QUALITITATIVE ANALYSIS OF AIR AND NOISE ENVIRONMENT WITHIN 5 KM RADIUS OF SGPGI, LUCKNOW, UTTAR PRADESH

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LUCKNOW

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CERTIFICATE

This is to certify that the work contained in the thesis entitled "**Qualitative Analysis of Air and Noise Environment within 5 km radius of SGPGI**", submitted by **Swapnil Srivastava (University seat no. - 1180470002)** for the award of **Master of Technology In Environmental Engineering from Babu Banarasi Das University Lucknow**, is a record of bona fide research works carried out by him under my direct supervision and guidance. I considered that the thesis has reached the standards and fulfilling the requirements of the rules and regulations relating to the nature of the degree. The contents embodied in the thesis have not been submitted for the award of any other degree or diploma in this or any other university.

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ABSTRACT

In today's world one can discover an increasing valuation of nature and the environment. In many ways there is more and more concern about environmental protection, nature conservation or sustainability in terms of resource or land use. EIA is defined by the International Association for Impact Assessment (IAIA) as the "process of identifying, predicting, evaluating and mitigating the biophysical, social and other relevant effects of development proposals prior to major decisions being taken and commitments made"

The key findings show that Air and Noise quality play a significant role in the development and design of a project (i.e. The Emergency Medicine Block), not only because of legal obligations but also because of the influence of the affected public. The analysis highlights the impacts on a Hospital's work load, strategies and project plans. Public participation is considered to be an important part in their Environmental and Social Impact Assessment processes.

The analysis focuses to examine environmental consequences of planned project (i.e. The Emergency Medicine Block) or other activities. Therefore, a process is started to assess in different 2 stages the impacts of a project plan, starting from a screening phase over a scoping phase, the consideration of alternatives, followed by a row of other steps and usually ends with a written Environmental Impact Statement. During the EIA process impacts of a project on physical-chemical, biological, cultural and socioeconomic components of the total environment are investigated. Consequently, this analysis ensures the consideration of the Air and Noise environment in planning and decision making.

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In the present world of competition there is a race of existence in which those are having will to come forward succeed. Project is like a bridge between theoretical and practical working. With this willing I joined this particular project.
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CHAPTER 1
INTRODUCTION

1.1 BACKGROUND

This project presents the findings of the Environmental Pre-Feasibility of the development of proposed Emergency Medicine Block inside Sanjay Gandhi Post Graduate Institute of Medical Sciences(SGPGI), Raibareli Road, Lucknow, Uttar Pradesh. The New Emergency block which is being constructed in located near the main entrance of SGPGI.

This report includes the Identification and Prediction of significant environmental impacts due to the proposed project along with an appropriate Environmental Management Plan both for the construction phase and for its operation and maintenance later on the basis of the Environmental Impact Assessment (EIA) Notification dated September 14, 2006.
The EIA (Environment Impact Assessment) is a tool of environmental management forming a part of project approval and decision-making. Environmental assessments may be governed by rules of administrative procedure regarding public participation and documentation of decision making, and may be subject to judicial review.

The International Association for Impact Assessment (IAIA) defines an environmental impact assessment as "the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made".EIAs are unique in that they do not require adherence to a predetermined environmental outcome, but rather they require decision makers to account for environmental values in their decisions and to justify those decisions in light of detailed environmental studies and public comments on the potential environmental impacts.

Getting Involved in the complete EIA process is a time taking task as the EIA process starts before the construction is started and is carried throughout the entire construction phase and even after the construction is completed, so we cannot focus on each and every aspect of it.
Our prime focus under this project would be on Air and Noise quality standards and we would try to cover each and every aspect under these topics.

1.2 RESEARCH AREA

Inside the study field of Environmental and Social Impact Assessment a lot of research has been done about methods, techniques or assessment tools. Nevertheless, only a limited number of studies– which can be described as a research gap – explored the role of a single project proponent, which can be a business or institution that faces such an Impact Assessment process.
This thesis tries to fill this gap and looks at Environmental and Social Impact Assessment processes with Public Participation through the eyes of an institution. Not only how institutions are affected will be investigated, but also new opportunities resulting from these Impact Assessment processes for companies shall be presented.

This study thereby looks for answers for the following underlying questions:

• What are the advantages and disadvantages for an Institutional Development that needs an Impact Assessment for its projects?
• How does such a process affect the decision-making of an Institutional Development?
• And finally, what does public participation during an Impact Assessment mean for an Institutional Development?
• Specify a set of benchmarks for Air and Noise environment in EIA process and outcomes in developing countries
• Establish the context for Air and Noise environment in EIA process and its outcomes in SGPGI
• investigate opportunities to address identified weaknesses in EIA process and outcomes.

The study will start from a general literature review on the three pillars: Environmental Impact Assessment, Social Impact Assessment and Public Participation. General research findings will be presented and some basic assumptions on an institution's role in an assessment process will be made. Before the overall research results will be analyzed, the used methods will be described. The thesis ends with a conclusion including some practical recommendations and an outlook for future research in the field of Air and Noise Environment.

CHAPTER
2
LITERATURE

2.1 LITERATURE SURVEY

The beginning of EIA dates back to 1969, when the National Environmental Policy Act (NEPA) was first established in the United States. NEPA is meant to protect and restore the environmental quality. It was also designed to minimize adverse environmental impacts and to preserve the environment through the use of reports and recommendations that assess environmental impacts of a proposed action, its negative effects, and alternatives as well as stating shortterm use vs. long-term productivity and any irreversible or irretrievable use of resources. All of these points are to be included in an Environmental Impact Statement (EIS).
Social or also known as Socioeconomic Impact Assessment was added to the NEPA process in 1973, and was intended to evaluate significant population and growth impacts or changes in resources like land use, water, and public services in the affected area. Besides, SIA is seen as a comprehensive tool to add the natural and physical environment and the relationship of people with the environment to the EIA process. In 1999, the IAIA, deemed by many to be the premier international organization in the field of EIA, published the Principles of Environmental Impact Assessment Best Practice which identified 14 basic best practice principles that the IAIA considers applicable to all stages of the EIA process.
The principles are intended as a reference tool by those who are professionally active in the field of EIA, and carry the objective of promoting effective EIA practice consistent with the institutional and process arrangements for EIA that exist around the world (IAIA, 1999). The principles were created by a working group of professional EIA experts from developed and developing countries and were open to comment by a broad range of IAIA practitioners. These 14 principles are intended to be applied to the EIA process as a single “package,” though the IAIA is conscious that in some cases, the principles, while interdependent upon one another, may conflict. The IAIA therefore advocates a balanced approach in the application of the principles.

1. Seyed All Akbar Jafari Mosavi, April 1993 - This chapter investigates waste management in general and particularly medical waste from hospital and other health care facilities. Over the last 20 years there has been a large change in waste disposal. It would seem reasonable for this study first to attempt to describe in which way the quantities and composition of waste have changed and to explain the previous and present position. In this chapter, thereforefirst waste in general is considered because the majority of hospital waste is of domestic origin. Hospital wastes are divided into the general categories of ordinary household waste, hazardous waste, infectious waste, chemical waste and radioactive waste. The classification and quantities of wastes are discussed and finally waste legislation is described. Hazardous and infectious waste is described in detail, chemical and radioactive waste in brief but mining and agricultural waste, as they are not relevant to the study, are not described.
Hospital incinerators, as well as other methods of waste disposal, can introduce hazardous materials into a community's environment. For instance by: waste water; air emission; leaking storage containers; accidents; explosions and fires. The British Department of

Health and Social Security believes that all contaminated waste from hospitals should be incinerated at the place of origin. (Department of the Environment, 1971). According to Lund (1977) incineration is the safest method for the disposal of hospital wastes butsince landfill costs are cheaper than incineration andf ill must be considered as an alternative to incineration wherever possible. The disposal of hospital infectious and contaminated wastes by controlled landfill is, however, not recommended, unless the wastes are pre-sterilised by autoclaving before landfilling (Hnatko, 1975).

2. Ortolano and Shepherd (1995)- noted that EIAs have had 'far less influence than their original supporters had hoped they would' in influencing project and plan decision-making and identify a number of broad areas of concern: the different views about the nature and purpose of EIA and especially its relationship to decision-making processes; institutional implementation issues; problems associated with practice, including limited or no public participation; and the limited substantive effect of EIA as a process.
These areas of concern are echoed by Retief (2010), who identifies three broad themes based on a review of the international literature on environmental assessment:

i. Theoretical grounding – do we have a clear sense of the purpose of EA, and what it comprises?
ii. Quality – what is good practice, how do we judge quality, what guidance do we provide?
iii. Effectiveness – what are we achieving through this process?

The following discussion of issues uses these three broad themes, but replacing quality with practice as the key consideration for the second theme as it provides a rather broader perspective. Public participation is given some prominence under practice issues, as a topic which has developed substantially in the last 20 years, is critical to all forms of impact assessment, but is still the source of many problems in practical impact assessment.

3. Munn - EIA is an activity designed to identify and predict on the impact on the bio-geophysical environment on man's health/wellbeing of legislative proposals, policies, programs, projects and operational procedures and to interpret and communicate about the impacts. This depicts that EIA reflects a preventive approach to environmental management. In 1987, United Nations Environment Program (UNEP) draft guidelines for assessing industrial environmental impact and criteria for industry siting, defined EIA as an aim to identify, predict and describe in an appropriate term the pros and cons (penalties and benefits) of a proposed development. The environmental impact assessment (EIA) according to them compares alternatives which could be used to realize a project and identifies one with the best combination of economic and environmental costs and benefits. The first form of assessment was first introduced in the US which was known as the National Environmental Policy Act (NEPA), of 1969, with the mandate of publishing an environmental impact statement (EIS), describing in detail the environmental impacts likely to arise from project developments. Since then, majority of countries have adopted similar procedure; with Nigeria's first ever promulgation on EIA known as EIA Act 86 of 1992.

4. Ali S.A. et al. (2003)- conducted a study on road traffic noise in Greater Cairo, the capital and the largest city in Egypt and the eleventh biggest city in the world. Extensive measurements were carried out in 21 sites in Greater Cairo. Restrictions were introduced to improve environmental conditions including (i) a ban on horns, (ii) a ban on horns and trucks (iii) a 17 ban on horns, trucks and noisy buses. Equivalent noise levels were measured before and after these restrictions. The equivalent noise level was considerably reduced by the bans.

This shows that various strategies can be used to change the traffic composition in order to achieve quieter city environments. The degree of annoyance was measured by means of questionnaire. The results showed that there was a strong relationship between road traffic noise levels and the percentage of highly annoyed respondents.

5. Roberts M.J. et al. (2003)- had detected unexplained peaks of annoyance in quieter places, or a plateau of annoyance in high noise. Such anomalies may especially affect those sensitive to noise. The pattern of alternation of passby noise and background traffic noise explains the positioning in soundspace of anomalies variously reported at 60 dB (A) Leq; 4000 NV (daily traffic volume) and 1800 NHV (daily heavy traffic volume). Such anomalies occur where there were regular or rapidly alternating patterns of passby noise.

6. Y.J.Jung and Y.K.Lee - created air pollution monitoring system using Geosensor network in 2008.Geosensor network is used to the detect the condition of remote place. In this context model and concept of flexible inspecting interim change was acquainted which builds the battery lifetime. Setting model outlined which decides the dirtied ranges and appropriately caution message and wellbeing rules send to the general population around there.

7. NihalKularatna and B.H.Sudantha- displayed environmental air pollution monitoring system in 2008. The framework in view of the IEEE 1451 standard. In this paper STIM savvy transducer interface module was created which comprise of microcontroller and gathering of different sensors like CO2, CO, NO2, and O3.This likewise utilized Personal PC for graphical portrayal. STIM associated with the PC by means of transducer autonomous interface which utilizes IEEE 1451 standard.

8. Jakovljevic Branko et al. (2009) determined principal factors for high noise annoyance in an adult urban population and to assess their predictive value. A cross-sectional study was performed on 3097 adult residents of a downtown municipality in Belgrade (1217 men and 1880 women), aged 18–96 years. Equivalent noise levels [Leq (dBA)] were measured during day, evening and night at all streets of the municipality. Noise annoyance was estimated using self-reported annoyance scale. Noise annoyance showed strong correlation with noise levels, personal characteristics and some housing conditions. Logistic regression model identified increased risk for a high level of noise annoyance with regard to orientation of living room/bedroom toward the street, duration of stay at apartment during the day, noise sensitivity and night time road-traffic noise level.

9. Paunović Katarina et al. (2009)- conducted a study to assess the predictive value of various factors on noise annoyance in noisy and quiet urban streets. Equivalent noise levels [Leq (dBA)] were measured during day, evening and night times at all of the streets of a central Belgrade municipality. Based on 24-hour noise levels, the streets were denoted as noisy (24-hour Leq over 65 dBA), or quiet (24-hour Leq under 55 dBA). A cross-sectional study was performed on 1954 adult residents (768 men and 1186 women), aged 18–80 years. Noise annoyance was estimated using a self-report five-graded scale. In noisy streets, the relevant predictors of high annoyance were the 12 orientation of living room/bedroom toward the street, noise annoyance at workplace, and noise sensitivity. Significant acoustical factors for high noise annoyance as reported were as under: i. Night time noise level and night time heavy traffic. ii. Day-evening-night noise level (Lden). iii. In quiet streets, the

significant predictors were noise sensitivity. iv. The time spent at home daily. v. Light vehicles at night time or heavy vehicles at daytime.

10. P.M.B Silva Girao - In 2009 implemented Smart sensor network for indoor and outdoor air quality monitoring. In this framework sensor hubs are introduced in various rooms and it comprise of tin dioxide sensors which was hardwired or remotely associated with the focal unit. It additionally measured the centralization of temperature and moistness for exactness. In this the idea of various information single yield neural systems was executed to repay temperature and moistness impact on gas fixation. Wi-Fi innovation was utilized for correspondence. In the time of 2010.

11. Lindgren A, Bjork J, Stroh E, Jakobsson K. (2010) Adult asthma and traffic exposure at residential address, workplace address, and self-reported daily time outdoor in traffic. A two-stage casecontrol study. BMC Public Health, 10 (716) Most epidemiologic studies use traffic at residential address as a surrogate for total traffic exposure when investigating effects of traffic on respiratory health. This study used GIS (Geographical Information Systems) to estimate traffic exposure, not only on residential, but also on workplace address, in addition to survey questions on time spent in traffic during commuting or other daily activities. The aim was to investigate 1) if there is an association between traffic exposure and prevalence of adult asthma and asthma symptoms, and 2) if so, does this association become stronger using more complete traffic exposure information.

