) in quarter-1 between 10:00 - 11:00 hrs for all months.

The quarterly diurnal L_{eq} (24hrs) showed a minimum value of 61.0 dB (A) during early morning from 3:00 - 4:00 hrs in quarter-1 followed by 62.6 dB (A) and 63.0 dB (A)
in quarter-2 and 3 respectively. The maximum diurnal $L_{eq}$ was recorded in quarter-3 (88.5 dB (A)) followed by 87.2 and 84.2 dB (A) in quarter-2 and 1 respectively during morning hours between 10:00 - 11:00 hrs.

The mean value of $L_{eq}$ for quarter-1 is 74.6 ± 7.8, 76.3 ± 8.1 and 77.8 ± 8.3 dB (A) for quarter-2 and 3 respectively. The percentage mean variation among the quarters is only 10 %. The differences between the noise levels in different quarter periods were found to be statistically insignificant (P<0.05). While the allowed limit value of 65 dB (A) for commercial area was exceeded 95.7 % in quarter-3, 87.5 % in quarter-2 and 83.3 % in quarter-1 respectively. All the values in Begumpet are above the permissible limits and the percentage mean variation classification of noise levels ($L_{eq}$) for different quarters and annual for study location of Begumpet is given below

<table>
<thead>
<tr>
<th>Noise range ($L_{eq}$)</th>
<th>Quarter-1</th>
<th>Quarter-2</th>
<th>Quarter-3</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;50</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>50-54</td>
<td>0.0</td>
<td>0.0</td>
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<tr>
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<td>65-69</td>
<td>12.5</td>
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</tr>
</tbody>
</table>
4.3.3 Noise Indices $L_{10}$, $L_{50}$ and $L_{90}$ at Study Location(s) of Begumpet

The average values of all Indices such as $L_{10}$, $L_{50}$ and $L_{90}$ were studied for 24 hrs at the commercial area of Begumpet is shown in Figure 4.3.2. The average $L_{10}$ values for 24 hrs showed maximum of 81.8 dB (A) during quarter -3 followed by 80.1 dB (A) during quarter-2 and a minimum of 78.1 dB (A) during quarter 1 and annual average of 80.0 dB (A).

The $L_{50}$ values for 24 hrs shows the same trend with minimum during quarter-land a maximum during quarter-3 showing a value of 71.6 dB (A) and 74.8 dB (A) respectively and whereas the annual average shows a value of 73.3 dB (A).

In case of the $L_{90}$ values for 24 hrs shows that both quarter-2 and quarter-3 have values of 65.4 dB (A) and 66.2 dB (A) respectively and a minimum of 64.3 dB (A) was seen during quarter-1 and the annual average of 65.3 dB (A).

4.3.4 Noise Parameters TNI, NC and $L_{np}$ at Study Location(s) of Begumpet

The different noise parameters such as TNI, NC and $L_{np}$ at the study location of Begumpet are shown in Figure 4.3.3. The average TNI values showed a minimum value of 89.6 dB (A) during quarter-1 and maximum of 98.5 dB (A) while quarter-2 and annual average both showed the same value of 94.1 dB (A).

The average NC showed a range between 13.8 - 15.6 dB (A) for quarter-1 and quarter-3 respectively, while both quarter-2 and annual average both showed the same value of 14.7 dB (A).

The average $L_{np}$ showed a minimum value of 88.7 dB (A) during quarter-1 and 94.5 dB (A) during quarter-3 while quarter-2 showed a value of 91.8 dB (A) and annual average showed a value of 91.7 dB (A).
4.3.5 Day and Night Noise Level Variations at Study Location(s) of Begumpet

The noise levels during day time (6:00 – 22:00 hrs) more commercial activity and vehicular flow is seen during day time compared to night time (22:00 – 6:00 hrs) in commercial area of Begumpet.

4.3.5.1 Analysis of noise levels during day time

The average day time variations of $L_{eq}$ for the commercial area of Begumpet showed a value of 81.8 dB (A) and all the other indices were almost high during the quarter-3 these higher values are due to increase vehicular flow and minimum value of 78.7 dB (A) during quarter-1, Whereas the annual average $L_{eq}$ value of 80.3 dB (A) and the other indices were also on a high which is exceeding the permissible range during the day time of 65 dB (A) as given by CPCB India 2000 which is shown in Figure 4.3.4.

