

**Analysis of Traffic Noise along Oyemekun - Oba-Adesida Road Akure Ondo State Nigeria****O. J Oyedepo\*, R. I Ekom and K.A Ajala***Civil Engineering Department, Federal University of Technology Akure, Ondo State, South-West Nigeria.*

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**Abstract**

The primary aim of the research is to quantify and analyze the traffic noise emissions along Oba-Adesida –Oyemekun Road. Measurements of noise were recorded in decibel (dBA) using digital sound level meters (IEC651 Type 2). While, the traffic volume and spot speed were obtained using cine –camera at six selected locations namely Alagbaka(L1), Biological Garden(L2), Adegbola(L3), Ondo Bye Pass(L4), Ilesha Garage(L5) and FUTA junction(L6) along Oba-Adesida- Oyemekun road during the peak period(7:30am -8:30 am & 4:00pm-5:00pm) and off peak period(11:30pm-12:30pm), repeated 3-5 times to account for time-fluctuation of these variables. All measurements were taken on a weighting frequency network, at a height of about 1.5m from the ground level. The vehicles were divided into five categories namely Cars, buses, motorcycles, 2-axle load, and 3-axle loads; and were converted into “Passenger Car Units” (PCU) by multiplying with recommended factors in accordance with Nigerian Federal Highway Capacity Manual 2006. The average L10(dBA) are 72.8, 73.8, 73.4, 74.4, 73.9, and 75.0dBA ; while average combine sound pressure level(SPL) in dBA are 76, 77, 78, 78, 77, and 78dBA for L1, L2, L3, L4, L5, and L6 respectively. Findings indicated that traffic generated noise pollution is at or above, the standard outdoor limits in most locations and area can adversely affect the welfare activities.

The present study revealed that the study area is getting noisier due to high traffic density and lack of traffic management, practical action to limit and control the exposure to environmental noise are essential. However, road traffic noise by treatments at source (such as to reduce engine noise, exhaust pipe noise etc.) is to be encouraged as the principal method of control. The techniques include road design, the management of traffic flow and the use of screens and barriers.

**Keywords:** Traffic Noise Emission, Decibel, Traffic Intensity, Spot Speed, Traffic Management

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**1. Introduction**

In urban areas, traffic noise, considered as one of the greatest public annoyances, is often generated by unstable traffic. This instability is largely correlated to traffic regulation devices, which generate acceleration/deceleration events depending on traffic conditions, road characteristics and driving behaviour. Acoustical noise produced by vehicular traffic depends on many parameters, including the geometry and the general features of the road. The presence of a conflicting point, i.e. an intersection, strongly affects and modifies the simulation strategy of noise in urban environments that is usually performed with statistical models tuned on experimental data related to standard condition (free flow traffic, intermediate vehicular volumes, etc.).

Noise is unacceptable level of sound that create annoyance, hampers mental and physical peace, and may induce severe damage to the health. Disturbances created by noise may cause hypertension, headache, indigestion, peptic ulcer, pharyngitis, atherosclerosis, bradycardia and ectopic beat (10 & 5).

In general, literature and law regulation consider vehicular traffic as one of the main noise source in an urban

framework, together with railways, industrial areas and airports. Road traffic noise, thus, is a very important element in environmental impact studies, since car is one of the most used transportation mean in developing countries like Nigeria. The prediction of noise coming from vehicular traffic is strongly influenced by some “intrinsic” parameters (due to both noise production and propagation processes), such as traffic volume, velocity, road features, etc., and other “specific” parameters (dependent on the particular area of interest), such as kind of vehicles, speed limits, vehicles maintenance duties, law emission thresholds, driving skills, amount and typologies of road intersections, etc..

The general expression of a traffic noise model (TNM) can be written in a three parameters given in equation 1.0 below.

$$Leq = A \cdot \log Q \left( 1 + \frac{P}{100} (n - 1) \right) + b \cdot \log(d) + C \quad (1)$$

Where: “Leq” is the acoustic equivalent level, “Q” is traffic volume in vehicles per hour, “P” is the percentage of heavy vehicles, “n” is the acoustical equivalent and d is the distance from observation point to center of the traffic lane. The parameters A, b and C coefficients may be derived, for a fixed investigated area, by linear regression methods on many Leq data taken at different traffic flows (Q, P) and

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distances (d). The acoustical equivalent, n, (defined as the number of light vehicle that generate the same acoustic energy of a heavy one) can be estimated both by regression method and by single vehicle emission measurements.

