ENVIROMENTAL IMPACT ASSESSMENT AND MANAGEMENT OF NIGERIAN NATIONAL PETROLEUM CORPORATION (NNPC) MEGA STATION, AWKA, NIGERIA.

BY

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APPROVAL PAGE

CERTIFICATION

This work on Environmental Impact Assessment and Management of Nigerian National Petroleum Corporation (NNPC) Mega station, Awka, Nigeria has not been presented elsewhere for the award of a degree, or any purpose.

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We certify that this work on the Environmental Impact Assessment and Management of Nigerian National Petroleum Corporation (NNPC) Mega station, Awka, Nigeria has been carried out by Mr. Olajide Akinwumi Sunday, in the Department of Mechanical Engineering of the Federal University of Technology, Akure.

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DEDICATION

This work is dedicated to almighty God for his guidance and protection during the course of my programme.

ABSTRACT

In this work, the Environmental Impact Assessment and Management of Nigerian National Petroleum Corporation (NNPC) Mega station, Awka, Nigeria was carried out. The method adopted involved collection of Baseline Information, assessment of the impact on the environment, preparation of an Environmental Management Plan (EMP) and assessment of the effectiveness of the mitigation measures.

Data for impact assessment of the Mega station, Awka, was generated using Overlay, Leopold matrix, Peterson matrix and Batelle Environmental evaluation techniques. Under Overlay technique, data on environmental factors were obtained through aerial photography, topography and land inventory map. The land use suitability and engineering feasibility of establishing the Mega station was determined based on a number of overlays. Impact of interactions between the Mega station developmental activities such as deforestation, land excavation and clearing and the environmental factors such as temperature, rainfall, and soil, air and water qualities were determined using Leopold matrix technique through listing and matching these factors. Under Batelle technique, impact of human involvement in Mega station project was categorized into ecological, physical, chemical, esthetical and socio economical, from which environmental quality indices were estimated, using a 0-1 scale function. Negative or positive impact of human involvement was determined based on this index. In Peterson matrix technique, ordinal scale was used to further evaluate the impact of the Mega station on the human activities and the environment, from which impacts such as risk were determined to be low, medium or high.

The result on the mean and standard deviation analysis of the environmental baseline data on the meteorological parameters considered, shows that the percentage of the variance and/or errors (deviation) from the mean is not more than 10% on the average basis, hence the installation of a mega station in the study area is possible at a reduced cost and with minimal effect on the environment.

CHAPTER ONE

INTRODUCTION

Environmental impact assessment (EIA) is the process by which information about the environmental effect of a project is collected, assessed and taken into account by the planning service in reaching a decision on whether the proposed development should be granted planning permission. EIA can also be defined as a systematic process to identify, predict and evaluate the environmental effect of proposed actions in order to aid decision making regarding the significant environmental consequences of projects, development and programmes (Abebe and Smith, 2005).The World Bank operational directive of 1989 states: Environmental Assessment is a flexible procedure, which can vary in breadth, depth and type of analysis, depending on the project (ECA, 2005). It may be carried out at one point in time, stretched over a year to account for seasonal variation, or done in discrete stages.

International Association for Impact Assessment (IAIA) and Institute of Environmental Assessment (IEA), define EIA as the process of identifying, predicting, evaluating and mitigating the biophysical, social and other relevant effect of development proposals prior to major decision being taken and commitments made (ECA, 2005). As a decision making tool, EIA compares various alternatives for a project and seeks to identify the one which represents the best combination of economic and environmental costs and benefits (Canter and Hill, 1977).

The EIA is carried out by a developer although the task is often carried out by environmental consultants. EIA is carried out in order to produce an environmental statement. The environmental statement must include:

a. a description of the project: location, design, scale, size e.t.c;
b. description of significance of the impact;
c. mitigating measures; and
d. a non technical summary.

EIA systematically examines both beneficial and adverse consequences of the project and ensures that these effects are taken into account during project design. It helps to identify

possible environmental effects of the proposed project, proposes measures to mitigate adverse effects. Considering environmental effects and mitigation early in the project planning cycle, environmental assessment has benefit, such as protection of environment, optimum utilization of resources and saves overall time and cost of project. Properly conducted EIA also lessens conflicts by promoting community participation, in form decision makers, and help lay the base for environmentally sound projects.

A review of application of EIA in Africa shows that some forms of environmental assessment have occasssionally been carried out on major development initiatives prior to its systematic institutionalization in the region. There has been a steady increase in the number of EIA to development project. The steady increase in the number of EIA application received has been attributed to the enactment of EIA legislation, the establishment of institution, increase in the level of economic activity and a general increase in awareness about EIA requirements. The sectoral distribution of EIA application depends on the dominance of the sector in the economy and its potential impacts on the environment.

1.1 Problem Statement

In an effort to make petroleum products available to the public and initiate a relieve for various scarcities and other problems identified in the downstream sector of the oil industries, NNPC came out with the establishment of mega retail filling stations throughout the country. It indeed commenced operation in August 2002 when it commissioned its first retail outlet in Lagos to market petroleum products to the public. This was a strategic move intended to provide NNPC with:

a. The vehicle for intervention in the market during periods of emergency and avoidable supply interruptions;
b. A tool to benchmark the activities of key players in the distribution chain and ensure safe, orderly and profitable retailing of product in the country;
c. Outlets for its own product in a deregulated environment on acceptable commercial terms; and
d. A vehicle to achieve its world-class vision by integrating its upstream and downstream businesses in a similar manner to the other National and

International oil companies.

NNPC delights many homes by establishing the Mega station project which undergoes a pre-commencement study known as Environmental Impact Assessment (EIA).

This project will definitely have impact on its immediate environment and this impact must be assessed in order to forestall unwanted occurrence in the nearest future; this is the aim of this study.

1.2 Objectives

The main objective of this research is to assess the environmental effects of the NNPC mega stations.

The specific objectives are to:

a. provide database for environmental impact assessment of petrol stations in Nigeria;

b. enhance environmental protection, security and global stabilization through proper implementation of the Environmental Impact Plan (EMP).

CHAPTER TWO

LITERATURE REVIEW

EIA is one of the successful policy innovations of the 20th century for environmental conservation. Thirty- seven years ago, there was no EIA, but today it is a formal process in many countries and is currently practiced in more than 100 countries. EIA is a mandatory regulatory procedure originated in the early 1970's, with the implementation of the National Environmental Policy Act (NEPA) in the United States. According to Goodland and Mercier, (1996) forms of what later became known as environmental assessment had started under town planning, land use and other policies prior to this period. Between 1970 and 1975 mandate and functions of EIA was established in the USA; it was latter adopted by a few other countries (e.g. Australia, Canada, and New Zealand); basic concept, procedure and methodology still apply. Increasing scope and sophistication started in mid '70s to early '80s. This involves more advanced techniques (e.g. risk assessment); guidance on process implementation (e.g. screening and scoping); social impacts considered; public enquires and reviews. Process strengthening and integration started in early '80s to early '90s.This involved review of EIA practice and experience; scientific and institutional frameworks of EIA updated; coordination of EIA with other processes, (e.g. project appraisal, land use planning) ecosystem-level changes and cumulative effect began to be addressed. The early '90s to date saw the era of strategic and sustainability orientation. This period EIA aspects enshrined in international agreement marked increase in international training, capacity building and network activities.

2.1 EIA in the Oil Industry in Nigeria

The first seminar on pollution of the Nigerian environment from oil industry activities was held in Port Harcourt in 1979. There has been a growing public and government concern about the pollution of the Nigerian environment. Slow poisoning of water is already witnessed in this country and the destruction of vegetation and agricultural land by oil spills which occur as a result of petroleum operations. With increasing public awareness of the damage done by oil operations on the environment, government has intensified

measures to combat these problems. In October 1979, the Federal Government created the Federal Ministry of Housing and Environment; this ministry took the realistic step of formulating a general policy for environmental protection and control.

Immediately after the 1979 seminar, the petroleum inspectorate of the NNPC established an environmental affairs unit within its field of operations and departments. The unit ensures that oil field operation is carried out at acceptable standard and in accordance with the provision of the various petroleum laws and regulations. The unit also maintains a close liaison with the Federal Ministry of Housing and Environment. The petroleum inspectorate has closely monitored the activities of the oil companies and has ensured that oil field operations are conducted in accordance with good oil field practice (PINE, 1983).

2.2 The EIA Process

The stages of an EIA process will depend upon the requirements of the country or donor. However most EIA processes have a common structure and the application of the main stage is a basic standard of good practice. The environmental impact assessment consists of eight steps with each step equally important in determining the overall performance of the project. Typically, the EIA process begins with screening to ensure that time and resources are directed at the proposal that matter environmentally and ends with some forms of follow up on the implementation of the decision and taken as a result of an EIA report. The eight steps of the EIA is briefly presently as follows (Gilpin, 1995).

a. ***Screening:*** This stage of EIA, which determines whether the proposed project, requires an EIA, then the level of assessment required;
b. ***Scoping:*** This stage identifies key issues and impact that should be further investigated. This stage also defines the boundary and time limit of study;
c. ***Impact analysis:*** This stage of EIA identifies and predicts likely environmental and social impact of the proposed project and evaluates significance;
d. ***Mitigation:*** This step in EIA recommends the actions to reduce and avoid the potential adverse environ..ental consequence of development activities;
e. ***Reporting:*** This stage presents the result of EIA in a form of a report to the decision-making body and other interested parties;

f. ***Review of EIA:*** It examines the adequacy and effectiveness of the EIA report and provides information necessary for the decision-making;

g. ***Decision-making:*** It decides whether the project is rejected, approved or needs further change.

h. ***Post Monitoring:*** This stage comes into play once the project is commissioned. It checks whether the impact of the project does not exceed the legal standards and implementation of the mitigation measures are in the manner as described in the EIA report.

Each stage of the EIA process has been described in detail subsequently. The overview of the EIA process is represented in Fig. 2.1

2.3 Three Core Values of EIA

The three core values of EIA are

a. ***Sustainability:*** The EIA process will result in environmental safeguards

b. ***Integrity:*** The EIA process will conform to agreed standards

c. ***Utility:*** The EIA process will provide balanced, credible information for decision making,

and the basic guiding principles of the Environmental Impact Assessment have been to:

a. inform decision makers as a result in appropriate levels of the environmental protection and community well being;

b. apply the best practicable environmental option' (BPEO) and 'best available technique not entailing excessive cost' (BATNEEC) methodologies to minimize the environmental impact of the plant;

c. provide information and output which assist with problem solving and are acceptable to and are able to be implemented by.the project team;

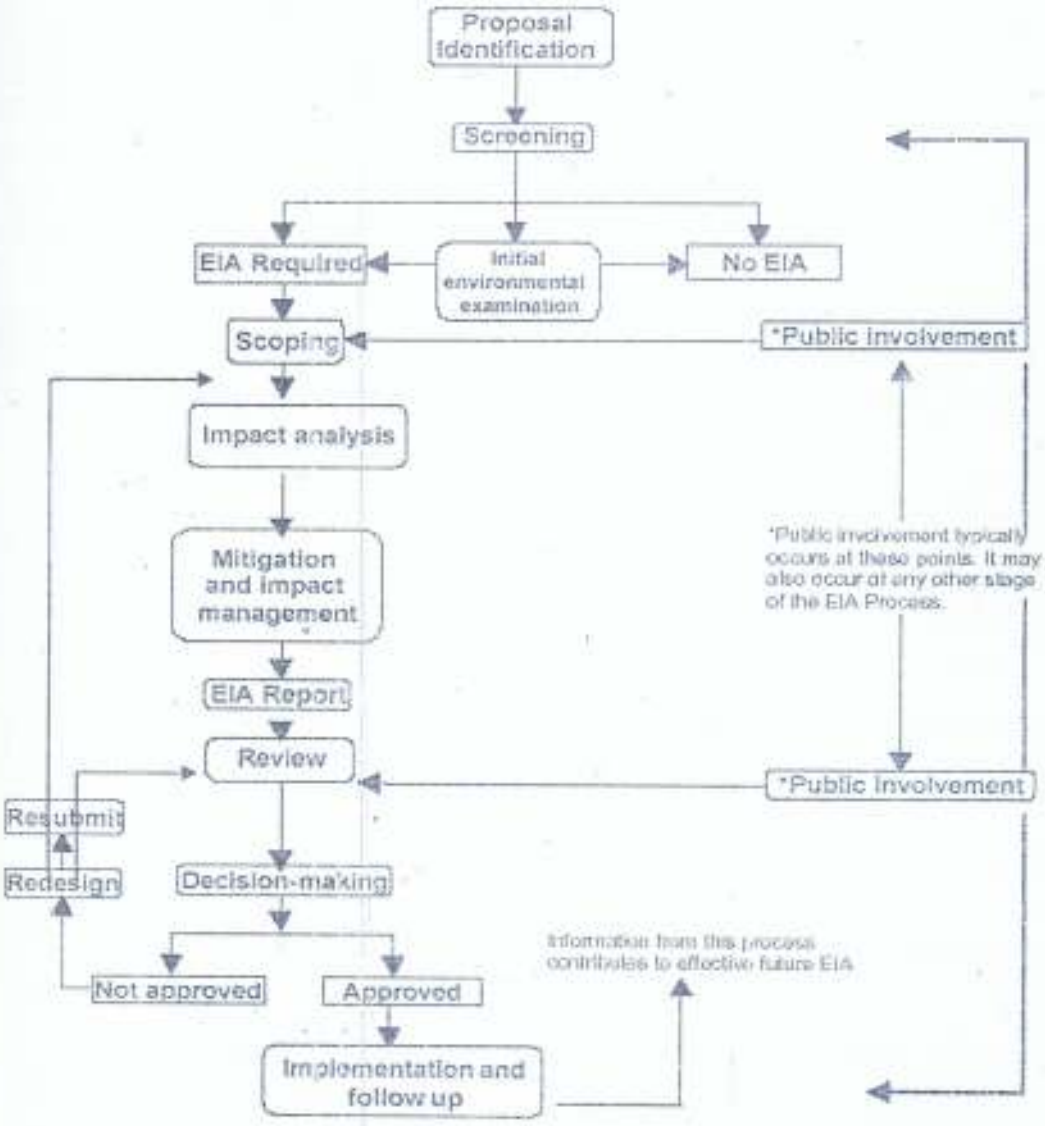
d. focus on significant environmental effect and key issues;

e. allow opportunities for participation by authorities involved;

f. ensure that the EIA team has involved appropriate techniques and experts from the relevant disciplines, including local experts, and to ensure that this team has had the chance to interact on the interrelationship between the

biophysical, social and economic issues;

g. provide as far as possible, an objective, rigorous and balanced assessment of the issues;



Source: http://www.euro.eu.int/comm/environment/eia/eia-guidelines/g-review-fulltext.pdf

Figure 2.1: Generalized process flow chart of the EIA process.

2.4 EIA OPERATING PRINCIPLES

EIA should be applied;

a. to all departmental project activities likely to cause potential significant adverse impact or add to actual or potential foreseeable cumulative effects;
b. as a primary instrument for environmental management to ensure that negative impact are minimized, avoided or rehabilitated;
c. so that the scope of review is constant with the nature of the project or activity and commensurate with the likely issues and impacts; and
d. on the basis of well defined roles, rules and responsibilities for key actors,

EIA should be undertaken;

a. throughout project cycle, beginning as early as possible in the concept design phase;
b. with clear reference to the requirement for project authorization and follow-up, including impact management;
c. consistent with the application of 'best practicable' science and technology in accordance with established procedures and project-specific terms of reference, including agreed timeliness; and
d. to provide meaningful public consultation with communities, groups and parties directly affected by, or with an interest in the project and/or its environmental impacts.

EIA should provide basis for;

a. environmentally sound decision making in which terms and conditions are clearly specified and enforced;
b. design, planning and construction of acceptable development projects that meet environmental standards and resource management objectives;
c. an appropriate follow-up process with requirements for monitoring, management, audit and evaluation that are based on the significance of

potential effects, the uncertainty associated with prediction and mitigation, and the opportunity for making future improvements in project design or process application.

Benefits of EIA include;

a. more environmental sustainable design;
b. better compliance with standards;
c. saving in capital and operating costs;
d. reduced time and cost for approvals;
e. avoid later plant adoptions;
f. reduced health costs; and
g. increased project acceptance.

2.5 Impact Assessment Methodology

There are several approaches and techniques developed for evaluating potential impacts of any project on the environment. Some of which were developed in the early 1970s and lean heavily upon approaches used in other spheres of environmental management (Glasson and Chadwick, 1994). The Overlays techniques ; Leopold matrix; Battelle Environmental Evaluation System; and Peterson Matrix are among the most widely used methods employed for impact assessment.

The overlay technique:

The overlay technique uses a series of transparencies to identify, predict, assign relative significance to, and communicates impacts in a geographical area. In this method, the study area is sub-divided into convenient geographical units, based on uniform spaced grid points, topographic features or differing land uses. Within each unit, the assessor collects information on environmental factors, through aerial photography, topography, land inventory maps, field observations, public meetings and discussions. The concerns are assembled into a set of factors, and used to draw a regional map. Based on series of overlays the land-use suitability, action compatibility, and engineering feasibility are evaluated visually, in order that the best combination may be identified.