4.3.5.2 Analysis of noise levels during night time

The average night time variations of $L_{eq}$ for the commercial area of Begumpet showed a minimum value of 66.3 dB (A) during quarter-1 due to cold weather conditions in Hyderabad city during the night time whereas during quarter-2 the value is 68.4 dB (A) and during quarter-3 also showed a high of 69.7 dB (A) and the annual average value of 68.1 dB (A) which is exceeding the permissible limit of 55 dB (A) as given by CPCB India, 2000. Similarly all the other Indices also showed higher values as shown in Figure 4.3.5 due to more number of cars and auto_rikshaws (3wheelers) plying on the road during night time with high speeds making a lot of noise.

4.3.6 Quarterly and Annual Average Noise Levels at Study Location(s) of Begumpet during Morning and Evening Peak Hours

The Table 4.3.3 shows the morning 9:00 - 12:00 hrs and evening 17:00 - 20:00 hrs are the peak hours for the commercial area of Begumpet. The average values of $L_{eq}$ showed a minimum value of 82.7 dB (A) during quarter-1 and maximum of 87 dB (A) during quarter-3 from morning peak and evening peak hours showed a minimum of 83.4 dB (A) during quarter-1 and maximum of 87.2 dB (A) during quarter-3 and other indices such as $L_{10}$, $L_{50}$ and $L_{90}$ the other parameters TNI, NC and $L_{np}$ for all quarters and annual
showed higher values. Which are clearly seen that all the levels during peak hours are very high when compared to permissible range given by CPCB India, 2000. This high values are due to fact that more number of vehicles all types plying during the peak hours of morning and evening and more urban activity resulting increase traffic noise. The analysis of variance (ANOVA) analysis revealed that non-significant variation ($p<0.05$).

4.3.7 Total Vehicle Composition

The Figure 4.3.6 shows the total vehicle density of 2 wheelers, 3 wheelers, 4 wheelers light vehicle and heavy vehicles for different quarters and annual for the commercial area of Begumpet. It is clearly evident that the 2 wheelers are predominant in this area and 3 wheeler and 4 wheelers are of almost equally distributed and 4 wheeler heavy vehicle count also contributes to increase in noise levels in this area compared to all other areas.

4.3.8 Vehicle Type vs $L_{eq}$

Table 4.3.4 shows the annual total sum of 2 wheelers and 3 wheelers, 4 wheeler light vehicle and heavy vehicles count were plotted with the observed $L_{eq}$ and regression equations were found using linear regression for the commercial area of Begumpet. The regression coefficients ($R^2$) were found to be very good and showed significant correlation between the different types of vehicle with $L_{eq}$ is shown in Figure 4.3.7(a-d) and good value of “r” is also shown. From this we can conclude that the $L_{eq}$ depends more on heavy vehicles as they produce more sound compared to other vehicles and also other hand the 2 wheelers and 3 wheelers are equally responsible in the increase in $L_{eq}$ especially in the commercial area of Begumpet.
4.4 JEEDIMETLA

4.4.1 $L_{eq}$ Noise Levels in dB (A) at Study Location(s) of Jeedimetla

The study location of Jeedimetla an industrial area where the average noise levels $L_{eq}$ were measured diurnal (6:00 - 5:00 hrs) from November 2010 to October 2011 is shown in Table 4.4.1. The monthly $L_{eq}$ values recorded a maximum value of 89.4 dB (A) during evening hours from 18:00 – 19:00 hrs in October and minimum of 61.9 dB (A) during early morning from 3:00 – 4:00 hrs in December 2010. The 24 hours average noise levels showed a minimum value of 75.1 ± 7.1 dB (A) recorded in the month of December 2010 to a maximum of 78.8 ± 7.5 dB (A) value recorded during October and annual average noise level is 76.9 ± 6.7 dB (A). The analysis of variance (ANOVA) analysis revealed that non-significant variation is existing between the mean average of data in different months ($\rho<0.05$).

