7.1 NOISE POLLUTION: EFFECT OF CONSTRUCTION ACTIVITIES ON THE URBAN ENVIRONMENT.

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Abstract:
Noise in construction sites continues to constitute a nuisance to the environment in such a way that it interferes with speech, communication, leisure and relaxation. This has resulted in the loss of hearing partially and in some instances a total loss of hearing. Problems related to noise also include stress, high blood pressure, sleep loss, distraction and less productivity, and a general reduction in the quality of life and opportunities for tranquillity. The methodology used for this research work includes personal observation through visit to Construction sites and oral interview. This paper looks into the problem of noise generation on site and proffers solutions on how to control and minimize its effect on the environment. It concludes by advocating that noise as a result of construction activities should be controlled at its source through proper design and maintenance of machines, use of vibration absorbing mounting materials and mufflers on machines.

Keywords: *construction, effect, environment, noise, pollution.*

INTRODUCTION

Environment according to Cunningham, (1999) as quoted by Ojoye and Yahaya (2007), was defined as the circumstances or conditions that surround an organism or group of organisms. It was further defined as the complex of social or cultural conditions that affect an individual or community. The rapid growth and high rate of development in an urban environment was as a result of man seeking for comfortable environment. Man therefore, engaged in some construction activities in order to improve on the environment to make it a habitable place for livings. These activities to modernize an environment constituted some level of noise as well as constituting nuisance to the environment in such a way that it interferes with speech, communication, leisure and relaxation.

Noise, an unwanted sound is one form of environmental contamination that disappears when source is turned off. Yet it is a form of environmental degradation and has implications for health that may be as serious as air and water pollution. Aremu, (2007). Noise as a pollutant can be defined as unwanted sound. This unwantedness, results from the negative effect noise has on the listener. Thus, noise is sounds that disturbs, interferes with, or harms.

Moreover, sound can be distinguished from noise in that sound is defined as the sensation perceived by the sense of hearing or, alternatively, as the mechanical radiant energy that is transmitted by longitudinal pressure waves in material medium (as air) and is the objective cause of hearing. It is well known that unwanted sound can cause permanent loss of hearing, damage to heart, increase the level of cholesterol in the blood and raise the blood pressure. The advancement of technology and construction activities has invariably increased noise and its effect unlike when they are not in existence.

Moreover, before the days of machines and mechanical transportation equipment, our noise environment consisted of noises such as those of household activities, animals (including a few blood-curdling wild ones), horse-drawn vehicles, hand tools and weather. But human ingenuity changed all this by creating Machines, Motor Vehicles, Subways, Radios, Guns, Bombs, Fire Sirens, Jet Aircraft, and New Year's Eve Horns. Noise has become such a pervasive aspect of working situations and community life as to be referred to as **noise pollution** and to be considered as a health hazards. McCormick, and Sanders, (1982).

This paper therefore, looks into the problem of noise generation as a result of construction activities and proffers solutions on how to control and minimize its effect on the environment.

NOISE CHARACTERISTICS

Noise has all the properties of sound (including the objectionable ones). Thus, noise energy propagates as a wave (through the air) with a definite velocity, pressure, wavelength, frequency and spectrum. Noise propagation in air is similar to sonar (sound wave) propagation in water.

Physical Properties and Measurement of Sounds

Physical properties:

Noise by definition is generally accepted as unwanted sound. To have a satisfactory understanding of the effect o noise, it will be useful to look briefly at the physical properties of sound.

Sound is the result of pressure change in a medium (usually air), caused by vibration or turbulence. The amplitud of these pressures is stated in terms of sound level, and the rapidity with which these changes occur is the sound' frequency. Sound level is measured in **decibels** (abbreviated **dB**), and sound frequency is stated in terms of cycle per second, or nowadays, **Hertz** (abbreviated **Hz**). Sound level in decibels is a logarithmic rather than a linea measure of the change in pressure in respect of a reference pressure level. A small increase in decibels ca represent a large increase in sound energy. Technically, an increase of 10dB represents a tenfold increase. The ear, however, perceives a 10-dB increase as doubling of loudness. Sutter (1991).