Traffic noise is increasing every day with the growth in urban population, auto ownership and travel, a continuous migration from rural to urban areas, lack of proper city planning and practically no control strategies for reducing the level of noise from various sources. Traffic noise pollution has become a pervasive aspect of working and living environments in most urban areas of the world, especially those in developing nations.

Currently all the developing countries like Nigeria are facing threat due to vehicular noise pollution. Migration of people from rural to urban areas, expansion of cities, infrastructure development, population growth and urbanization are important factors resulting in motorization and consequent increase in levels of various urban pollution (3; 4; 7; 8) quantify and analyze the traffic noise emissions along bus rapid transit(BRT) corridor in Delhi. Based on the study, it is concluded that traffic noise caused by heavy traffic flow condition on the main BRTS corridor is significant and exceeding the national central pollution control board (CPCB) standards. Environmental noise is as a result of human attitude, and is increasing with industrialization and urbanization. Noise can cause an emotional strain and become a source of great frustration when the noise is beyond a person's control. Noise causes exhaustion, absent-mindedness, tenseness and irritability. Increase in population coupled with the increase in number of motor vehicles is showing alarming levels of traffic congestion, air pollution, and noise pollution and road accidents. Urban traffic noise is one of the most critical types of noise and normally considered more interfering than the other types of noises (12; 15). (9) studied the road traffic noise in rural environment. During their study they measured the traffic noise alongside 26 miles of the A66 within the Lake District National Park and in the towns of Keswick and Coker mouth and they built a 50 dB (A) L10 contour for road traffic noise. A noise model for free flowing traffic had been proposed by Baranek and Newman. They illustrated that propagation loss varies from 34.5 dB per doubling of distance depending on the ground cover.

Accordingly, (1) study the level of traffic-induced noise pollution in Sylhet City; they concluded that noise level on the main road near residential area, hospital area and educational area were above the recommended level (65dBA). The study suggests that vulnerable institutions like school and hospital should be located about 60m away from the roadside unless any special arrangement to alleviate sound is used.(14), and (6) learned the urban noise scenario in Delhi and developed different traffic parameters like traffic volume, traffic speed and distance from pavement edge and the equivalent sound level( $L_{eq}$ ). From the developed correlations, it is possible to envisage the impact of traffic developments in terms of noise pollution if future and timely measures for control can be implemented. For silence zone, the developed equation is:

$$L_{eq}(1h) = 47.45 + 8.58 \times \log(Q_w) - 0.14 \text{ dB(A)} \quad (2)$$

Where:  $Q_w$  = traffic volume in EPCU / h

Traffic noise measurements and estimation can contribute significantly to the development of efficient methods of control. In the present study, traffic noises

emissions will be quantify and analyze in order to obtain an estimate of traffic noise on the major road network with relatively high traffic loads.

### 1.1 Road Noise Impacts

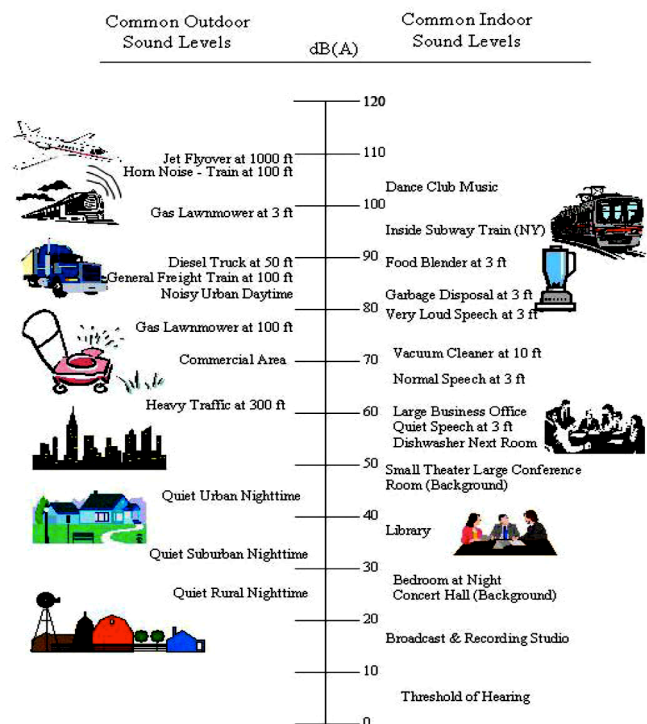
Noise has always been an important environmental problem; however, noise associated with road development affects the environment through which roads pass by degrading human welfare, by sonically vibrating structures, and by disrupting wildlife.