Leopold Matrix:

This method is useful as it reflects the fact that impacts result from interaction of development activities and the environment. Thus, Leopold Matrix is a comprehensive checklist designed for the assessment of impacts associated with almost any type of construction project. One hundred possible project actions are listed on one axis, eighty-eight human and natural environmental elements on the other. The Leopold matrix is also used to present the results of an appraisal. Numbers representing magnitude and significance, expressed on a 10-point scale, are included in each cell indicating where a likely impact is anticipated. Positive and negative impacts are identified with '+' or '-' sign, respectively.

Battelle Environmental Evaluation System:

The Battelle Environmental Evaluation system involves the separation of human concerns into four categories namely, ecology, physical/chemical, aesthetics and socio- economics. The method translates the state of individual environmental parameters into arbitrary, environmental quality indices all expressed in the same scale. For each component, the Battelle system develops an index of environmental quality, normalized to a scale ranging from 0 to 1, using a value function method. Each impact indicator is given as the difference in environmental quality between the states with and those without actions. Environmental quality scores are multiplied by the appropriate weightings and added to give a total score of environmental quality for each option under consideration.

Peterson Matrix:

Peterson Matrix is a modified version of Leopold matrix, adopted for the screening and scoping exercise of this project. This matrix relies directly on the multiplication properties of matrices. An ordinal scale is used to evaluate individual impacts by a team of assessors, and separate matrix layers are produced for physical and human impacts. The matrices are also multiplied to find the effect of the casual elements on human environment while the resulting product is weighed according to the significance of the human impact.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Baseline Data Collection

The Environmental impact assessment on the Mega station involves capture of Baseline ecological, social and health conditions of the project environment. The Environmental Assessment Document for the project was prepared using multi-disciplinary study strategies including desktop reviews. The methodology adopted in conducting the EIA for the Mega Station (MS) is articulated as follows.

a. Preliminary activities (entailing contracting, preparation, project scoping, literature review, etc);
b. Environmental baseline data acquisition, analysis and interpretation;
c. Impact assessment process (identification, categorization, and evaluation of impact significance); and
d. Proffering mitigation measures (adopting industrial standard practices, project experiences, etc);

Preliminary Activities

Preliminary activities in the EIA study included project initiation, development and submission of the project proposal for approval. The proposal contained synopsis of the project and the general scope of the EIA study, the regulatory framework for conducting the study, objectives, baseline data requirements and assessment tools and methods for the EIA.

Desktop/Literature Survey

Prior to field data gathering, desktop/literature survey would be carried out, and this generally involves consulting relevant textbooks, research publications, articles, maps, report on previous environmental surveys/previous project as well as technical presentations relevant to the study area. This is done in order to obtain relevant background information on the biophysical and social environment of the study area.

Results from desktop research would now be used to identify information gaps on the baseline status of the study area and hence the definition of the extent of the field investigation / data collection. Further research would also be conducted at the end of

the field data gathering exercise in order to compare literature information with generated field data and for additional information on the study area.

Consultation with Stakeholders and Experts

Consultation would be carried out to solicit stakeholders' views on the proposed actions. This involves engaging the stakeholders in a dialogue characterized by two-way flow of information that enables the potentially affected population to contribute information that might influence the decision-making process in project design, mitigation, monitoring and management plans, as well as the analysis of the alternative approaches to be considered. Consultation would also be conducted with Nigerian authorities with regulatory responsibility for environmental matters such as the Federal Ministry of Environment.

Impact Identification and Evaluation

The environmental aspects and impact of the proposed project that may interact positively or negatively with the environment during the construction, operation and decommissioning phases would be identified at this stage of assessment.

Impact Mitigation

Mitigation measures designed to prevent, reduce or control the adverse impact of the proposed project activities would be formulated using professional judgment based on previous project experiences, proven scientific methods and sound engineering practices.

3.2 Baseline Data Acquisition Methodologies

The field investigation would be preceded by a reconnaissance survey covering entire project stretch to identify host communities and smoothen sampling strategies. A number of documents and literature would also be consulted as part of the reconnaissance survey of this study.

a. Nigeria in Maps: Eastern States. Edited by Ofomata.(1975)

b. Natural Resources Conservation Council of Nigeria (NARESCOM) (1992) Report

c. Environmental Baseline Studies for the Establishment of Control Criteria and Standards against Petroleum-Related Pollution in Nigeria. Progress Report No. 5 by RPI (1984).

d. Interim Report on Gully Erosion (Nigeria), an IDRC/CRDI- (1996) Supported Project

e. Environmental Impact Assessment of Atlas Cove Optimization Project by NNPC (1997)

f. Digest of Statistics (1994). Federal Office of Statistics, Lagos.

g. Ground Water Study and Development in Nigeria, (2002) Offodile

3.3 Field Data Gathering and Sample Methodology

The field study involves a comprehensive capturing of data on climate and meteorology, air quality and noise, soil, vegetation, water quality, hydrogeology, wildlife, socio-economic and health assessment. Each of these environmental components is sampled in accordance with DPR EGASPIN (1991) (Part VIII) D (2) sampling and handling of samples procedures.

Sample Collection and Handling

This is carried out as far as possible in accordance with DPR (1991) Guidelines and Standards (Part (VIII) D (2) (Sampling & Handling of Samples)). Where logistic and safety considerations precluded strict compliance with the above guidelines and standards, other proven, scientifically acceptable methods of sample collection and handling would be used.

Laboratory Analysis

The methods of analysis used are those specified in DPR Guidelines and Standards and other International Analytical Standards such as APHA for water quality. Trace metal analysis was done using Atomic Absorption Spectrophotometer duly calibrated using standards. Physicochemical parameters were determined using DREL 2000 HACH Spectrophotometer and Orion ISE Meter Model 710A, duly calibrated with standards, as well as Flame Photometer. Other equipment required for the analysis include pH, Dissolved Oxygen, TDS and Conductivity meters.

Statistical Analysis

Errors in field data include those resulting from the instrument and those introduced by the observer. With proper, sustained calibration of the instrument and the use of standardized observational procedures, equipment errors are brought to acceptable minima. However, other errors may arise from the method of sampling. Errors often arise from two-stage sampling or sub sampling, or even from the fact that the samples collected are not representative samples of the medium. There are also spatial variations of the same medium, e.g. soil and water. Thus, it is necessary to determine the true mean and the estimated variance among the number of samples taken, so as to establish a reasonable level of confidence in the results obtained. A good result is obtained when the variance is within 5-10% of the mean (Gupta, 1991).

Data Coding and Manipulation

EIA studies in most developing countries where reliable data banks are non-existent, invariably involve acquisition of large amounts of baseline data. To ensure preservation of the integrity of data collected, data coding forms were used in the field in such a way that field data could be directly entered into computer data sheets.

Samples are properly sealed and labelled. All data collected are labelled and information such as the following provided:

a. Identification code or sample number
b. Date and time of sampling
c. Description of sample

d. Methods of sampling

e. Particulars of any photographs taken.

The details of the methodology for the acquisition of data for each of the environmental components are indicated.

3.3.1. Climate and Meteorology

In situ measurement of wind speed, wind direction, relative humidity and temperature were obtained using krestrel 4000 weather tracker. Also, complementing climate data were also obtained from the National Meteorological Agency Oshodi, Lagos, literature review and the Internet. The data collected include yearly records of rainfall, temperature, relative humidity and wind speed.

Air Quality

The ambient Suspended Particulate Matter (SPM) levels were sampled using the Hi-Volume sampler with its associated parts such as Vacuum pump and portable power generator.

The concentrations of the air quality parameters were sampled *in situ* using Testo 350 – XL Abgas – analyzer. Ambient temperatures were measured using the Testo 350 – XL analyzer and a weather tracker.

Noise Level

A SPER SCIENTIFIC Digital sound Level meter (840029) was used to measure the noise level of the location. The equipment measures noise via a microphone probe that generates signals approximately proportional to located sound waves. Measurements were done by directing the probe towards the direction of the prevailing wind and readings recorded at stability.

Soil and Water Sampling

Generally, the sampling strategy was based on a number of considerations, including habitat type, land use, land/soil surface condition and weariness of certain features to the

project site. Hence, the following points were sampled:

- NNPC mega station site (Impact Point)
- 100 m and 200 m (East) away front the mega station
- 100 m and 200 m (West) away from impact point.
- 100 m and 200 m (North) away from Impact point and,
- 100 m and 200 m (South) away from Impact point.

Soil Sampling Design

The soils of the study area were examined by choosing sampling points as stated above. Random soil samples were collected at each site by means of Dutchman hand soil auger (Smith and Akinson, 1975). At each point, composite soil samples were collected to give a representative soil of the area.

Surface (0 – 15 cm) and subsurface (15 – 30 cm) soils were collected into plastic bags and transported within 48 hours to the Laboratory for Physico-chemical and heavy metal analysis. The samples were bulked and bagged separately in accordance with (Hodgson, 1983). Soil samples meant for total hydrocarbon determinations were wrapped with aluminium foil and immediately placed in ice-cooled chests for storage and transportation to the Laboratory. On arrival to the Laboratory, the samples were also refrigerated until the time of analysis.

Water Quality Study Design

In collecting water samples, quality control/assurance (QC/QA) measures were adopted in accordance with standard procedures published by DPR (1991); FEPA (1991).

a. On the spot (*in situ*) measurements of physico-chemical parameters such as pH, temperature, conductivity, Total dissolved solids (TSD) and dissolved Oxygen using appropriate instruments (e.g. Dissolved Oxygen Meter) which have been properly calibrated against standards.
b. Preservation of water samples at 4°C in cooler before transportation to the laboratory for other laboratory analysis.
c. Acidification of water samples that were collected for heavy metal analysis,

with 1 ml concentrated nitric acid per litre to preserve the heavy metals in ionic forms and prevents precipitation and adsorption.

d. Fixing of water samples for the determination of dissolved Oxygen (DO) in the field by the addition of 0.1M magnesium sulphate solutions and alkaline solution of potassium iodide. Water samples for determination of Biological Oxygen Demand (BOD) were wrapped in black polythene bags and stored at 20°C for 5 days.

3.3.2 LABORATORY METHODS

Soil Analysis

The analysis is performed on sub-samples of the air-dried soil samples using materials less than 2 m.m diameter of the fine earth. Concentrations are expressed on a dry weight basis. The following physicochemical parameters were determined on a soil pH, electrical conductivity, organic carbon, total and mineral nitrogen, exchangeable cations, chloride, sulphate, moisture content. Analysis for heavy metals, Mn, Pb, Cr, Cd, V, Zn, Cu and Fe were determined whole, those for oil content (THC) were measured using fresh soil samples (Odu *et al,* 1985). The description of the methods used for the different analyses carried out on soil samples are as follows:

Measurement of PH

The soil pH was measured in 1:2.5 slurry of soil in water using Corning pH meter model 7. The pH was determined by dipping the electrode into a 1:2.5 soil water suspension that had been stirred and allowed to equilibrate for about 1 (one) hour.

Electrical Conductivity (E.C)

The E.C of soil samples was determined and the filtrate obtained after filtering the suspension used for pH determination. The conductivity bridge used for the measurement was the Lovibond Conductivity Model Type CM-21 Bridge Conductivity was expressed as µs/cm.

Nitrate

Nitrate-nitrogen was determined in soil obtained by shaking 5g of a representative soil sample with 50 ml of K_2SO_4. Nitrate-Nitrogen was determined by the phenol disulphuric acid method (Odu, *et al* 1985).

Exchangeable Cations

Exchangeable sodium, potassium, calcium and magnesium were extracted with neutral (PH = 7) ammonium acetate extraction method by (Thomas, 1982). The filtrate was used for the determination of Na and K by flame photometry, while Ca and Mg was by EDTA titration method.

Sulphate

Sulphate was measured by turbidimetric method using glycerol and $BaCl_2$ combination as described by (Odu, *et al* 1985).

Oil Content

The oil contents (THC) of the soil was determined by shaking 10 g of a fresh soil sample with 20 ml of toluene and the oil extracted was determined by the absorbance of the extract at 420 nm in a spectronic 21D spectrophotometer. Oil concentrations were then calculated.

Heavy Metal (Trace Elements)

Trace elements concentration Pb, Cr, V, Mn, Fe, Hg Zn, Ni and Cd were determined after extraction with HCL/HNO_3 mixtures. This procedure will release heavy metals tightly bound in clay minerals. The concentrations of the metals were determined by atomic absorption spectrophotometer (Sawyer and McCarty, 1987).

Water Analysis

The sampling and handling of the water samples were carried out as recommended (DPR Guidelines and standards, 1991). To ensure the integrity of some unstable physiochemical parameters, *in-situ* measurements of pH, Temperature, Dissolved oxygen, electrical conductivity and TDS were carried out in the field.

The laboratory analysis of their physico-chemical parameters was done in keeping with standard practice specified under DPR guidelines and standards (1991) as well as international analytical procedures and standard methods for water and wastewater quality measurements. Investigations involving the heavy metal concentrations were carried out using atomic absorption spectrophotometer . The exchangeable cations and anions were measured using flame photometer and spectronic 21-D spectrophotometer.

3.4 Socio-Economic Studies

The methodology adopted for generating data on socio-economic parameters for this EIA study includes the followings:

a. Reconnaissance visit to the study area;
b. Review of relevant literature;
c. Visit to proposed project site and neighborhood for administration of questionnaire;
d. Participatory forum/focused group discussions (FGDs) and interactions with stakeholders; and
e. Deployment of professional knowledge and experience, as well as general observations.

3.5 Site Meteorological Data

Mean values of meteorological parameters including wind speed and direction, temperature, pressure and relative humidity were measured within the study area during air quality monitoring. Meteorological parameters especially wind speed and directions are known to contribute to levels of fumigation arising from emissions of pollutants into the environment. Wind speed and directions are the main factors that control pollutants transport. However, during the transport, the concentrations are diluted by diffusion processes and depleted from the atmosphere by dry deposition, while, during rainfall the pollutants can be washed out resulting in wet deposition. The spatial mixing volume available to pollutants in the air basin extends from the ground surface to the top of the boundary layer. This is also dependent on the atmospheric turbulence at the time of sampling.

After the results from the baseline data analyses for the considered meteorological parameters are within the acceptable limits, the detailed discussion on the environmental, social and health effects of the proposed NNPC Mega Station in the study area is necessary. The following aspects were considered: identifying associated and potential environmental impacts of the proposed project activities, predicting the characteristics and magnitude of impacts (direct, indirect, residual, cumulative, beneficial, short term, long term, etc) and Proffering appropriate mitigation measures for the impacts. Moreover, at every phase of the project, including the actual construction activities, considerations for environmental protection and conservation shall be taken care of.

3.6 Associated and Potential Impacts Assessment

It has become necessary to undertake an early and open process for determining the scope of issues to be addressed and for identifying the significant issues relating to a proposed action. It is important that the effective screening of actions takes place in all environmental assessment systems. Without it, unnecessarily large numbers of actions would be assessed and some actions with significant adverse impacts may be overlooked. The determination of whether or not an environmental assessment is to be prepared for a particular action should hinge upon the likely significance of its environmental impacts. (Peavy, 1985) identified two broad approaches to the identification of such action and they include:

a. The compilation of list of actions, accompanying threshold and criteria (which may include location characteristics) to help in determining which actions should be assessed, and
b. The establishment of a procedure (which may include the preparation of a preliminary or intermediate environmental assessment report) for the case-by-case (discretionary) determination of which actions should be assessed.

To undertake this process, an assessment of the environmental impacts of action should be made. For this project, the likely significant potential impacts of the

proposed project on the ecosystem of study are derived from the following:

a. Knowledge of the project activities, equipment types and layout of the project facilities;
b. The status of the baseline of the environment;
c. Findings of other EIA studies on similar projects;
d. Experience on similar projects and
e. Series of expert group discussion and meetings.

The criteria applied for predicting the impacts for this project on the environment were:

a. Magnitude – probable severity.
b. Prevalence – likely extent of the impact.
c. Duration and frequency - intermittent, short term, long term.
d. Risk – probability of serious effects.
e. Importance – value attached to the undisturbed project environment.

The screening of the project activities indicate that clearing of vegetation, dredging, transportation of materials to site during construction phase, presence of infrastructure during operational phase pose a threat to the biotic and abiotic components. Most of the adverse effect will come from construction phase involving the installation of mega stations and dredging. These impacts are expected to be short-term and shall cease with the completion of the construction phase. Impacts from operational phase are expected to be long term.

The social components are expected to have beneficial impacts like the recruitment of labour force, which will increase income and inject a sizable amount of cash into the Nigerian economy.

The main environmental components that shall be significantly impacted are water quality, ecology, fisheries, wildlife fauna, health and safety of workers. The impact indicators are defined and adopted so as to identify potential environmental impacts. Impact indicators are the easily observable environmental components, which readily indicate changes. The impact indicators used for this study are presented in Table

3.1.

Table 3.1: Environmental Components and Potential Impact Indicators

Environmental Components	Impact Indicator
Climate	Temperature, Rainfall, Relative Humidity, wind
Air Quality	Particulate, NO_x, SO_x, CO_2, CO, VOC.
Surface water Characteristics	Dissolved and suspended Solids; Turbidity, Euthrophication and Toxicity
Ecology/Hydrobiology	Species diversity, Abundance, Productivity, Yield
Soil/Sediment Characteristics	PH, Heavy metal concentration.

