Environmental Impact Assessment (Draft)

India: Delhi–Meerut Regional Rapid Transit System Investment Project

Addendum to Environment Impact Assessment Report–Stabling Yard at Jangpura and Connecting Line from Sarai Kale Khan RRTS station to Stabling yard

Last updated in March 2022

Prepared by the National Capital Region Transport Corporation for the Asian Development Bank.

Currency Equivalents
(as of 31 March 2021)

Currency unit	–	Indian rupees (₹)
₹1.00	=	$0.0137
$1.00	=	₹73.2035

ABBREVIATIONS

ADB	-	Asian Development Bank
ASI	-	Archaeological Survey of India
ATO	-	automatic train operation
ATP	-	automatic train protection
ATS	-	automatic train supervision
BIS	-	Bureau of Indian Standards
CATC	-	continuous automatic train control system
CBTC	-	communication based train control
CEI	-	compliance, effectiveness, and integrity
CPCB	-	Central Pollution Control Board
CPI	-	consumer price index
CWC	-	Central Water Commission
CWR	-	continuous welded rails
DDA	-	Delhi Development Authority
DMRC	-	Delhi Metro Rail Corporation
DPCC	-	Delhi Pollution Control Committee
DPR	-	detailed project report
E&M	-	electrical and mechanical
E&S	-	environmental and social
EA	-	executing agency
EIA	-	environment impact assessment
EIRR	-	economic internal rate of return
EMP	-	environmental management plan
EPBM	-	earth pressure balance machine
EPC	-	engineering procurement construction
FIRR	-	financial internal rate of return
GDP	-	gross domestic product
GfP	-	guidelines for procurement
GoD	-	Government of Delhi
GOI	-	Government of India
GRC	-	grievance redressal committee
GSDP	-	gross state domestic product
IA	-	implementation agency
IFC	-	International Finance Corporation
IMD	-	Indian Meteorological Department
LDO	-	Land and Development Office
MCD	-	Municipal Corporation Delhi
MoEFCC	-	Ministry of Environment, Forest, and Climate Change
MRT	-	mass rapid transit
NCRTC	-	National Capital Region Transport Corporation
NGO	-	non-governmental organization
OHS	-	occupational, health and safety
PHPDT	-	peak hour peak direction traffic

PIU	-	project implementation unit
PMO	-	project management office
RAP	-	resettlement action plan
REA	-	rapid environmental assessment
RPF	-	resettlement policy framework
RRTS	-	regional rapid transit system
SDG	-	sustainable development goals
SEJ	-	switch expansion joint
SEMU	-	social and environmental management unit
SIA	-	social impact assessment
SMF	-	social management framework
SPS	-	safeguard policy statement of ADB
SPV	-	special purpose vehicle
TBC	-	to be confirmed
TOR	-	terms of reference

WEIGHTS AND MEASURES

^0C	-	degree Celsius
dB(A)	-	decibel acoustic
ha	-	hectare
km	-	kilometre
km/h	-	kilometre per hour
kWe	-	kilowatt-electric
kV	-	Kilo volt(s)
kVA -	kilo Volt-Amps	
kW	-	kilowatt
m	-	meter
mm	-	millimetre
MVA	-	Megavolt Ampere
MW	-	Megawatt
m^3	-	cubic meter
m^3/hr	-	cubic meters per hour
mg/l	-	milligrams per litre
m/s	-	meters per second
MTPA	-	metric tons per annum
MW -	megawatt	
ppm	-	parts per million
ppt	-	parts per thousand
rpm -	revolutions per minute	
$\mu g/m^3$	-	microgram per cubic meter

NOTES

The fiscal year (FY) of the Government of India ends on 31 March. FY before a calendar year denotes the year in which the fiscal year ends, e.g., FY2020 ends on 31 March 2020.

In this report, "$" refers to US dollars

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Appendices

EXECUTIVE SUMMARY

A. Introduction and Rational

1. This addendum to Environmental Impact Assessment (EIA) report for Delhi-Meerut RRTS corridor, already approved by ADB has been prepared for the stabling yard at Jungpura and the connecting line from Sarai Kale Khan RRTS station to the Jungpura Stabling Yard.

2. The Sarai Kale Khan station is the originating point of Delhi-Ghaziabad-Meerut RRTS corridor (82.15 km) and other two RRTS corridors. A stabling yard for the stabling of trains and for minor maintenance facilities has been planned at Jungpura. This stabling yard will be connected with Sarai Kale Khan- RRTS station with an elevated viaduct called as connecting line for the stabling yard to be developed at Jangpura. The total length of this connecting line alignment from Sarai Kale Khan RRTS station to stabling yard at Jangpura is approximately 1.35 km.The facilities at stabling yard include RRTS operational buildings and train parking area to create buffer time during starting hours of day operations. At the time of preparation of Environment Impact Assessment (EIA) report for the main line of Delhi-Meerut RRTS corridor, the alignment of the above connecting line and the plans for the stabling yard were not finalized and hence these components were not included in the approved EIA report. This document will be included as an Addendum to the Main EIA report as the design has been finalized by NCRTC.

3. The alignment is located within 2 km distance of Main line, hence, to avoid duplication of information on environment baseline, identification of impacts and mitigation measures are referred to EIA report for main line. The impacts and mitigation measures during construction and operational phase relevant to connecting line are mentioned in this report.

4. Delhi - Ghaziabad - Meerut RRTS corridor is being co-financed by Asian Development Bank (ADB), Asia Infrastructure Investment Bank (AIIB) and New Development Bank (NDB). The Environment Impact Assessment (EIA) Report for this RRTS corridor as per ADB’s policy for Environmental Safeguard was carried out by NCRTC in 2018-19 and approved by ADB in May 2020. This EIA report complies with the applicable State Government, Government of India legal framework and ADB Safeguard Policy Statement (2009). On account of significant occupational health and safety (OHS) risks, deterioration of ambient air quality mostly during the construction stage and noise vibration impacts, community health &safety from the Delhi-Ghaziabad-Meerut RRTS corridor Project was categorized as Category ‘A’[1] project.