**Human welfare:** Even when it is not perceived consciously, chronic exposure to road noise can affect human welfare in varying degrees, both physiologically and psychologically. Chronic noise exposure can be a source of annoyance, creating communication problems and leading to elevated stress levels as well as associated behavioral and health effects. It can cause auditory fatigue, temporary and permanent lessening of hearing ability, sleep disorders, and can even contribute to learning problems in children.

**Vibration:** The vibration induced by the resonance of traffic noise can have a detrimental effect on structures standing near the road. This is of particular concern in the case of cultural heritage sites, which may have been standing for many centuries, but which were not designed to withstand such vibration. Makeshift or lightly constructed buildings, common in many developing countries, may be the first to succumb to vibration damage.

**Wildlife disturbance:** Noise may prevent many animal species from approaching or crossing road corridors because they are afraid. As a result, road corridors become barriers to regular wildlife travel routes, effectively rendering roadside habitat areas inaccessible to some species. Such disturbance reduces the success of these species and contributes to ecological alteration.

Figure 1 below shows the representative sound pressure levels (decibels) for a variety of common indoor and outdoor activities. To put common sound levels into perspective, normal speech at a distance of 0.9metre is approximately 65 dBA.

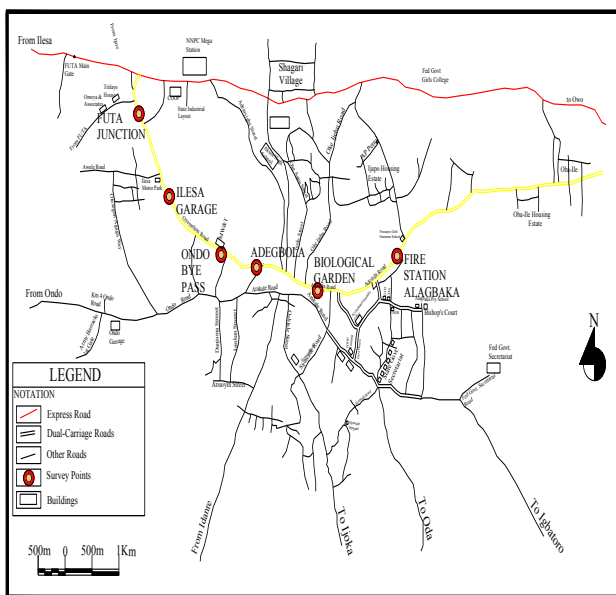


**Fig. 1.** Representative Sound Pressure Levels (Decibels) For Common Indoor and Outdoor Activities.

**Source:** Highway Traffic Noise Assessment Manual (HTNA) BS 4142

## 1.2 The Study Area

Akure with the provisional census figure of 387,087 people according to 2006 national population census, is located on latitude 70 20"N and longitude 50<sup>0</sup>E, while the natural pattern of development is linear along its main roads viz Oyemekun-Oba Adesida road and Arakale-Oda road. The existing land use is characterized by a medium density of structure within the inner core areas. Akure is mostly residential areas forming over 90% of the developed area but additional activities such as warehousing; manufacturing, workshops and other commercial uses are commonly located within the residential neighborhoods. At present the traffic composition of Akure is dominated by taxis, Okadas and minibuses (Owolabi, 2000). However, in this research, Oyemekun-Oba Adesida road shown in the road network map in figure 2.0 is selected for detailed study.



**Fig. 2.** Street Guide Map of Akure Showing the Survey Points  
Source: Ministry of Lands and Housing (2010)

## 2. Methods and Data

Six site were selected namely Alagbaka Junction, Biological Garden Junction Adegbola Junction, Ondo Bye Pass Junction, Ilesha Garage Junction and FUTA Junction along Oba-Adesida- Oyemekun road. Measurements of traffic noise, spot speed and traffic volume variables were performed during the peak period(8:00am -9:00 am & 4:00pm-5:00pm) and off peak period(12:00-1:00pm) at 300metres away from the junction to prevent interference;

repeated 3-5 times to account for time-fluctuation of these variables, while keeping in view the traffic and population densities. The noise levels were recorded in decibel(dB)using Sound level meters (IEC651 Type 2) shown in plate 1.0. Measurements were made recorded every 15 s for a period of 15 min/h. This was considered to represent the variations in noise levels of the entire hour while spot speeds were recorded for all categories of vehicles.