The duration of the sound, and the way it is distributed with time is another important aspect. Continuous sounds have little or no variation in time, intermittent sounds are interspersed with quiet periods, and impulsive sounds are characterized by relatively high sound levels and very short durations.

Some of the determinants of the effect of noise are mainly by the duration and level of the noise, which are also influenced by their frequencies. Long-lasting, high-level sounds are the most damaging to hearing and generally the most annoying. High-frequency sounds tend to be more hazardous to hearing and more annoying than low-frequency sounds. The way sounds are distributed in time is also important, in that intermitted sounds appears to be somewhat less damaging to hearing than continuous sounds because of the ear's ability to regenerate during the intervening quiet periods. However, intermitted and impulsive sounds tend to be more annoying because of their unpredictability.

Measurement of Sounds:

The instrument for measuring noise is the basic sound level meter or a number of its derivatives, including noise dose meters (usually called **dosimeter**), integrating sound level meters, graphical level recorders and community noise analyzers. Improvements in all of these instruments have taken place during the last decades. Now computerized dosimeter and integrating meters are used to measure, compute, store and display comprehensive data on the noise field (Earshen, 1986) as quoted by Suter, (1991). These instruments are capable of measuring over very wide dynamics range and to measure impulsive sounds with a high degree of accuracy.

ACCEPTABLE LIMIT OF NOISE

In trying to figure out the upper ceiling of noise that would be acceptable in a given situation, the question of the criterion of acceptability immediately bobs up. In typical work situations, hearing loss is perhaps the Prime Criterion for acceptable noise levels. Some noise is ever with us, but in large doses it is a potential bugaboo as far as speech communications are concerned, whether it is ambient noise (noise in the environment) or in-line noise in a communication system. Various approaches have been carried out with the view toward developing systematic procedures for evaluating the effects of noise on speech. The indices that resulted from a couple of these approaches will be described briefly, namely the preferred octave speech interference level (PSIL) and the noise criteria (NC) curves.

Preferred - Octave Speech Interferences Level (PSIL):

McCormick and Sanders (1982) referred to Peterson and Gross 1978 Reports which used Octave Speech Interference Level as a gross basis for comparing the relative effectiveness of speech transmission under different environment of reception. For any given situation, it is actually the simple numerical average of the decibel levels of noise in three octave bands, namely, those with centres at 500, 1000, and 2000 HZ. Thus, if the decibel levels of noise in the octave bands are 70, 80 and 75 dB, respectively, the PSIL would be their average, 75dB. The PSIL is useful as a rough index for estimating the effects of noise on speech intelligibility, especially if the noise spectrum is relatively flat. It loses some of its value if the noise has intense low-frequency components, has an irregular spectrum, or consists primarily of pure tones. The speech interferences level (SIL) (without the "preferred") usually refers to the arithmetic average of the levels in an earlier used set of three octave bands: 600 to 1200: 1200 to 2400; and 2400 to 4800 Hz (McCormick and Sanders (1982).