12. Phan Hai Yen Thi et al. (2010) established dose-response relationships between Lden (day evening night noise levels) and the percentage of highly annoyed respondents of Hanoi and Ho Chi Minh city. It was observed that the Hanoi respondents seemed to be more annoyed by noise than Ho Chi Minh City respondents. Compared to annoyance responses of European 11 people, Vietnamese (Hanoi and Ho Chi Minh City) were less annoyed by road traffic noise by about 5 dB.

13. A.R.Al-Ali, Imran Zualkernan and FadiAloul- Presented Mobile GPRS sensors for pollution monitoring. This included Data procurement unit, GPRS modem, and GPS module and contamination server. In this DAQ unit, GPRS and GPS were associated with the microcontroller by means of RS-232 Interface lastly assembled information was sending to the pollution server.

14. Andersen ZJ, Hvidberg M, Jensen SS, Ketzel M, Loft S, Sørensen M, Tjønneland A, Overvad K, Raaschou-Nielsen, O. (2011)- Chronic obstructive pulmonary disease and long-term exposure to traffic-related air pollution: a cohort study. Am J Respir Crit Care Med; 183 (4): 455-61. Short-term exposure to air pollution has been associated with exacerbation of chronic obstructive pulmonary disease (COPD), whereas the role of long-term exposures on the development of COPD is not yet fully understood. The authors assessed the effect of exposure to traffic-related air pollution over 35 years on the incidence of COPD in a prospective cohort study. They found that long-term exposure to traffic-related air pollution may contribute to the development of COPD with possibly enhanced susceptibility in people with diabetes and asthma.

15. Raja Vara Prasad et al. - In 2011 proposed a real time wireless pollution monitoring. This framework depended on the multihop information accumulation calculation. Aligned gas sensors were interfaced to remote sensor bits, in that Libelium WASP bit was utilized

which comprise of preparing unit and correspondence unit. All gas sensors were associated with sensor board on rotational premise. The collected data were sending to base station. Multihop data aggregation algorithm was used to increase a monitoring range.

16. Jen-Hao Liu et al.- Introduced micro-scale air quality monitoring system for urban areas in 2012. This System monitors the convergence of carbon monoxide co brought on by substantial vehicles discharge. Sensor hubs were sent in exceptionally populated ranges. Framework was incorporated with the GSM for information transmission. Gateway collected the data from all sensor nodes and sends to control centre by GSM network.

17. Buonanno, G., Marks, G.B., Morawska, L. (2013)- Health effects of daily airbourne particle dose in children: Direct associations between personal dose and respiratory health effects. Environmental Pollution; 180: 246-250. Air pollution is a widespread health problem associated with respiratory symptoms. Continuous exposure monitoring was performed to estimate alveolar and tracheobronchial dose, measured as deposited surface area, for 103 children and to evaluate the long-term effects of exposure to airborne particles through spirometry, skin prick tests and measurement of exhaled nitric oxide (eNO). The mean daily alveolar deposited surface area dose received by children was 1.35 × 103 mm2 . The lowest and highest particle number concentrations were found during sleeping and eating time. A significant negative association was found between changes in pulmonary function tests and individual dose estimates. Significant differences were found for asthmatics, children with allergic rhinitis and sensitive to allergens compared to healthy subjects for eNO. Variation is a child's activity over time appeared to have a strong impact on respiratory outcomes, which indicates that personal monitoring is vital for assessing the expected health effects of exposure to particles.

18. Abdullah Kadri et al. in 2013 displayed ongoing air contamination observing in view of Machine to machine correspondence. The system was implemented with various monitoring station which consist of different gaseous and meteorological sensors. Each monitoring station communicates with the backend server through M2M communication which uses GPRS network.

19. Anuj Kumar et al. in 2013 conducted a review on environmental monitoring system. The review discussed distinctive procedures and different equipment utilized as a part of the earth checking frameworks. It also considered the parameters like low cost, low power consumption, reliability, and signal to noise ratio and RF interference.

20. Pradeep D. Landge1, R.R.Harne -2018- Objective of this paper is to design and implement a system for air quality monitoring using Internet of Things called as IoT. The model initiates from sensor devices that can sense, compute, and communicate data in a network. This study measures real-time PM2.5, temperature, humidity, Air Quality Index. Monitored data is wirelessly transmitted via WiFi module to a server. When the sensor node reads pollutant gases composition, temperature and humidity it will be displayed on the website. The monitored data with date and time can be retrieved as a tabular data for future analysis. With implementation of this work, precautionary alerts can be given to public on the designed website to wear anti-pollution mask, change paths while transporting where there is high air pollution ensuring high reliability. It will promote the public awareness about state of air pollution and how much important it is to reduce it. There will be news,

surveys regarding pollution in different countries, different ways to reduce air pollution on the website.

Some of the existing methodologies for the air pollution monitoring are described as below, in plug and sense device method, it Uses multiple sensors with location co-ordinate, AQI LED indicator is actuated as per pollution level and the Real time pollution level visualized using line graph. In distributed sensor data computing, it uses distributed intelligence for the sensor nodes and uses spatial database for locations. In Arduino based method it uses sensor devices for data, Uses ESP8266 Wi-Fi module for connection to server, Uses Node.js and Node RED for displaying data on the server side. In personal assessment methods, Biochemical dose assessment methods are used Ex. Biomarkers. In ZigBee technology, ZigBee transmitters and receivers are used, GPS module is used for locations for pollution level on map . This paper presents the summary of various techniques of air quality monitoring. These techniques are elaborately discussed in the paper. In the proposed system, one of the most preferred technique is cloud based air quality monitoring system.

Figure 2.1 SGPGI Plan

Table 2.1: Basic principles of EIA

BASIC PRINCIPLES OF EIA BEST PRACTISE	DESCRIPTION
Purposive	EIA should inform decision makers and result in environmental protection.
Rigorous	The EIA process should apply best practicable science and appropriate methodologies.
Practical	EIA should result in outputs which assist in decision making and are acceptable to all involved stakeholders.
Relevant	EIA should provide sufficient, reliable and useable information for decision making.
Cost-Effective	The EIA process should achieve its objectives within the limits of available resources.
Efficient	The EIA process should impose the minimum cost burdens (financial and time) on proponents and participants while meeting accepted requirements and objectives of EIA.
Focused	The EIS should be concentrated on significant impacts and key issues that need to be taken into account by decision makers.
Adaptive	EIA should be adapted to the realities, issues and circumstances of the proposals under review without compromising the integrity of the process.
Participative	The process should provide appropriate opportunities to inform and involve interested and affected stakeholders, and their inputs and concerns should be incorporated in the EIA documentation and decision making stage.
Interdisciplinary	Appropriate techniques and expertise in the relevant disciplines, including use of traditional knowledge where relevant, should be employed.
Credible	The process should be carried out with professionalism, fairness, objectivity and balance.
Integrated	EIA should address the interrelationships of all social, economic and biophysical aspects.
Transparent	The process should have clear, comprehendible requirements for EIA content, ensure public access to information, identify the factors what will be considered during decision making, and acknowledge limitations.
Systematic	The process should result in full consideration of all relevant information on the affected environment, proposed alternatives and the necessary mitigation and monitoring measures.

CHAPTER 3
METHODOLOGY

3.1 ENVIRONMENTAL MONITORING PLAN

Purpose:

- A detailed EMP is important to cater the following aspects: -
- To check the pollutant levels in the local environment from time to time
- To make the local population aware of any steep rise in the level of any pollutant
- To keep the local population healthy and free from diseases
- To check any probable outbreak of an epidemic
- To promote and maintain stress free living environment
- To maintain an environment that could provide sufficient sustenance to flora and fauna of the local environment

Monitoring parameters:

- There can be many environmental parameters that can be studied at a site, however following parameters of utmost importance are selected due to the presence of well-known comparative data series: -
- Ambient air quality
- Noise
- Water quality
- Rainwater harvesting
- To ensure the effective implementation of the mitigation measures and environmental management during construction and operation phase of project road, it is essential that an effective Environmental Monitoring Plan be designed and followed. The table below shows the detailed EMP for the proposed project.

Table 3.1: Environment Monitoring Plan for the proposed project

Parameter	Project phase	Parameter	Standards	Locations	Duration /Frequency
Air	Construction	PM2.5, PM10, SOx, NOx	Ambient air quality standards	**1. PGI Campus** **2. Kali Paschim(SW of SGPGI)** **3. Sanskriti Enclave** **4. New Police Line Kalli** **5. Purseni** **6. Ashiyana** **7. Bijnaur**	Twice a year
	Operation	PM2.5, PM10, SOx, NOx	Ambient air quality standards	Project site	Twice a year
Noise	Construction	Noise level in dB(A)	Ambient air quality standards for noise	**1.Ekta Nagar** **2.PGI residences Type 1** **3.Pushpendra Nagar** **4.Sanskriti Enclave** **5.Alinagar Khurd** **6.Hospital SGPGI** **7.Suyansh Public School**	Twice a year
	Operation	Noise level in dB(A)	Ambient air quality standards for noise	Project site	Twice a year
Ground water	Construction	Drinking water parameters	Drinking water standards (IS 10500)	Project site	Twice a year
	Operation	Drinking water parameters	Drinking water standards (IS 10500)	Project site	Twice a year

Drinking water	Construction	Drinking water parameters	Drinking water standards (IS 10500)	Project site	Twice a year
	Operation	Drinking water parameters	Drinking water standards (IS 10500)	Project site	Twice a year
Treated wastewater	Operation	pH, BOD, COD, TDS, TSS, DO	General effluent discharge standards	Project site	Twice a year
Surface water	Construction	Surface water parameters	Surface water standards (IS 2296)	Project site	Twice a year
Rainwater harvesting	Operation	Inspection of drains and recharge pits	Design parameters	Project site	Twice a year

3.2 EMERGENCY MANAGEMENT

Following points must be taken care of to tackle any alarming situation at the site: -

- The monitoring results must be made public from time to time in order to keep the residents aware of the situation prevailing at the site.
- The residents must be made aware of the alarmingly rising pollutant levels, if any.
- Provision of ambulance shall be made to cater to any unwanted situation.
- Construction workers must be provided for medical and healthcare checkups especially for respiratory illness.
- Women helpers must be made available all the time to take care of the medical needs of females.

Construction workers shall be provided with all the protective gears needed to safeguard their lives while working on the site.

CHAPTER 4
FINDINGS AND RESULTS

4.1 SITE ANALYSIS

Sanjay Gandhi Post Graduate Institute of Medical Sciences Institute is situated to the Southeast of Lucknow city on Lucknow- Raebareli Road. It is situated nearly 12 Km from the main (Charbagh) railway station and 15 Km from the city center (Hazratganj).

4.1.1 Site Surrounding & Connectivity:

The proposed expansion site is located at Sanjay Gandhi Post Graduate Institute of Medical Sciences, Raebareilly road, District- Lucknow, Uttar Pradesh and it is well connected to the railway station and bus stand of Lucknow through public conveyance network. From the railway station, private buses (route 3) run to the Institute at short intervals. Alternatively, pre-paid auto-rickshaws are also available for travel to the Institute. The environmental setting of the proposed site is as follows:

Location details:

- Latitude : 26.7435° N
- Longitude : 80.9452° E
- Elevation above MSL :
- Topography : Plain
- Land use classification : Institutional / Residential

Nearby areas:

- Ashiyana : 6.81 Km, NW
- HarikanshGarhi : 3.35 Km, SE
- KalliPoorab : 3.69 Km, S
- Baraulli Khalilabad:2.7 Km, E
- Nilmatha- 5.24 Km, NE
- RasoolpurIduria- 1.82 Km, W
- Alinagar Khurd- 2.27 Km, SW
- Sharda Nagar- 5 Km, N

Roads:

- Raebareilly Road, NH-24B- 0.3 Km, E
- Mahatma Gandhi Marg- 1.55 Km, SE
- Ekta Nagar Marg- 0.33 Km, S
- Lucknow Road- 0.77 Km, N
- Marshall St.- 1.26 Km, NE
- Amar Shaheed Path- 2.68 Km, N
- Uttrathiya Railway station road- 2.4 Km, NE
- Jail Road- 5.2 Km, NE
- Bijnor Road- 4.42 km, NE

Railway Station:

- Uttrathiya railway station- 3.35 Km, NE
- Mohanlalganj Railway station- 7.3 Km, SE
- Lucknow Railway station- 9.9 Km, N
- Manak Nagar Railway station- 9.39 Km, NW

Bus Station:

- SGPGI bus station- 0.35 Km, NE
- Deen Dayal Upadhyay bus station- 0.33 Km, E
- Mawaiya bus station- 1.38 Km, NE

River/Canal/Pond:

- Sharda canal- 0.4 Km, E
- Lake- 1.89 Km, NW
- Canal- 1.35 Km, W
- Gomti river- 10.94 Km, N

Schools/Colleges:

- Swami Vivekanand Mahila Mahavidyalaya- 2.37 Km, NW
- Maharaj BijliPasi degree college- 5.6 Km, NW
- Sardar Patel PG Institute of Medical science- 5.2 Km, NE
- Baba Saheb Ambedkar Central University- 3.71 Km, NW
- JB Memorial Inter college- 4.5 Km, W
- St. Terrassa College- 6.08 Km, N

Hospital:

- Nephrology OPD- 0.27 Km, W
- Sun Rise Hospital- 0.29 Km, S
- General Hospital- 0.61 Km, W
- Javitri Hospital- 3.92 Km, N
- Sanskar Hospital- 0.48 Km, N
- SGPGI Apex Trauma centre- 1.18 Km, NE
- Indira Gandhi Hospital and Research center- 4.34 Km, W

Places of worship:

- Bharat Mata Mandir- 0.38 Km, S
- Durga Mandir- 0.68 Km, SW
- Masjid faruqui- 0.84 Km, SW
- Koat Mata Mandir- 1.78 Km, S
- Mandir- 1.24 Km, SW
- Shiv Mandir- 1.16 Km, SW

Parks/ Playgrounds:

- Iskon Vatika- 0.88 Km, W
- Football ground- 1.06 Km, W
- Deen Dayal Upadhyay Kisan Park- 0.5 Km, SE
- SGPGI Forest- 1.96 Km, W
- Playground- 2.17 Km, NW
- Triangular Park- 2.20 Km, N