The most common measures of sound level are sound intensity and sound pressure. Sound intensity (also called sound power density) is the average rate of sound energy transmitted through a unit area perpendicular to the direction of sound propagation, typically measured in picowatts per square meter. Since no instrument is available for direct measurement, the power level of a source, sound pressure is employed as a measure in this regard. Sound pressure is usually proportional to the square root of sound power. Because of dealing with large range of numbers, a logarithmic measure called decibel (dBA) is used to describe sound level.

## 3. Results

Generally, traffic noise is measured and predicted by utilizing the  $L_{10}$  and  $L_{eq}$  indices. The sound pressure level (SPL) is given in equation 4.1, while table 4.1 is the summary of traffic volume, speed and noise measurement at the selected location.



**Plate 1.** Sound level meters (IEC651 Type 2)

**Table 1.** Summary of Traffic Volume, Speed and Noise Measurement at the Study Location.

Location	Section /Time	Traffic Composition							Average Sound Level (dBA)
		Car/Taxi (x1.0)	Buses (x1.0)	Motorcycle (x0.5)	2Axles Load (x2.0)	3Axle Load (x3.0)	Total Volume PCU veh/hr	Average Spot Speed (km/hr)	
Alagbaka	Morning 8:00-9:00am	106 (83.0%)	82 (6.4%)	233=117 (9.1%)	9=18 (1.4%)	0 (0.0%)	1279	37.27	71.60
	Afternoon 12:00-	846 (81.60%)	64 (6.2%)	198=99 (9.5%)	11=22 (2.1%)	2=6 (0.6%)	1037	38.22	71.34

	1:00pm								
	Evening 4:00-5:00pm	782 (90.70%)	41 (4.80%)	65=33 (3.80%)	3=6 (0.70%)	0 (0.0%)	862	35.09	75.60
<b>Biological Garden</b>	Morning 8:00-9:00am	1076 (84.4%)	76 (6.0%)	204=102 (8.0%)	9=18 (1.4%)	1=3 (0.2%)	1275	37.50	74.03
	Afternoon 12:00-1:00pm	984 (83.6%)	69 (5.9%)	196=98 (8.30%)	13=26 (2.2%)	0 (0.0%)	1177	37.22	73.99
	Evening 4:00-5:00pm	1168 (81.3%)	80 (5.6%)	342=171 (11.9%)	6=12 (0.8%)	2=6 (0.4%)	1437	35.86	73.25
	Morning 8:00-9:00am	1022 (83.0%)	71 (5.8%)	234=117 (9.5%)	9=18 (1.5%)	1=3 (0.2%)	1231	35.89	72.78
<b>Adegbola Junction</b>	Afternoon 12:00-1:00pm	978 (85.0%)	58 (5.0%)	194=97 (8.40%)	7=14 (1.2%)	1=3 (0.3%)	1150	36.11	72.41
	Evening 4:00-5:00pm	1067 (81.0%)	85 (6.5%)	276=138 (10.5%)	10=20 (1.5%)	2=6 (0.5%)	1316	35.71	74.88
	Morning 8:00-9:00am	1056 (81.4%)	64 (5.0%)	344=172 (13.3%)	1=2 (0.2%)	1=3 (0.2%)	1297	35.71	76.65
	Afternoon 12:00-1:00pm	828 (90.9%)	32 (3.5%)	92=46 (5.0%)	1=2 (0.2%)	1=3 (0.2%)	911	36.51	73.25
<b>Ondo Bye Pass Junction</b>	Evening 4:00-5:00pm	1034 (87.6%)	41 (3.5%)	154=77 (6.5%)	8=16 (1.4%)	4=12 (1.0%)	1180	38.14	73.37
	Morning 8:00-9:00am	1079 (90.5%)	30 (2.5%)	97=49 (4.1%)	11=22 (1.8%)	4=12 (1.0%)	1192	32.07	75.04
	Afternoon 12:00-1:00pm	968 (90.4%)	21 (2.0%)	78=39 (3.6%)	14=28 (2.6%)	5=15 (1.4%)	1071	41.67	72.5
	Evening 4:00-5:00pm	1319 (90.5%)	68 (4.7%)	86=43 (3.0%)	9=18 (1.2%)	3=9 (0.6%)	1457	36.59	74.30
<b>Ilesha Garage Junction</b>	Morning 8:00-9:00am	1168 (87.6%)	84 (6.3%)	66=33 (2.5%)	14=28 (2.1%)	7=21 (1.6%)	1334	37.42	75.13
	Afternoon 12:00-1:00pm	993 (89.5%)	73 (6.6%)	56=28 (2.5%)	8=16 (1.4%)	0 (0.0%)	1110	37.74	75.64
	Evening 4:00-5:00pm	996 (86.9%)	87 (7.6%)	79=40 (3.5%)	11=22 (1.9%)	0 (0.0%)	1145	34.00	74.20

$$SPL = SWL - (20 \log_{10}(\text{distance}) - 8) \quad (3)$$

assuming no adjustment to barrier.