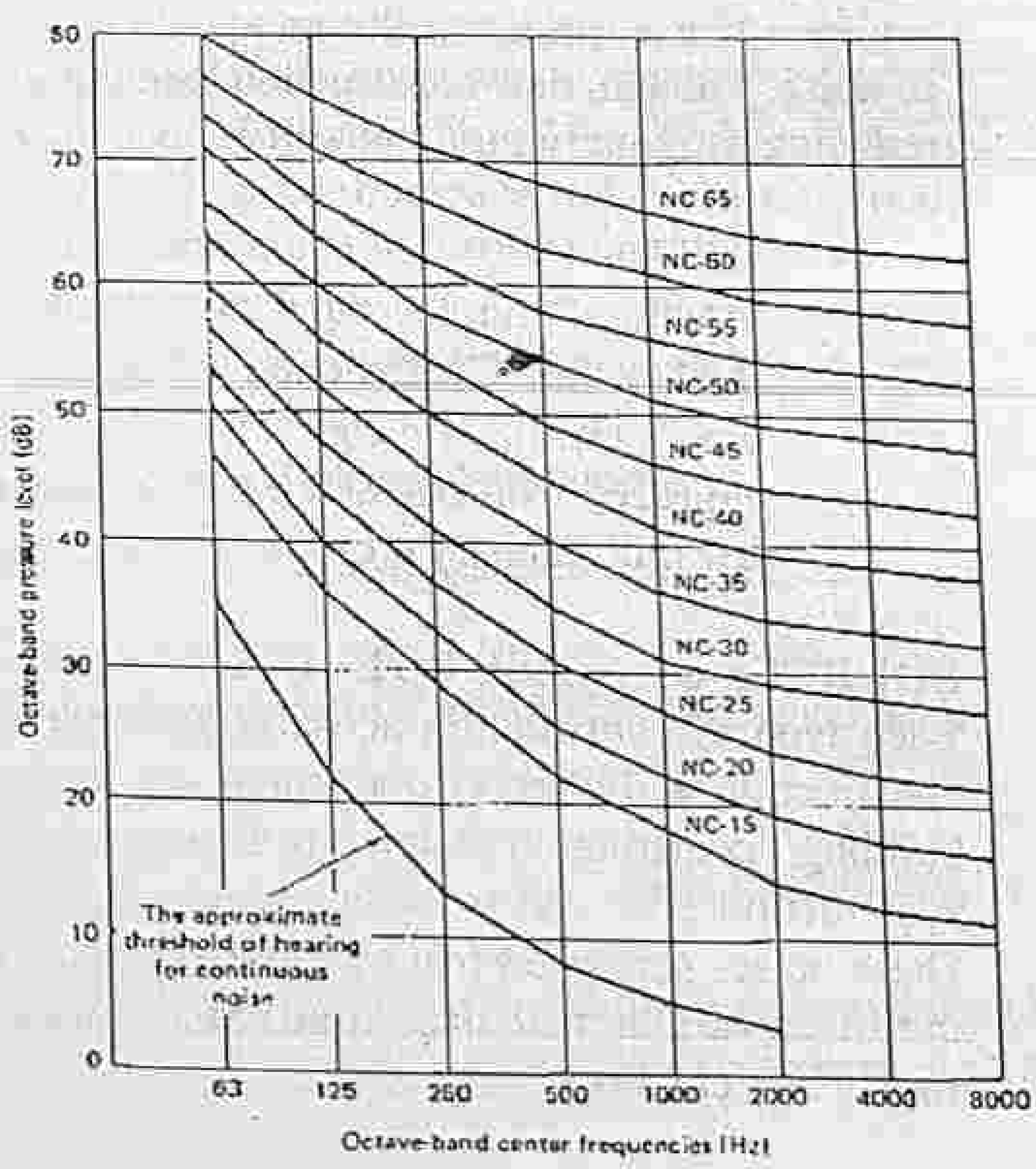

Fig 1:.Showing Noise Criteria Curve,
Source: McCormick, and Sander, (1982)

Noise criteria (NC) curves:

These curves, originally developed by Beranek in 1957 as was referred by McCormick and Sanders (1982) are particularly useful for evaluating background noise inside office building, in rooms and halls in which speech communications are important. A set of NC curves is shown in figure 1. In use, the noise spectrum of the area is plotted on the chart, and each octave – band level is then computed with the NC curves to find the one that penetrates to the highest NC level. The corresponding value on the NC curve is the NC rating of the noise.