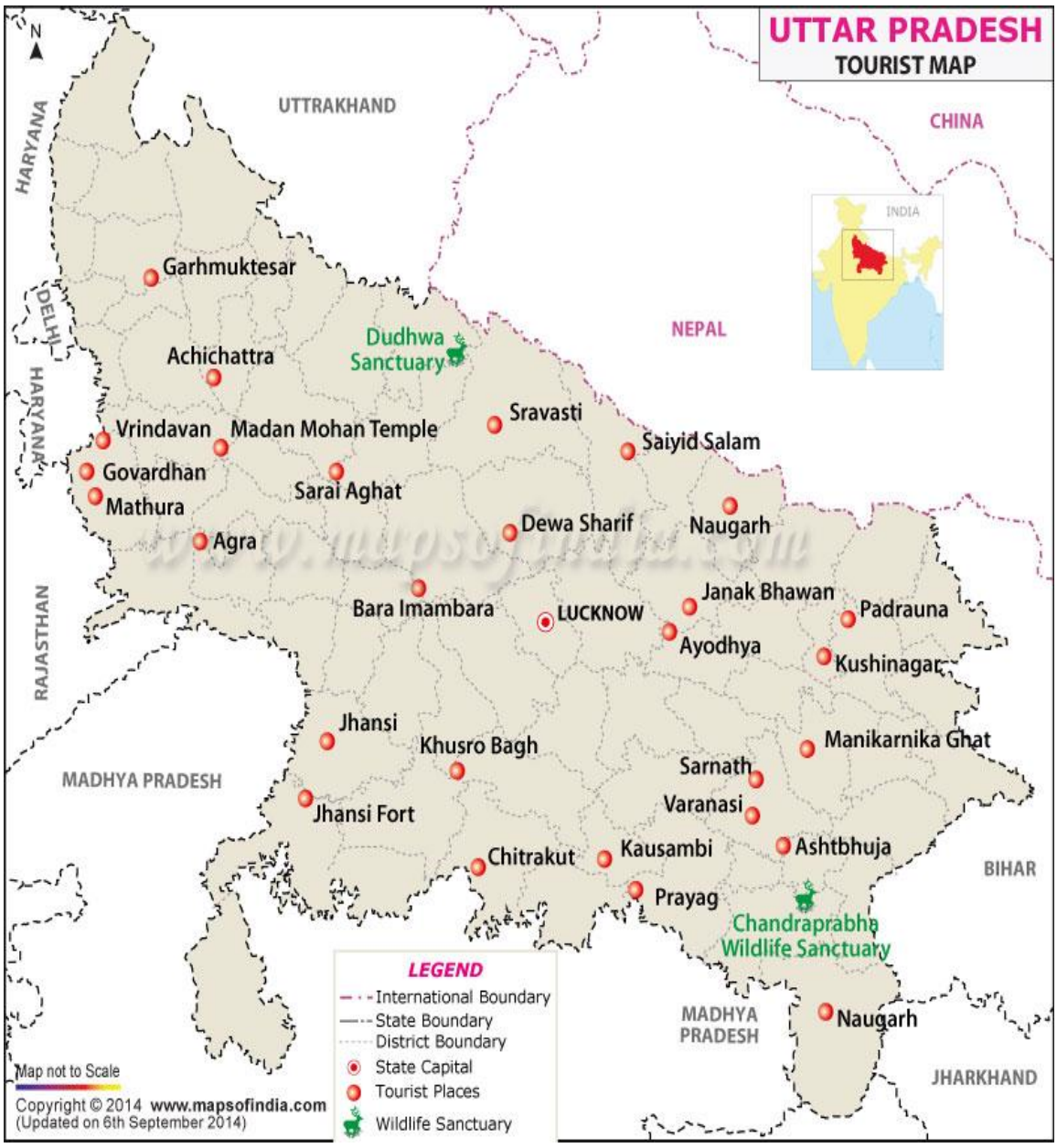


Figure 4.1: Uttar Pradesh Tourist hotspot

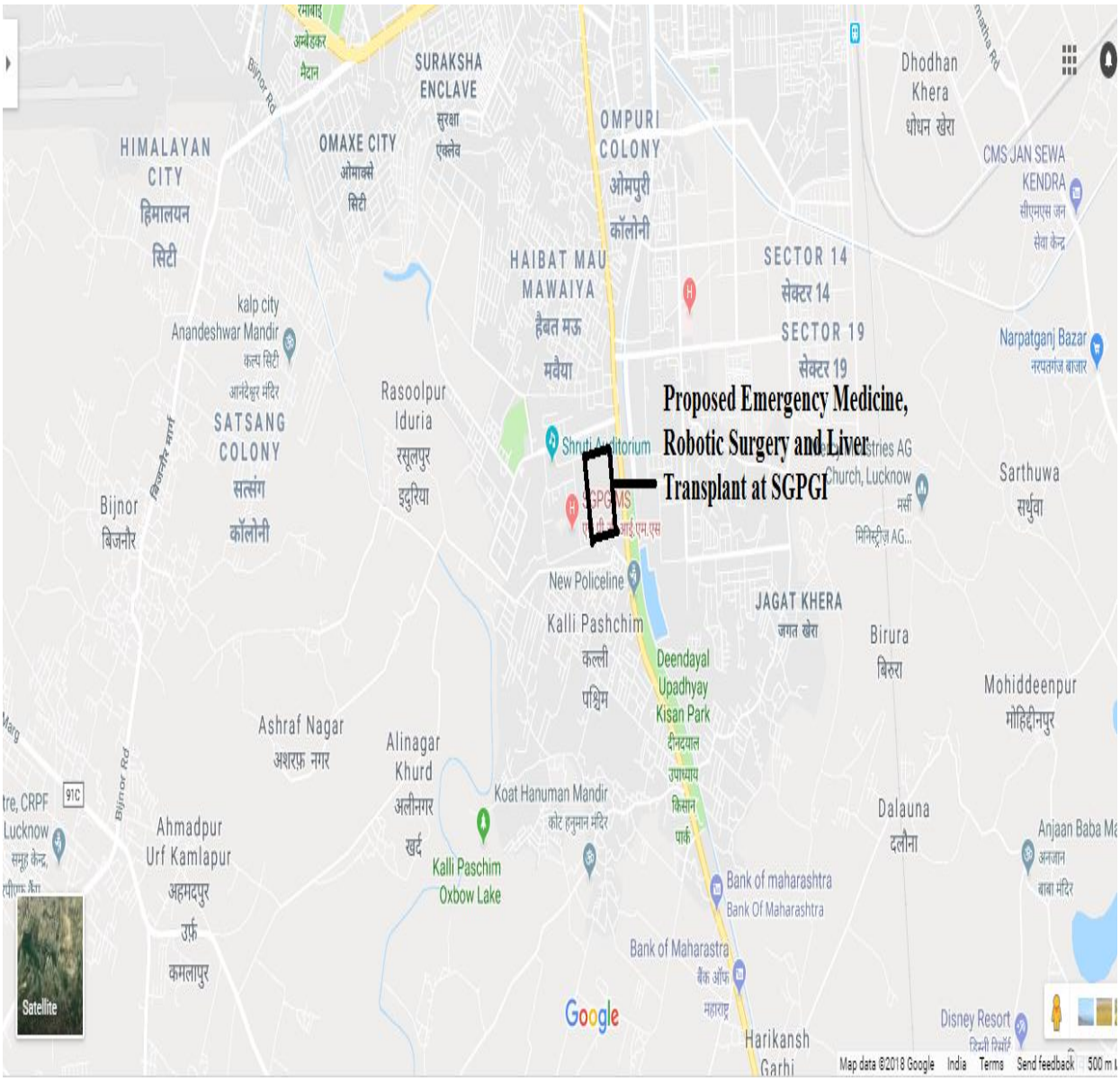


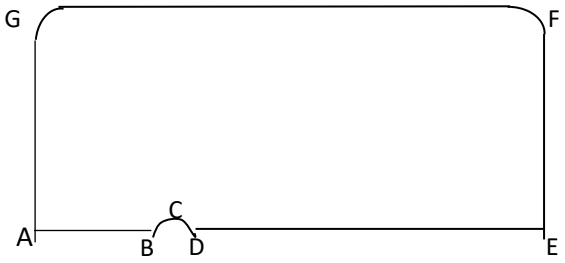
Figure 4.2: Google map location of SGPGI

4.1.2 Site selection:

The site is located at Sanjay Gandhi Post Graduate Institute of Medical Sciences, Raebareilly road, District- Lucknow, Uttar Pradesh. The coordinates of SGPGI campus is 26°44'41.49"N 80°56'50.81"E and for the proposed emergency medicine block along with project site are represented hereunder:

A	26°44'44.20"N 80°56'50.24"E
B	26°44'41.49"N 80°56'50.81"E
C	26°44'40.93"N 80°56'51.33"E
D	26°44'40.31"N 80°56'51.19"E
E	26°44'30.93"N 80°56'53.46"E
F	26°44'32.52"N 80°57'1.30"E
G	26°44'45.71"N 80°56'58.64"E

Table 4.1: Site coordinates



4.2 CRITERIA FOR SELECTION OF THE SITE

Lucknow, state capital of Uttar Pradesh is accessible from every part of India through Air, Rail and Road. It is directly connected with New Delhi, Patna, Calcutta, Mumbai, Varanasi, and other major cities by Amausi airport. Similarly, city is linked to north, east, south and west through rail and road links. In fact, rail link joins Lucknow to Pakistan via Amritsar in the west and to Bangladesh railways in the east. The following criteria are taken into consideration for selection of site:

4.2.1 Proximity to linkage:

SGPGI, Lucknow has hassle-free connectivity via an extensive network of all modes of transport. It is nearly 12 Km from the main (Charbagh) railway station, city center (Hazratganj) and Chaudhary Charan Singh International airport, Lucknow which is connected with most of the Indian as well as international cities through airway.
As the proposed project is bound within the existing SGPGI campus, it is obvious that it has well managed accessibility through all modes of transport.

4.2.2 Proximity to existing settlements:

The areas of project site existing in a developing zone and population pressure is likely to witness growth pattern influenced by the surrounding existing institutes & institutional establishments.

Nearby Areas

- Ashiyana- 6.81 Km, NW
- HarikanshGarhi- 3.35 Km, SE
- KalliPoorab- 3.69 Km, S
- Baraulli Khalilabad- 2.7 Km, E
- Nilmatha- 5.24 Km, NE
- RasoolpurIduria- 1.82 Km, W
- Alinagar Khurd- 2.27 Km, SW
- Sharda Nagar- 5 Km N

The map showing local connectivity to the project site in the nearby region is given as Figure

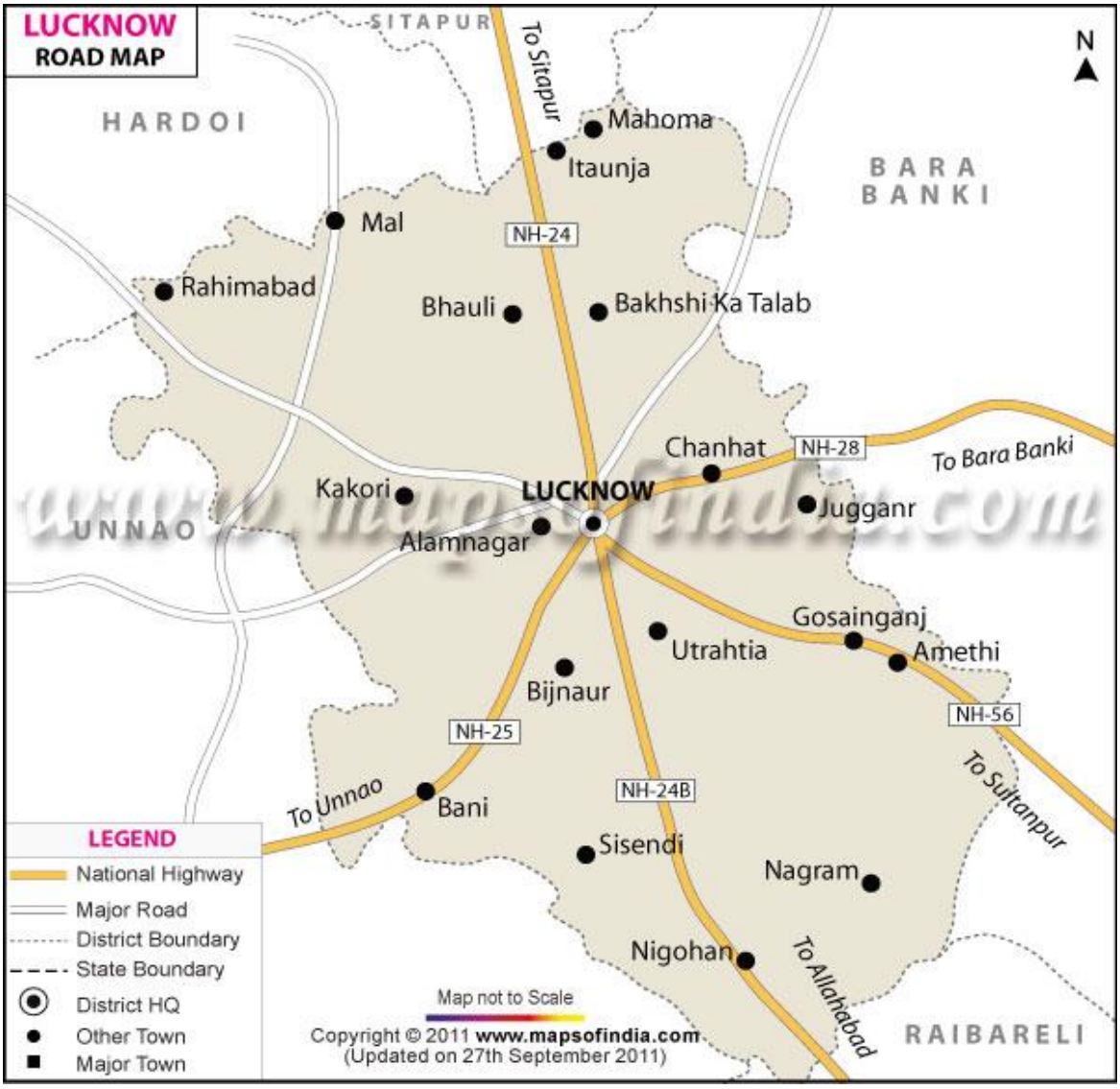


Figure 4.3: Lucknow road map

4.2.3 Ground water availability/resources:

- Ground water occurs in the pore spaces of the unconsolidated alluvium sediments in the zone of saturation under phreatic and semi confined conditions. In deeper aquifer it occurs under semi confined to confined conditions. To know the depth of tube well to meet the water requirement of SGPGI, a study has been conducted by Central Ground Water Board, NR, Lucknow.
- Based on the study of CGWB, NR, Lucknow, the ground water requirement of SGPGI campus, is met by the tube wells having depth down to 480 m yielding about 800-200 LPM. For the proposed construction the water requirement is easily sourced from the existing tube wells.