Where SWL= Sound power level provided by manufacturer as the maximum output sound level the machine can produce.

According to BS 5228 1997 Annex D

Pressure attenuation = 10dB (including a barrier)

Pressure attenuation = 5dB (infront of a barrier)

$$\text{Total SPL} = 10 \log_{10} \left[ 10^{SPL_1/10} + 10^{SPL_2/10} + \dots + 10^{SPL_n/d} \right] \quad (4)$$

Where:

$$SPL_1 = 10 \log_{10} \left[ \frac{p_1}{p_0} \right]^2 ; \quad SPL_2 = 10 \log_{10} \left[ \frac{p_2}{p_0} \right]^2$$

and d= distance of the sound level meter away from the road shoulder

But  $P_1 = P_2$  = attenuation sound pressure level in front of the barrier= 5dBA

$$SPL_2 = 10 \log_{10} \left[ \frac{p_1}{p_0} \right]^2 + 5 \text{dB} = SPL_1 + 5 \text{dBA}$$

Where: P = Magnitude of pressure fluctuation ( $P_a$ )

$P_0$ = Magnitude of reference pressure=  $20 \mu\text{Pa}$

$P_1$ =Original sound pressure

$P_2$ = New sound pressure

Absolute combine total sound pressure level(BS4142) is given by:

$$SPL = SWL - 33 + 10 \log_{10}(\text{flow rate}) - 10 \log_{10}(\text{velocity}) - 10 \log_{10}(\text{distance})$$

But

$$L_{flow} = k + 10 \log_{10} q$$

Where:  $L_{flow}$  = Traffic flow component of  $L_{10}$  dBA

K=Constant which varies according to traffic composition

q=Traffic volume in (PCU veh/hr)

$L_{10}$  =the sound level that is exceeded for 10% of the sample period. It is typically used as a descriptor for traffic noise.

### Calculation for the Predicted Absolute Sound Pressure Level

The predicted absolute sound pressure level for Alagbaka location one(L1) for the morning, afternoon and evening period is calculated as follows:

#### Absolute combine total sound pressure level for Morning period at location 1

$P_1$ =Original sound pressure=71.67dB and  $P_0$ = Magnitude of reference pressure=  $20\mu p_a$

$$SPL_1 = 10\log_{10} \left[ \frac{p_1}{p_0} \right]^2 = 20\log_{10} (71.67/0.0002) = 131\text{dBA}$$

$$SPL_2 = SPL_1 + 5\text{dB} = 136\text{dBA}$$

$$\text{Total SPL} = 10\log_{10} [10^{SPL_1/d} + 10^{SPL_2/d}]$$

Where  $d=7.5$ metres

$$SPL = 10\log_{10} [10^{17.47} + 10^{18.13}] = 182\text{dBA}$$

Absolute combine total sound pressure level =

$$SPL = SWL - 33 + 10\log_{10}(\text{flow rate}) - 10\log_{10}(\text{velocity}) - 10\log_{10}(\text{distance})$$

Velocity=10.35m/s and  $q = 21.32$  veh/min obtained from measurement.

$$L_{flow} = k + 10\log_{10} q = 5 + 10\log_{10}(21.32) = 18.29 \text{ PCU veh/min}$$

Therefore absolute combine total sound pressure level is given as:

$$SPL = 130 - 33 + 18.29 - 10\log_{10}(10.35) - 182 = 76.71\text{dBA}$$

#### Absolute combine total sound pressure level for Afternoon period at location One

$P_1$ =Original sound pressure=71.34dB and  $P_0$ = Magnitude of reference pressure=  $20\mu p_a$

$$SPL_1 = 10\log_{10} \left[ \frac{p_1}{p_0} \right]^2 = 20\log_{10} (71.34/0.0002) = 131\text{dBA}$$

$$SPL_2 = SPL_1 + 5\text{dB} = 136\text{dBA}$$

$$SPL = 10\log_{10} [10^{SPL_1/d} + 10^{SPL_2/d}]$$

Where  $d=7.5$ metres

$$SPL = 10\log_{10} [10^{131/7.5} + 10^{136/7.5}] = 182\text{dBA}$$

$$\begin{aligned} \text{Absolute combine total sound pressure level} = \\ SPL = SWL - 33 + 10\log_{10}(\text{flow rate}) \\ - 10\log_{10}(\text{velocity}) \\ - 10\log_{10}(\text{distance}) \end{aligned}$$