The above figure is a Noise Criteria (NC) curves used in evaluating noise levels of various rooms or spaces in which speech communications are important. Generally human ear is not equally sensitive to all frequencies of sound and therefore we are less sensitive to low frequencies (below 1000 Hz) and more sensitive to higher frequencies. The summary of the graph is that when the Octave Band Centre Frequencies decreases, the Octave

Band Level in decibel increases and vice visa. In fig.1, the noise level at 2000 hertz is rated 15, 20, 25, 30, 35, 40, 45, 50, 60 and 65 decibels respectively since that is the value of octave band of the noise that penetrates to the highest NC Level.

Table1. : Showing the Maximum Preferred-Octave Speech Interference Levels (PSIL) for Certain Types of Rooms and Spaces

TYPE OF ROOM	Maximum Permissible PSIL (measured when the room is not in use)
SECRETARIAL OFFICES,TYPING	60
COLISEUM FOR SPORTS ONLY(AMPLIFICATION)	55
SMALL PRIVATE OFFICE	45
CONFERENCE ROOM FOR 20	35
MOVIE THEATER	35
CONFERENCE ROOM FOR 50	30
THEATERS FOR DRAMA, 500 SEATS (NO AMPLIFICATION)	30
HOMES, SLEEPING AREAS	30
ASSEMBLY HALLS (NO AMPLIFICATION)	30
SCHOOL ROOMS	30
CONCERT HALLS (NO AMPLIFICATION)	25

Source: McCormick, and Sander (1982) Human Factors in Engineering and Design

The above Table 1 gives a summary of Maximum Permissible Preferred Octave Speech Interference Level (PSIL) for certain types of rooms and spaces when not in use. For instance in the above table, Secretarial Offices is rated 60 PSIL, Conference Room for 20 people is rated 35 PSIL while Concert Hall is rated25 PSIL.

In summary, the noise spectrum of any given type of area not exceeds the recommended level for that type of area (such as shown PSIL in table 1).

NOISE AND CONSTRUCTION ACTIVITIES

Some noise experienced by man in an urban environment was as a result of various construction activities engaged by man. The new technology has replaced the use of some hand tools and other devices which existed with pre-human primates almost a million years ago. The use of hand tools have its detrimental effect as regards to noise. Though, new construction technology has indeed maximized the output in construction activities thereby reducing the time input, and still it constitutes a major source of noise. There are various types of construction activities which has become source of noise pollution to the environment namely:

- Building Construction e.g. Residential house, banks etc
- Structural Engineering Construction e.g. Bridges, dam etc.
- Boat or Ship Construction
- Steel Construction e.g. Steel Fabrication, Welding and Panel-beating
- Industrial Construction e.g. Manufacture of goods in factory like roof, coal, cracking of rocks (quarry) saw mill industry etc.

SOURCES OF NOISE POLLUTION /CONTROL

Each type of construction activity generates its own noise. Therefore, source of noise pollution as a result construction activities is dependent on the type of construction which generates it. For instance noise fr building construction site, structural engineering construction work, boat/ship construction, industr construction, steel construction and road construction.

These noises generated from various types of construction activities can be as a result of manual tools/equipm and other various machines used. Such machines include mechanical excavators, bulldozers, back hoe, dur truck, concrete mixers, cranes etc.

The various sources of noise under construction activities are listed below:-

1. Hand Tool Noise,
2. Fan noise in machines
3. Machinery Noise
4. Road Traffic/ Ground Transportation Noise.

Hand Tool Noise

In construction generally, hand tools are mostly used to aid in construction activities and these tools be sources of noise when in use. For instance, in the building construction, some of these tools when appli construction work produce noise which disturbs the environment. Such tools include cold chisel, saw, axe, digger and club harmer.