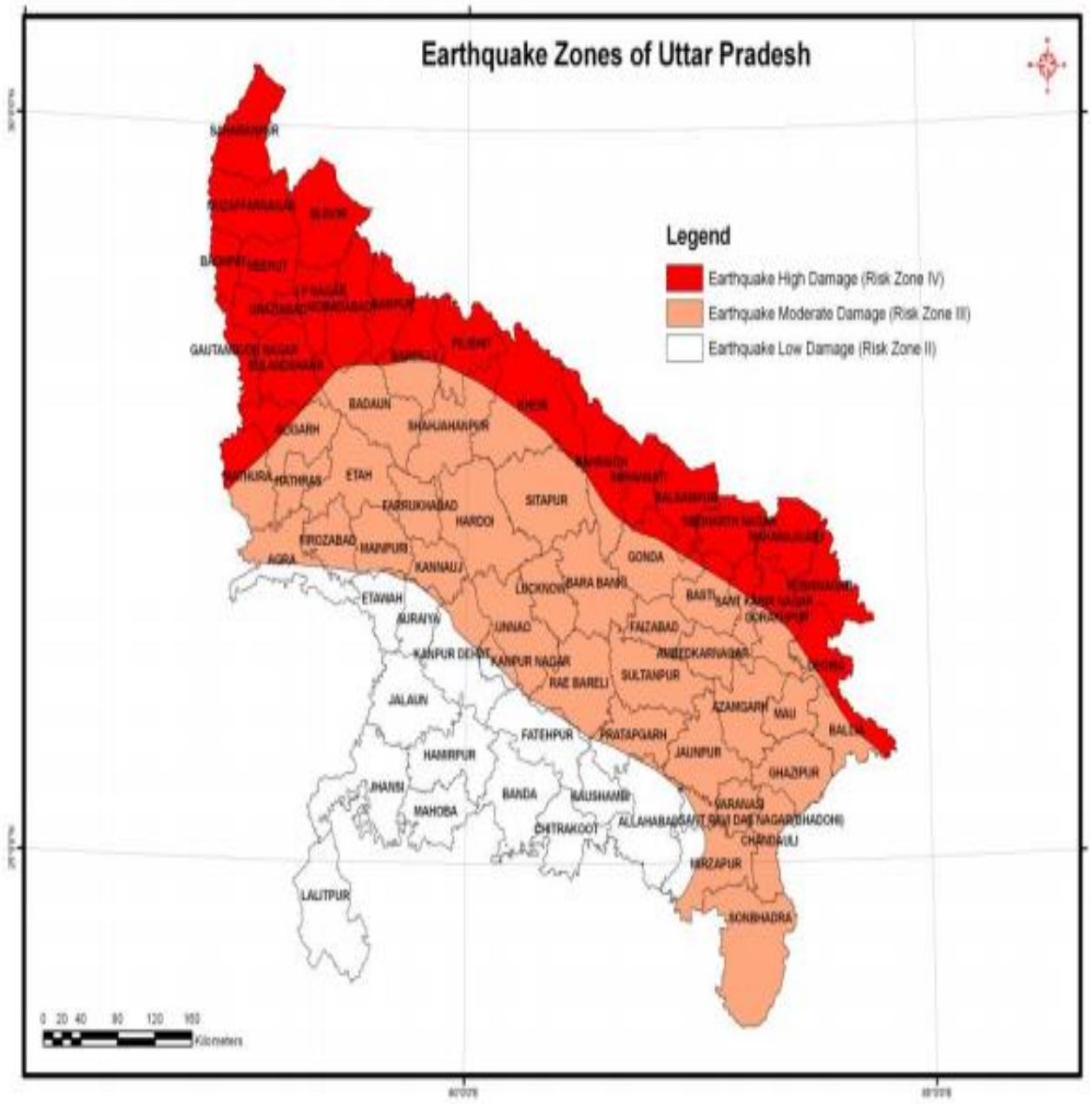
4.2.4 Topography:

- The project site is located at an average elevation of 122 meters from mean sea level (MSL) and has a flat topography. The latitude and longitude coordinates are 26°44'41.49"N 80°56'50.81"E respectively. The detailed map of the area showing 10 km radius around the boundary (topographical map) of the SGPGI campus is attached as Annexure I.

4.2.5 Seismicity :

- As per the seismic hazard map of India (updated in 2000 by the Bureau of Indian Standards, Lucknow falls under Seismic Zone III i.e. Moderate risk zone.
- As the SGPGI is located at Lucknow, the proposed project site falls under Seismic Zone III which is moderate risk zone.

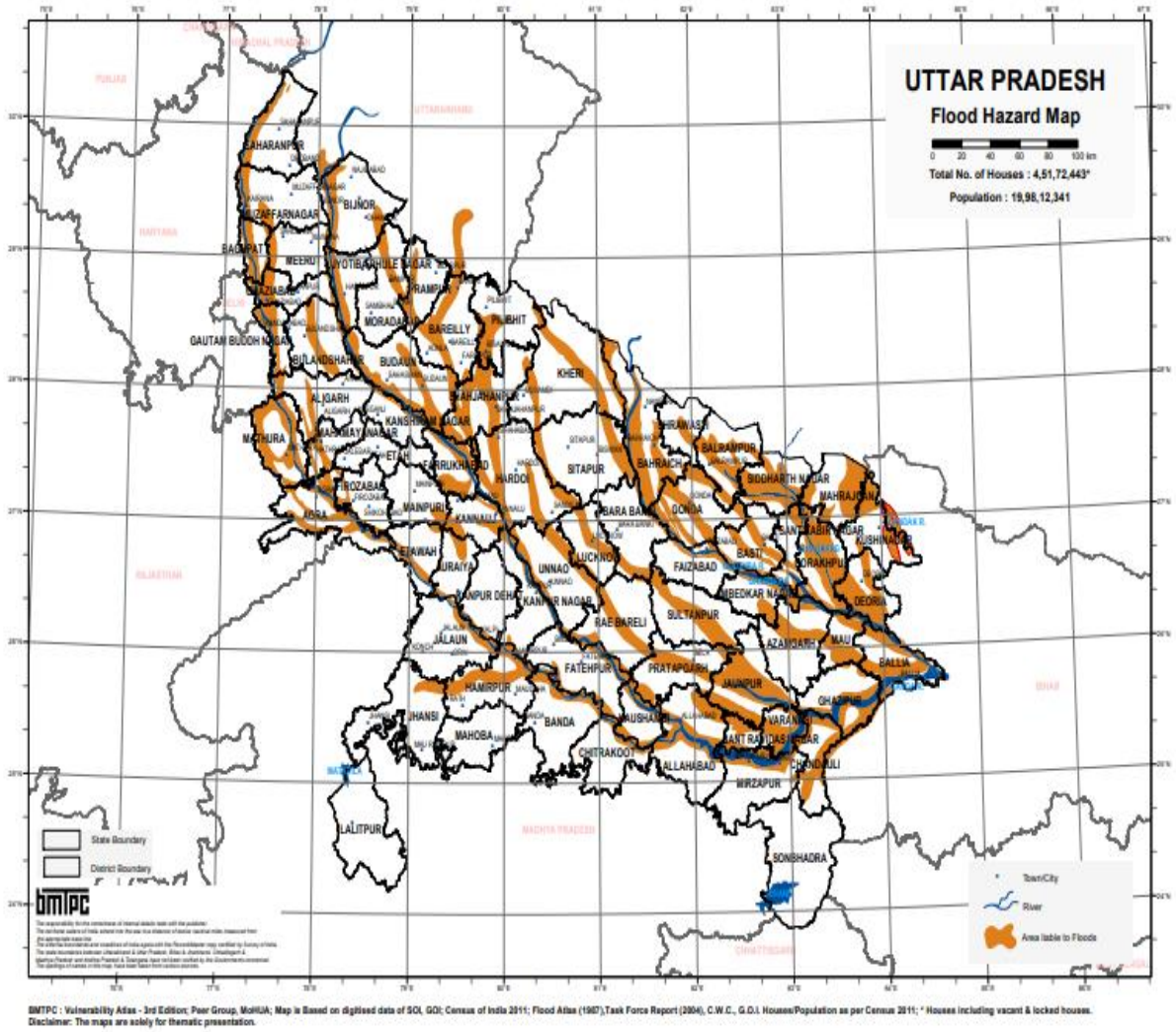
Figure 4.4: Earthquake zone in UP



4.2.6 Floods:

The proposed area falls in the Lucknow region that is not liable to floods which is very clear from the above map. Hence the proposed group housing project does not fall in the danger zone with respect to floods. The flood contour map below also shows that the proposed project area region (Lucknow) not lying in the flood prone zone and hence the proposed township and area development project is not liable to be harmed by the floods.

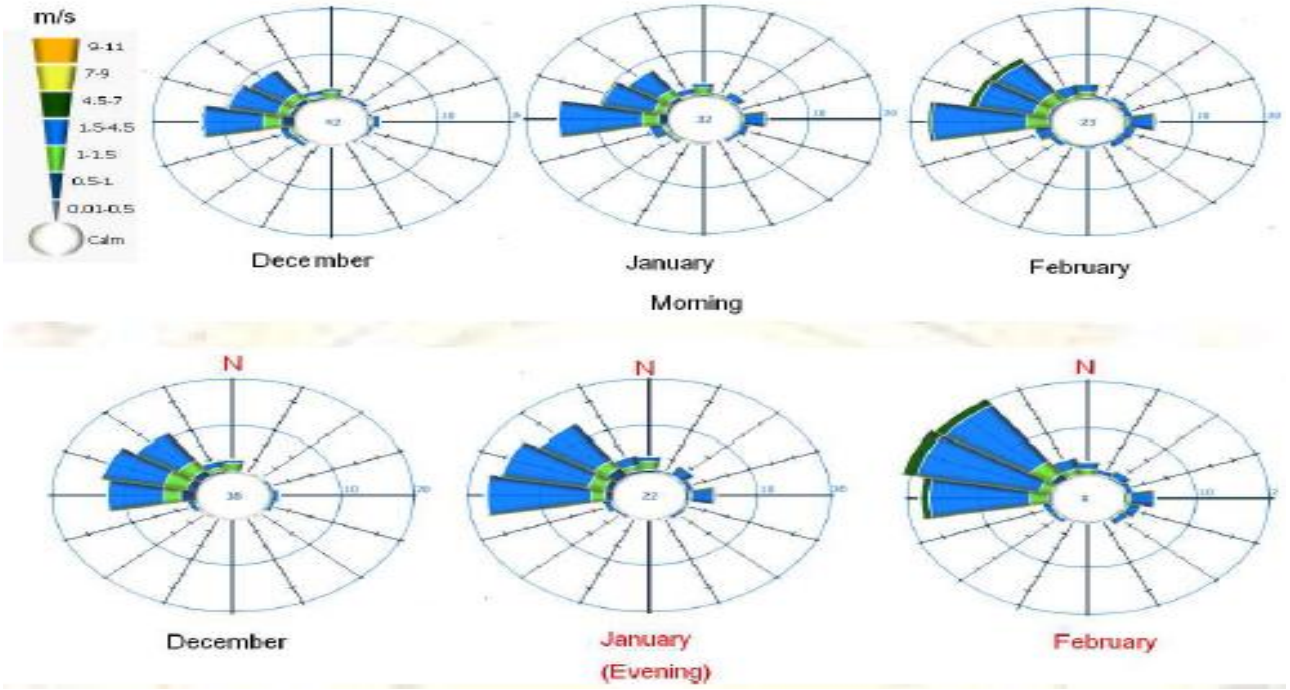
Figure 4.5: Flood prone zone in UP



4.2.7 Climate and Rainfall:

The distance from the sea gives Lucknow an extreme type of continental climate with the prevalence of continental air during major parts of the year. Only during the four months from June to September does the air of oceanic origin penetrate to this region and causes increased humidity, cloudiness and rain. Winter is not a windy season for Lucknow. The average wind speed is 4to 7 kmph from 18:00 hrs IST in the evening till 08:00 hrs IST in the morning. As the sunrises, wind speed starts rising from 09:00 hrs IST and reach the peak around 14:00 to 15:00 hours in the afternoon. The wind speeds drop sharply from 15:00 to 18:00 hrs. There is a general increase in wind speed as the season progresses. The mean monthly wind roses for morning (08:30 IST) and evening (1730 IST) given which show that the most prominent wind direction during the season is west to west-northwest. In the evening(1200 Hrs IST) the winds are prominently west-northwest in December, west in January and west-northwest to north westerly in February. The winds exhibit an anti-clock wise shift from December to February (IMD 2012).

Figure 4.6: Wind Rose Diagram for Winter Season



Summer season

Increased insolation and occasional steep pressure a gradient over North West India makes summer a relatively windy season for Lucknow. In fact, it is the windiest season for Lucknow as both the average winds and the strength of squall is highest· the average wind speed is 4 to 7 kmph from 20:00 hrs in the night to 07:00 hrs IST in the morning. As the sun rises, wind speed starts rising from 07:00 IST and reach the peak around 15:00 IST in the afternoon in the month of March and April. The maximum in the month is around 1400 IST in the afternoon. The wind speed drops drastically after 17:00 hrs IST in the evening. The increase in wind speed from morning to afternoon is highest during April than other two months. The most prominent wind direction in the morning remains West to northwesterly in March and April and Easterly in May. In the evening northwesterly is the most prominent wind in the season however frequency of Easterly wind increases in the month of May (Fig.29) the winds tend to rotate anticlockwise as the season progresses (IMD 2012).