B. Policy, Legal, and Administrative Framework

5. An assessment of the policies and administrative framework has been carried out. This includes (i) applicable national legislation for components of environment viz. air, water, soil, terrestrial and aquatic flora and fauna, natural resources, and sensitive habitats, (ii) International and regional Environmental agreements, conventions and protocols signed by India (iii) ADB’s Environmental and Social Safeguard policy requirements, (iv) Permissions and clearances required for the project. This assessment is about the applicability of laws and regulations, conventions, protocols, and safeguards. The EIA has been carried out in compliance with Government of India and ADB safeguards policies and requirements.

6. **Government of India Policy and Regulatory Requirements:** As per national policy and regulatory framework requirements as stipulated in EIA Notification 2006 by MOEF&CC, all railways projects in India are exempted from requirements of prior environmental clearance

[1] According to ADB Safeguard Policy Statement (SPS-2009), a proposed project is classified as category A if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An environmental impact assessment is required.

and preparation of the EIA. Therefore, environmental clearance from MOEF&CC for connecting line from Sarai Kale Khan to RRTS Stabling yard and associated facilities at Jungpura project is not required.

7. **Category of the Project as per ADB's SPS 2009**: The environmental screening has been carried out for the proposed project as per ADB Safeguard Policy Statement (SPS) 2009 using the Rapid Environmental Assessment (REA) checklist. Though the proposed RRTS corridor (Sarai Kale Khan - Jungpura) does not pass through any environmentally sensitive areas, the civil works for proposed connecting line for stabling yard involve the transport and use of large quantities of construction material and heavy machinery in the middle of populated urban areas of Delhi requiring large number of workers. This poses significant occupational, health and safety (OHS) risks mainly during the construction stage. Long term noise and vibration caused by operation of the rail line is also a major environmental risk posed by the project. Therefore, the project is categorized as environment Category 'A' requiring an EIA. Accordingly, this Addendum to environmental impact assessment report (EIA) has been prepared for connecting line from Sarai Kale Khan RRTS station to Stabling Yard at Jungpura RRTS Project to fulfill ADB's SPS 2009 requirements for environment Category 'A' project.

C. Description of the Project

8. The Project involves construction of stabling yard, operation building, offices, residentials complex, TOD, station ,1.35 km long rapid rail elevated corridor connecting line between SKK Station to Jangpura Stabling Yard, overhead electrification, signaling, communication systems etc. to access the stabling yard with associated facilities etc. The connecting line is proposed to access operational and administrative facilities in the stabling yard. The estimated land requirement for this stabling yard including other facilities is 18.9621 Ha which will be developed in phases. Out of 18.9621 Ha, 17.21 Ha pertains to MoHUA, balance pertains to DDA, DJB, SDMC and DUSIB. NCRTC identified the abandoned factory premises of M/s Hindustan Prefab Limited (HPL) at Jangpura as the likely site for the above stabling yard and approached Ministry of Housing and Urban Affairs (MoHUA), Govt. of India, for the allotment of 17.21 Ha land for setting up of stabling yard including operation building, offices and residential buildings etc. . Ministry of Housing & Urban Affairs have already allotted 12 Ha. of land to NCRTC and approval in principle issued for 5.21 Ha. Other departments have also been agreed in principle to transfer the balance land., Additional connectivity of the stabling yard complex to Ring road and Mathura road has been planned by providing underpass/flyover .. The connecting line from Sarai Kale Khan RRTS station to Stabling Yard at Jungpura (Stabling Yard alignment) project is included in already awarded construction contract package no.6 for the elevated section in Delhi and is proposed for financial assistance from ADB. The works in stabling yard are proposed to be financed by New Development Bank. A zone of 5 m from the edges of viaduct has been considered for safety in accordance with DMRC and NCRTC policy.

9. The criteria for selecting the final alignment for the connecting line for Stabling Yard included right of way, ground conditions, capital and operating costs, availability of land for the stabling yard as well as minimum disturbance/avoidance of community.

D. Description of the Environment

10. **Physical Environment:** The topography of project area is plain and about 33 % in built up area. The RRTS elevation varies between 676 ft to 734 ft above mean sea level. There is no presence of Aravalli ridges in project corridor and surroundings although these are prominent in other parts of NCR region.

11. The project region falls in seismic zone IV, a region of high seismic hazard zone. Earthquakes in this region are mainly shallow focus and lie within the alluvium covered northern part in collinearity with the Mahendragarh – Dehradun fault.

12. The climate of the project region is subtropical. In summer, the heat wave is immense, and the minimum and maximum temperature variation is 27°C to 45°C and in winter temperature variation is 3°C to 22°C. Storms are common during summer in May and June when day temperature exceeds 40°C. As per IMD long term data, average annual rainfall in the project region is 797.3 mm. The maximum rainfall occurs during the monsoon months. Humidity range is between 43-89%, monsoon season experience the higher humidity as compared to summer and winter seasons.

13. Results of the ambient air monitoring show that PM10 and $PM_{2.5}$ values in all the monitored locations are much higher than the permissible level of NAAQS (100μg/m^3 and 60μg/m^3) as well as IFC standards. A maximum value of 152.67μg/m^3 and a minimum value of 139.97 μg/m^3 was observed for PM2.5 in the study area while for PM10, a maximum value of 263.15μg/m^3 and a minimum value of 244.98 μg/m^3 was observed. The SOx and NOx values recorded at the study areas are lower than the permissible limit. The range of SOx varied from 27.56 μg/m^3 to 30.51 μg/m^3 while NOx varied from 38.08 μg/m^3 to 41.81 μg/m^3. The CO is within permissible limit while HC and heavy metal values at all monitored locations were below the detectable limits. The noise levels monitored at four locations along the alignment were above the CPCB (national) and IFC/World Bank (international) permissible limits.