Control:

The control measure to this type of noise generation is through technical procedure which may include noise reduction improvements through protective devices for workers in occupations having high level of noise. E.g. plastic foam, earmuffs and earplugs made of rubber plastic or disposable materials such as wax impregnated cotton. Aremu et.al (2007)

Design approach can also be used through landscaping. Trees reduce noise either by absorbing or suppressing. The wood of deciduous trees, being of laminar structure, absorbs and transmits sonic waves, by adsorption, they also reduce their intensity. The cylindrical needles of conifers rather distribute sonic waves and these by mutual interference are reduced. A 30m wide, mixed deciduous and coniferous, dense forest belt reduces noise from 80 to 60 phons (Meister 1959) as cited by Kovacs (1985). The unit **phon** (of German origin) is used to indicate the loudness level of sounds. The loudness level in **phons**, then, is numerically equal to the decibel level of a tone of 1000 Hz, which is judged equivalent in loudness.

Fan Noise in Machines

Most fans in machines are noisy, even the "so – called" quiet fans. The level of fan noise may be estimated by the following formula:

$LW = KW + 10 \log Q + 20 \log P$

Where LW = estimated sound power level in dB ref 10^{-12} watt

KW = specific sound power level of fan

Q = volume flow rate

P = pressure

Further, the blade passing frequency (B_F) is determined by

$$B_F = \frac{\text{RPM multiplied by No. of blades}}{60}$$

Where, RPM = Revolution per minute

Control:

To minimize the necessity of reducing noise from fans with the installation of diet lining materials and dust bends; the following factors should be considered:

1. The air distribution system should be designed for minimum resistance since fan sound generation, regardless of fan type, increases with static pressure.
2. Fans with relatively few blades (less than 15) tend to generate pure tones that may dominate the spectrum. They occur at the blade passage frequency and its harmonies. (The blade passage frequency is the product of the number of blades and the blade rotation speed in revolution per second). The intensity of this tone depends on resonances within the duct system and a fan design, as well as inlet flow distortions.
3. The fan should be selected to operate near its maximum efficiency point when handling the required air quality and static pressure. Therefore, proper size is important in assuring a minimum of sound for any given type of fan.
4. Duct connections at both the fan inlet and outlet should be designed for uniform and straight air flow. Gusty and swirling inlet air flow particularly should be avoided. Also variations accepted application arrangements can severely degrade both the aerodynamic and acoustic performance of any fan typing and invalidate manufacturer's rating or other performance predictions.

Machinery Noise

This includes noise from electric motors, gear noise, noise from home appliances, building and construction equipment and noise from gas turbines – which has three sources namely the casing, the intake and the exhaust.

Control

Machinery noise can be controlled through the followings:

1. Making of machines quieter by the use of absorbent mounting.
2. Careful construction of the moving parts in order to decrease vibrations leading to noise.
3. To protect human ears when control at the source fails, ear plugs have been ingeniously designed to cut out loud sounds of certain frequencies while still permitting the hearing of conversational speech. .
4. The use of absorbing materials on the walls or built into the partitions and floors.

Transportation Noise

Vehicles like trucks, Lorries, train e.t.c are used to convey materials during construction activities and as a result pose serious noise problem. Transportation noise is a noise which comes as a result of road traffic or ground transportation. These noises are from the following:

- The engine
- The tyres friction on the roads
- Transmission in engines.

Control:

Planting of trees, shrubs, grasses should be adopted as well as reduction of these noises from the source.

THE EFFECTS OF NOISE

In general, it is observed that as the sound pressure level increases, the effects of noise spread from attitudinal to behavioural ultimately to physiological effects. Thus, at levels above 130 dB, noise can cause death, certainly intense pain and permanent damage to the hearing mechanisms. Therefore, the effects of noise will be outlined such that one can have an overall view of the effect at a glance as was cited by Adedibu (1996) in Edward's work in 1975. Listed them as follows:-

- It affects sleep
- It affects the performance of tasks
- It affects attitudinal and Social behaviour
- It affects the general health condition.