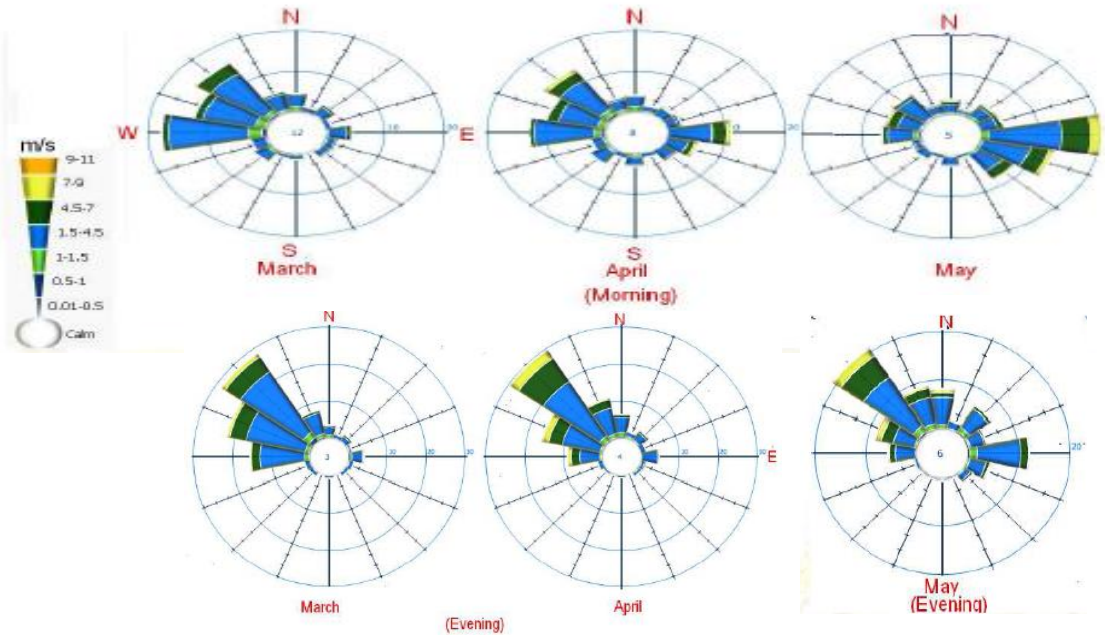


Figure 4.7: Wind Rose Diagram for Summer Season

Monsoon season

The average wind speed decreases in monsoon season compared to the summer season. The decrease continues as the season progresses and is higher in the month of June and July as compared to August and September. The average winds are the strongest in June and fall progressively till end of August. The again increase in the first fortnight of September before falling to their lowest values in the second fortnight of September. The peak average wind speed is around 14 kmph in first fortnight of June and it decreases till August as the season progresses. Once again it rises up to 15 kmph in the first fortnight of September and further decreases up to 11 kmph in the second fortnight of September (IMD 2012).

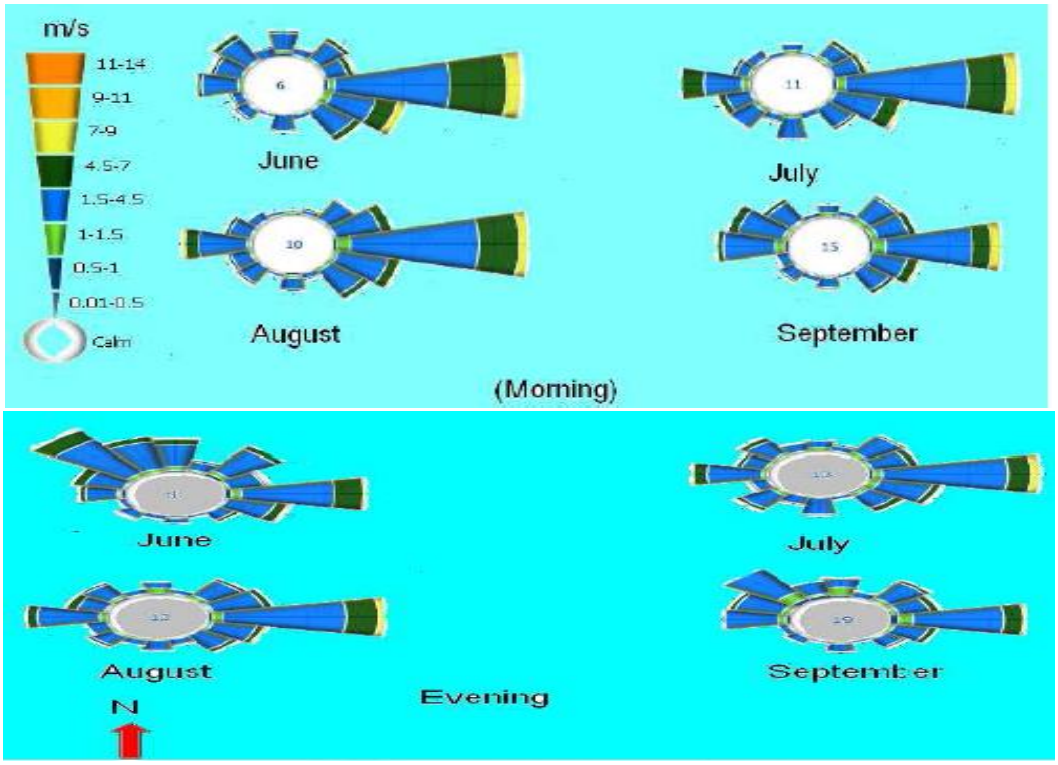


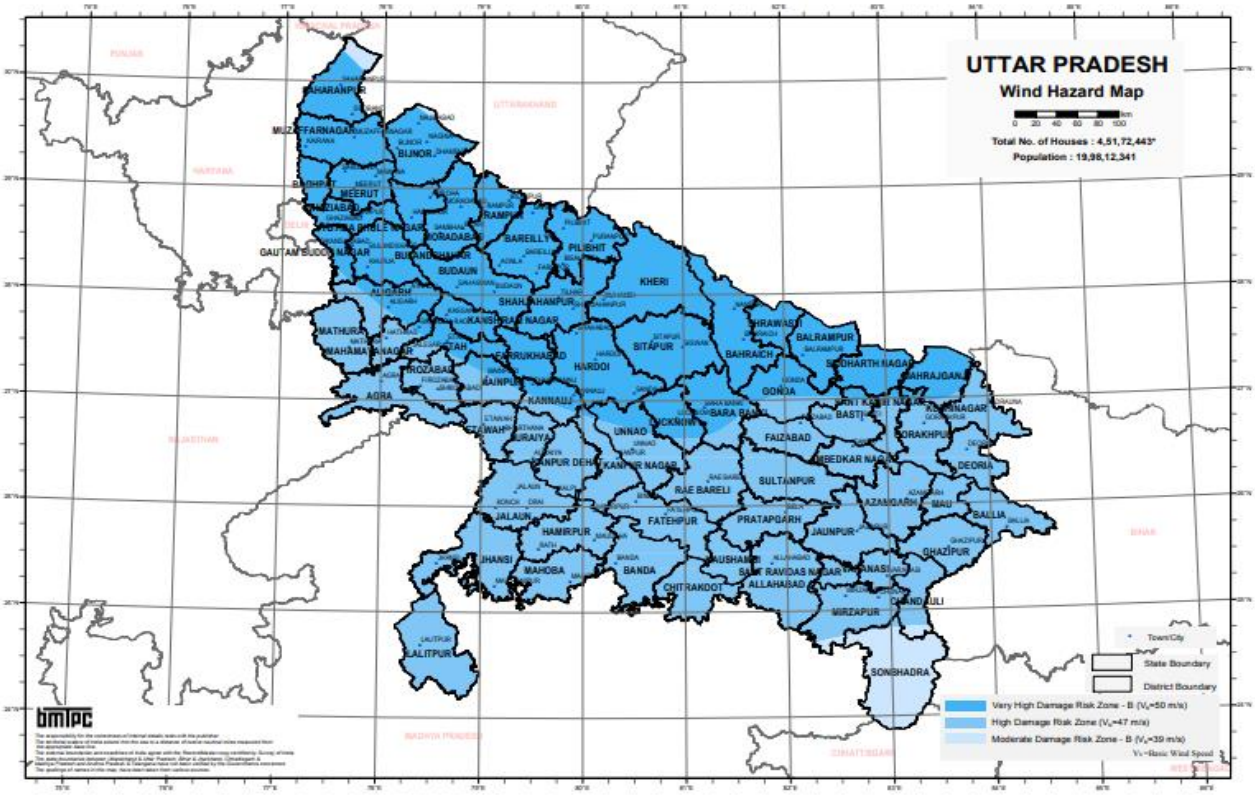
Figure 4.8: Wind Rose Diagram for Monsoon Season

The normal rainfall (1901-1970) of Lucknow district is 966.24 mm. The maximum rainfall occurs during the monsoon period i.e. June to September having normal value of 849.78 minimum which is 87.9% of the annual rainfall. July is the wettest month having the normal rainfall of 289.56 mm followed by August with normal rainfall of 287.66 mm. The climate of Lucknow district is subtropical type with three district seasons namely summer, monsoon, and winter. The winter commences usually in the month of November and extends till February followed by summer April to middle of June and then monsoon starts and lasts upto September / October.

4.2.8 Cyclone-

The below map shows the cyclone prone areas of Uttar Pradesh in the map retrieved from BMTPC, Government of India. The proposed project site falls in the moderate to high damage risk zone with maximum cyclone wind speeds of upto 47 m/s. The architectural design considerations and the building material quality must conform to the Indian standards that would provide safe housing to the residents of the proposed township area.

Figure 4.9: Cyclone map of UP



4.2.9 Landslide-

The proposed new Medical Block within SGPGI falls in the Lucknow region of Uttar Pradesh that comes under very low hazard zone with respect to landslides which is evident from the above map. Hence the proposed project would not be liable to any danger posed by landslides.

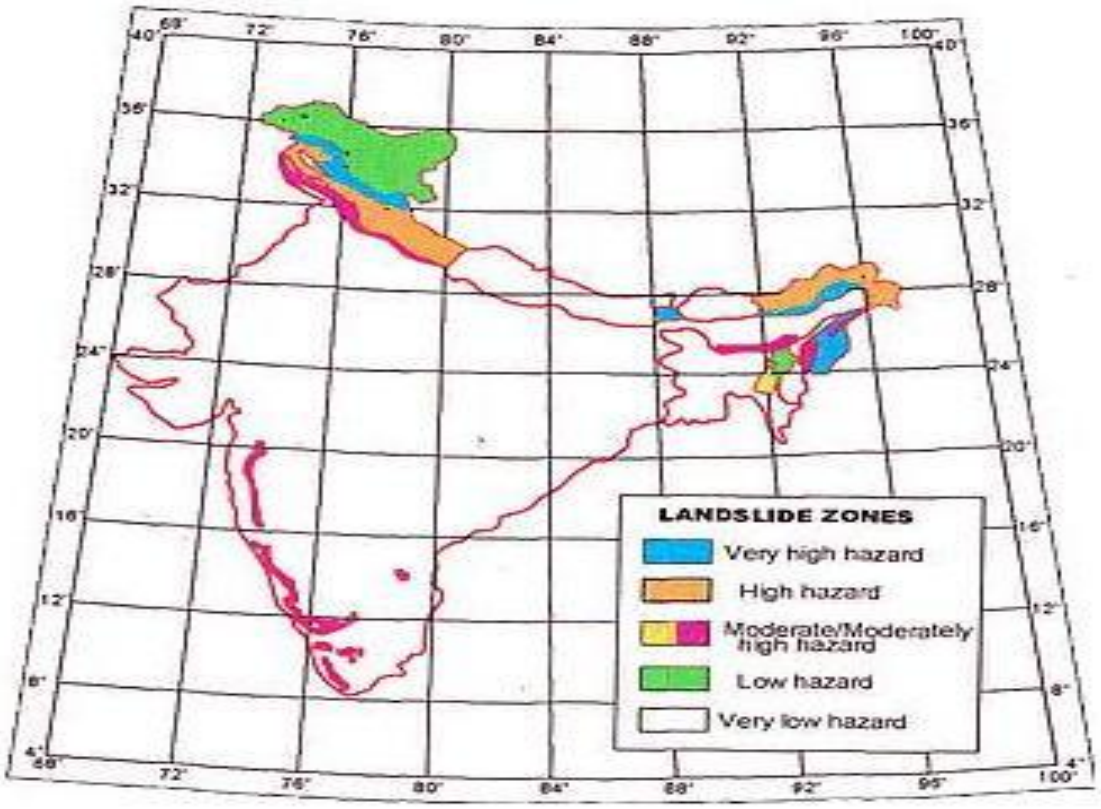


Figure 4.10 Landslide map of UP

4.2.10 Economic status of Lucknow

Lucknow Ranked 6th among all the cities in India for fastest job-creation,[1] The city is a major market and trading place in northern India and an emerging hub for producers of goods and services. Being the capital of state, the Government departments and the public sector undertakings are the principal employers of the salaried middle class. Liberalization has created many more opportunities in the business and service sector and self-employed professionals are burgeoning in the city.

The distribution of main workers in 2001 by different categories reveals that almost 21 percent are cultivators while another 6 percent are agricultural laborers. This is quite understandable in the district where rural population percentage is low as 37 percent. What is remarkable is that the share of population in rural areas has registered a decline from about 37 percent in 1991 to 36 percent in 2001. In the same row cultivators declined from 29.73 percent in 1991 to 21.06 percent and agricultural labourers declined from 8.70 percent to 6.50 percent in 2001. Agricultural fervor of the workforce shows a decline in favour of non-agricultural activities in the state.

Traditionally, Lucknow has been a mandi town for mangoes, melons, and grains grown in the surrounding areas. Sugarcane-growing plantations and sugar industries are also in close proximity. This attracted Edward Dyer to set up a unit based on molasses in the city. Dyer Breweries was incorporated in 1855 and was Asia's first commercial brewery.The company name was changed to Mohan Meakin Brewery in 1967 (the word "Breweries" was dropped in the eighties as the company diversified into other industries). Lucknow is famous for its small scale industries that are based on unique styles of embroidery, namely, Chikan and Lakhnawi Zardozi, both of which are significant foreign exchange earners. Chikan has caught the fancy of fashion designers in Bollywood and abroad. It is very popular in Indian markets and have very high demand.During the period of the Nawabs, kite-making reached a high level of artistry, and is still a small-scale industry. Lucknow has also been an industrial producer of tobacco products like 'Kivam', edible fragrances like 'attars' and handicrafts such as pottery, earthen toys, silver and gold foil work, and bone carving products.The Khadi products of the Gandhi Ashram are also quite popular among the population.