The scoping of potential impacts involves identifications of interactions between project activities and environmental impact indicators. This stage of the impact assessment process simply qualifies impacts as beneficial or as adverse. Ranking of the potential impacts at this stage is done on a scale of 1 to 5 and the interpretations are as follows:

1 = Very low impact
2 = Low impact
3 = Moderate impact
4 = High impact
5 = Very high impact
+ = Positive impact
- = Negative impact

The ranking, relative to recovery period was as follow:

Transient A few hours to some days
Short term ≤ 6 months,
Medium 6 - 12 months
Long term > 12 Months
Very long/permanent ≤ 5 years

The identified and evaluated impacts are further characterized based on their nature,

duration and other characteristics on the various ecological components of the environment as follows:

a. ***Beneficial Impacts*** (B) – These are impacts that would produce positive effect on the biophysical or socio-economic environment.
b. ***Adverse Impacts*** (A) – These are impacts that are not beneficial but detrimental to biophysical and socio-economic environment.
c. ***Time (duration) of Impacts*** (T) – Impacts could be characterized as long-term (LT) or short term (ST) depending on the duration.
d. ***Direct impacts*** (D) – These are impacts resulting directly (direct cause-effect consequence) from a project activity.
e. ***Indirect Impacts*** (I) – These are impacts that are at least one step removed from a project activity.
f. ***Cumulative Impacts*** (C) - These are impacts resulting form interaction between ongoing project activities with other activities, taking place simultaneously within the project area.
g. ***Residual Impacts*** (R) - These are impacts that would still remain after mitigation measures have been applied.

3.7 Risks and Hazard Assessment

The term risks and hazards are often used interchangeably. However, from a technical point of view, they are different. Hazard can be defined as the set of inherent properties of a substance, which, under production, usage or disposal condition, makes it capable of causing adverse effects to organisms or the environment. In other words, it is the possibility of a toxic effect manifesting upon exposure. On the other hand, risk is the expected frequency of occurrence of a harmful event (death, injury or loss) arising from exposure to a substance under specific conditions. Thus, risk is the probability of hazard occurring.

For risk analysis purposes, chemicals which are of concern include those that: cause irreversible harmful effects, e.g. carcinogens; are absorbed through the lungs or skin; have

an exposure response relationship which is not well defined; have significant Occupational Exposure Limits and have poor warning properties

Risks addressed include potential effects on the terrestrial and air environment as well as health effects on the local population of the areas affected. This has differed from the chronic releases from the other impacts, and mitigation was done by focusing on the potential non-routine (acute) events, which may be caused by human error, extreme conditions or other phenomena.

The methodologies used to perform a risk assessment study for the project include the following:

- HAZID (hazard identification) analysis
- HAZOP (hazard and operability) analysis
- Fault Trees or the similar Cause and Effect Diagrams
- Event Trees

The qualitative analysis for this study was carried out using the HAZID technique. It should be noted that the HAZID analysis is similar to preliminary HAZOP study, which is usually carried out during the early stages in a project life. The basic concept is to take a close look at the process and to question every part of it to discover what deviations from the intention of the design could occur, and what their causes and consequences could be. The failure modes and effects analyses for some process components were also carried out.

3.7.1 Hazards and Effects Management Process

The approach adopted to describe the management of the acute hazards that have been identified for the NNPC Mega station project is consistent with Proponent's Hazards and Effects Management Process (HEMP).

HEMP Process

The Hazards and Effects Management Process (HEMP) is the name given to a structured methodology for assessing hazards and associated risks where the focus is on health, safety and environment. The process describes the hazards in four phases, identify, assess, control and recovery.

Identify	-	What are the hazards?
	-	What could go wrong?
Assess	-	How likely?
	-	What consequence? I.e. what is the *risk*?
Control	-	Is there a better way?
	-	Controls adequate?
Recovery	-	Consequence limited?
	-	Recovery adequate?

Hazards and Risks

The HEMP structured methodology aims to secure awareness of the relevant hazards and manages the associate risks.

A hazard is a 'potential to harm'.

By recognizing and preventing that potential being realized harm would be avoided. There are many hazards and associated with each hazard are risks.

Risk (Likelihood x Consequence).

Risk is function of the likelihood, or chance of something going wrong and the severity of the potential consequence or outcome.

Mismanagement of one particular hazard can have consequences that simultaneously

impact to a varying degree on several of the broad risk types. For instance, a loss of containment resulting in an oil spill whilst being primarily an environmental risk can also escalate to asset damage and loss of life.

Application of HEMP

In order to provide additional structure to HEMP as well as *'Hazard '* the key terms used are indicated in Table 3.2 while the way these terms relate to each other is illustrated in Fig. 3.1.

Table 3.2: HEMP and Hazard key terms

Hazardous (or 'Top") Event:	The release of the hazard e.g. Loss of containment Loss of control, e.g. collision impact
Threat	Something that may cause release of the hazard e.g. Over pressure (causing loss of containment) Fog (causing ship collision)
Threat Barrier	A protective measure to prevent the threat from releasing the hazard, e.g. Overpressure process control systems Radar and audible warning devices for vessels
Escalation	The development of events following the Top event such those things get worse
Escalation barriers (or controls)	Protective measures in place to prevent or mitigate escalation
Recovery measures	Measures in place to efficiently and effectively re- establish control and make good any damage that may have occurred
Potential Consequences	The range of possible outcomes resulting from a potential Top Event. Potential outcomes will range from 'none' to 'worst case'. Each outcome is associated with a 'scenario'. Outcomes also take into account Recovery Measures.

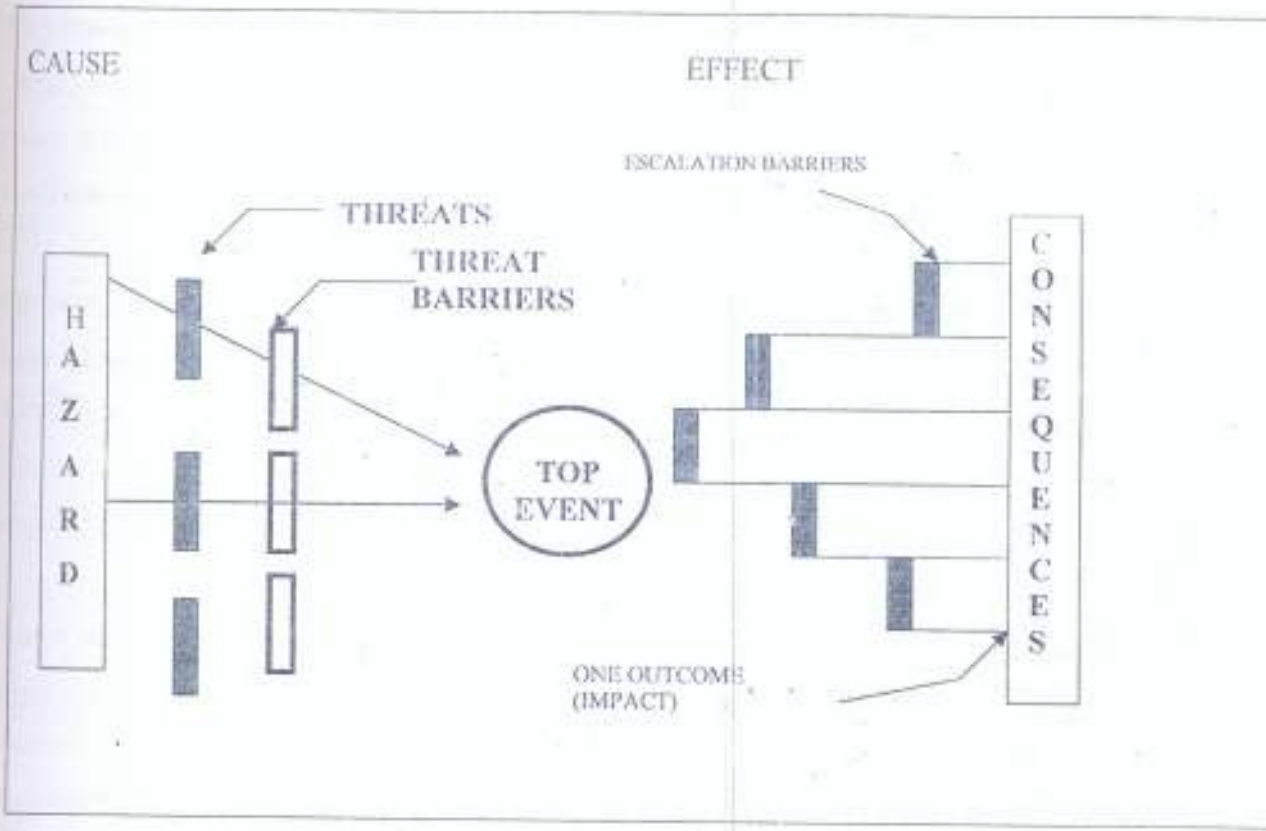


Fig. 3.1: Relationship among the HEMP Terms

3.7.2 Environmental Risk Assessment

Certain hazards have risks associated with them that will impact on the environment. The events leading to the release of the hazard that give a potential to harm the environment can b grouped into two categories:

Chronic: Continuous or occasional releases or impacts that is inherent in the operations. Such releases or impacts can be minimized but are invariably a fundamental necessity of the process or activity given the state of technology today. Threshold values are set for which the effect is deemed to be tolerable for the environment. Threshold excellence targets are normally zero.

Acute: Releases or impacts due to accidents or incidents (e.g. spills, fires etc.). Here the target is zero.

Whilst the potential impacts from each type of release may be similar, the method of risk management for each type differs. Over the lifetime of a project, the cumulative effects of chronic releases (e.g. to the atmosphere) are invariably greater than that due to acute releases. However, the potential effect of an acute release can be extreme.

Environmental effects (or impacts) include:

- Harm to living resources
- Damage to human health
- Hindrance to other activities
- Impairment of quality for use
- Reduction of amenities
- Damage to cultural and heritage resources
- Damage to physical structures

Environmental hazards are thus seen as substances or activities with the potential to cause these effects whether they are:

- Beneficial or adverse

- Short or long term
- Temporary or permanent
- Direct or indirect
- Local or strategic

3.7.3 Residual Risk and Tolerability

As a project develops several actions are taken to reduce risk such that it is only the *residual risk* that must be managed. This process is shown in Figure 3.2.

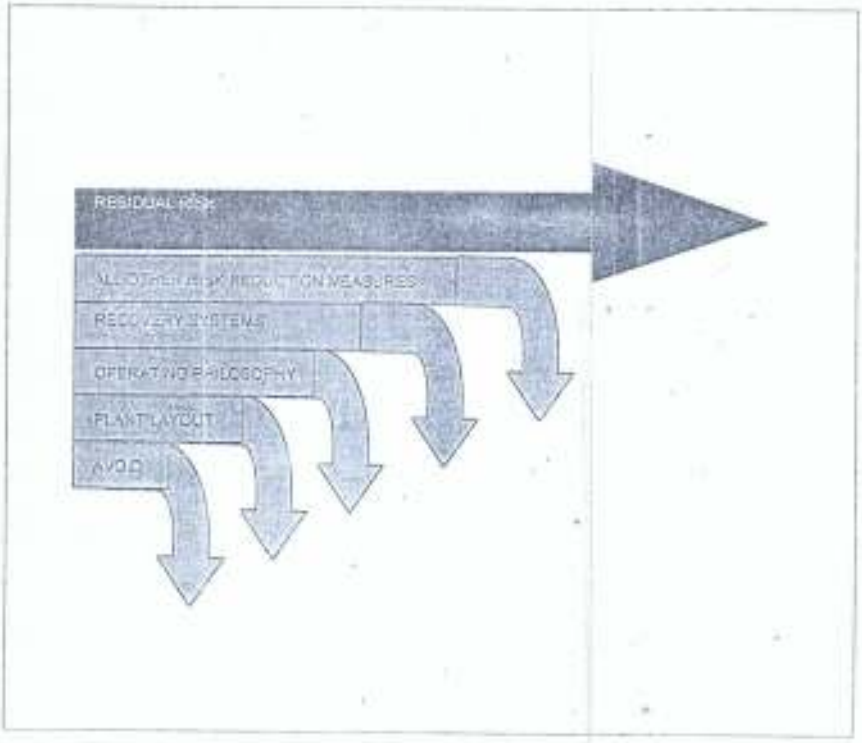


Fig. 3.2: Residual Risk

Residual risk levels tend to be regarded, as tolerable 'or' tolerable but should be reduced 'and' intolerable. Once a risk is deemed tolerable it must be managed through maintenance of proper controls and normal precautions supported by the HSE Management system and HSE (Safety) Cases.

3.8 Mitigation Measures and Alternatives

The mitigation and enhancement measures for the adverse and beneficial impacts of the proposed NNPC Mega Station are carried out. Mitigation measures are activities aimed at reducing the severity, avoiding or controlling project impacts and where possible enhance environmental quality through design alternatives, scheduling or other means. Mitigation may be in the form of avoidance (alternative action taken to avoid impact); compensatory payment of money or replacement in kind for losses or recreation of lost/damaged habitat.

The mitigation requirements and measures for the identified impacts (significant and adverse) of the proposed project were generally based on the associated effect to the environment and human health/safety. Various instruments and techniques are devised to manage the identified impacts in the various phases of the project. Besides, the control technology employed includes the following:

Formal Control: This involves the application of documented policy, process or procedure in mitigating the impacts of project activities.

Informal Control: This involves the application of sound judgment and best practice in mitigating the impacts of project activities.

Physical Control: This involves application of physical processes or instruments (e.g. pegs, flags, signposts etc,) not necessarily requiring any special technology, in order to mitigate the impacts of a project activity.

Avoidance: This involves the modification of plant, designs or schedules in order to prevent the occurrence of an impact or impacts.

Training: This involves personnel awareness in specific/specialized areas. Also, in line with NNPC S & E policy of good environmental practice, the Environmental Management Plan (EMP) of the NNPC Mega Station, project was designed in accordance with FMENV and DPR specifications.

3.9 APPLICABLE ENVIRONMENTAL LEGISLATIONS AND STANDARDS

The summary of Legislation concerning development, planning and environmental protection utilised in this study included:

a. FEPA (Now FMENV) National Guidelines for Spilled Oil Fingerprinting (Act 14 of 1999)
b. The Mineral Oil (Safety) Regulations (1963)
c. Petroleum (Drilling and Production) Regulations (1969)
d. Forestry Law CAP 51, 1994
e. Regulations for industrial safety (Betr.SichV), EU Regulation (2002)
f. Technical regulations for flammable liquids (Tjn"/RbF 20). (2002)
g. Regulations for the transport of hazardous goods on the Rhine. (ADNR) (2003)

3.10 Statistical Analysis Based On Variance and Error Estimate

Error and variance in field data include those resulting from the instrument, those introduced by the observer, and method of sampling are analysed statistically. This is necessary because two-stage sampling or sub-sampling used in this study is prone to errors. Therefore there is need to determine the true mean and estimate variance among the number of samples taken, so as to establish a reasonable level of confidence in the results obtained. However, a good result is obtained when the variance is within 5-10% of the mean. The errors and variance were obtained using the following relevant statistical equations:

$$\text{Mean } (\bar{X}) = \frac{\sum_{i=1}^{n} x_i}{n} \qquad (1)$$

$$\text{Variance } (\sigma) = \frac{\sum_{i=1}^{N} \left(x_i - \bar{x}\right)^2}{N} \qquad (2)$$

$$\text{Standard Deviation (SD)} = \sqrt{\frac{\sum_{i=1}^{N}\left(x_i - \bar{x}\right)^2}{N}} \quad (3)$$

$$\text{Mean Square Error (MSE)} = \frac{\sum_{i=1}^{N}\left(x_i - \bar{x}\right)^2}{N} \quad (4)$$

$$\text{Mean Absolute Deviation (MAD)} = \frac{\sum_{i=1}^{N}\left|x_i - \bar{x}\right|}{N} \quad (5)$$

Where x, n, N are data points, sizes of sub-sample and sample respectively.

CHAPTER FOUR

RESULTS AND DISCUSSION

The results obtained are discussed based on the analysis of environmental baseline data collected, assessment of associated and potential impact of establishing a MEGA station in this environment, development of mitigation measures and alternatives, and environmental management plan.

4.1 Analysis of Baseline Data

The baseline data analysed are site meteorological data. Other meteorological parameters analysed include rainfall, wind speed, wind speed direction, temperature, pressure, relative humidity, sunshine, air quality, and noise level.