14. **Biological Environment:** The connecting line is located within urban populated areas and do not have any significant ecological values. The stabling yard is located in the premises of an abandoned factory. Hence, the habitat type in the project area is modified habitat. There are no environmentally sensitive zones as prescribed by the Environment Protection Act of 1986 or protected areas within direct impact zone of the proposed connecting line. The proposed project area is located neither within an existing nor any proposed ecological sensitive zone known for providing habitat and movement corridor for any kind of wildlife. No rare or endangered species of flora and fauna are reported along the corridor of impact of the project. About 1272 trees are likely to be affected due to construction of this RRTS alignment.

15. **Socio-economic Environment:** There are no ancient monuments of archaeological importance declared to be of State or National importance are present throughout the alignment.

16. An inventory of the receptor like residential, commercial area etc. within 150 m on either side of line alignment has been prepared. In total there are 7 location of receptors identified within 150m along the proposed Stabling Yard RRTS alignment.

E. Anticipated Environmental Impacts and Mitigation Measures

17. Based on analysis of project activities and environmental baseline conditions 16 valued environmental components (VECs) under physical, biological and social environment were identified. Impacts on each of these VECs during pre-construction and design stage, construction stage and operation stage was been carried out. Impacts were determined to be minor, moderate or major based on a rating criterion of sensitivity of the VEC, duration of impact, area of impact and severity of impact.

18. The key positive environmental impacts of the project include reduced use of private vehicle leading to reduction in pollutants and greenhouse gases (GHG); road safety improvements; and increased accessibility and mobility.

19. Minor, moderate and major impacts are expected on all VECs. Negative environmental impacts of the project include: (i) project will require acquisition of about (including permanent and temporary) 18.9621 Ha. of Govt. land for the proposed Sarai Kale Khan - Jungpura Stabling Yard RRTS line; (ii) there are two groups one group of owners of eight

flats is directly affected. Second group is represented by Resident Welfare Association (RWA) and a group of persons namely Senior Citizen Welfare Forum. This group is continuously raising their concerns with NCRTC on safety /health issues due to RRTS construction through emails/letters/ CPGRMS. NCRTC has adequately responded to these communications. The Copy of last letter dated 17.08.2021 and 05.07.2021 is enclosed as Appendix-9 which is self-explanatory. (iii) transplantation/ cutting down of about 1272 trees; (iv) finite use of scarce, sometimes carbon intensive, materials, such as cement; (v) noise, vibration and visual intrusion for properties adjacent to the alignment; and (vi) traffic inconveniences during construction stage. The project does not impact any nature conservation areas or urban parks or sites of historical/archeological importance.

20. Mitigation measures proposed include: (i) compensation for loss of land and properties to affected people as per The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (ii) compensatory afforestation in line with local rules; (iii) various energy saving measures such as regenerative braking and use of solar panels; (iv) noise reduction measures (i.e. lower down speed or noise barriers at sensitive receptor locations); and (v) reuse of excavated material where feasible and disposal of construction waste in a regulated manner.

21. Minor negative impacts are expected during all three project stages in relation to noise, vibration and community health and safety. Analysis of noise impacts show that 6 locations of receptor during construction stage and one sensitive receptors during operation stage are at risk of experiencing an increase in noise levels greater than 3 dBA. The proposed measures incorporation of noise reducing design features in the railway tracks and rolling stock, adjusting timing of use of noisy equipment, use of mufflers on noisy equipment and installation of acoustic screens have been proposed to minimize construction related noise. During operation, in addition to embedded measure in design, 125 m long noise barriers as recommend by CRRI to maintain noise levels within the existing ambient noise levels are proposed to be installed along the viaduct in the Siddhartha Extension. Further in operational stage impacts will be addressed by the regular noise monitoring, inspections, proper maintenance and reconditioning of trains and tracks, maintenance or replacement of suspension system, brakes and wheels etc.

22. About 5 location of receptors are at risk of experiencing physical vibration levels above the threshold for causing damage during construction stage. To mitigate this risk only bored piling (not impact piling) will be carried out for boring works. A pre-construction survey will be conducted to identify sensitive buildings at risk of being damaged and pre-construction and during construction monitoring of vibration levels will be conducted.

F. Analysis of Alternatives

23. Various alternatives meeting technical requirements such as radius of curve, alignment, design, optimal cost, technical feasibility in crossing existing railway line etc. have been considered and analyzed for its likely impacts on various environmental parameters. Additionally, an evaluation of potential environmental impacts in terms of ‘with’ and ‘without’ project situation has been considered for the justification of the project. The alignment of the connecting line was finalized after considering merits and demerits of various alignment options. Due to the short distance between Sarai Kale Khan station and stabling yard, the alignment options are very limited and the final alignment passing through Sidharatha extension is the best possible technical option and thus acquisition/purchase of 8 residential flats falling with zone of 5 m from edge of viaduct is inevitable. The comparison of plans showing option-3 (new alignment) and option-1 (old alignment) at Siddharth Extension and the design of the preferred alignment is given in figure- 1, 2 and 3 in Appendix-10.