4.2 POLULATION BREAKDOWN OF SGPGI

Table 4.2: Existing Population Break Up

S.No.	Accommodation Type/ Total units	Population (Nos.)
1	**Housing quarters and guest houses**	
	Type I (147) @ 5 persons /unit	735
	Type II (542) @ 5 persons /unit	2710
	Type III(84) @ 5 persons /unit	420
	Type IV (113) @ 5 persons /unit	565
	Type V (56) @ 5 persons /unit	280
	Type VI (1) @ 5 persons /unit	5
	MRA (A) (220) @ 5 persons /unit	1100
	MRA (B) (22) @ 5 persons /unit	110
	Patient Relative Accommodation (70) @ 3 persons /unit	210
	Guest house I (25) @ 3 persons /unit	75
	Guest house II (10) @ 3 persons /unit	30
	Guest house III (10) @ 3 persons /unit	30
2	**Hostel**	
	Old hostel (520) @ 2 persons /unit	1040
	New hostel (150) @ 2 persons /unit	300
3	**Hospital**	
	OPD	5000
	Visitors	5000
	Number of beds	1300
	Family attendant for bedded patients	1300
	Our sourced staff	5000
4	**School**	
	Nursery	90
	Primary	660
5	Bank	20
6	Police station	20
7	Post office	20
8	Professional visitors	500
9	Contractual staff	1000
TOTAL		**27520**

Proposed Population Break Up for emergency medicine block

Table 4.3: Proposed Population Break Up for emergency medicine block

S.No.	Accommodation Type/ Total units	Population/ Numbers/ area
1	Administration Staff (Doctors, Nurses, Clinical staff ,Service & support Staff)	(10+240+50+50) =350
2	Resident Doctors /Research Scholars	65
4	Non clinical staff	150
5	OPD	200
6	Visitors	350
7	Number of beds	500
8	Family attendant for bedded patients	500
	TOTAL	**2115**

4.4 GEOLOGICAL AND HYDROGEOLOGICAL ENVIRONMENT

Hydrogeology

The proposed site SGPGI lies in the Lucknow region. The following figure shows the hydrogeological cross section of the lucknow district.

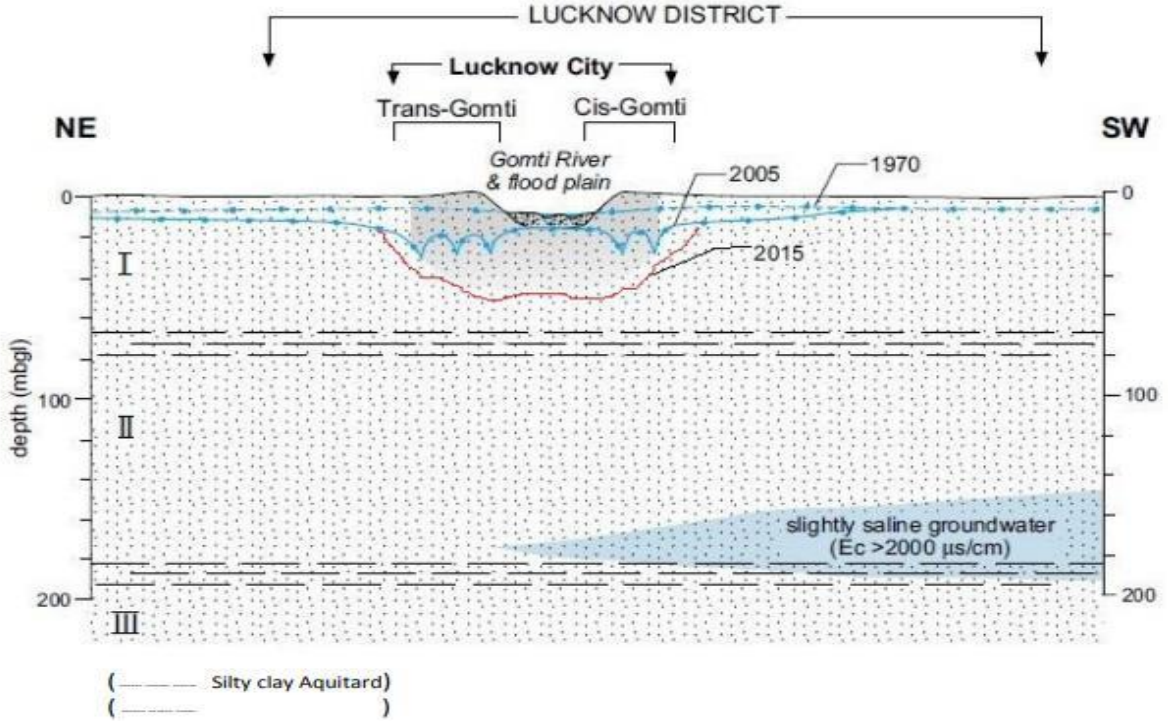


Figure 4.11: Hydrogeological cross section of the lucknow district.

The above cross section of Lucknow City clearly shows that since 1970 how ground water has depleted. The graph shows a "Trough" like situation that has developed in the Lucknow city as depicted by ground water level of 2015.

In Lucknow city, as per the extensive exploration carried-out by CGWB down to the depth of 750 mbgl, 04 Aquifer Groups, each separated by 5 to 10 m thick clays, are distinguishable.

Table 4.4: Aquifer groups of Lucknow.

S.no.	Aquifer group	Depth range (mbgl)
1	I (under stress)	Upto 155
2	II	160-240
3	III	260-370
4	IV	380-485/680

The aquifer material in these aquifer groups comprises sands of various grades, clays, Kankar and silt. The hydrological properties of these aquifers has been determined by conducting parameter tests on the tube wells in Lucknow city are given in the following table:-

S.no.	Aquifer group	Depth range (mbgl)	Discharge potential (lpm)	Draw down (m)	Transmissivity (sqm/day)	Hydraulic conductivity (m/day)	Storativity	Quality
1	I (under stress)	Upto 155	1100-1500	4-10	250-1050	1.8-7.6	4.2*10-4	Good
2	II	160-240	300-600	23-31	40-70	1.2-1.7	-	Inferior /saline
3	III	260-370	1000-1500	25-33	140-160	3.0-4.0	-	Good
4	IV	380-485/680	`400-1600	18-33	140-280	2.0-3.0	3.65*10-3	Good

Table 4.5: Properties of aquifers of Lucknow.

There are no such clear marker clay horizons in the city area to significantly delineate and classify the different aquifer groups. There are intermixed zones of unconsolidated sandy aquifer. First aquifer thickness is increasing in central part of the city and decreased towards south direction. Second aquifer group is relatively thinner than first aquifer and comprises more clay content, holding inferior/poor quality of ground water, mostly occurring towards south of Gomti river. Third aquifer group is not very distinguishable due to data gaps. Clay content in this group is increasing in southward direction.

Since last 2 decades, the city is witnessing indiscriminate exploitation of ground water and such abstractions have reached to a point where the geoscientists have projected possible threat of land-subsidence in some prominent localities of the city in next 10-20 years. The trend of ground water exploitation in Lucknow shows continuous rise in resource withdrawals. Construction of drinking water tube wells to meet water demand of this growing urban agglomerate had started in early 70's and by 1985 about 70 tube wells were operating. Now, this number of tube wells, under the control of Lucknow Jal Sansthan, has gone up to 672 (relative increase almost 9.5 times). Apart from large scale ground water exploitation for city's municipal water supply, the residents of Lucknow, with the mindset to have alternative & secured water supplies, generally prefer to have own tube well and with this attitude, private tube well construction activities have gone up in multiple proportion and as a result the city has mushroomed with innumerable private tube wells/domestic borings to an extent which has led to intensive & unregulated extractions, but there is no realistic estimate of such unregulated withdrawls which are responsible for the present day ground water crisis. As per adhoc estimates, the possible ground water withdrawals in the city from both the municipal & private systems are extremely high which may be tentatively taken as 750 million litres per day (MLD) or more.

In the 1970s, the pre-monsoon depth to water table in Lucknow city was less than 10 mbgl for the most part, which was even shallower along the flood plain of Gomti. With continuous large scale withdrawls, today the ground water table has depleted widely beyond the depth of 20 mbgl and even crossed much deeper levels i.e. 30m bgl or more in some areas, including Lalbagh, Cantt, HAL, Indira Nagar, Alambagh, Jail Road, Puraniya. As a result, a TROUGH (depressed area) has developed within the ground water regime of the city, indicative of heavily depleted aquifers in the city. This situation has further aggravated at some places, where ground water level depth has reached to a more critical level, i.e. beyond 40m. These places are Babu Bhawan, Cantt Sadar, Maunibaba. The emerging situation of ground water levels is very alarming, as such areas seems to have reached to an irreversible stage.

Geology and Geomorphology

The Lucknow district forms a part of Central Ganga Plains and Lucknow city forms a part of Sai-Gomti sub basin. General elevation of the district varies between 103 to 130 meters above mean sea level showing southeasterly slope. The district forms a part of Ganga Basin with flat alluvial terrain as depicted in the figure below. The general slope of district is south-east. Geomorphologically, the district is divided into two geomorphic units (i) Older flood plains & (ii) Active flood plain. Soil in the district exhibits a wide variation in composition texture and appearance. The major position of district is occupied by soils locally known as “Bhur” or “Silty Sand” on the ridges. “Matiyar” or Clayey soils” occurs along the topographic lows and “Dumat or Loamy soils” in the level lands. Clay is dominant in the acres where “Reh” (Usar) prevails. Along the river valleys, a very fertile soil called “Dumat” is prevalent which is youngest. The sub soil of the proposed site is mainly silty clay and Silty Sand soils.

Lucknow has a humid subtropical climate with cool, dry winters from mid-November to February and dry, hot summers from late March to June. The rainy season is from July to mid-September. In winter, the maximum temperature is around 25 °C (77 °F) and the minimum is in 3 °C (37 °F) to 7 °C (45 °F) range. Fog is quite common from mid-December to late January. Summers are extremely hot with temperatures ranging from 40 °C (104 °F) to 45 °C (113 °F).

4.5 ENVIRONMENTAL MITIGATION MEASURES

Air Pollution

- During the construction phase, operation of construction equipment and vehicles will be the main source of pollution. A dust control plan will be implemented and regular maintenance of vehicles and equipment will be carried out.
- During the operation phase, emissions from DG sets and emissions due to vehicular movement will be there. Proper mitigation measures shall be implemented to maintain the working environment fit for the workers.

Noise Pollution

- During the construction phase, adequate mitigation measures will be taken to protect the workers from adverse effects of noise pollution. Proper measures such as controlled time of construction, job rotation and provision of ear plugs will be provided.
- During the operation phase, the sources of noise emissions shall be from vehicular movement. Noise enclosures shall be provided wherever possible.

Socio Economic Environment

- The proposed project will lead to employment generation and will have a positive impact on the socio economic environment.
- Preference to local population shall be given and adequate mitigation measures will be ensured to reduce odor emissions and disease vectors from proposed site.

4.6 AIR ENVIRONMENT QUALITY

The data mentioned on the CPCB site shows that however PM2.5 levels in Lucknow are quite high, but SOx and NOx levels are in limit. High values of PM2.5 can be attributed to development and urbanization activities going on in the lucknow region.

S.no.	Pollutant (µg/cum)	Time weighted average	Concentration in ambient air	
			Industrial, Residential, Rural & Other Area	Ecologically Sensitive Area (notified by Central Government)
1	SO_2	24 hours	80	80
2	NO_2	24 hours	80	80
3	$PM_{2.5}$	24 hours	60	60
4	PM_{10}	24 hours	100	100

Table 4.6: National Ambient Air Quality Standard

PM2.5 (Particulate matter 2.5)

It is a term used to describe the mixture of solid particles and liquid droplets in the air. It can be either human-made or naturally occurring. Some examples include dust, ash and sea-spray. Particulate matter (including soot) is emitted during the combustion of solid and liquid fuels, such as for power generation, domestic heating and in vehicle engines. Particulate matter varies in size (i.e. the diameter or width of the particle). $PM_{2.5}$ means the mass per cubic metre of air of particles with a size (diameter) generally less than 2.5 micrometres (µm). $PM_{2.5}$ is also known as fine particulate matter (2.5 micrometres is one 400^{th} of a millimetre).

Health Effects of PM2.5: Inhalation of particulate pollution can have adverse health impacts, and there is understood to be no safe threshold below which no adverse effects would be anticipated. The biggest impact of particulate air pollution on public health is understood to be from long-term exposure to $PM_{2.5}$, which increases the age-specific mortality risk, particularly from cardiovascular causes. Several plausible mechanisms for this effect on mortality have been proposed, although it is not yet clear which is the most important. Exposure to high concentrations of PM (e.g. during short-term pollution episodes) can also exacerbate lung and heart conditions, significantly affecting quality of life, and increase deaths and hospital admissions. Children, the elderly and those with predisposed respiratory and cardiovascular disease, are known to be more susceptible to the health impacts from air pollution.

Sources of PM2.5: Human-made sources of PM2.5 are more important than natural sources, which make only a small contribution to the total concentration. Within UK towns and cities, emissions of PM2.5 from road vehicles are an important source. Consequently, levels of PM2.5 (and population exposure) close to roadsides are often much higher than those in background locations. In some places, industrial emissions can also be important, as can the use of non-smokeless fuels for heating and other domestic sources of smoke such as bonfires. Under some meteorological conditions, air polluted with PM2.5 from the continent may circulate over the UK – a condition known as the long range transportation of air pollution. Long range transport, together with pollution from local sources, can result in short term episodes of high pollution which might have an impact on the health on those sensitive to high pollution.
In addition to these direct (i.e. primary) emissions of particles, PM2.5 can also be formed from the chemical reactions of gases such as sulphur dioxide (SO2) and nitrogen oxides (NOx: nitric oxide, NO plus nitrogen dioxide, NO2); these are called secondary particles. Measures to reduce the emissions of these precursor gases are therefore often beneficial in reducing overall levels of PM2.5.

PM10 (Particulate matter 10)

PM10 is particulate matter 10 micrometers or less in diameter, PM2.5 is particulate matter 2.5 micrometers or less in diameter. PM2.5 is generally described as fine particles. By way of comparison, a human hair is about 100 micrometres, so roughly 40 fine particles could be placed on its width.