4.4.2 Noise Levels $L_{eq}$ during Different Quarters in dB (A) at Study Location(s) of Jeedimetla

The noise data was measured in Jeedimetla as shown in plate 4 was compiled for all quarters and the data is presented in Table 4.4.2 and Figure 4.4.1. The average noise levels in $L_{eq}$ for 24 hrs recorded a minimum of 53.1 dB (A) in quarter-1, and 54 dB (A) in quarter-3 during early morning from 3:00 - 4:00 hrs and 55 dB (A) in quarter-2 during early morning from 5:00 - 6:00 hrs. The maximum $L_{eq}$ recorded in quarter-3 (105.7 dB (A)) during morning between 10:00 - 11:00 hrs followed by 104.5 dB (A) in quarter-2 and 98.1 dB (A) in quarter-1 during evening between 18:00 - 19:00 hrs.

The quarterly diurnal $L_{eq}$ (24hrs) showed a minimum value of 62.8 dB (A) during early morning from 3:00 - 4:00 hrs in quarter-1 followed by 65.4 dB (A) and 66.1 dB (A) in quarter-2 and 3 respectively. The maximum diurnal $L_{eq}$ was recorded in quarter- 3 (88.8 dB (A)) followed by 87.0 and 84.6 dB (A) in quarter-2 and 1 respectively during evening hours between 18:00 - 19:00 hrs.
The mean value of $L_{eq}$ for quarter-1 is 75.4 ± 6.8, 77.0 ± 6.6 and 78.3 ± 7.0 dB (A) for quarter-2 and 3 respectively. The percent mean variation among the quarters is only 9%. The differences between the noise levels in different quarter periods were found to be statistically insignificant (P<0.05). While the allowed limit value of 75 dB (A) for industrial area was exceeded 62.5% in quarter-3, 62.5 % in quarter-2 and 58.3 in quarter-1 respectively. All the values in Jeedimetla are above the permissible limits and the percentage mean variation classification of noise levels ($L_{eq}$) for different quarters and annual for study location of Jeedimetla is given below

<table>
<thead>
<tr>
<th>Noise range ($L_{eq}$)</th>
<th>Quarter-1</th>
<th>Quarter-2</th>
<th>Quarter-3</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;50</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>50-54</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>55-59</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>60-64</td>
<td>8.3</td>
<td>0.0</td>
<td>0.0</td>
<td>4.2</td>
</tr>
<tr>
<td>65-69</td>
<td>16.7</td>
<td>16.7</td>
<td>16.7</td>
<td>16.7</td>
</tr>
<tr>
<td>70-74</td>
<td>16.7</td>
<td>20.8</td>
<td>20.8</td>
<td>16.7</td>
</tr>
<tr>
<td>75-79</td>
<td>25.0</td>
<td>29.2</td>
<td>16.7</td>
<td>29.2</td>
</tr>
<tr>
<td>&gt;80</td>
<td>33.3</td>
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<td>45.8</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

### 4.4.3 Noise Indices $L_{10}$, $L_{50}$ and $L_{90}$ at Study Location(s) of Jeedimetla

The average values of all Indices such as $L_{10}$, $L_{50}$ and $L_{90}$ were studied for 24 hrs at the industrial area of Jeedimetla is shown in Figure 4.4.2. The average $L_{10}$ values for 24 hrs showed maximum of 82.3 dB (A) during quarter -3 followed by 81.0 dB (A) during quarter-2 and a minimum of 79.2 dB (A) during quarter-1 and an annual average value of 80.8 dB (A).
The $L_{50}$ values for 24 hrs shows the same trend with minimum during quarter-1 and a maximum during quarter-3 showing a value of 72.6 dB (A) and 75.3 dB (A) respectively and whereas the annual average shows a value of 74.0 dB (A).

In case of the $L_{90}$ values for 24 hrs shows quarter-3 showed maximum value of 66.5 dB (A) and a minimum of 64.6 dB (A) was seen during quarter-1. Whereas both quarter-2 and annual average shows a value of 65.6 dB (A).