G. Consultations and GRM

24. Meaningful consultations have been conducted with stakeholders, local communities, shopkeepers and affected people during preparation of Environment and Social Impact Assessment study. Consultations will be continued during the process of land acquisition and project implementation. A total of 2 public consultation sessions were carried out at Siddhartha Extn. (Delhi). Issues associated with environment, health and safety were also discussed during these consultation meetings. NCRTC is regularly interacting with residents of Sidhartha Extension, Senior Citizen Welfare Forum and RWA and keeping them well informed about the details of RRTS construction. Details of such meetings in chronological order are as under:

Date	Meeting Hold with
27.08.2020	Flat Owners-24 Nos
10.09.2020	Flat Owners-24 Nos
30.09.2020	SERWA
21.10.2020	Sr. Citizen Welfare Forum
07.11.2020	Flat Owners-24 Nos
10.11.2020	Sr. Citizen Welfare Forum
10.11.2020	SERWA
09.01.2021	Flat Owners-24 Nos
12.06.2021	Flat Owners-24 Nos
13.07.2021	Sr. Citizen Welfare Forum
24.07.2021	Flat Owners-8Nos.
14.08.2021	Flat Owners-8Nos
06.01.2022	Sr. Citizen Welfare Forum along with ADB

25. Majority of concerns voiced by affected persons and stakeholders were related to compensation for land acquisition (LA). All LA related concerns have been addressed in the addendum to the Resettlement Plan prepared for the project.

26. NCRTC has established a well structured Grievance redress mechanism (GRM), as detailed in the EIA for main corridor and the same will be followed for this extension part as well.

I. Environmental Management Plan

27. An Environmental Management Plan (EMP) with budgetary provisions has been prepared. The EMP consists of a set of mitigation, monitoring and institutional measures to be taken for the project to avoid, minimize and mitigate adverse environmental and social impacts and enhance positive impacts. The EMP included appropriate mitigation measures and monitoring requirements to address all construction- and operation-related impacts. The EMP has been developed in conjunction with general safety, health and environment provisions (which are included in the standard bidding document) and it forms part of the contract document of the contractors. Contractors will prepare project specific SHE Manual and Plan as well as contract specific Construction EMPs. Construction EMPs will include specific subplans for key activities require specific management. Quarterly environmental monitoring reports will be submitted by the Contractor and NCRTC will submit environmental monitoring report on semi annual basis, the same will be submitted to ADB and will be disclosed publicly at the ADB website. An external monitor consultant already engaged by NCRTC will monitor and report the implementation of environmental safeguards aspects of the project independently and submit reports to NCRTC and ADB. The preliminary estimated cost of the

environmental management plan for this RRTS alignment including implementation and monitoring is US$ 0.56 million (INR 41.22 million). This cost estimate is exclusive of land acquisition and resettlement & resettlement cost.

J. Conclusion and Recommendation

28. The alignment of Sarai Kale Khan RRTS station to the proposed stabling yard at Jungpura and the stabling yard are ~~is~~ not located in any environmentally sensitive or protected areas. The alignment does not lie within 100m from the sites of historical significance. No impact on wildlife is envisaged. The project will not result in any long-term significant adverse environmental impacts. Minimal environmental impacts are anticipated, mostly during construction. These can be mitigated successfully by implementing the EMP and associated subplans with estimated costs for implementation.

29. The construction of connecting line viaduct is included in already awarded contract package no.6 for the elevated section in Delhi area which includes NCRTC's SHE manual and requires the contractor to prepare contract specific EMP~~.~~ The same is the case with the already awarded contract package for the construction of multi-story staff quarters. In future bidding packages, NCRTC shall ensure that the SHE manual and requirement to prepare a contract specific EMP is included in the bidding documents.

I. INTRODUCTION

A. Background

1. The National Capital Region (NCR) is a multi-state region with Delhi as its center. It covers an area of 58,332 sq. km spreading over four states of Haryana, Rajasthan, Uttar Pradesh and the National Capital Territory (NCT) of Delhi. The total population of NCR region is 460.69 lakhs (as per Census 2011) and is projected to be 641.38 lakhs by 2021. It is also a high growth, large investment region, consisting of several large and small cities with high movement of people and goods within the region.

2. Efficient movement of people and goods within the NCR is a primary concern for the planned development of the NCR. The existing transport system within the region, consisting of a variety of modes like private and public road transport, and suburban rail system, is inadequate and there is urgent need to enhance the regional transport system. Development of an efficient regional transport system is also necessary to avoid migration of people to Delhi, by offering them the alternative of settling in surrounding cities and being able to commute to Delhi through a fast public transport system. The various roads from Delhi to cities in the nearby States are used as link and carries most of the road traffic between NCT and surrounding. The average journey time from Delhi to nearby state is about 3-4 hours by road.

3. Thus, to promote the development of the NCR in a balanced manner, the Functional Plan on Transport for NCR prepared by National Capital Region Planning Board (NCRPB) recommended a rail based sub urban transport system i.e., Regional Rapid Transit System (RRTS) for NCR. A total of 8 RRTS corridors linking Delhi to various nodal towns in NCR were proposed. The Planning Commission appointed Task Force prioritized three RRTS corridors namely Delhi-Ghaziabad-Meerut, Delhi – Gurugram – Rewari – Alwar and Delhi – Sonipat-Panipat for implementation in the first phase.

4. Delhi – Ghaziabad – Meerut RRTS corridor is identified as one of the prioritized corridor to be taken up in first phase of RRTS project. The Detailed Project Report (DPR) for this corridor has been prepared by Delhi Integrated Multi Modal Transit Systems (DIMTS), a joint venture of Govt. of Delhi and IDFC (a financial institution promoted by Government of India) in 2016. The National Capital Region Transport Corporation (NCRTC), New Delhi is the implementing agency (IA) with its head quarter at New Delhi.

5. Delhi - Ghaziabad - Meerut RRTS corridor is being co-financed by Asian Development Bank (ADB), Asia Infrastructure Investment Bank (AIIB) and New Development Bank (NDB). The Environment Impact Assessment (EIA) Report for this RRTS corridor as per ADB's policy for Environmental Safeguard was carried out by NCRTC in 2018-19 and approved by ADB in May 2020. This EIA report complies with the applicable State Government, Government of India legal framework and ADB Safeguard Policy Statement (2019). On account of significant occupational health and safety (OHS) risks, deterioration of ambient air quality mostly during the construction stage and noise vibration impacts, community health &safety from the Delhi-Ghaziabad-Meerut RRTS corridor Project was categorized as Category 'A'[2] project.