Velocity=10.62m/s and  $q = 17.28$  veh/min obtained from measurement.

$$\begin{aligned} L_{flow} &= k + 10\log_{10} q = 5 + 10\log_{10}(17.28) \\ &= 22.38 \text{ PCU veh/min} \end{aligned}$$

Therefore absolute combine total sound pressure level is given as:

$$SPL = 130 - 33 + 22.38 - 10\log_{10}(10.62) - 182 = 72.62\text{dBA}$$

#### Absolute combine total sound pressure level for Evening period at location One

$P_1$ =Original sound pressure=75.60dB and  $P_0$ = Magnitude of reference pressure=  $20\mu p_a$

$$SPL_1 = 10\log_{10} \left[ \frac{p_1}{p_0} \right]^2 = 20\log_{10} (75.60/0.0002) = 132\text{dBA}$$

$$SPL_2 = SPL_1 + 5\text{dB} = 137\text{dBA}$$

$$SPL = 10\log_{10} [10^{SPL_1/d} + 10^{SPL_2/d}]$$

Where  $d=7.5$ metres

$$SPL = 10\log_{10} [10^{132/7.5} + 10^{137/7.5}] = 184\text{dBA}$$

Absolute combine total sound pressure level

$$SPL = SWL - 33 + 10\log_{10}(\text{flow rate}) - 10\log_{10}(\text{velocity}) - 10\log_{10}(\text{distance})$$

Velocity=9.75m/s and  $q = 14$  veh/min obtained from measurement.

$$\begin{aligned} L_{flow} &= k + 10\log_{10} q = 5 + 10\log_{10}(14) \\ &= 16 \text{ PCU veh/min} \end{aligned}$$

Therefore absolute combine total sound pressure level is given as:

$$SPL = 130 - 33 + 16 - 10\log_{10}(9.75) - 184 = 80\text{dBA}$$

Therefore average combine SPL at location one

$$L_1 = (76.71 + 72.62 + 80)/3 = 76\text{dBA}$$

Similarly, the absolute sound pressure level was calculated for other locations along the road network in the same manner using data in table 4.1. However, the results are presented in table 4.2 .

**Table 2.** Summary of Absolute Sound Pressure Level (SPL) Along the Study Road Network

Location	Period of The Day/Pressure level in dB				Average $L_{10}$ (dBA)
	Morning 7:30am- 8:30 am	Afternoon 11:30pm- 2:30pm	Evening 4:00pm- 5:00pm	Average Combine SPL in dBA	
<b>BS4142</b>				75	75
<b>L1</b>	77	73	76	76	72.8
<b>L2</b>	77	77	77	77	73.8
<b>L3</b>	77	79	77	78	73.4
<b>L4</b>	78	79	76	78	74.4
<b>L5</b>	76	78	76	77	73.9
<b>L6</b>	77	79	77	78	75.0

#### 4. Conclusions

The average  $L_{10}$ (dBA) are 72.8, 73.8, 73.4, 74.4, 73.9, and 75.0dBA ; while average combine sound pressure level(SPL) in dBA are 76, 77, 78, 78, 77, and 78dBA for L1, L2, L3, L4, L5, and L6 respectively. Findings indicated that traffic generated noise pollution is at or above, the standard outdoor limits in most locations and area can adversely affect the welfare activities.

There can be no doubt that in Akure, road transport constitutes the greatest source of noise in the majority of an urban area. This noise source is of great importance, as it might constitute environmental hazard to majority of the

population. The present study revealed that the study area is getting noisier due to high traffic density and lack of traffic management. In this perspective, practical action to limit and control the exposure to environmental noise are essential. While controlling road traffic noise by treatments at source (such as to reduce engine noise, exhaust pipe noise etc.) is to be encouraged as the principal method of control, measures which attempt to limit the spread of noise, once generated, are also of considerable value. The techniques include road design, the management of traffic flow and the use of screens and barriers.

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