### 4.4.4 Noise Parameters TNI, NC and $L_{np}$ at Study Location(s) of Jeedimetla

The different noise parameters such as TNI, NC and $L_{np}$ at the study location of Jeedimetla is shown in Figure 4.4.3. The average TNI values recorded during quarter-1 showed a minimum value of 93.2 dB (A) and quarter-2 showed a value of 97.1 dB (A) while quarter-3 recorded a maximum value of 99.7 dB (A) and annual average of 96.7 dB (A).

The average NC recorded showed a range of 14.7-15.8 dB (A) for quarter-1 and quarter-3 respectively while the quarter-2 and annual average showed a value of 15.4 and 15.3 dB (A) respectively.

The average $L_{np}$ showed a minimum value of 90.9 dB (A) for quarter-1 and maximum value of 95.3 dB (A) while quarter-2 showed a value of 93.6 dB (A) and annual average showed a value of 93.3 dB (A). From the study it is clear that both TNI and $L_{np}$ showed higher values.

### 4.4.5 Day and Night Noise Level Variations at Study Location(s) of Jeedimetla

The noise levels during day time (6:00 – 22:00 hrs) more industrial activity and vehicular flow is seen during day time compared to night time (22:00 – 6:00 hrs) in industrial area of Jeedimetla.

#### 4.4.5.1 Analysis of noise levels during day time

The day time (6:00 – 22:00 hrs) has industrial activity and more vehicular flow is seen during day time compared to night time (22:00 – 6:00 hrs). The average day time
variations of $L_{eq}$ for the industrial area of Jeedimetla showed a value of 82.1 dB (A) and all the other indices were almost high during the quarter-3 these higher values are due to increase vehicular flow and minimum value of 79.1 dB (A) during quarter-1, whereas the quarter-2 showed a value of 80.3 dB (A). Annual average showed a value of 80.5 dB (A) and the other indices were also on a high which is exceeding the permissible range during the day time of 75 dB (A) as given by CPCB India 2000 which is shown in Figure 4.4.4.

4.4.5.2 Analysis of noise levels during night time

The average night time variations of $L_{eq}$ for the industrial area of Jeedimetla showed a minimum value of 68.0 dB (A) during quarter-1 due to cold weather conditions in Hyderabad city during the night time whereas during quarter-2 the value is 70.2 dB (A) and during quarter-3 also showed a high of 70.8 dB (A) and the annual average value of 69.7 dB (A) which is almost exceeding reaching and sometimes crossing the permissible range of 70 dB (A) as given by CPCB India, 2000. Similarly all the other Indices also showed higher values as shown in Figure 4.4.5 due to more heavy vehicles plying during night time as it is an industrial area. The analysis of variance (ANOVA) analysis revealed that non-significant variation ($\rho<0.05$).

4.4.6 Quarterly and Annual Average Noise Levels at Study Location(s) of Jeedimetla during Morning and Evening Peak Hours

The Table 4.4.3 shows the morning 9:00 - 12:00 hrs and evening 17:00 - 20:00 hrs are the peak hours for the industrial area of Jeedimetla. The average values of $L_{eq}$ showed a minimum value of 82.5 dB (A) during quarter-1 and maximum of 86 dB (A) during quarter-3 from morning peak and evening peak hours showed a minimum of 83.3 dB (A) during quarter-1 and maximum of 87.6 dB (A) during quarter-3 and other indices such as $L_{10}$, $L_{50}$ and $L_{90}$ the other parameters TNI, NC and $L_{np}$ for all quarters and annual showed higher values. Which are clearly seen that all the levels during peak hours are very high when compared to permissible range given by CPCB India, 2000. This high values are due to fact that more number of vehicles all types plying during the peak hours of morning and evening and more industrial activity resulting increase traffic noise.
4.4.7 Total Vehicle Composition

The Figure 4.4.6 shows the total vehicle density of 2 wheelers, 3 wheelers, 4 wheelers light vehicle and heavy vehicles for different quarters and annual for the industrial area of Jeedimetla. It is clearly evident that the 2 wheelers are predominant in this area and 3 wheeler and 4 wheelers are of almost equally distributed and heavy vehicles like tippers contributes to increase in noise levels in this area compared to all other areas.