6. Sarai Kale Khan RRTS station is the originating point of Delhi-Ghaziabad-Meerut RRTS corridor and also originating point for other two prioritized corridors namely Delhi-Alwar and Delhi-Panipat. For the stabling of trains for the morning operation and for minor maintenance of RRTS trains, a stabling yard near Sarai Kale Khan RRTS terminus station has

[2] According to ADB Safeguard Policy Statement (SPS-2009), a proposed project is classified as category A if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An environmental impact assessment is required.

been planned. The estimated land requirement for this stabling yard including other facilities is 18.9621 Ha which will be developed in phases. Out of 18.9621 Ha, 17.21 Ha pertains to MoHUA, balance pertains to DDA, DJB, SDMC and DUSIB. NCRTC identified the abandoned factory premises of M/s Hindustan Prefab Limited (HPL) at Jangpura as the likely site for the above stabling yard and approached Ministry of Housing and Urban Affairs (MoHUA), Govt. of India, for the allotment of 17.21 Ha land for setting up of stabling yard including operation building, offices and residential buildings etc . Ministry of Housing & Urban Affairs have already allotted 12 Ha. of land to NCRTC and approval in principle issued for 5.21 Ha. Other departments have also been agreed in principle to transfer the balance land. The total length of this viaduct from Sarai Kale Khan RRTS station to stabling yard at Jangpura is approximately 1.35 km. Additional connectivity of the stabling yard complex to Ring road and Mathura road has been planned by providing underpass/flyover.

7. At the time of preparation of Environment Impact Assessment Report for Delhi-Meerut RRTS corridor, the stabling yard location and the alignment of the connecting line from Sarai Kale Khan RRTS station to the stabling yard was not finalized and hence these components were not included in the approved EIA report for Delhi-Meerut RRTS corridor.

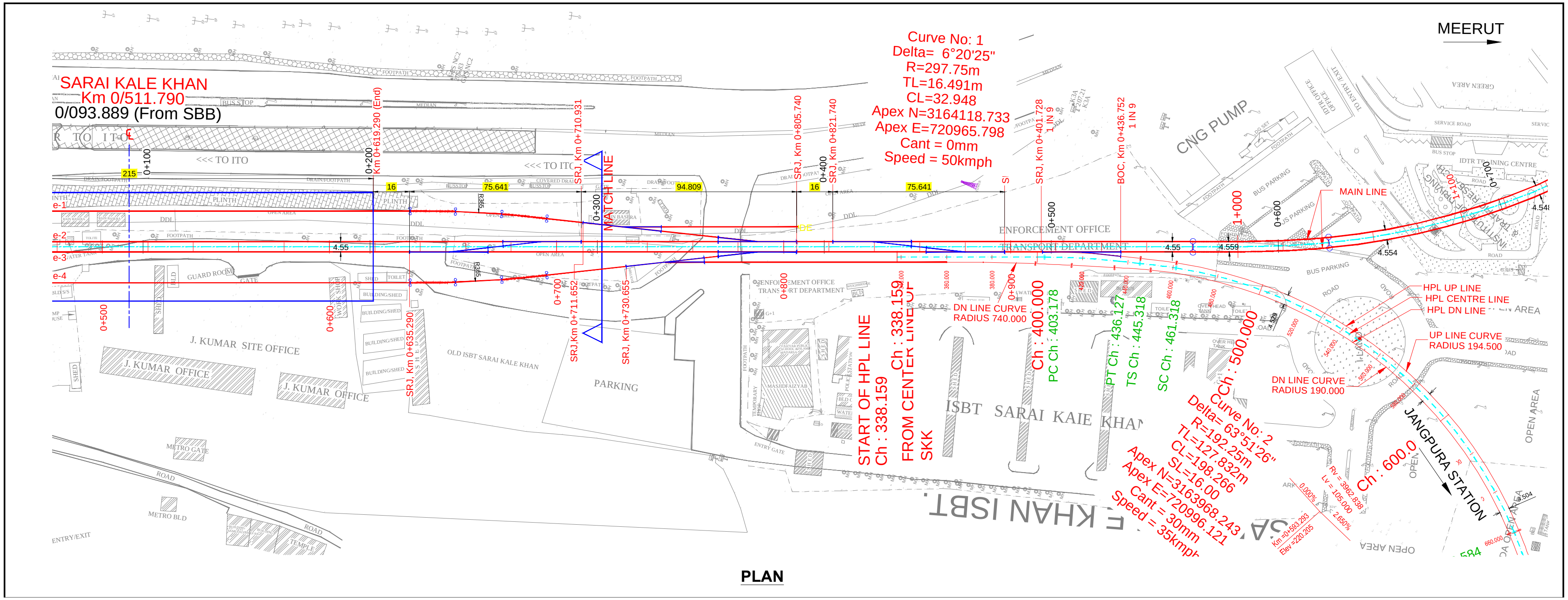
8. This addendum covers the Environment Impact Assessment for this stabling yard at Jangpura and connecting line from Sarai Kale Khan RRTS station to stabling yard (hereinafter termed as “Project”). Since, this addendum is an extended part of original EIA report for Delhi-Ghaziabad-Meerut RRTS corridor, the Category of the project as per ADB’s SPS will remain the same.