Table 4.1 shows the results of the meteorological data measured during the field sampling in dry and wet seasons. These records are similar to those obtained from the National Meteorological Agency for about 10 year period in the study area (Tables 4.1A-H)

Table 4.1: Average Meteorological Data of the Study Area

S/N	Locations	CORDINATES	Temp (°C)		Wind Direction		Wind Speed (m/s)		Relative Humidity (%)		Atmospheric Pressure (mm/Hg)	
			DRY	WET	DRY	WET	DRY	WET	DRY	WET	DRY	WET
1	Point 1	06°13′01″N 07° 02′57″E	40.0	31.0	SE	SE	1.8	1.2	34.0	66	746.3	749.3
2	Point 2	06°13′ 15″N 07° 02′55″E	42.0	31	SE	SE	1.6	0.9	32.0	65	745.5	749.3
3	Point 3	06°13′ 04″N 07°02′58″E	36.0	32	SE	SE	1.8	0.8	41.0	66	745.5	749.3
4	Point 4	06°13′03″N 07° 03′ 01″E	36.0	36	SE	SE	1.4	1.1	44.0	50	745.5	749.3
5	Point 5	06°13′07″N 07° 03′ 02″E	37.0	36	SE	SE	1.2	0.9	47.0	51	745.5	749.3
6	Point 6	06° 12′ 59″N 07°02′ 59″E	39.0	38	SE	SE	2.7	0.8	35.0	44	745.5	748.5
7	Point 7	06° 13′07″N 07° 02′ 58″E	41.0	38	SE	SE	1.9	1.0	33.0	43	744.7	748.5
	Average Values		38.7	34.6	SE	SE	1.8	0.96	38.0	55	745.5	749.1

4.1.1 Rainfall Data

Average rainfall measurements for 10-year in the study area are given in Table 4.1A. Rainfall as in a typical tropical climate is generally high with an average of between 240 mm and 500 mm per annum, based on historical records.

Table 4.1A: Average Rainfall Measurements for 10-Year Period in the Study Area

			RAINFALL (cm)									
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1995	59.6	12.5	72.2	115.9	361.5	339.2	484	381.6	460.9	292.4	26.7	15.8
1996	21.1	74.6	68.7	238.4	252.7	395.3	350	502	573.2	228	1.5	Trace
1997	31.7	0.0	215.1	309.8	542.7	504.8	311.9	304.3	242.5	262.5	137.4	28.7
1998	14.6	0.0	48.7	130.5	253.7	289.4	288.9	168.5	254.2	179.2	12.4	0.0
1999	49.1	73.9	118.7	161.5	256.7	218.3	270.5	302.7	609	354.5	100.5	0.0
2000	39.1	0.0	53.2	354.2	47.3	391.8	382.7	356.4	344	246.5	116.5	5.5
2001	5.5	62	206.4	172.2	140.8	385.4	301.7	348.7	430.8	213.4	22.6	14.8
2002	27.9	90.4	241.7	265.6	198.3	391.5	131.5	293.5	372.4	40.9	0.0	0.0
2003	92.6	136.9	73.3	278.1	277.4	439.5	379.2	476.4	123.8	50.6	28.1	6.0
2004	73.5	32.4	173.3	163.1	225.2	240.4	185.4	309.1	322.9	37.0	0.0	1.3
2005	35.5	58.4	102.6	194.3	469.8	367	260	302.4	232.9	199.8	13.9	Trace

Source: National Meteorological Agency, Lagos.

4.1.2 Wind Speed and Direction

Wind acts as a catalytic medium for physiological and other processes and events in the ecosystem. Prevailing wind direction in the study area is the South and South Westerly. There are few instances, especially during the dry season when East and North Easterly winds were observed. Records indicate that the average wind speed in the study area ranges from 2.0 – 5.3 m/s (Tables 4.1B & C).

However, the prevailing wind direction observed in the field during the current study was in the South-Easterly (SE) direction with relative average speed of 1.8 m/s and ranged from 1.2 to 2.7 m/s in the dry season. The wind speed ranged from 0.8 to 1.2 m/s with a mean value of 1.0 in the wet season.

Table 4.1B: Mean Wind Speed Records in the Study Area

			WIND SPEED (m/s)									
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1995	2.9	3.6	3.4	3.5	2.8	3.3	2.5	2.5	2.9	2.6	2.3	2.6
1996	3.1	2.7	3.0	2.8	2.9	2.8	2.5	2.3	2.7	2.5	2.6	2.2
1997	2.7	2.7	3.2	3.2	3.0	2.9	2.4	2.1	2.9	2.6	2.7	3.2
1998	4.3	4.1	4.9	4.6	4.2	4.0	2.9	5.3	4.9	2.7	2.6	2.7
1999	2.8	3.3	3.5	4.5	3.9	3.4	3.0	4.2	4.0	4.0	2.3	2.9
2000	3.6	4.0	3.2	3.7	3.5	3.7	3.2	4.2	4.0	4.0	2.5	2.4
2001	3.1	4.1	3.3	3.8	3.4	3.3	3.2	2.9	2.5	2.2	2.8	4.3
2002	3.1	4.1	4.1	3.8	3.5	3.7	3.4	3.0	2.8	2.6	3.1	4.6
2003	3.6	3.3	3.8	3.6	3.8	3.8	3.8	3.7	3.4	3.3	2.8	3.2
2004	3.7	3.5	2.4	2.9	2.7	3.5	3.5	3.7	2.9	2.3	2.0	3.1

Source: National Meteorological Agency, Lagos.

Table 4.1C: Prevailing Wind Directions around the Study Area

			WIND DIRECTION									
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1995	W	W	SW	S	S	W	SW	W	W	W	W	NE
1996	W	NE	W	SW	SW	S	SW	SW	SW	SW	SW	E
1997	NE	NE	W	SW	SW	SW	SW	SW	SW	SW	SW	W
1998	NE	SW	SW	SW	S	SW	W	SW	SW	SW	W	W
1999	W	SW	S	S	S	S	S	S	SW	S	SW	W
2000	NE	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	NE
2001	SW	NE	SW	SW	SW	SW	SW	SW	SW	SW	SW	NE
2002	NE	NE	SW	SW	SW	SW	SW	SW	SW	SW	SW	E
2003	NE	NE	SW	SW	W	SW	W	W	SW	SW	SW	E
2004	W	W	S	S	S	S	S	W	S	S	S	W

Source: National Meteorological Agency, Lagos.

4.1.3 Ambient Temperature, Pressure and Relative Humidity

Generally, the study area has a humid, semi-hot equatorial climate with adequate sunshine distribution. The recorded average temperature is between 19.2 – 36 °C. However, average ambient air temperature recorded over the sampling period ranged from 36.0 to 42.0 °C with an average of 38.7 °C in the dry season and 31 to 38 °C with an average 34.5 °C in the wet season. Such temperature differences are responsible for the generation of turbulence necessary for transport of pollutants, in combination with pressure difference, which directly affect the mean wind vector.

Tables 4.1D and 4.1E show the maximum and minimum temperatures for 10-year period around the study area.

Table 4.1D: Maximum Temperatures for 10-Year Period around the Study Area

					T_{MAX}							
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1995	32.8	34.5	33.6	33.2	31.8	30.9	29.1	29.5	30.2	30.3	33.3	33.5
1996	34.0	34.3	33.5	33.1	32.8	31.2	30.0	29.8	30.0	31.5	34.4	35.0
1997	33.6	36.5	34.0	32.7	32.3	30.6	29.7	29.2	31.0	31.9	32.2	33.6
1998	33.8	36.4	36.6	35.0	33.5	32.2	30.4	30.9	30.8	31.3	33.3	33.3
1999	33.3	33.3	33.7	33.0	32.4	31.0	29.9	30.3	29.6	29.8	31.9	33.9
2000	33.6	35.1	35.8	33.2	32.5	31.0	29.3	29.0	30.2	30.9	32.3	33.2
2001	34.3	35.9	33.8	33.9	32.3	30.9	29.6	28.3	30.0	31.8	32.9	34.4
2002	34.2	35.6	33.6	32.7	32.6	31.1	29.8	29.3	30.3	30.8	33.0	34.5
2003	35.3	34.5	33.9	32.6	30.4	30.3	29.9	30.3	32.3	32.7	33.3	32.9
2004	36.0	36.0	33.0	32.0	31.8	30.0	28.0	31.0	32.0	32.5	35.0	33.3

Source: National Meteorological Agency, Lagos.

Table 4.1E: Minimum Temperature Measurements for 10-Year Period around the Study Area

						T_{MIN}						
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1995	19.2	21.9	23.1	23.4	22.4	22.6	22.5	22.6	22.5	22.0	22.9	23.2
1996	23.9	24.6	24.5	24.1	23.8	24.3	22.9	22.7	22.5	21.9	21.2	20.1
1997	22.5	23.0	24.6	24.0	23.5	23.4	23.0	23.2	23.5	23.3	23.6	24.0
1998	20.1	24.9	23.9	25.1	24.7	23.8	23.5	23.1	23.4	23.7	24.4	23.1
1999	23.3	24.8	24.5	24.4	23.9	24.0	23.0	23.0	22.8	23.1	23.8	23.2
2000	23.9	23.4	25.1	24.2	24.4	23.4	23.3	23.0	23.4	23.4	23.9	22.2
2001	22.8	24.1	24.5	24.5	24.0	23.5	22.9	23.1	23.2	23.7	24.5	24.9
2002	22.7	23.7	25.2	24.4	23.6	23.4	23.5	23.5	23.3	23.5	24.4	23.5
2003	25.4	25.2	25.0	24.3	23.6	23.3	23.5	23.3	24.1	24.4	24.2	23.3
2004	25.0	26.0	24.0	24.0	23.7	23.0	23.0	23.0	24.0	23.9	24.0	23.1

Source: National Meteorological Agency, Lagos.

The daily average relative humidity in the study area was generally high and ranges between 60 - 90%. The relative humidity during field measurements ranged from 32 to 47% with an average of 38.0% in the dry season and 43 to 66% in the wet season with a mean value of 55% (Table 4.1). The atmospheric pressure ranged from 744.7-746.3mm/Hg with a mean of 745.5mm/Hg in the dry season and 748.5 to 749.3 mm/Hg with an average of 749.5 mm/Hg in the wet season (Table 4.1).

Table 4.1F: Average Monthly Vapour Pressures around the Study Area

		VAPOUR PRESSURE (Mpa)										
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1994	19.0	27.5	27.8	30.3	30.2	29.6	28.7	28.8	28.9	29.1	30.0	25.5
1995	23.9	29.2	31.0	30.5	29.9	29.7	28.7	28.5	29.2	29.1	28.2	16.4
1996	20.8	28.1	30.4	31.0	30.8	29.8	29.2	29.3	29 5	29.4	30.4	28.8
1997	31.3	31.7	31.2	31.0	30.8	29.6	28.8	28.3	29.1	29.4	29.4	31.3
1998	19.2	21.8	29.4	30.3	30.7	29.5	29.0	29.0	29.7	30.1	30.4	30.8
1999	18.8	29.9	30.8	32.8	32.6	30.8	29.9	29.9	29.9	30.3	31.4	27.1
2000	27.1	30.9	30.7	30.7	30.0	29.8	29.0	29.0	29.1	29.3	30.3	26.5
2001	27.9	20.5	29.4	30.5	30.4	29.6	29.3	28.6	29.4	29.6	30.6	25.3
2002	26.1	24.3	30.7	30.3	30.3	29.4	28.7	28.5	28.8	29.9	30.7	30.4
2003	26.1	31.8	30.9	31.1	30.5	29.8	29.2	28.8	30.0	30.8	24.4	30.1
2004	32.5	32.1	30.8	30.7	29.6	29.6	29.5	29.4	30.5	31.4	25.6	28.6

Source: National Meteorological Agency, Lagos

Table 4.1G: Relative Humidity Average in the Study Area

	RELATIVE HUMIDITY @ 15 HOURS (%)											
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1995	35	30	55	63	64	79	83	81	76	74	56	45
1996	37	44	55	63	68	74	83	82	74	67	65	50
1997	50	48	58	62	66	74	75	79	80	75	65	37
1998	38	43	58	65	70	70	77	81	77	68	53	54
1999	53	57	63	66	66	73	75	76	80	74	51	52
2000	45	28	58	67	68	73	75	75	71	71	68	55
2001	39	50	50	61	65	67	73	71	75	71	64	50
2002	52	60	61	63	65	70	76	74	92	77	68	55
2003	50	55	60	63	65	68	76	74	92	77	68	50
2004	51	34	45	62	62	74	79	79	78	74	66	66

Source: National Meteorological Agency, Lagos.

Table 4.1H Average Sunshine Measurements around the Study Area

				SUNSHINE HOURS								
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1995	4.5	4.0	5.3	4.4	5.5	4.9	4.5	2.6	2.7	1.5	1.3	3.9
1996	4.2	5.6	1.2	1.2	8.3	5.2	4.2	2.3	3.0	4.0	5.1	5.2
1997	5.7	5.6	5.0	5.5	4.3	4.5	3.0	2.2	3.3	3.9	5.1	5.8
1998	5.0	6.0	3.1	4.6	6.3	3.7	2.2	1.7	3.0	4.4	6.1	6.7
1999	4.9	5.7	5.7	5.7	5.8	4.1	2.0	2.1	3.9	6.1	5.4	5.2
2000	5.8	5.2	5.8	5.4	5.5	3.7	3.3	3.4	3.0	4.6	6.6	7.0
2001	5.2	6.3	4.7	5.7	5.8	5.1	2.9	3.2	3.6	4.4	6.6	6.1
2002	5.9	6.5	4.6	5.4	5.7	4.8	2.7	1.8	2.9	3.5	6.6	5.4
2003	5.6	4.4	4.5	5.6	5.9	4.9	3.3	1.8	2.9	4.0	5.1	5.3
2004	5.7	5.4	4.4	5.5	5.7	5.2	2.9	1.5	2.8	3.9	5.1	5.1
2005	5.7	5.3	5.0	4.2	5.5	4.5	3.3	4.6	4.0	3.2	5.7	4.8

Source: National Meteorological Agency, Lagos.

4.1.4 Air Quality and Noise

The wet and dry season's results of *in-situ* air quality studies of the study area are presented in Table 4.2.

Table 4.2: Air quality Measurements in Study Area

OCATIONS	CORDINATES	SO_2 (ppm)		CO (ppm)		H_2S (ppm)		CxHy (ppm)		NOx (ppm)		NO_2 (ppm)		TSP (µg/m³)	
		DRY	WET	DRY	WET	DRY	WET	DRY	WET	DRY	WET	DRY	WET	DRY	WET
OINT 1	06°13'' 01'N 07° 02'' 57E'	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.01	<0.01
OINT 2	06°13'' 15'N 07° 02'' 55'E	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.01	<0.01
OINT 3	06°13'' 04'N 07°02'' 58'E	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.01	<0.01
OINT 4	06°13'' 03'N 02° 03'' 01'E	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.01	<0.01
OINT 5	06°13'' 07'N 07° 03'' 02'E	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.01	<0.01
OINT 6	06° 12'' 59'N 07°02'' 39'E	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.01	<0.01
OINT 7	06° 13' 00 'N 07° 02'' 58'E	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.01	<0.01
verage Values		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.01	<0.01

Key: ND = Not Detected; TSP = Total Suspended Particles

Suspended Particulate Matter (SPM)

Suspended particulate matter (SPM) is a complex mixture of organic and inorganic substances, light materials; usually dust, aerosol and other particles found suspended in the atmosphere, and carried around by the wind. Ambient concentration of SPM above a daily average of hourly values of 250 $\mu g/m^3$ may cause or aggravate respiratory problems (Sawyer and McCarty, 1987). Excessive concentrations of SPM and SO_2 are associated with mortality, morbidity and pulmonary difficulties. In the study area the SPM was less than 0.01 $\mu g/m^3$ in all the points.

Volatile Hydrocarbon Compounds

Organic compounds comprise hydrocarbons and other substances. Many of them are reactive in air and have considerable environmental and health implications. The most abundant Volatile hydrocarbon is methane. They are all suspected carcinogens. They may also irritate the eye, throat, lungs, and inhibit plant growth. Their sources may include emissions from refineries, combustion industry, vessels, land filling, solid fossil fuels, natural sources, etc. In the study area, volatile hydrocarbon compounds were below detectable limit as at the time of field investigation.

4.1.5 Noise Level Measurements

A detailed survey of ambient noise levels was carried out at the Awka Mega Station site. Table 4.3 compared the noise levels obtained during the dry and wet seasons sampling with FMEnv and DPR statutory limits. The noise levels measured ranged from 48.2 dB (A) to 67.6 dB (A) with an average of 54.6 dB (A) during dry season and from 60.1 dB (A) to 69.8 dB (A) with mean value of 65.9 dB (A) in the wet season. The recorded noise data are within tolerable limits of 80 –90 dB (A) specified by FMENV and DPR guidelines.

ble 4.3: Noise levels of the Study Area.

	LOCATIONS	CORDINATES	Noise Level (dBA)	
			DRY	WET
	Point 1	06°13'' 01'N 07° 02'' 57E'	48.2	79.8
	Point 2	06°13'' 15'N 07° 02'' 55'E	48.8	68.4
	Point 3	06°13'' 04'N 07'02'' 58'E	50.4	66.5
	Point 4	06°13'' 03'N 07'' 03'' 01'E	67.6	66.2
	Point 5	06°13'' 07'N 07' 03'' 02'E	54.7	60.1
	Point 6	06° 12'' 59'N 07'02'' 59'E	53.0	72.9
	Point 7	06° 13''00 'N 07'' 02'' 58'E	59.6	77.6
	Average Values		54.6	70.2
	FMEnv and DPR Limit		80-90	80-90

1.6. Summary of Results

e summary of the results of the maximum and average values of the environmental seline data are presented in Table 4.4; while the summary of the results of the mean and ndard deviation analyses of the environmental baseline data, on meteorological rameters considered, are presented in Table 4.5. The evaluation shows that the rcentage of the variance and/or errors (deviation) from the mean is not more than 10 % average basis (Table 4.5).

able 4.4: Maximum and Average Values of the Parameters.

arameters	Maximum Values	Average	Permissible Value
emperature	36.6	30.3	40 ^{0}C
Vind Speed	5.3	3.93	4.5m/s
apour pressure	32.8	29.51	30mPa
elative humidity	83	63.5	70%
ainfall	573.2	225.45	305mm
oise level	79.8	70.2	80-90 db (A)

Table 4.5: Percentage of variance and errors from the mean results.