4.4.8 Vehicle Type vs L_{eq}

Table 4.4.4 shows the annual total sum of 2 wheelers and 3 wheelers, 4 wheeler Light vehicle and Heavy vehicle count were plotted with the observed L_{eq} and regression equations were found using linear regression for the industrial area of Jeedimetla. The regression coefficients (R^2) were found to be very good and showed significant correlation between the different types of vehicle with L_{eq} is shown in Figure 4.4.7(a - d) and good value of “r” is also shown. From this we can conclude that the L_{eq} depends more on heavy vehicles as they produce more sound compared to other vehicles and also other hand the 2 wheelers and 3 wheelers are equally responsible in the increase in L_{eq} especially in the industrial area of Jeedimetla.

4.5 Comparison between Study Areas

4.5.1 Annual Average Noise Levels L_{eq} in dB (A) for Different Study Locations

The annual noise data was measured in all study locations and the data is presented in Table 4.5.1 and Figure 4.5.1. The quarterly diurnal L_{eq} (24hrs) showed a minimum value of 52.2 dB (A) during early morning from 3:00 - 4:00 hrs in Marredpally and maximum diurnal L_{eq} was recorded in Jeedimetla (86.8 dB (A)) during evening hours between 18:00 - 19:00 hrs and followed by 86.8 dB (A) at Begumpet during morning hours between 10:00 - 11:00 hrs respectively.
The annual (24hrs) mean noise levels $L_{eq}$ at the study location of Trimulgherry is $72.4 \pm 8.5$ dB (A), Begumpet $76.2 \pm 8.0$ dB (A), Jeedimetla areas $76.9 \pm 6.7$ and $66.3 \pm 6.7$ dB (A) was recorded at Marredpally.

The noise levels $L_{eq}$ at the study location of Marredpally is recorded least when compared to other study locations but it was observed that average noise equivalent levels $L_{eq}$ at all study locations as shown in Figure 4.5.2.

The analysis of variance (ANOVA) analysis revealed that some significant variation ($\rho > 0.05$) at all study locations. While the day time permissible limit values of 55 dB (A) for residential area was exceeded 91.2 % in Marredpally, 60 dB (A) for mixed area 91.8 % in Trimulgherry, 65 dB (A) for commercial area 87.5% and 75 dB (A) for industrial area 62.5% respectively. All study areas are above the permissible limits and the percentage mean variation classification of noise levels ($L_{eq}$) for different study locations is given below

<table>
<thead>
<tr>
<th>Noise range($L_{eq}$)</th>
<th>Marredpally</th>
<th>Trimulgherry</th>
<th>Begumpet</th>
<th>Jeedimetla</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;50</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>50-54</td>
<td>8.3</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>55-59</td>
<td>8.3</td>
<td>8.3</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>60-64</td>
<td>25.0</td>
<td>16.7</td>
<td>12.5</td>
<td>4.2</td>
</tr>
<tr>
<td>65-69</td>
<td>25.0</td>
<td>12.5</td>
<td>16.7</td>
<td>16.7</td>
</tr>
<tr>
<td>70-74</td>
<td>25.0</td>
<td>16.7</td>
<td>12.5</td>
<td>16.7</td>
</tr>
<tr>
<td>75-79</td>
<td>8.3</td>
<td>16.7</td>
<td>20.8</td>
<td>29.2</td>
</tr>
<tr>
<td>&gt;80</td>
<td>0.0</td>
<td>29.2</td>
<td>37.5</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

4.5.2 Annual Average Noise Indices $L_{10}$, $L_{50}$ and $L_{90}$ Variations for Different Study Locations

The annual average noise indices ($L_{10}$, $L_{50}$ and $L_{90}$) variations for all study locations shown in Figure 4.5.3. The $L_{10}$ showed a maximum value of 80.8 dB (A) at industrial area of Jeedimetla where as the commercial area of Begumpet showed a value
of 80.0 dB (A) and the mixed area of Trimulgherry showed a value of 76.0 dB (A) whereas the residential area showed a minimum value of 69.5 dB (A). $L_{50}$ was ranging between 63.1 - 74.0 dB (A) and background noise level, $L_{90}$ was ranging between 56.2 – 65.6 dB (A) with maximum at industrial area of Jeedimetla and minimum at residential area of Marredpally. The noises indices are ranging between 56.2 - 80.8 dB (A). The residential area of Marredpally shows lower value of all noise indices compared to other locations while industrial area of Jeedimetla showed the maximum and commercial area of Begumpet also shows value near to Jeedimetla. All the indices at all study locations are showing higher values.