PM10 describes inhalable particles, with diameters that are generally 10 micrometers and smaller. Under the Clean Air Act, EPA sets and reviews national air quality standards for PM. Air quality monitors measure concentrations of PM throughout the country. EPA, state, tribal and local agencies use that data to ensure that PM in the air is at levels that protect public health and the environment. Nationally, average PM10 concentrations have decreased over the years.

Health Effects of PM2.5 - PM10 particles are so small that they effectively act as a gas. When breathed in they penetrate deep into the lungs. Exposure to high concentrations of PM10 can result in a number of health impacts ranging from coughing and wheezing to asthma attacks and bronchitis to high blood pressure, heart attack, strokes and premature death.The young and old and persons with existing medical conditions are most likely to be adversely affected by exposure to high PM10 concentrations.

A major study carried out in New Zealand suggests that PM10 results in 900 premature deaths every year. This study, for the first time, provides detailed epidemiological information on the short term and long term effects on mortality of exposure to urban air pollution in New Zealand. To find out more about the survey, use the link below.

Table 4.7: Results on PM2.5 and PM10

Date of monitoring	AQ1 PGI Campus (Project Site) (DW)		AQ2 Kalli Pashchim (UW)		AQ3 Sanskriti Enclave (DW)		AQ4 New Police Line Kalli (UW)		AQ5 Purseni (UW)		AQ6 Aashiyana (DW)		AQ7 Bijnaur (UW)	
	PM 2.5 (60)	PM 10 (100)	PM 2.5	PM 10	PM 2.5	PM 10	PM 2.5	PM 10	PM 2.5	PM 10	PM 2.5	PM 10	PM 2.5	PM 10
3-01-20(F) 114;245;202°	52.8	107.9	44.8	97.8	48.4	102.8	45.8	98.6	43.7	96.5				
4-01-20(Sa)											47.8	101.6	43.8	96.8
6-01-20(M) 87;194; 197°	53.2	109.2	40.8	91.2	49.8	103.4	43.8	96.8	45.8	98.7				
7-01-20(T)											48.2	103.8	44.5	98.8
9-01-20(Th) 75;155; 198°	48.6	103.4	42.1	92.4	49.8	104.8	45.2	97.6	43.5	94.8				
10-01-20(F)											47.2	102.6	46.5	98.8
13-01-20(M) 136;290; 190°	47.4	101.2	43.9	95.2	48.2	102.2	42.6	92.4	41.8	93.2				
14-01-20(T)											51.2	108.4	47.2	101.6
16-01-20(Th) 37;82; 191°	52.8	109.6	41.9	92.6	47.6	104.8	41.8	92.2	43.5	95.4				
17-01-20(F)											47.9	105.2	45.5	101.4
20-01-20(M) 82;176; 218°	51.8	110.8	42.7	93.9	46.5	102.3	44.2	96.2	43.9	96.2				
21-01-20(T)											46.8	102.8	44.4	97.7
23-01-20(Th) 56;123; 217°	48.9	106.6	44.8	98.3	50.3	110.2	44.3	97.6	43.5	95.2				
24-01-20(F)											47.8	105.2	42.8	94.2
27-01-20(M) 120;264;163°	47.9	100.6	44.6	98.2	48.3	105.4	42.6	93.8	44.2	97.2				
28-01-20(T)											46.8	102.9	43.5	95.8
30-01-20(Th) 34;75; 216°	48.9	107.6	43.2	95.2	47.8	105.2	43.5	95.7	41.8	91.9				
31-01-20(F)											47.8	104.8	42.5	93.5
03-02-20(M) 117;254;211°	47.2	103.8	44.2	97.2	48.2	106.1	42.8	94.2	40.8	89.4				
04-02-20(T)											48.9	107.6	43.5	95.7
06-02-20(Th) 21;42;189°	47.8	105.3	43.7	96.2	45.7	100.5	43.2	95.2	43.4	95.4				
07-02-20(F)											47.2	103.8	44.2	97.2
10-02-20(M) 72;148;214°	48.2	106.2	42.8	94.2	47.2	103.8	42.8	94.2	44.5	97.9				

11-02-20(T)											46.8	102.9	42.8	94.2
13-02-20(Th) 61;125;212°	49.2	108.2	43.5	95.7	45.7	100.5	43.5	95.7	43.5	95.7				
14-02-20(F)											47.6	104.8	43.7	96.1
17-02-20(M) 99;217; 220°	51.5	110.4	47.8	105.2	45.6	100.4	44.8	98.6	46.8	102.4				
18-02-20(T)											48.8	106.2	43.8	92.4
20-02-20(Th) 56;121; 184°	46.8	102.8	43.5	95.6	44.3	97.5	42.8	94.2	42.8	95.4				
21-02-20(F)											47.9	102.7	41.2	91.2
24-02-20(M) 60;130; 189°	49.2	108.2	42.7	93.8	41.2	91.7	43.3	95.3	41.8	91.8				
25-02-20(T)											47.8	105.2	44.2	97.2
27-02-20(Th) 35;84; 167°	47.6	104.7	41.8	91.8	42.8	94.2	40.1	88.2	42.4	93.3				
28-02-20(F)											45.6	100.2	42.2	92.8
02-03-20(M) 42;96; 227°	48.2	104.8	42.8	94.2	41.8	91.8	41.5	91.4	43.2	95.2				
03-03-20(T)											46.4	102.1	43.2	95.2
Minimum	**46.8**	**100.6**	**40.8**	**91.2**	**41.2**	**91.7**	**40.1**	**88.2**	**40.8**	**89.4**	**45.6**	**100.2**	**41.2**	**91.2**
Maximum	**53.2**	**110.8**	**47.8**	**105.2**	**50.3**	**110.2**	**45.2**	**98.6**	**46.8**	**102.4**	**51.2**	**108.4**	**47.2**	**101.6**
Average	**49.33**	**106.18**	**43.42**	**95.48**	**46.62**	**101.53**	**43.26**	**94.88**	**43.38**	**95.31**	**47.69**	**104.04**	**43.86**	**96.14**
Std.Dev.	**2.11**	**3.06**	**1.55**	**3.228**	**2.69**	**4.98**	**1.37**	**2.68**	**1.44**	**2.89**	**1.20**	**2.09**	**1.46**	**2.89**

Table 4.8: Summary for particulate matter data

S.no	Sampling stations	PM2.5			PM10		
		Min	Max	Avg	Min	Max	Avg
1	AQ1 **PGI Campus (Project Site) (DW)**	46.8	53.2	49.33	100.6	110.8	106.18
2	AQ2 **Kalli Pashchim (UW)**	40.8	47.8	43.42	91.2	105.2	95.48
3	AQ3 **Sanskriti Enclave (DW)**	41.2	50.3	46.62	91.7	110.2	101.53
4	AQ4 **New Police Line Kalli (UW)**	40.1	45.2	43.26	88.2	98.6	94.88
5	AQ5 **Purseni (UW)**	40.8	46.8	43.38	89.4	102.4	95.31
6	AQ6 **Aashiyana (DW)**	45.6	51.2	47.69	100.2	108.4	104.04
7	AQ7 **Bijnaur (UW)**	41.2	47.2	43.86	91.2	101.6	96.14

Table 4.9: Results on SO_2 and NO_2

Date of monitoring	AQ1 PGI Campus (Project Site) (DW)		AQ2 Kalli Pashchim (UW)		AQ3 Sanskriti Enclave (DW)		AQ4 New Police Line Kalli (UW)		AQ5 Purseni (UW)		AQ6 Aashiyana (DW)		AQ7 Bijnaur (UW)	
	SO_2 (80)	NO_2 as NO_x (80)	SO_2	NO_2 as NO_x	SO_2	NO_2 as NO_x	SO_2	NO_2 as NO_x	SO_2	NO_2 as NO_x	SO_2	NO_2 as NO_x	SO_2	NO_2 as NO_x
3-01-20(F) 14;19	16.4	28.2	18.2	22.8	15.2	31.8	18.8	18.9	13.8	18.4				
4-01-20(Sa)											17.4	29.6	15.8	31.4
6-01-20(M) 16; 30	17.9	29.8	16.9	25.2	16.2	34.3	16.4	20.8	14.6	19.4				
7-01-20(T)											15.8	33.8	14.2	31.7
9-01-20(Th) 19;27	15.9	35.4	19.8	22.6	18.6	33.8	19.6	21.2	19.3	20.9				
10-01-20(F)											18.6	29.8	16.9	33.6
13-01-20(M) 16;24	14.3	34.2	18.9	21.6	16.8	40.2	17.8	19.5	18.9	22.8				
14-01-20(T)											19.3	31.3	15.8	32.4
16-01-20(Th) 12;12	15.2	33.5	16.7	20.8	17.2	34.8	15.5	20.1	17.2	20.4				
17-01-20(F)											17.8	32.2	16.2	30.4
20-01-20(M) 17;26	14.8	32.4	16.2	19.8	16.8	22.8	14.8	19.8	18.7	22.6				
21-01-20(T)											16.9	30.1	14.8	31.7
23-01-20(Th) 21;44	13.9	29.9	15.3	20.7	15.2	33.8	16.3	18.7	16.4	19.8				
24-01-20(F)											15.3	32.3	15.7	30.8
27-01-20(M) 21;85	12.8	19.3	16.2	19.4	16.2	31.4	15.7	20.8	14.8	22.1				
28-01-20(T)											16.8	31.2	14.8	30.8
30-01-20(Th) 19;55	16.5	20.6	15.8	20.8	17.2	30.7	18.4	19.8	16.2	21.2				

31-01-20(F)											15.7	32.7	15.1	31.4
03-02-20(M) 21;66	15.2	27.8	16.1	21.7	18.1	29.5	15.2	20.4	14.9	22.7				
04-02-20(T)											18.3	33.4	16.8	29.3
06-02-20(Th) 17;36	17.8	35.7	18.2	26.7	20.4	28.5	19.3	21.6	16.8	24.8				
07-02-20(F)											19.4	34.2	18.7	37.4
10-02-20(M) 17;40	18.3	32.5	16.7	28.3	21.3	29.8	18.8	24.1	18.9	26.7				
11-02-20(T)											20.4	32.4	19.4	36.4
13-02-20(Th) 16;56	19.3	38.2	17.6	30.7	20.4	27.8	20.4	28.2	19.2	29.6				
14-02-20(F)											22.4	33.5	22.4	37.2
17-02-20(M) 11;43	20.7	33.5	19.8	29.4	21.5	29.2	21.5	26.5	18.5	34.8				
18-02-20(T)											21.7	34.8	24.3	35.7
20-02-20(Th) 12;14	21.5	35.4	19.7	31.7	22.1	36.2	22.4	27.6	19.4	36.8				
21-02-20(F)											23.7	34.8	22.4	33.8
24-02-20(M) 16;14	20.8	32.7	20.8	32.4	23.4	37.2	23.8	32.4	21.7	32.6				
25-02-20(T)											24.8	35.2	28.4	34.1
27-02-20(Th) 12;19	23.8	33.2	22.1	33.4	27.1	34.7	22.4	33.4	22.5	33.7				
28-02-20(F)											27.8	38.2	28.7	37.2
02-03-20(M) 18;26	28.2	37.5	27.8	37.8	28.2	37.2	24.5	34.2	24.8	34.2				
03-03-20(T)											24.5	37.3	26.5	38.2
Minimum	**12.8**	**19.3**	**15.3**	**19.4**	**15.2**	**22.8**	**14.8**	**18.7**	**13.8**	**18.4**	**15.3**	**29.6**	**14.2**	**29.3**
Maximum	**28.2**	**38.2**	**27.8**	**37.8**	**28.2**	**40.2**	**24.5**	**34.2**	**24.8**	**36.8**	**27.8**	**38.2**	**28.7**	**38.2**
Average	**17.96**	**31.66**	**18.49**	**25.88**	**19.55**	**32.43**	**18.98**	**23.78**	**18.14**	**25.75**	**19.81**	**33.16**	**19.27**	**33.53**
Std.Dev.	**3.90**	**5.13**	**3.00**	**5.58**	**3.84**	**4.18**	**3.03**	**5.26**	**2.91**	**6.16**	**3.60**	**2.38**	**4.91**	**2.83**

Table 4.10: Summary for SOx and NOx data

S.no	Sampling stations	SOx			NOx		
		Min	Max	Avg	Min	Max	Avg
1	**AQ1 PGI Campus (Project Site) (DW)**	12.8	28.2	17.96	19.3	38.2	31.66
2	**AQ2 Kalli Pashchim (UW)**	15.3	27.8	18.49	19.4	37.8	25.88
3	**AQ3 Sanskriti Enclave (DW)**	15.2	28.2	19.55	22.8	40.2	32.43
4	**AQ4 New Police Line Kalli (UW)**	14.8	24.5	18.98	18.7	34.2	23.78
5	**AQ5 Purseni (UW)**	13.8	24.8	18.14	18.4	36.8	25.75
6	**AQ6 Aashiyana (DW)**	15.3	27.8	19.81	29.6	38.2	33.16
7	**AQ7 Bijnaur (UW)**	14.2	28.7	19.27	29.3	38.2	33.53

The above two tables provide the site specific monitoring results corresponding to the SOx and NOx values. The stations AQ1 and AQ5 were found to be best in regards to the SOx and NOx levels while the other three stations reported a slightly higher values. All the stations however showed the SOx and NOx levels within the permissible limits.

Figure 4.12: Air Sampler at Kalli Pashchim

Figure 4.13: Air Sampler at SGPGI

Figure 4.14: Air Sampler

4.7 NOISE ENVIRONMENT QUALITY

Noise Levels have been recorded by means of a *Precision Noise Level Meter of make 'Bruel and Kjaer, Denmark (2232)'.* The basic parts of a sound level meter include a microphone, amplifier, weighting networks and a display reading in decibel (one-tenth part of "bel", unit of sound). The noise levels will measure with the help of a portable precision digital sound level meter (Model- SL-4010), Lutron. This instrument is primarily designed for community noise surveys. A large digital display gives a single value indication of the maximum 'A' weighted RMS (root mean square) sound pressure level measured during the previous second. It is equipped with high sensitivity Bruel and Kjaer pre polarized multi-function acoustic calibrator model 4226 condenser Measurements from 30 dB(A) to 135 dB(A) can be carried out with this instrument. Noise levels at different spots will recorded in the day and night .