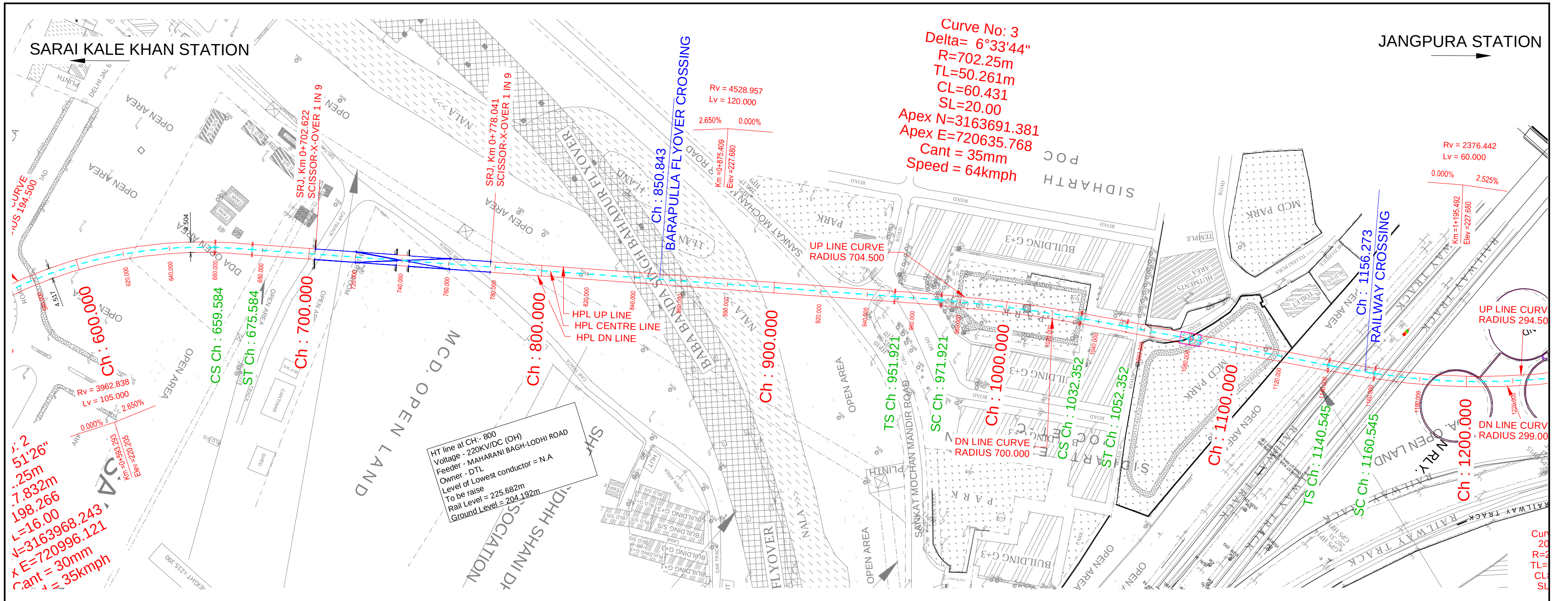
9. This addendum should be read in reference with EIA report for the main corridor of Delhi-Ghaziabad-Meerut RRTS as regards the institutional set-up, grievance redress mechanism etc. which shall be the same as provided in the EIA repot for the main line.

B. Nature, Size and Location of the Project

10. Construction of stabling yard, connecting line from SKK RRTS station to Jangpura stabling yard etc at Jangpura is part of Delhi-Meerut RRTS Corridor The connecting line from Sarai Kale Khan RRTS station to stabling yard at Jangpura(approx. length 1.35 Km), originates from Sarai Kale Khan RRTS station and ends at stabling yard at Jangpura in South East Delhi. As per the present planning , under Phase-I , the stabling yard complex at Jungpura comprises of (i) Stabling yard for stabling of trains with minor maintenance facilities (ii) A commuter station (iii) Operation Control Centre (OCC) and Backup Control Centre (BCC) and (iv) Multi-story Quarters for the operational staff with associated facilities. The entire “Project:” is located within the boundary of the State of National Capital Territory of Delhi. The location map of the project corridor including stabling yard is given in **Figure-1.**

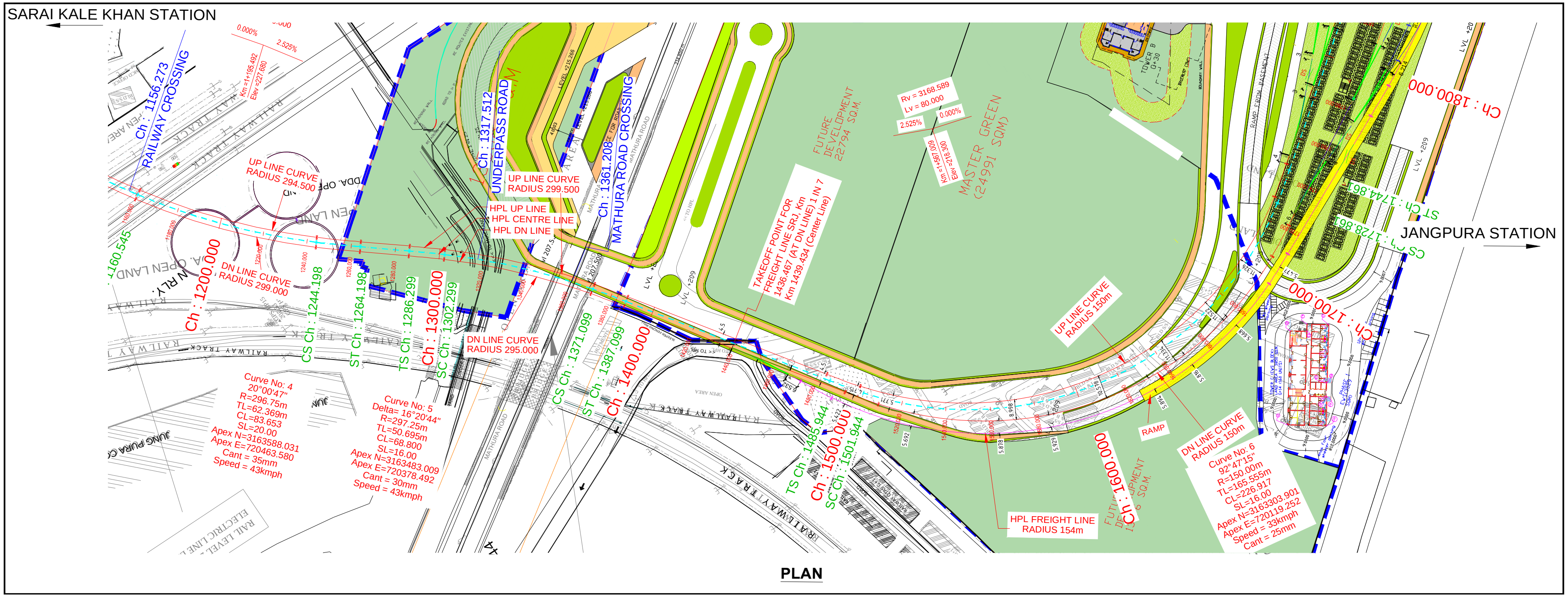
Figure 1: Proposed alignment from Sarai Kale Khan station to Stabling Yard, Jangpura