Parameters	Variance/mean (%)	SD/Mean (%)	MSE/mean (%)	MAD/mean (%)
Temperature	0.9-7.7	2.0-4.8	0.9-7.7	1.4-2.9
Wind Speed	4.6-7.5	-	4.6-7.5	-
Vapour pressure	0-1.9	0-2.6	0-1.9	0-1.9
Relative humidity	0-5.3	0-2.9	0-5.3	0-2.8
Rainfall	-	-	-	0-10
Noise level	-	9.1-10	-	7.9-9.4

This shows that installation of a Mega Station in the study area is possible. The installation cost and the effect on the environment will be minimal. The procedure for the errors and variance calculations is shown in Appendix II. Then assessment of associated and potential impact of establishment of a MEGA station in the study area is necessary based on results from the baseline analyses.

4.2 Associated and Potential Impacts of the Mega Station

A developed checklist of the associated and potential impacts of the NNPC Mega station project activities is presented in Table 4.6

Table 4.6 Associated and Potential Impacts of the NNPC Mega Station Project Activities

Project Phase	Environmental Aspect
Mobilisation/Pre-construction phase Survey and clearing Establishment of base camp Transportation of Equipment and materials Recruitment of local labour	☐ Destruction of vegetation at the base camp and project site ☐ Ecosystem fragmentation and habitat destruction ☐ Wildlife (snake) attack ☐ Road traffic accident ☐ Traffic jam on local roads due to movement of heavy duty truck ☐ Disruption/destruction of power cables crossing roads ☐ Emission of combustion engines exhaust gases and noise ☐ Soil/water contamination from spilled oil/fuel from storage facilities ☐ Land taken for temporary base camps and restriction on land use ☐ Influx of labour/personnel into host communities and resultant

	increase in population. □ Conflict with native cultures, traditions and life styles □ Conflict between host communities especially youths arising from recruitment of local labour □ Introduction of diseases into the community □ Increase demand on social infrastructure □ Employment opportunities for members of host communities
truction Phase	□ Increased traffic on local roads due to construction activities
Excavation/burying of underground tanks	□ Obstruction of traffic by construction equipment at road crossing □ Soil/water contamination from spilled oil/fuel from storage facilities
Transport of underground tanks	□ Personnel injury from welding burns □ Personnel injury/death resulting from malfunction and mal-operation of excavator/cranes etc.
Welding and laying of tanks in trenches	□ Soil erosion and run off from exposed soil □ Ecosystem fragmentation and habitat destruction
Backfilling	□ Noise nuisance to wildlife
Paintings	□ Increase traffic flow and congestion □ Stimulation of local economics within the host communities (increased demand for food, fuel and other goods in local markets) □ Pollution from solid wastes (scrap metals, packaging material, paint cans, etc). □ Sewage contamination of soil/grdandwater
tional Phase	□ Water/soil pollution, resulting from disposal of wastes
Product Transportation	□ Fire and explosion hazards associated with leakages.
Products Storage/Loading	□ Increase restriction on land use □ Traffic congestion arising from vehicle seeking to buy products especially during scarcity
Sale of products to public	□ Increased revenue will accrue to Nigeria from availability and sale of products
Maintenance	Stimulation of local economy due increased business opportunities □ Creation of employment and skill acquisition opportunities for Nigerians especially members of host communities
nment/Dec-sioning	□ Environmental pollution from abandoned metal scraps, equipment, machines etc. □ Risk of injuries to local peoples from abandoned equipment, machines, etc.

4.2.1 Characterization of Impacts of the NNPC Mega Station Project

The results of the characterisation of identified and evaluated impacts of the proposed mega station project based on their nature, duration and other characteristics on the various ecological components of the environment are given in Table 4.7.These include Beneficial Impacts (B), Adverse Impacts (A), Time (duration) of Impacts (T), long-term (LT) or short term (ST), Direct impacts (D), Indirect Impacts (I), Cumulative Impacts (C), Residual Impacts (R). The definitions of these impacts have been given in Chapter Three. The results of the aggregate potential impact evaluation are summarised in Table 4.8.

Table 4.7: Associated and Potential Impacts Characterization using the Leopold Matrix method

Associated and potential Impacts	Impacts Characteristics						
	D	I	R	C	B	A	T
Road traffic accident	X					X	ST
Traffic jam on local roads due to movement of heavy duty truck	X					X	ST
Disruption/destruction of power cables crossing roads	X					X	ST
Emission of combustion engines, exhaust gases and noise	X			X		X	ST
Soil/water contamination from spilled oil/fuel from storage facilities		X				X	ST
Land take for temporary base camps and restriction on land use	X					X	LT
Destruction of vegetation at base camp site	X					X	ST
Conflict between host communities especially youths arising from recruitment of local labour		X				X	ST
Conflicts with native cultures, traditions and life-style		X				X	ST
Changes in public health due to workers influx (proliferation of STIs)						X	ST
Increase demand on social infrastructure	X					X	ST
Employment opportunities for members of host communities	X		X	X			LT
Wildlife (snake) attack	X					X	ST
Increased traffic on local roads due to construction activities	X			X		X	ST
Personal injury/death from malfunction and maloperation of excavator/crane etc	X		X			X	ST
Obstruction of traffic by construction equipment at road crossing	X		X			X	ST
Ecosystem fragmentation and habitat destruction especially at the project site	X			X		X	ST

l erosion and run-off from exposed soil	X					X	ST
ise nuisance to wildlife from internal combustion gines	X		X			X	ST
isance to nocturnal wildlife from electricity light	X		X			X	ST
mulation of local economies within the host mmunities (increased demand for food, fuel and other ds in local markets)	X			X	X		ST
uced secondary development (squatter settlements) in surrounding area		X				X	ST
lution from solid wastes (scrap metal, packaging terial, paint cans, etc)	X					X	ST
ffic congestion due to increased number of product er especially during scarcity	X					X	ST
vage contamination of soil/groundwater		X				X	ST
ter/soil pollution, resulting from disposal of ste/spent oils		X				X	ST
e and explosion hazards associated with leakages	X					X	ST
reased restriction on land use	X			X		X	LT
ation of employment and skill acquisition portunities for Nigerians especially members of host mmunities	X			X	X		ST
ablishment and implementation of community and astructure development programmes	X			X	X		LT
vironmental pollution from abandoned equipment, chines, etc.	X				X	X	ST
k of injuries to local people from abandoned ipment, machines, etc.	X					X	ST

Table 4.8 Aggregated Potential Environmental Impact Evaluated for the Mega Station Project

Ranking of the potential impacts at this stage is done on a scale of +5 (high impact) to -5(low impact) using the Battelle Environmental Evaluation System method.

Project Activities	Excavation works	Site preparation	Undergroud Tank laying	Operations/ Maintenane	Materials transport	Accidental Leaks	Gaseous Emission	Community Development Activities
Environmental Component (x)								
CLIMATE/METEOROLOGY								
Temperature	1	N.A.	N.A	N.A	N.A	N.A	N.A	N.A
Rainfall	1							
Humidity	1							
AIR QUALITY								
S. P. M.	2	-1		-1		-2	-1	
Cox	2	-1		-1		-2	-1	
VOC	2	-1		-1		-2	-1	

SURFACE WATER								
PHYSICO-CHEMISTRY								
Turbidity and solids	4	-3	-3	-2	-1	-1	N.A	N.A
Oil and Grease	4			-2				
Toxicity	4		-2			-2		
SOILS/LANDUSE								
Soil	2	-1	-3	-1	N.A	-3	N.A	N.A
fertility/Productivity	3	-3	-3	-1	N.A	N.A	N.A	N.A
Soil Erosion	3	N.A		-1	N.A	N.A	N.A	N.A
Land take								
VEGETATION/TERRESTRIAL ECOLOGY								
Diversity&abundance	5	-3	-2	N.A	2	-2	-1	N.A
Forest Resources	5	-3	-2	N.A	2	-2	-1	N.A
Habitat	5	-3	-3	N.A	2	-2	-1	N.A
Productivity	5	-2	-2	N.A	2	-2	-1	N.A
SOCIO-ECONOMICS & HEALTH								
Population	2	-1	-2	N.A	N.A	N.A	N.A	N.A
Education	2	N.A	N.A	N.A	+1	N.A	N.A N.A	+3
Income/Occupation	2	+3	+4	+3	+2	N.A	-2	+5
Health and Safety	2	-1	-1	-3	+1	-3	N.A	+4
Infrastructures	2	+2	+1	N.A	N.A	-1		+2

4.2.2 Summary of Potential Impact Evaluation

The proposed NNPC Mega Station, Awka project has been evaluated and some of the identified project activities, which could adversely impact the environment in the area, are transportation of equipment and materials, underground tank burying (trenching, backfilling, etc), operations, maintenance and abandonment. The evaluation of the impact of these project activities on the various environmental components is presented in Table 4.6.

Although some of the project activities shall adversely impact the environment, the impact shall be insignificant since these activities shall be carried out only at the construction phase of the project that will be for a very short duration. Consequently, these adverse impacts will be localized and transient. In addition, mitigation measures have been proffered, to eliminate or reduce these impacts to manageable levels

However, the long-term impacts from the project shall be beneficial. These include increase business activities, uninterrupted availability and distribution of petroleum products, employment opportunities for skilled and unskilled labour and community development activities. The impact from these activities shall be significant, long termed and beneficial.

4.2.3. Detailed Description of Associated and Potential Impacts

Some of the identified potential Environmental, Health and Social impacts of the project are described as follow.

Impact on Ecological (Natural) Environmental and Resources Utilization

The results of ecological environmental and resources utilisation components based on biodiversity and wildlife, vegetable destruction, and disposal among others are considered.

Biodiversity and Wildlife

Biodiversity impacts will be minor since there are no endangered wildlife species (as listed by IUCN or Decree 11 of 1985) found in the study areas.

Noise and vibration from the land-clearing machinery will also frighten wildlife around the site. Also lights from power supply systems will adversely affect nocturnal wildlife in the project area. The impacts due to noise and vibration will be temporary while the impact from light will be permanent.

Destruction of vegetation (medicinal, economic and food)

Clearing of vegetation for the various project facilities could result in the destruction of indigenous plant communities in the proposed project site. This will lead to the loss of economic, medicinal and food crops.

Disposal of Cleared Plant Material

Clearing of vegetation on the project site will generate a large measure of debris and refuse. No impact will be serious since the local communities will dispose of the debris through composting and fetching of fuel wood.

Increased nuisance from dust, emissions, noise, vibrations etc.

The use of heavy equipment for construction and excavation activities could generate nuisance in form of dust. noise emission and vibrations. The noise from these activities might impair hearing. Emissions (SPM, CO_x, SO_x, and NOx) from construction/ excavation equipment could impair air quality. The noise level would be highest in areas where heavy machinery is being operated, but it would fade off with increasing distance from the construction site. The workforce and nearby communities could be exposed to these nuisance

Increased Soil Erosion.

The use of heavy construction equipment and machineries will impact on the soil quality while the removal of vegetation cover will expose the soil to water run-offs thereby increasing the chances of erosion in an area that is already prone to this environmental problem.

learing/preparation will lead to the destruction of trees/forests and, therefore, the ction of habitats for birds and animals. Stripping of topsoil for campsites, modular modation, etc will reduce vegetation cover, decrease transpiration and affect the climate.

ncreased rain run-off, erosion can lead to accumulation of silt in bodies of water. utrient cycles will be accelerated, leading to nutrient enrichment of surface waters. n turn can profoundly affect the chemical and biological characteristics of bodies of

ription of Socio-Economic Impacts

esults of expected social-economic impacts based on employment opportunities. of construction crew among others are discussed as follow:

yment Opportunities

roject both during construction and operation is expected to generate limited yment opportunities for local residents. The construction crew of the project will e skilled and unskilled labour for several months.

of Construction Crew

resence of non-resident workers involved as construction crew is expected to ute to increased income to the area. Their presence will enhance the downstream t sector like food shops, trading and entertainment centers, among others, due to sed spending. This is a temporary short-term positive impact. Negligible disruption mmunity peace and order is foreseen as the activity is covered by the project ved security procedures and presence of construction crew in the area will be for a eriod only.

Socio-cultural Impacts

Breach of peace and order caused by interactions between workers and communities in the vicinity of the facilities is not expected. The project activities are not expected to alter the community lifestyle and native traditions because the project execution shall be carried out in transitory manner. However, there could be some temporary impacts at the individual level in terms of lifestyle, which could change temporarily when they take up construction jobs.

In addition, there would be infusion of money into the local communities. The injection of money into the communities is not expected to alter the economic stability of the host communities. The impacts that may arise here are expected to be beneficial, long-term, and direct on the individuals and communities.

The impacts that may arise from land use conflicts are expected to be adverse, long-term, reversible and indirect.

Increased Demands on Services and facilities in Local Communities

The construction phase of the project activities involving sizeable number of people could increase demands on services and facilities in the local communities. However, this impact is not expected to be significant since the presence of NNPC and construction workers, at worksite shall be in the short-term and most needs, including utilities/facilities shall be provided at the work site. Nonetheless, migratory workers in search of employment would trail the project and might settle in nearby communities thereby putting pressure on local facilities.

Influx of workers into rural communities would affect the cultural as well as social values of the host communities. Such negative impacts include the introduction of commercial sex with the attendant propagation of alien diseases, unwanted childbirth, stealing and other social vices.

and may also lead to psychosocial effects and annoyance.

Increase in respiratory tract ailments

Several dust generating activities during mobilisation of men and equipment, site clearing, and other construction activities including excavations, could lead to respiratory problems. Also emissions (SPM, CO_X, NO_X) during construction and operation of machinery could provoke respiratory diseases and worsen existing cases such as chronic bronchitis and asthma.

Reduction in access to nutritious and healthy diet

During mobilisation, influx of workers, job seekers, camp followers, other service providers such as food vendors, petty traders, cobblers etc is anticipated. This will lead to an increase in the local population. Such an increase is expected to trigger off an increase in the demand for food and consequently an increase in the prices of available food. Income in the local population will be generally moderate, since they are mostly farmers, hence they may therefore not be able to afford nutritious and healthy diets on the light of the anticipated escalation in prices of foodstuff.

Increase in morbidity and mortality

The current levels of morbidity and mortality from common ailments are high. The availability and capabilities of health services is also less than adequate. Influx of people into the area is expected to occur at all phases of the project, but more during mobilisation and peak of construction activities. This implies that the demand on existing health services shall increase. It also implies that the current levels of morbidity and mortality may increase if not properly managed.

The influx of people including camp followers, commercial sex workers and migrant workmen, (many of who are likely to be either single or without their families) could increase the potential for casual sex and the transmission of sexually transmitted infections (STI). This health impact is particularly very important given the current low level of

knowledge of STI transmission routes, low availability and use of protective mechanisms in the local communities.

Currently, the project area is characterised by inadequate sanitation and water supply. Influx of people is likely to increase pressure on an already deficient and inadequate community infrastructure and could lead to increase in the morbidity from other communicable diseases such as diarrhoea/gastroenteritis, respiratory tract infections and malaria.

These impacts are likely to be greatly reduced since the construction company is likely to accommodate some of the key staff at the camp, provide water, toilet and health facilities. This will reduce dependence on the facilities within the host communities.

Increase in cost of living and inflation

An increase in cost of living and inflation implies a likely increase in health-related problems. Considering the income level of the local communities and the inadequacy of existing health service the situation may deteriorate further. Malnutrition may also increase in local communities from anticipated inflation and higher cost of living, resulting in less resource for food.

Degradation of habitats

At present, the project host communities are relatively small in population with a dearth of social infrastructure. An influx of work force and camp followers into the area especially will put pressure on an already compromised system with resultant implications on the sanitation status of the living environment. Waste management, housing and water supply are of particular concern.

Increase in traffic accidents

An increase in movement of people, equipment and goods means an increase in the potential for road traffic accidents. This would act indirectly to increase the morbidity and mortality in the area.

Disruption of family structure and traditional institutions

The influx of people into the area, starting from the mobilization phase, will mean that mainly young men and women of different lifestyles will migrate into the area. The presence of such people is expected to lead to various socio-cultural effects, which may impact, negatively on family structures and family values (e.g. with regards to sex and moral values)

This may influence health status, particularly by increasing the morbidity and mortality from early pregnancies (with its complications), sexually transmitted infections and injuries. Social vices such as increase in crime rate, fraud, prostitution, drug and alcohol abuse, etc. may also increase pressure on existing health services.

4.2.4 Risks and Hazard Assessment

In this section we present results of project-specific risk assessment exercise carried out to identify any induced potential hazards that may arise from the proposed mega station project. Table 4.9 provides a quick overview of the main contributions to overall risk for each area of the project based on HAZID technique.