4.5.3 Annual Average Noise parameters TNI, NC and $L_{np}$ Variations for Different Study Locations

The annual average noise parameters (TNI, NC and $L_{np}$) variations for all study locations shown in Figure 4.5.4. The TNI showed a maximum value of 96.7 dB (A) for the industrial area of Jeedimetla and the commercial area of Begumpet showed a value of 94.1 dB (A) and the mixed area of Trimulgherry showed a value of 85.3 dB (A) and the residential area of Marredpally showed a minimum value of 79.6 dB (A).

The NC shows a range of 13.1 - 15.3 dB (A) with minimum at mixed area of Trimulgherry and maximum at industrial area of Jeedimetla. $L_{np}$ shows a minimum value of 79.5 dB (A) at residential area of Marredpally and the mixed area of Trimulgherry showed a value of 85.8 dB (A) and the commercial area of Begumpet shows a value of 91.7 dB (A) and shows a maximum value of 93.3 dB (A) at industrial area of Jeedimetla.

4.5.4 Annual average Day and Night variations of $L_{eq}$ and other indices for all study locations

The noise levels during day time (6:00 – 22:00 hrs) are more due to urban and industrial activity and vehicular flow is seen during day time when compared to night time (22:00 – 6:00 hrs).
4.5.4.1 Annual Average Noise Levels during Day time for Different Study Locations

The equivalent noise levels $L_{eq}$ are more during day time (6:00 – 22:00 hrs) and increases gradually as the day progresses due to more urban activities and more number of vehicles plying on roads.

The minimum $L_{eq}$ value of 61.8 dB (A) is seen during 13:00 - 14:00 hrs due to less residential activity and maximum value of 77 dB (A) during 9:00 - 10:00 hrs due to more residential activity, shouting of vendors and increased vehicular flow at residential area of Marredpally is above permissible values of 55 dB (A) during day time.

The $L_{eq}$ value at the mixed area of Trimulgherry showed a minimum value of 66.7 dB (A) during 6:00 - 7:00 hrs due to less urban activity and which is above the permissible limits of 60 dB (A) during daytime.

The commercial area of Begumpet showed a minimum value of 68 dB (A) during 6:00 - 7:00 hrs due to less commercial activity and less number of vehicles plying on roads and maximum value of 86.6 dB (A) during 10:00 - 11:00 hrs due to more commercial activity and increased vehicular flow which is above the permissible limits of 65 dB (A) during daytime.

The industrial area of Jeedimetla showed a minimum value of 71.9 dB (A) during 6:00 - 7:00 hrs which is below the permissible levels of 75 dB (A) during day time due to less industrial activity and vehicular flow and most of time the value is exceeding the permissible limits with a maximum value of 86.8 dB (A) during 18:00 - 19:00 hrs due to more vehicular flow and industrial activities.

In the present study at Secunderabad at different areas the average day time variations of $L_{eq}$ for the industrial area of Jeedimetla and commercial area of Begumpet both almost show a value of 80.5 dB (A) and 80.3 dB (A) and minimum value of 69.7 dB (A) for residential area of Marredpally, whereas the mixed area of Trimulgherry showed a value of 77.4 dB (A) which are all above the prescribed permissible ambient noise level standards of different areas as given by (Central Pollution Control Board) CPCB of India, 2000.
Noise indices and parameters

The average noise indices $L_{10}$ showed a minimum value of 73.1 dB (A) at residential area of Marredpally and maximum value of 84.6 dB (A) at industrial area of Jeedimetla and closely followed by commercial area of Begumpet with a value of 84.3 dB (A).

The noise indices $L_{50}$ is ranging between 66.4 - 77.7 dB (A) with minimum at residential area of Marredpally and maximum at industrial area of Jeedimetla with commercial area showing a value of 77.3 dB (A).

The background noise level $L_{90}$ showed a minimum value of 59.5 dB (A) at residential area of Marredpally and maximum value of 68.2 dB (A) at both locations of Begumpet and Jeedimetla.