SARAI KALE KHAN STATION
JANGPURA STATION
Curve No: 3
Delta= 6°33'44"
R=702.25m
TL=50.261m
CL=60.431
SL=20.00
Apex N=3163691.381
Apex E=720635.768
Cant = 35mm
Speed = 64kmph
Ch : 600.000
Ch : 700.000
Ch : 800.000
Ch : 900.000
Ch : 1000.000
Ch : 1100.000
Ch : 1200.000
CS Ch : 659.584
ST Ch : 675.584
TS Ch : 951.921
SC Ch : 971.921
CS Ch : 1032.352
ST Ch : 1052.352
TS Ch : 1140.545
SC Ch : 1160.545
Ch : 850.843
BARAPULLA FLYOVER CROSSING
Ch : 1156.273
RAILWAY CROSSING
SRJ, Km 0+702.622
SCISSOR-X-OVER 1 IN 9
SRJ, Km 0+778.041
SCISSOR-X-OVER 1 IN 9
HPL UP LINE
HPL CENTRE LINE
HPL DN LINE
UP LINE CURVE
RADIUS 704.500
DN LINE CURVE
RADIUS 700.000
Rv = 4528.957
Lv = 120.000
Rv = 3962.838
Lv = 105.000
Rv = 2376.442
Lv = 60.000
HT line at CH:- 800
Voltage - 220KV/DC (OH)
Feeder - MAHARANI BAGH-LODHI ROAD
Owner - DTL
Level of Lowest conductor = N.A
To be raise
Rail Level = 225.682m
Ground Level = 204.192m
M.C.D. OPEN LAND
BABA BANDA SINGH BAHADUR FLYOVER
SANKAT MOCHAN MANDIR ROAD
SIDHARTH
MCD PARK
OPEN AREA
NALA
Cant = 30mm

PLAN


SARAI KALE KHAN STATION
JANGPURA STATION
Ch : 1156.273
RAILWAY CROSSING
UP LINE CURVE
RADIUS 294.500
DN LINE CURVE
RADIUS 299.000
Ch : 1200.000
CS Ch : 1244.198
ST Ch : 1264.198
TS Ch : 1286.299
Ch : 1300.000
SC Ch : 1302.299
DN LINE CURVE
RADIUS 295.000
Ch : 1317.512
UNDERPASS ROAD
UP LINE CURVE
RADIUS 299.500
HPL UP LINE
HPL CENTRE LINE
HPL DN LINE
Ch : 1361.208
MATHURA ROAD CROSSING
CS Ch : 1371.099
ST Ch : 1387.099
Ch : 1400.000
TAKEOFF POINT FOR
FREIGHT LINE SRJ, Km
1436.467 (AT DN LINE) 1 IN 7
Km 1439.434 (Center Line)
FUTURE
DEVELOPMENT
22794 SQM.
MASTER GREEN
(24991 SQM)
Rv = 3168.589
Lv = 80.000
2.525%
0.000%
TS Ch : 1485.944
Ch : 1500.000
SC Ch : 1501.944
HPL FREIGHT LINE
RADIUS 154m
Ch : 1600.000
UP LINE CURVE
RADIUS 150m
RAMP
DN LINE CURVE
RADIUS 150m
Ch : 1700.000
CS Ch : 1728.861
ST Ch : 1744.861
Ch : 1800.000
Curve No: 4
20°00'47"
R=296.75m
TL=62.369m
CL=83.653
SL=20.00
Apex N=3163588.031
Apex E=720463.580
Cant = 35mm
Speed = 43kmph
Curve No: 5
Delta= 16°20'44"
R=297.25m
TL=50.695m
CL=68.800
SL=16.00
Apex N=3163483.009
Apex E=720378.492
Cant = 30mm
Speed = 43kmph
Curve No: 6
92°47'15"
R=150.00m
TL=165.555m
CL=226.917
SL=16.00
Apex N=3163303.901
Apex E=720119.252
Speed = 33kmph
Cant = 25mm
RAILWAY TRACK
MATHURA ROAD
LVL +209