Applicable Risks

Overall analysis carried out indicates which of the hazardous events identified in the environmental risk assessment are applicable to each project area. A major focus of the design effort for the project and the procedures implemented during the construction/abandonment phases will be to make the equipment and activities, as far as possible, inherently safe. This means that the likelihood of any hazardous event or its consequences are reduced to either negligible or to a recognized acceptably low value.

Throughout the design phase of the project the importance of safety, environmental protection and the societal risk will be addressed by the large number of safety tools and techniques adopted by the Proponent (e.g. HAZOP). Once any hazard is recognized, the

magnitude of the risk will be determined and if it is too high the design will be changed to give an acceptable value.

The incorporation of safety and environmental protection throughout the project means that the hazards identified in Table 4.9 represent a risk to the environment, which is low enough to be recognized as tolerable. For events with consequences, the design effort is focused on preventing the hazardous event from occurring. An emergency response plan will be developed once the design is finalized.

Small events are often caused by human error and may have a higher likelihood of occurrence. However, the environmental risk is regarded as tolerable when the consequences can be managed. In these cases, effort is focused on minimized the likelihood of an event but also recognizing that some recovery measures will be required. An example of this is the possibility of some small amounts of fuel being spilled during construction activities. Although strict adherence to re-fuelling procedures should prevent spillage, spill clean-up contingency plans will be drawn-up. The appropriate clean-up equipment will be provided at all locations.

Summary of environmental risks of the project

The main risks associated with each project component are briefly described in the following sections.

Mega station Hazards

The identification and analysis of acute environmental hazards that apply to the Mega station have already been listed above. The list follows the HEMP structure of hazard identification, assessment of risk, control of the event and recovery. In many cases a hazard or the threat releasing the hazard applies only during specific phases of the project. Table 4.9 below looks at the acute hazards associated with the onshore mega station for the following project phases.

1. Construction/Installation
2. Operation
3. Abandonment

The identified environmental impact of hazards and threats are generally prevented or mitigated through the application of internationally tested and proven design codes, sound operating practices and standards, procedures and emergency response/contingency plans. For example weather and natural hazards are not controllable but the facilities design is based on avoiding a hazard where possible by surviving the worst predicted effects. Operating procedures and contingency plans will reduce or stop any activities that would exceed acceptable threshold values.

Acute risks associated with the installation phase of the mega station mainly involve incidents relating to onshore construction activities. These risks can be managed and reduced to tolerable levels by applying sounds, standard construction practices, and by following the procedures defined in emergency response and contingency plans. which will be developed specifically for the installation activities.

The main hazard during operation of the mega station is loss of containment, resulting from exceptional environmental conditions. The mega station will be designed to reduce all foreseeable threats identified (generic failure, fishing activities, seismic activity, etc.) to a tolerable level, in line with international best practice.

Oil Spills

There is a potential for minor oil spillage to occur during refuelling operations of the construction equipment. Single incidents of small volume spills are unlikely to pose a threat to terrestrial habitats. Depending on the spill volume, the impact is expected to be localized. Only repeated instances of small spills would create the potential to impact ground water and these should be prevented by the construction management plan.

Other construction related acute threats include vehicle collisions, welding. The impact from these events will be local and should be manageable using standard procedures and contingency plans.

Radiography of Pipes/Tank Welds

During the underground tank laying activities, normal weld testing will be undertaken using x-ray. The threat to the local environment and population is small. The test site will be isolated from onlookers and unauthorized people to reduce exposure risk. Testing procedures will be done at night.

Risks Associated with Operation

Generally, petroleum products are highly flammable, hence areas where product are stored/ discharged at the mega station should be provided with danger sign to warn people against naked fire. There will also be enlightenment programmes of the danger of naked fire around the mega stations. Apart from these, the populace will be enlightened on the need to obey safety rules, avoid building recklessly around the mega station facility.
On the part of the Proponents, regular corrosion and underground tank integrity checks will be conducted and remedial actions taken promptly.

Major Underground Tank Rupture

Total loss of oil containment is regarded as very unlikely, but could occur in the event of a major tank rupture. The probability for such an event is considered very small because it would likely occur only as a result of a major event or sabotage.

Sabotage and Rioters Activities

Risks from such activities are un-quantifiable and beyond the Proponent's control. They are acknowledged to be significant enough to warrant attention in the facility HSE and Security management plan, which will advise managers on proper proactive responses to all sources of risk in the normal operation of the facility.

Findings on the HAZID Analysis of the Mega station Project

The identified hazards are shown in Tables 4.9 and 4.10 for external/environmental and facility hazards respectively. The failure modes and effects analyses are shown in Table 4.11. Tables 4.9 and 4.10 show the various hazards that may occur, their causes and effects, how they could be controlled for various phases of the project. The probability of such hazards occurring is also included. As can be seen, quite a number of the identified hazards are occasional while relatively fewer ones are either probable or remote. The terms probable, occasional and remote refer to high, medium and low chances of occurrence respectively.

Table 4.9: Environmental Risk Assessment of the Mega station Project – Natural and Human Sources

Hazard Identification		Assessment of Risk		Controls for Event		Recovery	Comments
Hazard	Threat	Potential Consequences	Likelihood	Threat Barriers	Escalation Barriers	Curative Measures	
Accidental excavation by third party	Hydrocarbons and toxic gases under pressure	Release of potentially flammable hydrocarbons and toxic gas into soil and ambient air due to facilities damage	Low	Mega station facilities clearly demarcated through signs and limited access.	Emergency response plan isolation of mega station by ESD System Contingency plan for mega station leakage	Natural gas dispersion mechanisms	The risk of release from accidental third party action is low.
Sabotage, piracy or terrorist activity	Capture of and damage to facilities	Release of potentially flammable hydrocarbons and toxic gas into soil and ambient air due to facilities damage	Unknown	Mega station storage tanks not immediately accessible as it is buried deep below the surface	Emergency response plans isolation of mega station by ESD System. Contingency plan for mega station leakage	Natural gas dispersion mechanisms	Proponent's HSE and mega station management plans will address actions to be taken in the event of these extraordinary occurrences

Table 4.10: External and Environmental Hazards

S/No	Hazard	Threats & Causes	Controls	Development phase	Probability
1	Theft and pilfering	Uncontrolled access to facility	Adequate fencing and manning policy	Construction/Operation	Occasional
2	Civil and communal disturbance	Inadequate community relations	1. Consultations with host communities 2. Provision of amenities for host communities.	Construction/Operation	Occasional
3	Damaging noise from the facility on the surrounding	Proximity of host community	Use acoustic enclosure	Construction/Operation	Probable
4	Low steady noise levels	Community building	Design/operation philosophy	Construction	Probable
5	Local attitudes	Community interference	Constant consultation with host community	Design/Construction	Occasional
6	Water transport hazards	1. Driver competence 2. Weather condition 3. Vehicle condition 4. Water-ways condition 5. Traffic situation 6. Swimming capability	1. Training/retraining 2. No night sailing 3. PPE"s/Life vests 4. Effective maintenance strategy 5. Compliance with water ways rule and regulations	Construction/Material procurement	Occasional
7	Storage hazards	1. Falling objects 2. Heavy loads	1. PPE"s 2. Training	Construction	Occasional

Table 4.10. (Contd.): External and Environmental Hazards

8.	Continuous discharge to water	Open drain system	Design/ Operation	Occasional	
9.	Emergency/Upset discharge	1. Open drain 2. Vent gases	Design/ Operation	Remote	
10.	Continuous discharge to soil (contamination, slips, etc).	Poor spill response	Construction/ Operation	Remote	
11.	Contaminated ground/ground-water	1. Rain 2. Micro-organisms 3. Soil permeability	Construction/ Operation	Occasional	
12.	Excavation hazards during wet season	1. Rain 2. Muddy area 3. Wet ground 4. Flood site	Develop job hazard analysis Construction	Occasional	

Table 4.11: Facility Hazards

S/No	Hazard	Threats & Causes	Controls	Development Phase	Probability
1.	Poor operation and maintenance	1. Operator competence 2. Inadequate training	1. Training 2. Handover procedures	Design, Commissioning and Operation	Occasional
2.	Design concept selection hazards	1. Inadequate design review 2. Consultant competence	Structured design review technique	Design	Occasional
3.	Stored flammables	1. Improper storage 2. Operator's error 3. Sparks/open flame 4. Impact	1. Design to standard specification 2. Proper layout design 3. Fire protection analysis	Design	Probable
4.	Sources of ignition	1. Electricity 2. Defective equipment 3. Lightening	1. Earthen of electrical equipment 2. Maintenance philosophy 3. Lightening protection	Design Construction and Operation	Probable
5.	Ineffective fire protection/response	1. Equipment failure 2. Wind direction	Maintenance philosophy	Design/Operation	Occasional
6.	Inadequate operator protection	1. Operator's exposure 2. Wrong use of PPE 3. Non standard PPE	1. Training 2. Compliance with regulation on PPE	Construction/ Operation	Occasional
7.	Building erection/Demolition hazard	Poor pre-mobilization inspection	Follow appropriate mobilization procedure during construction	Construction	Occasional

4.3 Mitigation Measures and Alternatives

Mitigation measures at reducing the severity, avoiding or controlling project impacts are proposed and they included provision of design alternatives, avoidance, and compensatory payment. This was done based on the intensity of the impact of the proposed NNPC Mega station project on the environment and human health/safety.

Compensation

To ensure that all conflicts and concerns with regards to loss of resources by the host communities are resolved, NNPC shall carry out accurate assessment of all damages to crops, economic trees, and thereafter pay adequate commensurate compensation for all such economic resources directly to the affected victims. The use of Claim Agents or' Urban Indigenes' who often emerge to corner these rewards at such occasions should be avoided.

Alternatives Routes and Location

Selection of the preferred surface location for the NNPC Mega Station, Awka project has been done based on amongst critical advantages including the availability of already acquired land, ease of surveillance, minimal land take and overall duration and cost.

Based on this and the baseline information gathered, the preferred location for the NNPC Mega Station, Awka project is the parcel of land at Amikwo/Agulu Awka along Onitsha-Enugu expressway, Awka in Anambra State. The location is accessible, sizeable and well laid out. It is moreover situated at the outskirt of main Awka town and the high-density area of the capital city. The access roads to these locations are already in existence. However, whenever this proposed project site would cause significant negative impact, adjustments shall be made to avoid it. This may involve providing alternative routes especially during the construction and operations stage.

Compliance to Safety and Environmental Management Standards

Safety and Environmental standards shall be complied with throughout the life of the project, from site preparation, construction, commissioning, decommissioning and abandonment. NNPC Group Safety and Environmental policy shall be constantly kept in focus. The principle of "if the job can not be safely done, then don't do it" shall be strictly followed.

The mitigation measures prescribed for identified associated and potential impacts of the proposed NNPC Mega Station, Awka Project are presented in Table 4.12.

Table 4.12: Mitigation measures for the identified Associated and Potential Impacts of NNPC Mega Station, Awka Project

ated and Potential cts	Mitigation Measures
nstruction/Construction traffic accident t jam on local roads due to ment of heavy truck	NNPC shall apply effective journey management (transport of heavy duty equipment and pipes during peak traffic period shall be avoided) Vehicles shall be maintained at optimal operating condition to avoid break down and obstruction of roads NNPC shall make available mobile workshop in case of an unforeseen breakdown. NNPC shall ensure all vehicles are checked/inspected before embarking on a trip NNPC shall use escort riders (outriders) during heavy equipment transportation NNPC shall ensure that only NNPC certified drivers are used for all vehicles Drivers shall be adequately briefed by safely personnel before embarking on any journey
uction of power cables ng roads	NNPC drivers and vehicles shall avoid physical contact with power cables at road during bulky material transport
sion of combustion engines ust gases	NNPC shall maintain fuel combustion engines at optimal operating conditions. NNPC shall ensure periodic maintenance of vehicles and equipment
water contamination from l oil/fuel from storage ties	Storage containers shall be periodically checked for leaks Operators shall be trained on safe fuel handling practice Containers shall be provided with secondary containment capable of holding 110% of its contents
take for temporary base camps striction on land use	Due process of land acquisition and compensation shall be applied by NNPC with each community NNPC shall remove all temporary facilities and restore the site to its natural state as practically possible using indigenous plant species
action of vegetation at base site	NNPC shall base site selection for Base Camp on a location with the most minimal impact on the vegetation and forestry resources Site clearing shall be limited to the area needed Use of bulldozers for site clearing shall be minimized NNPC shall re-vegetate all cleared areas
licts with native cultures, ions and lifestyles	NNPC shall brief all employees to ensure awareness of and sensitivity to the native cultures, traditions and lifestyles of the host communities NNPC shall advice village/community heads to educate their followers/subjects of the project and benefits NNPC shall advice all employees against entering sacred forests or tampering with totems where applicable

Table 4.12 (Contd): Mitigation measures for the identified Associated and Potential impacts of NNPC Mega Station, Awka Project

Conflicts between host communities especially youths arising from recruitment of local labour	NNPC shall consult/discuss with host communities its strategy for recruitment of local labour NNPC shall employ locals for non-skilled job positions
Change in public health due to workers influx (proliferation of STDs)	NNPC shall ensure that all workers are screened for sexually transmitted diseases (STD) The use of contraceptives/condoms will be encouraged amongst workers NNPC shall encourage workers to as much as possible avoid sexual interaction with the locals Periodic health briefing shall be conducted for the workforce
Increased demand on social infrastructure	Workforce shall as far as practicable, be isolated from host communities NNPC shall provide self sufficient base camps with medical facilities
Construction Phase	
Increased traffic on local roads due to construction activities	Construction shall be carried out in segmented pattern to minimize traffic load Drivers shall be subjected to defensive driving training Appropriate road/warning signs shall be installed on local roads NNPC shall inform the communities through their respective community heads and CDC of the time for the construction
Soil erosion and run-off from exposed soil surface	Soil shall be stabilized mechanically using compactors to reduce erosion potential Exposed surfaces shall be concreted and/or grassed
Ecosystem fragmentation and habitat destruction	Workers shall be discouraged from cutting or opening up of forest in the adjoining area. Cleared area not in use shall be re-vegetated as far as practicably possible
Damage to designated burial sites and shrines	NNPC shall identify the location of burial sites and shrines to avoid damage during construction
Noise nuisance to wildlife	Construction activities shall be limited to day time hours NNPC shall employ the use of low noise generating equipment as much as practicable. Conventional mufflers shall be installed on operating machines to bring noise to acceptable levels.
Increased traffic flow and congestion	NNPC shall engage the use of outriders during haulage of wide/large equipment/materials NNPC shall engage and use traffic control warders All drivers shall be subjected to defensive driving training
Stimulation of local economics within the host communities (increased demand for food, fuel and other goods in local market)	This impact is positive and shall be maintained throughout the operational life of the project

Table 4.12 (Contd.): Mitigation measures for the identified Associated and Potential impacts of NNPC Mega Station, Awka Project

Obstruction of traffic by construction equipment at road crossing	Cautions signs shall be placed at appropriate locations NNPC shall engage and use traffic control wardens
Wildlife attack (e.g. snake bite, bee sting)	First facilities shall be provided at the work sites and medical facilities at ba camps Mandatory comprehensive S & E induction training shall be given to t workforce
Damage to existing gas pipeline leading to explosion/fire	Accurate drawings of location of buried pipes shall be provided to proje supervisors and engineers Positions of buried pipes shall be marked out Permit-to-Work system shall be implemented Mánual excavation shall be considered where new line is close to existing one
Soil/water contamination from spilled oil/fuel from storage facilities	Fuel containers shall be tested for leaks before use Operators shall trained on safe handling practice Containers shall be provided with secondary containment capable of holdi over 100% of its content
Personnel injury from welding burns	NNPC shall provide and enforce the use of PPE for all workers Competent and certified welders/personnel shall be used
Personnel injury/death resulting from malfunction of excavator/cranes etc	Equipment used shall be properly maintained and adequately calibrated befo use Equipment operation shall be competent personnel with years of experience excavator/crane safety.
Induced secondary development (squatter settlements) in the surrounding area	NNPC shall establish standard base-camp and houseboats as applicable a will liaise with host communities to discourage squatter settlements.
Pollution from solid wastes (scrap metals, packaging materials, paint cans, etc)	Scrap yards shall be designated at the campsite. Scrap metal drums and cans resulting from the project activities shall periodically moved to NNPC scrap metal yard and disposed in line with NNP management procedure.
Sewage contamination of soil/groundwater	Sewage shall be collected in septic tanks and treated to residual chlorine lev of 0.8 – 2.0 mg/l, transported and discharged at approved sites.

Table 4.12 (Contd.): Mitigation measures for the identified Associated and Potential impacts of NNPC Mega Station, Awka Project

ration	
r/soil pollution, resulting disposal of pigging waste	NNPC shall collect and dispose pigging waste in appropriate manner
ased restriction on land	NNPC shall promptly pay fair compensation to authentic land owners
ion of employment and acquisition opportunities Nigerians especially bers of host communities	NNPC shall ensure that effective capacity building through the hire of local personnel
blishment and lementation of munity/infrastructure lopment programmes	NNPC shall sustain development programmes including skill acquisition by host communities based on their respective needs.
ndonment/decommission	
ironmental pollution from ndoned metal scraps, ipment, machines etc.	All decommissioned metal scraps, pipes etc., shall be returned to NNPC metal scrap yard for re-use or recycling. NNPC shall re-vegetate the ROW where necessary with indigenous species after decommissioning.
k of injuries to local people m abandoned equipment, chines, etc.	Appropriate warning signs shall be used to alert residents of the presence of such machines/equipment.