The noise parameter TNI and $L_{np}$ showed a minimum value of 84 dB (A) and 83.2 dB (A) at residential area of Marredpally which exceeded the threshold values of 74 dB (A) (Scholes and Sargent, 1971, Ma et al, 2006) and $L_{np}$ has a threshold values of 72 dB (A) (Scholes and Sargent, 1971). While the other locations showed higher values TNI is ranging between 93.4 - 103.6 dB (A) and $L_{np}$ ranging between 92.2 - 98.5 dB (A). The NC shows a minimum value of 13.6 dB (A) at residential area of Marredpally and all other areas are ranging between 14.1 - 16.3 dB (A), these higher values of TNI and $L_{np}$ are due to increase vehicular flow, which are exceeding the permissible range during the day time as given by CPCB India, 2000 which is shown in Figure 4.5.5.1 for all study locations.

4.5.4.2 Annual Average Noise Levels during Night time for Different Study Locations

The equivalent noise levels $L_{eq}$ is less during night time (22:00 – 06:00 hrs) and gradually decreases as the night progresses due to less urban activities and decrease in number of vehicles plying on roads.
The average night time variations of $L_{eq}$ for the industrial area of Jeedimetla shows a maximum value of 69.7 dB (A) due to more industrial activity and heavy vehicles plying on the roads which is just below the permissible level of 70 dB (A).

The commercial area of Begumpet shows a soaring high value of 68.1 dB (A) which is above permissible limits of 55 dB (A) due to more number of 3 wheelers and 4 wheeler Light vehicles(cars) especially plying on the roads during night time with high speeds.

The mixed area of Trimulgherry showed a value of 62.5 dB (A) which is above the permissible levels of 50 dB (A) due to some vehicular activity especially in the early morning due to milk vans and auto_rikshaws plying on roads.

Whereas the residential area of Marredpally showed a minimum value of 59.7 dB (A) which is above the permissible limits of 45 dB (A) due to early morning activity of milk vans, barking of dogs and water tankers during summer especially all the study locations are exceeding the permissible range as given by CPCB India, 2000. This is shown in Figure 4.5.5.2 for all study locations.

In the present study at Hyderabad at different areas the average night time variations of $L_{eq}$ for the industrial area of Jeedimetla showed a value of 69.7 dB (A) and commercial area of Begumpet showed a value of 68.1 dB (A), minimum value of 59.7 dB (A) for residential area of Marredpally, whereas the mixed area of Trimulgherry shows a value of 62.5 dB (A) which are all above the prescribed permissible ambient noise level standards of different areas as given by (Central Pollution Control Board) CPCB of India, 2000.

**Noise indices and parameters**

The average noise indices $L_{10}$ showed a minimum value of 62.3 dB (A) at residential area of Marredpally and maximum value of 73.4 dB (A) at industrial area of Jeedimetla and closely followed by commercial area of Begumpet with a value of 71.5 dB (A).
The noise indices $L_{50}$ is ranging between 56.6-66.8 dB (A) with minimum at residential area of Marredpally and maximum at industrial area of Jeedimetla.

The background noise level $L_{90}$ showed a minimum value of 49.6 dB (A) at residential area of Marredpally and maximum value of 60.2 dB (A) at industrial location of Jeedimetla and closely followed by commercial area of Begumpet with a value of 59.5dB (A).

The noise parameter TNI and $L_{np}$ showed a minimum value of 70.6 dB (A) and 72.1 dB (A) at residential area of Marredpally While the other locations showed higher values TNI is ranging between 69.2 - 82.8 dB (A) and $L_{np}$ ranging between 73 - 82.8 dB (A). The NC shows a minimum value of 11.1 dB (A) at mixed area of Trimulgherry and the interesting fact is that the Begumpet showed a less value of 12 dB (A) when compared to Marredpally which showed 12.7 dB (A), and the Jeedimetla showed highest value of 13.1 dB (A) these higher values of TNI and $L_{np}$ are due to increase vehicular flow. The average noise levels $L_{eq}$ for each hour showed that noise levels started falling around midnights at all locations and reached a minimum around 03:00 - 04:00 hours, when it started rising again. The analysis of variance (ANOVA) analysis revealed that some significant variation ($p>0.05$) during day and night times at all study locations.