RESEARCH METHODOLOGY

The research method employed in this work includes personal observation through visit to Construction sites and oral interview conducted both within construction sites and the neighbourhood. Randomly, several construction sites were visited such include Roads and Building Construction Sites manned by Julius Berger Company at Abuja, even some private owned companies at Abuja were visited, various construction sites at Minna - the state capital of Niger state and some Building Construction Sites at Awka the state capital of Anambra state. Oral interviews were conducted by the researcher as regard to the effect of noise pollution on the urban environment as a result of construction activities.

Method of Data Collection

The research examined the effect of noise in construction industry through secondary and primary sources which involved the conduction of oral interview and site observation, in order to have firsthand information.

Study Area and Population.

A total of 120 persons were orally interviewed through selective random sampling. The oral interviews were conducted in Minna-Niger state and Abuja- the Federal Capital Territory. The Federal Capital Territory-Abuja had 80 people interviewed while Minna had 40 persons interviewed. The distribution of number of interviews conducted was based upon the trend of construction activities which is more in Abuja.

Sample Size

A total of 24 sites were visited and for each site 5 persons were interviewed (3 of the staff working on each site and 2 persons living around the site.). The distribution is shown in table 1.0

Table 1: Showing the sample size

Population Group	Number	Percentage expression
Site workers	72	60
People living around the site	48	40
Total	120	100

Source: Researcher's field work (2010)

A simple random sampling method was used in selection of sample base on proximity, access to information and representativeness. From the above table, it is observed that 72 out of 120 people selected are construction site workers representing 60% while 48 out of 120 people are people living around the site representing 40%.

Data Analysis

A total number of 120 persons were interviewed but only 104 people responded to all the questions asked. Therefore the data analysis used was based on 104 which represent 86% of the total number of persons that were interviewed.

Table 2: Showing Level of Noise Pollution

levels	No of respondents	Percentage expression
High	72	69
Moderate	25	24
Low	7	7
Total	104	100

Source: Researcher's field work (2010)

PERSONAL OBSERVATION BY THE RESEARCHER

The researcher also made several observations during the course of visits to various sites while conducting oral interviews. The major observation is high level of noise as a result of construction activities which interferes with speech.

NCLUSION

menace of noise and its effects on the urban environment as a result of construction activities can never be emphasized. Therefore, controlling of noise can be accomplished by attacking it from the source, along its and at the receiver. Control at the source include proper design and maintenance of machines, use of tion absorbing mountings and mufflers and use of sound absorption materials on the inside and outside ces of the machine. Controlling noise along its path includes use of barriers, enclosure, acoustical treatment baffles.

ally, there are many effective variations of these and other means that aid in noise reduction. Where the noise cannot reasonably be reduced to "safe" limits, some form of ear protection should be considered for those e who are exposed to the noise (especially factory workers).

ERENCES

ibu, A.A (1996) Man and pollution. Omoade printing press, Ibadan Pp15.

u, S.C, Olagunju R.E, Ayuba P, & Ogundele J. (2007) Environmental Pollution: Causes Effects. Prevention Strategies and Control Measures. Proceedings of 1st Annual National Conference of School of Environmental Technology, Federal University of Technology Minna Niger State, 28th February -2nd March 2007.Pp 207-213.

clopaedia, Britannica (Volume 17) Pp 32-34

cs, M. (1985), Pollution Control and Conservation, Chichester, Ellis Horwood Ltd. Page 358

ormick, J.E and Sander, M.S (1982) Human Factors in Engineering and Design. New York, Mc Graw-hill Publication (Pages 426-448)

, S. and Yahaya, T. I. (2007), Land Pollution and Its Effect on the Environmental. Proceedings of 1st Annua National Conference of School of Environmental Technology, Federal University of Technology Minn Niger State, 28th February -2nd March 2007.Pp 160-175.

A.H (1991) Noise and its Effects, A paper presented at 1991 Administrative Conference of the Unite States.