4.3.2 Environmental Management Plan (EMP)

The results of the Environmental Management Plan (EMP) for NNPC Mega Station, Awka project provided the following EMP long- term objectives, which are to:

a. ensure compliance with existing legislation and NNPC's S & E policy;
b. achieve, enhance and demonstrate sound environmental performance built around the principle of continuous improvement;
c. integrate environmental issues fully into the project construction and implementation;
d. rationalize and streamline environmental activities to add value in efficiency and effectiveness.

e. encourage and achieve the highest environmental and socio-economic performance and response from individual employees and contractors throughout the duration of the project;
f. provide the standards for overall planning, operation, audit and review;
g. enable management to establish environmental priorities for the project;
h. be applicable throughout the organization.

Periodic reviews and updating should be carried out throughout the project life cycle, to incorporate better environmental technologies, management systems and economic policies. This will be achieved due to the company's S & E policy on continuous improvement of sound environmental performance.

4.3.3. Emergency Response Procedure

NNPC recognizes that hazards exist in its areas of operations. All necessary plans and measures shall be put in place to ensure compliance with standards, codes and specifications, operations and maintenance activities associated with this project implementation. Nevertheless, accidents may still occur which could have adverse effects on the environment. The probable causes of accidents in the execution of this mega station project are equipment failure, negligence and sabotage. Consequently, contingency plans have been developed to handle such accidents. The proposed emergency response procedures are shown in Figure 4.1

The proposed emergency response procedures are shown in Figure 4.1.

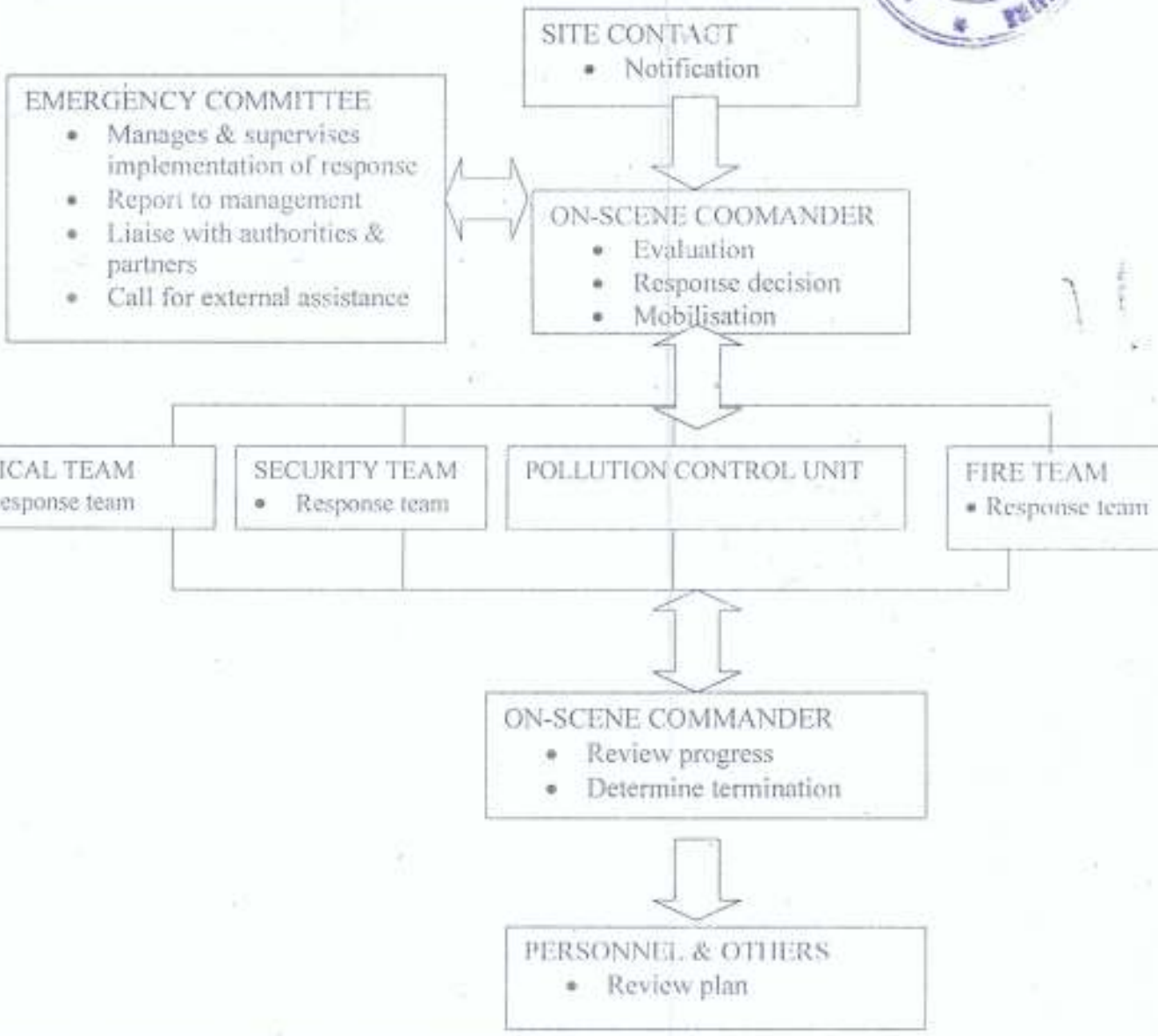


Fig. 4.1: Schematic Diagram of the Emergency Response Chart

4.3.4. Identified Environmental Risks and Uncertainties

The summary of the identified environmental effects (or impacts) of the proposed NNPC Mega station are:

a. Harm to living resources
b. Damage to human health
c. Hindrance to other activities

d. Impairment of quality for use
e. Reduction of amenities
f. Damage to cultural and heritage resources
g. Damage to physical structures

These environmental hazards are generally seen as substances or activities with the potential to cause effects whether they are:

a. Beneficial or adverse
b. Short or long term
c. Temporary or permanent
d. Direct or indirect
e. Local or strategic

4.3.5. Mitigation Plans/Measures for the Impacts

The summary of the mitigation plans and measures results included the use of control technologies, consideration of best environmentally friendly options, adequate compensations for damages and compliance to safety rules and guidelines. In circumstances where the project activities are likely to cause very significant adverse effects, NNPC is to review the mitigation plan and consider alternatives. The alternatives, which offer the highest opportunities for environmental protection and safety of human lives, are to be adopted over and above other consideration including budget matters. All designs and modifications to the project activities are subjected to an environmental appraisal to identify new potentials impacts and appropriate mitigation measures proffered. It was also discovered that regular inspection of all work activities by the supervisory team and project HSE Supervisor to ensure compliance to standards and procedures are necessary. The supervisors are ensured that mitigation measure proffered by the EIA are implemented and subsequently documented, and report violations to safety enforcement agencies. A comprehensive datasheet on safety performance of all phases of the project are to be maintained for regular inspection.

4.3.6. Applicable Environmental Legislations and Standards

The environmental management activities at each stage of the Mega Station, Awka project have been guided by the environmental standards including national legislation, international conventions and agreements and company's codes of practice.

The Federal Ministry of Environment (formally Federal Environmental Protection Agency, FEPA established in 1988) and DPR have responsibilities for environmental protection and the enforcement of environmental standards. Where standards and regulations are not prescribed in Nigeria, standards issued by international bodies such as the World Health Organization (WHO) and World Bank have been adopted.

All the above standards especially the FEPA and DPR standards and limits are to be complied with. NNPC's S & E Policy is to be adopted and also required that all contractors (and sub-contractors) are complied with the S & E policy in both the construction and operational phases of the project.

4.3.7 Training Programmes and Responsibilities

All staff working on the Mega Station, Awka project are to be made aware of their environmental responsibilities through induction and training courses. Training in environmental protection is to be an integral part of the training programme for the company's operators and techniques.

Moreover, NNPC must see responsibility for environmental protection as a line responsibility for which at all levels has accountability. The accountability for the Mega Station, Awka project is defined in an annual S & E plan. The design of the proposed mega station project is based on NNPC Operations, Maintenance and S &E philosophies and also on relevant Technical Specifications in agreement with standard on oil and gas engineering practices. These guidelines are structured for easy implementation and

ensured design compliance. A team is proposed comprising: an environmental officer (EO), who shall be an environmental specialist to be appointed by NNPC; a project quality assurance engineer (QAE); and relevant NNPC Departments for effective implementation of the plan.

The EO shall be the focal point for all environmental matters in relation to the implementation of the engineering of the proposed project. It shall be the responsibility of the EO to ensure that the design provides for implementation and reviewed in the concept plan. At the end of the review, using relevant checklists (prepared by the QAE), the design S & E for implementation may be approved, referred or rejected if considered environmentally unjustifiable.

4.3.8 Recommendations for Environmental Management

The results also provided the preliminary EMP guidelines that cover the entire Mega Station, Awka project activity. These include pre-construction activities (mobilizations, establishment of base camp-site, etc); construction activities; operations and abandonment/decommissioning. These are detailed as follows:

Pre-construction Phase

Pre-construction phase included site clearance, health and safety of workers.

Site Clearance

All site clearance works shall be carried out within defined perimeters and only when necessary. The maximum permissible time lapse between site clearing and initiation of construction operations shall be reduced to the barest minimum. Clearing of vegetation shall be kept to the barest minimum necessary to permit safe operations. Trees felled from site shall be re-utilized for the benefit of the host communities or as otherwise requested by NNPC in consultation with the communities. Areas cleared in excess of operational requirements shall be reinstated with indigenous topsoil and vegetation by NNPC.

Health and Safety of Workers

All NNPC contractors, staff and third party shall be well informed and trained on the E & S issues at site. All facilities shall be designed to enhance safety planning. All activities shall be executed within the confines of the relevant Nigerian legislation (including DPR and FMENV guidelines) as well as stakeholders' interests.

The contractor shall provide adequate health services as well as site first aid services for its workforce. The aid services shall be extended to all visiting personnel.

All project activities shall be properly managed through careful planning and the application of relevant NNPC safety policies including the following:

- Use of Permit to work (PTW);
- Job Hazard Analysis and toolbox meetings before embarking on a job;
- Use of appropriate personal protective equipment (PPE);
- Prohibition of alcohol in the project area;
- Proper journey management;
- Regular emergency drills;
- Prohibition of smoking in designated area.

Contingency plans shall be developed in line with the existing NNPC contingency plans.

Construction phase

Construction phase entails drainage protection, control of gaseous emission, noise and vibration.

Drainage Protection

NNPC shall ensure that there will be a minimal environmental impact on the drainage pattern of the project area, and that all hydrological characteristics and qualities will be maintained at its present status or improved on.

Control of Gaseous Emission

Gaseous emission is not envisaged to be a significant environmental aspect of the project except at the construction phase. However, NNPC shall regularly review current and potential air emission sources. This will ensure that all processes are controlled by the best available techniques. The reviews will consider the necessity for any discharge to the atmosphere and will consider all means of possible emission reduction. All emissions to atmosphere from project activities will be monitored in line with NNPC commitment and in compliance with regulatory limits and guidelines.

Noise and Vibration Control

Noise level shall be established for each noise source and targets. The personnel as well as environment that shall be affected by any established noise source shall be provided or equipped with appropriate protective or corrective device to ameliorate noise effect.

Waste Management

The provision of adequate waste management guideline and disposal facility is vital to the implementation of the Mega Station, Awka project. Waste shall be managed in accordance with NNPC Waste management Plan. The principle of waste reduction, recycle recovery and reusing shall be practiced.

All wastes, which cannot be reused, will be managed and disposed in accordance with NNPC Waste Management plan.

Some of the waste management options and waste disposal systems that were considered for this project are highlighted as:

Solid Waste/Used containers (Garbage and Inert materials)

NNPC shall apply the following principles in handling of general garbage (wood, plastics, paper, and food wastes):

a. Segregate components such as wood, plastic and paper, for recycling or reuse.

b. Reduce packaging wastes such as paper and plastic by the use of bulk handling systems.
c. Dispose all wastes at approved dumps.
d. Refilling and reusing of containers.

Sanitary Waste

Appropriate septic tanks shall be provided. Sewage shall be treated to residual chlorine level of 0.8 – 2.0 mg/l before disposal at approved sites. Waste management guidelines provided are shown in Appendix III.

4.3.9 Monitoring and Auditing Plan

Monitoring and auditing of the proposed NNPC Mega station project is also planned for as depicted in Appendix IV. The monitoring programme provided information on the actual impacts compared to predicted impacts and, by so doing, provided advance warning of any adverse changes in the ecosystem.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSION

A multi-disciplinary approach was adopted in the assessment of the environmental status and sensitivities of the various ecological components of the NNPC Mega Station, Awka Project. Desktop/extensive literature search, field sampling and measurement/testing and laboratory analyses were carried out to obtain the relevant Baseline information on the project area. Further research was also conducted at the end of the field data gathering exercise in order to compare literature information with generated field data and for additional information on the study area.

Data for impact assessment of the Mega station, Awka was generated using Overlay, Leopold matrix, Peterson matrix and Batelle Environmental evaluation system techniques. The impact assessment report shows that the NNPC Mega station Awka project will have adverse effect on land use, air, socio economic, health and the environment on short-term basis. The EIA report also indicate that these adverse impacts can be reduced to as low as reasonably practicable (ALARP) levels by the application of proven Best Available Technology (BAT) in the oil and gas industry that meet national and international standards and codes of practice.

Moreover, Mitigation plans and measures designed to prevent, reduce or control the adverse impact of the proposed project activities were formulated using professional judgment based on previous project experiences, proven scientific methods and sound engineering practices. Also an Environmental Management Plan (EMP) developed for the project, would ensure that procedures for managing the adverse potential impacts of the proposed project on the environment are established and maintained throughout the life cycle of the project.

The NNPC Mega Station, Awka Project will have significant beneficial impacts on the

national economy and the socio-economic life of the host communities. These would result from the sale of petroleum products, employment of indigenous labour/ contractors, and the socio-economic gains to the project host communities.

The result on the mean and standard deviation analysis of the environmental baseline data on the meteorological parameters considered shows that the percentage of the variance and/or errors (deviation) from the mean is within acceptable standard.

From the foregoing, therefore, NNPC Mega station, Awka project is feasible and environmentally friendly.

5.2 RECOMMENDATION

i. NNPC should ensure appropriate follow-up process with requirement for monitoring, management, audit and evaluation that are based on the significance of potential effects, the uncertainty associated with predictions and mitigation and the opportunity for making future improvements in the project design or process application.

ii. Ensure periodic reviews and updates are carried out throughout the project life cycle, to incorporate better environmental technologies, management system and economic policies.

iii. Ensure compliance to and implementation of various measures that will ameliorate negative impacts while promoting the positive Impacts. In this way, the economic benefit of this project will be shared by all in environmentally and socially sustainable arrangement.

iv. Ensure that safety and environmental standards are complied with throughout the life cycle of the project, from site preparation, construction, commissioning, decommissioning and abandonment.