**4.5.5 Annual Average Noise Levels of Different Study Locations during Morning and Evening Peak Hours**

The Table 4.5.2 shows the peak hours of Traffic especially during morning (8:00 - 11:00 hrs) for Marredpally and (9:00 - 12:00 hrs) for all other study locations and evening (17:00 - 20:00 hrs) for all study locations. The average values of $L_{eq}$ showed a minimum value of 74.2 and 74.4 dB (A) during the morning and evening peaks at the study location of Marredpally and the other locations noise levels are ranging between 81.2 - 85.1 dB (A) during morning peaks and 83.2 - 85.6 dB (A) during evening peaks.

The other indices such as $L_{10}$ are varied from a minimum of 77.9 dB (A) at Marredpally and to a maximum value of 89.4 dB (A) at Begumpet during morning peaks and the evening peaks are varying from a minimum value of 77.9 dB (A) at Marredpally and maximum at 90.2 dB(A) at Jeedimetla While $L_{50}$ is ranging between 70.8 - 82.1 dB
(A) during morning peaks and 71 - 82.8 dB (A) during evening peaks and the background noise $L_{90}$ is ranging between 63.4 - 72.9 dB (A) during morning peaks and ranging between 63.9-73 dB (A) during evening peaks with maximum at Jeedimetla and minimum at Marredpally.

The noise parameters TNI, NC and $L_{eq}$ showed a range of 91.3 - 109.7 dB (A), 14.5 - 16.9 dB (A) and 88.9 - 103.2 dB (A) during morning peaks and showed a range of 89.8 - 112.1 dB (A), 14 - 17.3 dB (A) and 88.3 - 105.1 dB (A) during evening peaks for all study locations with always minimum at Marredpally and maximum at Jeedimetla.

4.5.6 Correlation between Annual Average Noise Level $L_{eq}$ and Total Vehicles Count for Different Study Locations

The vehicle categories are divided into 2 wheelers, 3 wheelers, 4 wheelers light vehicles and heavy vehicles. The Figure 4.5.6 (a-d) shows the annual total sum of vehicle count was plotted with the observed $L_{eq}$ and regression equations were found using linear regression for all study locations. The commercial area of Begumpet and industrial area of Jeedimetla showed strong correlation having a value of 0.989 and 0.988 while the residential area of Marredpally also showed good correlation of 0.982 while the mixed area of Trimulgherry showed the least correlation having a value of 0.963. Table 4.5.3 shows the correlation between annual average noise level $L_{eq}$ and total vehicles count for all study locations but the correlation coefficient $R^2$ value of 1.0 is considered to be the best fit, where as values above 0.7 is considered to be good. The value of ‘r’ is also shows good results. So there a strong correlation between total vehicles and $L_{eq}$ at all study locations where regression coefficients ($R^2$) were found to be very good.

4.5.7 Traffic Noise Model Validation: Annual Variations of Observed $L_{eq}$ vs Calculated $L_{eq}$ for Different Study Locations

The Statistical model (Calixto) which is based on percentage of heavy vehicles is taken from the total number of vehicles and the weighting factor (n) is taken as 9.5 in our present study and the Tables 4.5.4.1 to 4.5.4.4 showed the observed vs calculated $L_{eq}$ for different study locations of Marredpally, Trimulgherry, Begumpet and Jeedimetla. The Figure 4.5.7 (a –d) shows a strong correlation coefficient ($R^2$) was found between the
annual observed $L_{eq}$ and calculated $L_{eq}$ for all study locations. The $R^2$ values for industrial area of Jeedimetla showed the highest correlation of 0.917 whereas the mixed area of Trimulgherry also showed the best results of $R^2$ value of 0.913, whereas the commercial area of Begumpet showed a $R^2$ value of 0.827 and the residential area of Marredpally shows least correlation coefficient $R^2$ value of 0.817. Table 4.5.5 shows correlation between annual observed $L_{eq}$ and calculated $L_{eq}$ for all study locations but the correlation coefficient $R^2$ value of 1.0 is considered to be the best fit, whereas values above 0.7 is considered to be good. The value of “$r$” is also shows good results.