This equipment has been designed to meet the measurement requirement of sound quality control in which traffic noise Measuring Range: 35~130dBA * Accuracy: ±2dB * Frequency Range: 31.5HZ-8. 5KHZ * Linearity Range: 50dB * AC/DC

Figure 4.15: Noise Monitor

Figure 4.16: Noise Monitoring at PGI

Ambient noise Quality Standards in respect of Noise given by CPCB

- Silence zone is defined as an area comprising not less than 100 meters around hospitals, educational institutions and courts.
- Day time shall mean from 6.00 a.m. to 10.00 p.m.
- Night time shall mean from 10.00 p.m. to 6.00 a.m.

Table 4.11: Noise Standards

Area Code	Category	L_{eq} dB (A)	
	Area/Zone	Day time	Night Time
		(6 a.m. – 10 p.m.)	(10 p.m. – 6 a.m.)
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence Zone	50	40

4.8 RESULT AND STATEMENT ON NOISE ENVIRONMENT TESTING

The noise was recorded in different near by areas of the SGPGI campus.

- The permissible noise limits of the Residential zone are 55 dB in the day time and 45 dB in the night time.
- The permissible noise limits of the silence zone are 50 dB in the day time and 40 dB in the night time
- The permissible noise limits of the Commercial zone are 65 dB in the day time and 55 dB in the night time Generator, traffic congestion, indiscipline and over commercialization were basically responsible for the high noise pollution.

Table 4.12: Noise Readings at various places near SGPGI

Date	Site	Average of Noise Levels (in dB)		Type of zone	Weather in limit?	
					Yes/No	
		Day Hours	Night Hours		Day Hours	Night Hours
27-28.02.2020	EKTA Nagar	52.2	44.2	Residential	Yes	Yes
24-25.02.2020	PGI Residence Colony Type 1	53.80	41.4	Residential	Yes	Yes
25-26.02.2020	Pushpndra Nagar	53.8	41.4	Residential	Yes	Yes
27-28.02.2020	Sanskriti Nagar	54.0	37.8	Residential	Yes	Yes
27-28.02.2020	Alinagar Khurd	49.7	42.8	Residential	No	Yes
24-25.02.2020	At the Gate of Hospital SGPGI	48.6	38.6	Silence	Yes	Yes
27-28.02.2020	Suryansh Public School	50.0	38.19	Silence	Yes	Yes

Table 4.12: Comparison graphs for day hours

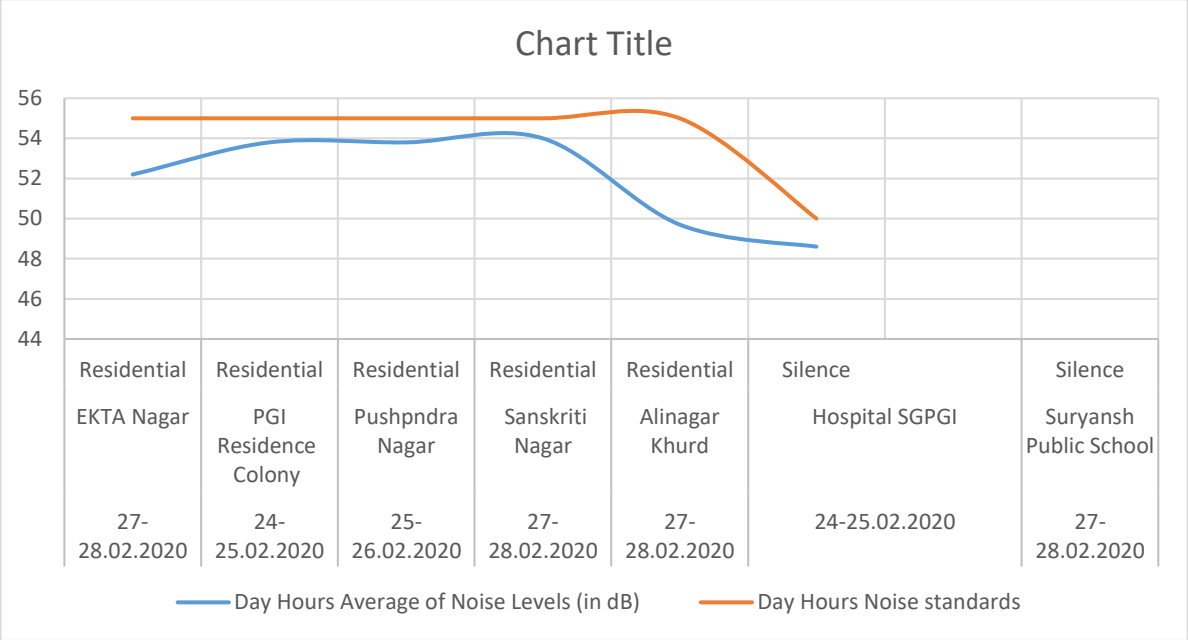
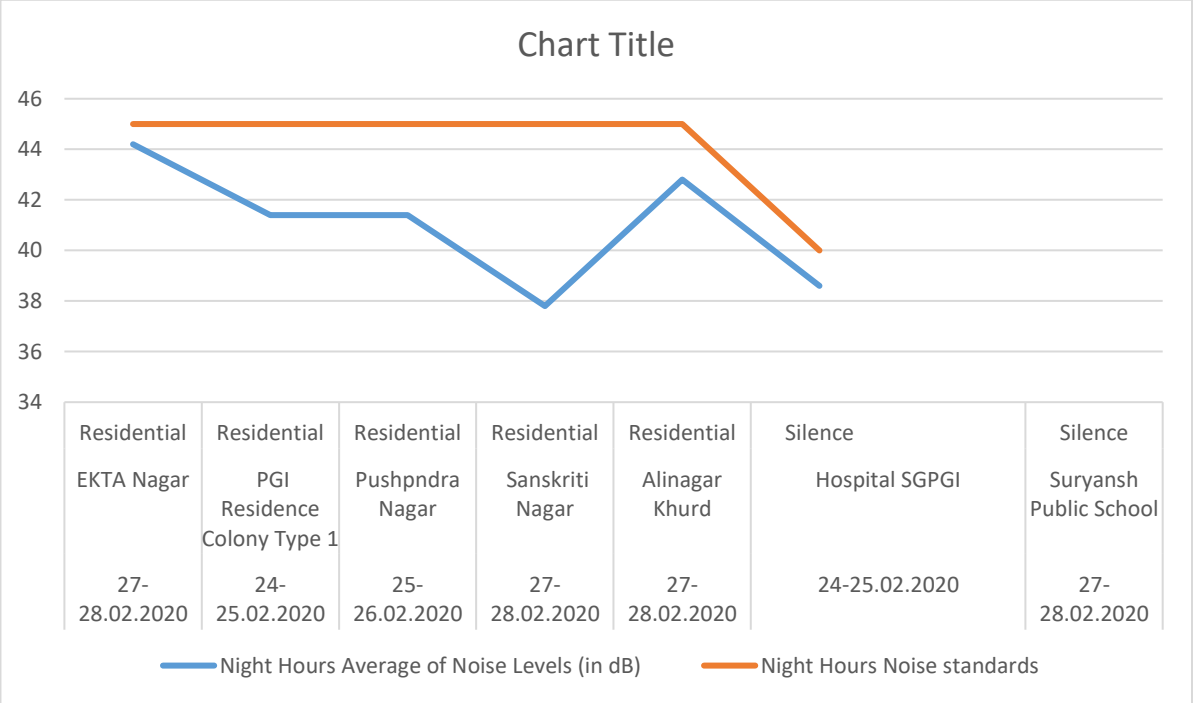


Table 4.12: Comparison graphs for night hours



4.9 ENVIRONMENTAL SENSITIVITY OF THE PROJECT SITE

The proposed expansion project involves construction of emergency medicine block within SGPGIMS campus. The site is already categorized as institutional use Zone. The existing land use does not get altered as the proposed project is just expansion of the existing SGPGIMS. Topo map covering 500 m radius periphery of the project site is enclosed

CHAPTER 5
RECOMMENDATIONS AND CONCLUSION

5.1 RECOMMENDATIONS

Air Pollution

Increased traffic generation i.e. due to project (no. of parking space proposed for the project is not going to cause significant increase in atmospheric concentration of gases and may not result in heat island formation as adequate landscaping and green cover has been provided.

Mitigation Measures for Air Pollution during Construction Stage

Air quality around the project site will be impacted during construction stage. Various construction activities especially related to handling of loose material are likely to generate fugitive dust that will affect the air quality of the surrounding area of the project site. To minimize such impacts following measures has been proposed:

a) All the loose material either stacked or transported will be provided with suitable covering such as tarpaulin, etc.

b) Water sprinkling shall be done at the locations where dust generation is anticipated.

c) To minimize the occupational health hazard, proper personal protective gears i.e. mask shall be provided to the workers who are engaged in dust generation activity.

d) The raw materials such as coarse sand and fine sand should be covered by trampoline.

e) Water puddles/mini ponds to be made near the vehicle tracks, in order to ensure the moisture to be present in the dust.

Mitigation Measures for Air Pollution during Operational Stage

Operation of DG Sets is the only source of air pollution during operational phase. Sufficient stack height will be provided for proper dispersion of pollutants. Also, it is proposed to minimize air pollution by providing plantation as buffer on the periphery of the project site and on the open spaces.

Few other recommendations are:

Material for construction: The material used for construction of the building shall be of non-combustible. The interior finish materials shall be of very low flame spread ability, i.e. Class-I duly tested and certified by CBRI, Roorkee. All the fabric used for seats, curtain, covering on sidewall, matting carpeting etc. shall also have Class-I rating as prescribed in NBC part-IV.

Compartmentation: The building shall be suitably compartmentalized so that the fire/smoke remain confined to the area where fire incidents has occurred and mechanically exhausted as approved in the meeting, so smoke does not spread to the remaining part of the

building. The services, standby generator, store etc. must be segregated from other by erecting fire-resisting wall of not less than 2 hours rating. Each of the compartments must be individually ventilated and the opening for entry into each of these compartments must be fitted with self-closing fire/smoke check doors of not less than one-hour fire rating fitted with magnetic latches. All electric cables shall be laid in separate shafts shall be sealed at every floor with fire resisting material of similar rating. The partition walls in between and all around the shafts shall also be of minimum two hours' fire rating. Under no circumstances, two services shall pass through the same shaft, i.e. separate shaft be used for different purpose.

The entry to the staircase from all levels shall be segregated with a self-closing fire/smoke check door of not less than 1-hour fire rating. All vertical and horizontal opening at each floor level in entire building shall be sealed properly with the non-combustible material. Wherever false ceiling/suspended ceiling is provided, the same shall be of non-combustible in nature and that the Compartmentation shall be extended up to ceiling level.

Ventilation: The building shall be provided with the ventilation strictly in accordance with Part-VIII Section-I and Clause D-1.6 of Part IV of National Building Code of India Mechanical ventilation system having interlocking arrangements as well as upper floor also. Extractor system shall be designed to permit 30 air changes per hour in case of fire in basement. The smoke extraction system shall be designed as per NBC Part-IV and approved by the department.

Air Conditioning System: Air conditioning system shall conform to Section-3 Part-VIII and Clause D-1.17 of Part-IV National Building code of India 1983. Following points shall be ensured.

- All ducting shall be constructed of substantial gauge metal conforming to IS: 655. Air duct serving main floor areas, corridors etc. shall not pass through the staircases enclosures.
- Automatic fire dampers shall be provided in the ducts at the inlets of the fresh air and return air of each compartment/floor.
- Automatic fire dampers shall be closed automatically upon operation of a detector sprinkler.
- The air ducts for every floor/compartment shall be separated. In no way inter-connected with the ducting of any other compartment
- Under no circumstances, plenum shall be used as "Return Air Passage" for air conditioning purposes.

Intercommunication System: An emergency inter-communication system shall be provided in the entire complex. The instrument shall be provided in the common areas on each floor.

Lighting Protection: The lighting protection shall be provided in the building as per IS: 2309.

Noise Pollution

During construction the machineries used were of highest standard of reputed make adhering to stipulated standard. Hence, insignificant impacts due to construction machinery are envisaged. Apart for this, the construction activities were restricted to day time only. Source of noise for the existing as well post construction phase is from the material handling operations and utility units like cooling tower and DG sets. The DG sets are operated during power failure only and provided with inbuilt acoustic enclosure as per CPCB standard.

Mitigation Measures for Noise Pollution during Construction Stage

During the construction stage, expected noise levels shall be in the range of 80-85 dB (A) which will decrease with increase in distance as per the Inverse Square Law. Administrative as well as engineering control of noise will be implemented. Isolation of noise generation sources and temporal differentiation of noise generating activities will ensure minimum noise at receiver's end. To prevent any occupational hazard, ear muff / ear plug shall be given to the workers working around or operating plant and machinery emitting high noise levels. Use of such plant or machinery shall not be allowed during night hour. Careful planning of machinery operation and scheduling of operations shall be done to minimize such impact.

Mitigation Measures for Noise Pollution during Operation Stage

It is envisaged that there shall be maximum movement of light motor vehicles like cars which will lead to some increase in noise levels. It is proposed to minimize the noise levels by providing plantation as buffer on the open spaces and around the periphery of whole complex. Informatory signboards shall be provided to encourage vehicle owners to maintain their vehicle, not to blow horns and follow the emission standards fixed by Government Authorities DG sets will be kept in the acoustic chamber and ambient noise will be within the CPCB standard limits.

5.2 CONCLUSIONS

The following Thesis was made for the assessment of impacts that would come on the environment by the development of the Emergency Medicine block inside the SGPGI campus.

The impact assessment for the proposed project was done with the assistance of on field monitoring of critical environmental parameters. The critical environment parameters were analyzed for both qualitative and quantitative aspect. The project was found not to have any long term significant adverse environmental impact on the local as well global environment. The quality of environmental parameters that were analyzed was envisaged to be affected periodically but the extent of impact was not envisaged to go out of control. The short term impacts that are supposed to affect the local environment can be minimized through the implementation of control and preventive measures.

As per the Air Data suggests, that the PM2.5 and PM10 Levels of the adjoining area are on the border lines and might be well controlled when the construction work is complete. The add-on in this project is the huge Forest cover inside the SGPGI campus which compensates for the major pollution levels. And as far as the noise data goes, the noise levels of the nearby area quiet decent but the data inside the campus is a bit above the recommended guidelines which is due to the construction work and the transportation vehicles which commute inside the campus, which may further be reduced by establishing commuting points dedicated bus stands which are to be constructed away from the hospital facilities.

The proposed project would not result in displacement and relocation of local population. The project would also not involve loss of large extent of green cover inside the SGPGI campus.

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