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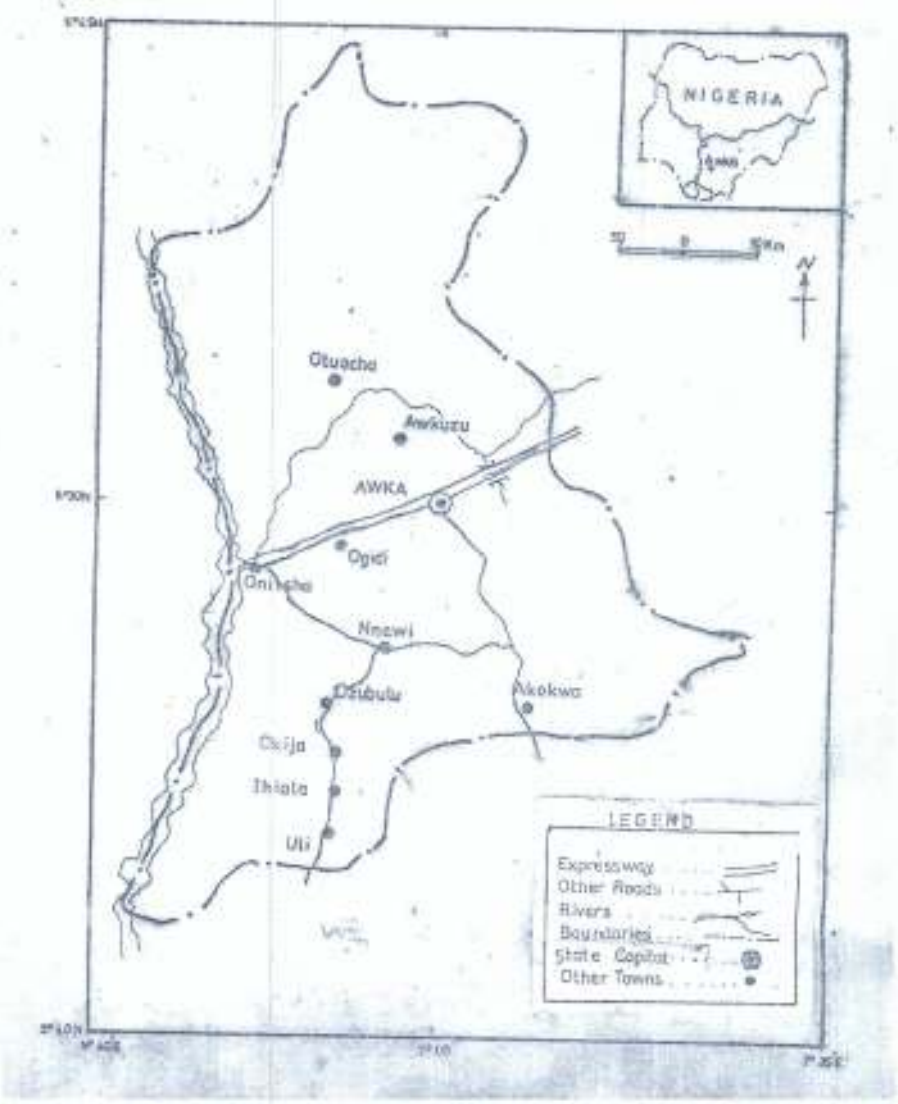
APPENDIX 1
MAP OF THE STUDY AREA



APPENDIX II

Rainfall data analysis

Year	x	$(x-\bar{x})$	$/x-\bar{x}/$	$(x-\bar{x})^2$
1	218.5	22.2	22.2	492.8
2	246.0	49.7	49.7	2470.1
3	241.0	44.7	44.7	1998.1
4	136.7	-59.6	59.6	3552.16
5	209.6	13.3	130.8	176.9
6	194.8	-1.5	1.5	2.25
7	194.8	-1.5	1.5	2.25
8	171.14	-25.2	25.2	63.5
9	196.8	0.5	0.5	0.25
10	146.9	-49.4	49.4	2440.4
11	203.3	7	7	49
$\sum$	2159.6		224.9	11247.7

$$\bar{X} = \frac{\sum x}{n} = \frac{2159.6}{11} = 196.3$$

$$\text{Variance} = \frac{\sum\left(x-\bar{x}\right)^2}{N}$$

$$= \frac{11247.7}{11} = 1022.5$$

$$\text{S. D} = \sqrt{1022.5} = 31.98$$

Errors

MSE = VAR = 1022.5

$$\text{MAD} = \frac{\sum /x_i - \bar{x}/}{n} = \frac{224.9}{11} = 20.4$$

Wind speed data analysis

Year	x	$(x-\bar{x})$	$/x-\bar{x}/$	$(x-\bar{x})^2$
1	2.6	-0.7	0.7	0.49
2	2.7	-0.6	0.6	0.36
3	2.8	-0.5	0.5	0.25
4	3.9	0.6	0.6	0.36
5	3.5	0.2	0.2	0.04
6	3.5	0.2	0.2	0.04
7	4.2	0.9	0.9	0.81
8	3.5	0.2	0.2	0.04

9	3.5	0.2	0.2	0.04
10	3.0	-0.3	0.3	0.09
$\sum$	33.2		4.4	2.52

$\bar{x} = 3.32$

Variance$= \frac{2.52}{10} = 0.252$

S. D $= \sqrt{\text{var}} = 0.502$

Errors

MSE = Variance =0.252

MAD$= \frac{4.4}{10} = 0.44$

Maximum temperature analysis

Year	x	$(x-\bar{x})$	$/x-\bar{x}/$	$(x-\bar{x})^2$
1	31.9	-0.9	0.9	0.87
2	37.5	4.7	4.7	22.09
3	32.3	-0.5	0.5	0.25
4	33.1	0.3	0.3	0.09
5	31.8	-1.0	1.0	1.0
6	32.2	-0.6	0.6	0.36
7	32.3	-0.5	-0.5	0.25
8	32.3	-0.5	0.5	0.25
9	32.4	-0.4	0.4	0.16
10	32.6	-0.2	0.2	0.04
$\sum$			9.6	25.3

$\bar{X} = 32.8$

Variance$= \frac{\sum\left(x-\bar{x}\right)^2}{N}$

$= \frac{25.37}{10} = 2.53$

S. D $= \sqrt{Var}$

$\sqrt{2.53} = 1.59$

Errors

MSE = VAR =2.53

MAD$= \frac{\sum /x_i - \bar{x}/}{N} = \frac{9.6}{10} = 0.96$

Relative humidity data analysis

Year	x	$(x-\bar{x})$	$/x-\bar{x}/$	$(x-\bar{x})^2$
1	61.8	-2.8	2.8	7.8
2	63.5	-1.1	1.1	1.21
3	64.1	-0.5	0.5	0.25
4	62.8	-1.9	1.8	3.24
5	65.5	0.9	0.9	0.81
6	62.8	-1.8	1.8	3.24
7	66.6	2	2	4.00
8	67.8	3.2	3.2	10.24
9	66.5	1.9	1.9	3.61
10	64.2	-0.4	0.4	0.16
$\sum$			18.2	34.56

$\bar{X} = 64{:}6$

Variance= $\frac{\sum\left(x-\bar{x}\right)^2}{N}$

$= \frac{34.56}{10} = 3.46$

S. D = $\sqrt{3.46} = 1.86$

Errors

MSE = VAR =3.46

MAD= $\frac{\sum /x_i - \bar{x}/}{N} = \frac{18.2}{10} = 1.82$

Minimum temperature data analysis

Year	x	$(x-\bar{x})$	$/x-\bar{x}/$	$(x-\bar{x})^2$
1	22.4	-1.1	1.1	1.21
2	23.0	-0.5	0.5	0.25
3	23.5	0	0	0
4	23.6	0.1	0.1	0.01
5	23.7	0.2	0.2	0.04
6	23.6	0.1	0.1	0.01
7	23.8	0.3	0.3	0.09
8	23.6	0.1	0.1	0.01
9	24.2	0.7	0.7	0.49
10	24.2	0.4	0.4	0.16
$\sum$			3.5	2.21

$\bar{X} = 23.5$

Variance= $\frac{\sum\left(x-\bar{x}\right)^2}{N}$

$= \frac{2.21}{10} = 0.221$

S. D = $\sqrt{0.221} = 0.47$

Errors

MSE = VAR =0.221

MAD= $\frac{\sum/x_i - \bar{x}/}{N} = \frac{3.5}{10} = 0.35$

Vapour pressure data analysis

Year	x	$(x-\bar{x})$	$/x-\bar{x}/$	$(x-\bar{x})^2$
1	28.0	-1	1	1
2	27.9	-1.1	1.1	1.21
3	29.0	0	0	0
4	30.2	1.2	1.2	1.44
5	28.3	-0.7	0.7	0.49
6	29.5	0.5	0.5	0.25
7	29.4	0.4	0.4	0.16
8	28.4	-0.6	0.6	0.36
9	29	0	0	0
10	29.5	0.5	0.5	0.25
11	30.0	1	1	1
$\sum$			6.0	6.16

$\bar{X} = 29.0$

Variance= $\frac{\sum\left(x-\bar{x}\right)^2}{N}$

$= \frac{6.16}{11} = 00.56$

S. D = $\sqrt{0.56} = 0.75$

Errors

MSE = VAR =0.56

MAD= $\frac{\sum/x_i - \bar{x}/}{N} = \frac{6}{11} = 0.55$

Temperature data analysis (dry period)

	$(xi-\bar{x})$	$(xi-\bar{x})^2$	$/x-\bar{x}/$
1	1.28	1.64	1.28
2	1.28	10.75	1.28
3	-2.71	7.36	2.71
4	-2.71	7.36	2.71
5	-1.71	2.92	1.71
6	0.28	0.08	0.28
7	2.29	5.55	2.29
$\sum$		35.66	14.26

$$\bar{X} = \frac{\sum_{i=1}^{n} xi}{n}$$

$$\bar{X} = \frac{271}{7} = 38.7$$

$$\text{Variance} = \frac{\sum\left(xi-\bar{x}\right)^2}{N}$$

$$= \frac{35.66}{7} = 5.09$$

$$\text{S. D} = \sqrt{5.09} = 2.25$$

Errors

Variance=MSE

=5.09

$$\text{MAD} = \frac{\sum_{i=1}^{n} /xi-\bar{x}/}{N} = \frac{14.26}{7} = 2.04$$

Temperature data analysis (wet)

	$xi-\bar{x}$	$/x-\bar{x}/$	$(xi-\bar{x})^2$
1	-3.6	3.6	12.96
2	-3.6	3.6	12.96
3	-2.6	2.6	6.76
4	1.4	1.4	1.96
5	1.4	1.4	1.96
6	3.4	3.4	11.56
7	3.4	3.4	11.56
$\sum$		17.4	59.72

$\bar{X} = 34.6$

Variance= $\frac{\sum_{i=1}^{n}\left(xi-\bar{x}\right)^2}{N} = \frac{59.72}{7} = 8.53$

S. D = $\sqrt{8.53} = 2.92$

Errors

Variance=MSE

=5.09

MAD= $\frac{\sum_{i=1}^{n} / xi-\bar{x}}{N} = 2.77$

Wind speed data analysis (dry)

	xi-$\bar{x}$	/x-$\bar{x}$/	(xi-$\bar{x}$)^2
1	0	0	0
2	-0.2	0.2	0.04
3	0	0	0
4	-0.4	0.4	016
5	-0.6	0.6	0.36
6	0.9	0.9	0.81
7	-0.1	+0.1	0.01
$\sum$		2.2	1.38

$\bar{x} = 1.8$

Variance= $\frac{\sum_{i=1}^{n}\left(xi-\bar{x}\right)^2}{N} = \frac{1.38}{7} = 0.197$

S. D = $\sqrt{0.197} = 0.44$

MSE=variance= 0.197

MAD= $\frac{\sum_{i=1}^{n} / xi-\bar{x}}{N} = \frac{2.2}{7} 0.317$

Wind speed data analysis (wet)

	xi-$\bar{x}$	/x-$\bar{x}$/	(xi-$\bar{x}$)^2
1	0.24	0.24	0
2	-0.06	0.06	0.04
3	-0.16	0.16	0
4	0.14	0.14	016
5	-0.06	0.06	0.36

6	-0.16	0.16	0.81
7	0.04	0.04	0.01
$\sum$		0.860	1.315

$\bar{x} = 0.96$

Variance= $\frac{0.315}{7} = 0.045$

S. D = $\sqrt{0.045} = 0.212$

MSE=0.045

MAD= $\frac{0.86}{7} = 0.123$

Relative humidity data analysis (dry)

	$xi-\bar{x}$	$/x-\bar{x}/$	$(xi-\bar{x})^2$
1	-4	4	16
2	-6	6	36
3	3	3	9
4	6	6	36
5	9	9	81
6	-3	3	9
7	-5	5	25
$\sum$		36	222

Variance= $\frac{222}{7} = 31.71$

S. D = $\sqrt{31.71} = 5.63$

MSE= 31.71

MAD= $\frac{36}{7} = 5.143$

Relative humidity data analysis (wet)

	$xi-\bar{x}$	$/x-\bar{x}/$	$(xi-\bar{x})^2$
1	11	11	121
2	10	10	100
3	11	11	121
4	-5	5	25
5	-4	4	16
6	-11	11	121
7	-12	12	144
$\sum$		64	648

Variance= $\frac{648}{7} = 92.5$

S. D = $\sqrt{92.5} = 9.62$

MSE= 92.5

MAD= $\frac{64}{7} = 9.143$

Atmospheric pressure data analysis (dry)

	$xi-\bar{x}$	$/x-\bar{x}/$	$(xi-\bar{x})^2$
1	0.8	0.8	0.64
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0
7	-0.8	0.8	0.64
$\sum$		1.6	1.28

Variance= $\frac{1.28}{7} = 0.183$

S. D = $\sqrt{var} = 0.428$

MAD= 0.229

Atmospheric pressure data analysis (wet)

	$xi-\bar{x}$	$/x-\bar{x}/$	$(xi-\bar{x})^2$
1	0.2	0.2	0.04
2	0.2	0.2	0.04
3	0.2	0.2	0.04
4	0.2	0.2	0.04
5	0.2	0.2	0.04
6	-0.6	0.6	0.36
7	-0.6	0.6	0.36
$\sum$		2.2	0.96

Variance= $\frac{0.92}{7} = 0.131$

S. D = $\sqrt{var} = 0.362$

MAD= $\frac{2.2}{7} = 0.314$

Noise level data analysis (dry)

	$xi-\bar{x}$	$/x-\bar{x}/$	$(xi-\bar{x})^2$
1	-6.4	6.4	40.96
2	-5.8	5.8	33.64
3	-4.2	4.2	17.64
4	13	13	169
5	0.1	0.1	0.01
6	-1.6	1.6	2.53
7		5	25
$\sum$		36.1	288.81

$$\text{Variance} = \frac{\sum_{i=1}^{n}\left(xi-\bar{x}\right)^2}{N} = \frac{288.81}{7} = 41.26$$

$$\text{S. D} = \sqrt{\text{var}} = 6.423$$

MAD= 361/7
=5.157

Noise level data analysis (wet)

	$xi-\bar{x}$	$/x-\bar{x}/$	$(xi-\bar{x})^2$
1	9.6	9.6	92.16
2	-1.8	1.8	3.24
3	-3.7	3.7	13.69
4	-4.0	4.0	16.0
5	-10.1	10.1	102.0
6	2.7	2.7	7.29
7	7.4	7.4	54.76
$\sum$			289.15

$$\text{Variance} = \frac{\sum_{i=1}^{n}\left(xi-\bar{x}\right)^2}{N} = \frac{289.15}{7} = 41.31$$

$$\text{S. D} = \sqrt{\text{var}} = \sqrt{41.81} = 6.43$$

$$\text{MAD} = \frac{39.3}{7} = 5.61$$

APPENDIX III

Waste Handling Guidelines

Wastes handling and disposal procedures shall be well defined at source and a waste inventory register kept. The waste contractor shall define, and document appropriately, all wastes generated and transferred in the course of his work. The general information required, as a minimum, for adequate definition of wastes include:

a. Waste stream identification;
b. Proper waste categorization;
c. Waste segregation;
d. Appropriate handling and disposal practice; and
e. Recommended Management practices

Waste Minimization Guidelines

The four principles of waste minimization process; recycle, reduce, reuse and recovery shall be adopted as applicable, to ensure reduction to the possible extent, of the volume or relative toxicity of liquid or solid wastes.

A large proportion of the excavated material shall be used for landscaping or other remedial works on site. All wastes associated with hydrocarbons, oils, hydraulic fluids, oily sump water, etc. shall be treated and channeled to the appropriate waste treatment facility of NNPC.

Waste Segregation Guidelines

All wastes to be generated from the Mega Station, Awka project shall be segregated at source, into clearly designated bins at strategic locations.

Waste Disposal Guidelines

All debris, rubbish and other wastes, except excavated soil, shall be cleared regularly from the site and disposed of accordingly at Government designated sites for such wastes.

Instructions on material safety handling sheet (MSDS) shall be strictly adhered to and shall form the basis for the disposal of wastes related to such product. Adequate treatment measures shall be undertaken, where applicable, in line with applicable guidelines, for all waste before final disposal.

All wastes in transit shall be tracked by waste consignment note. The waste consignment note records shall be kept and should include as a minimum the following information:

- Date of dispatch
- Description of waste
- Waste quantity/container type
- Designated disposal site and method
- Consignee/driver name and means of transportation.
- Confirmation of actual disposal (time and date).

APPENDIX IV

Monitoring and Environmental Auditing Plan for Mega Station, Awka Project

vironmental mponents	Indicator Parameters	Frequency	Location	Responsibility
r Quality	□ NO_x, SO_x, CH_x, SPM	Bi-weekly during construction	Site	S & Department
derground water ality	□ Oil and grease □ Hydrocarbon	Twice a year	Site	S & Department
clo-economics	□ Population -demographic -occupational distribution -ethic mix □ Infrastructure -infrastructural development □ Local economy □ Natural resources -quality and quality of exploited natural resources □ Lifestyle and Social Value -crime rate, anti-social tendencies □ Health status -communicable diseases -stress-related diseases -malnutrition -accidents, injuries/fatalities	Three (3) years interval	Amikwo and Agulu-Awka communities	S & Department

Environmental Auditing Plans

NNPC shall set up a QA/QC function to monitor through regular auditing the quality management system of the project to ensure compliance with the project design concepts. This audit shall check the prediction of the EIA and assess the general performance of the project to ensure that environmental standards are maintained and that NNPC policies and environmental management guidelines are strictly maintained.

Each environmental audit shall be geared towards achieving the following:

□ Compliance with all necessary codes, standards and procedures;

- Examine compliance with regulatory requirements;
- Identify current and potential environmental problems;
- Examine line management systems, pipeline operations, monitoring practices and data, procedures and plans;
- Check the predictions in the Environmental Impact Assessment and ensure that recommendations are being implemented; and
- Recommend areas of improvement in operations management.

After every audit exercise, the environmental auditor shall produce an Environmental Audit Report (EAR), which shall be submitted to NNPC for onward submission to regulators and operating contractor.