PLAN

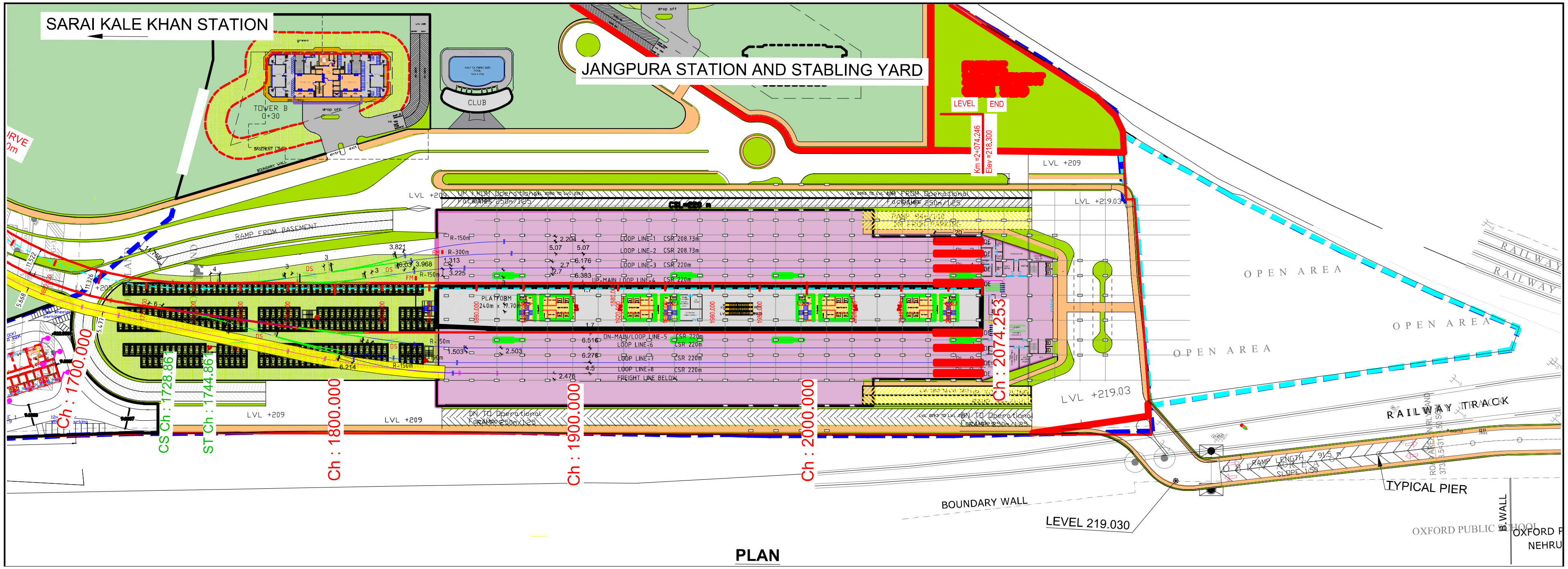

SARAI KALE KHAN STATION
JANGPURA STATION AND STABLING YARD
TOWER B G+30
CLUB
LEVEL
END
LVL +209
LVL +219.03
OPEN AREA
OPEN AREA
OPEN AREA
RAILWAY
RAILWAY
RAILWAY TRACK
LOOP LINE-1
LOOP LINE-2
LOOP LINE-3
DN-MAIN/LOOP LINE-5
LOOP LINE-6
LOOP LINE-7
LOOP LINE-8
FREIGHT LINE BELOW
RAMP FROM BASEMENT
Ch : 1700.000
CS Ch : 1728.861
ST Ch : 1744.861
Ch : 1800.000
Ch : 1900.000
Ch : 2000.000
Ch : 2074.253
TYPICAL PIER
BOUNDARY WALL
LEVEL 219.030
B.WALL
OXFORD PUBLIC SCHOOL
PLAN

Table 1: Structural Description of proposed RRTS

Name of Corridor/ Line	Stations				Length in km		
	Elevated	Underground	At Grade	Total	Elevated	Underground	Total
Sarai Kale Khan - Jungpura Stabling Yard	0	0	1	0	1.35	0	1.35

Source: Detailed Project Report and Addendum to DPR.

11. The connecting line from Sarai Kale Khan RRTS station to Stabling Yard at Jungpura (Stabling Yard alignment) project is included in already awarded construction contract package no.6 for the elevated section in Delhi and is proposed for financial assistance from ADB. The works in stabling yard are proposed to be financed by New Development Bank

C. Environmental Categorization

12. The proposed project has been screened for environmental impacts based on Government of India as well as ADB's SPS 2009 requirements.

13. **Category of the Project as per ADB's SPS 2009**. The environmental screening has been carried out for the proposed project as per ADB SPS 2009 requirements. The Rapid Environmental Assessment (REA) checklist has screened the project considering the aspects of project siting, design, and potential environmental impacts including climate change risk. Although, the proposed project will bring in many benefits to the area, there is potential for environmental impacts on physical and biological environment including built-up area with old structures due to construction and future operation of RRTS. The project will require transportation and use of large quantities of construction material and deployment of heavy machinery and large numbers of workers.

14. The project has been classified as environment **Category 'A'** in accordance with ADB's Safeguard Policy Statement 2009, and therefore requires an Environmental Impact Assessment (EIA) Report. The classification in based on following aspects.

(i) The proposed project requiring construction of a new 1.35 km rail line between RRTS station at Sarai Kale Khan and stabling yard at Jungpura
(ii) The stabling yard is an associate facility for the stabling of the RRTS trains and also for carrying out daily light cleaning of passenger area of the stabled trains and occasional failure investigation and rectification of light nature. The stabling yard complex will also have an at grade RRTS station, operational and administrative buildings of RRTS operations and housing for operation staff.
(iii) Significant safety risks for road users and local people living in and near the project area during construction.
(iv) Safety risks, inconvenience, noisy conditions etc. will also be created from using construction equipment, plying of large number of heavy duty trucks transporting construction material, equipment and machinery in and around the project area.
(v) Significant occupational health and safety risks for the construction workers given the large scale of works requiring use of heavy machinery and hazardous working conditions.
(vi) Risks for long term noise and disturbances to residents and sensitive receptors during operation of the RRTS

15. ADB's Rapid Environmental Assessment (REA) Checklist has been used for screening and categorization of the project for ADB requirements. The REA Checklist is attached as Appendix 1.

16. **Government of India Policy and Regulatory Requirements:** The EIA Notification 2006 (and its amendments) under the Environment (Protection) Act, 1986 provides for requirement of prior environmental clearance to the projects/activities listed in the schedule to the EIA Notification from concerned regulatory authority. Since rail based system is not listed in the said schedule of the EIA Notification, environmental clearance (in the form of approved EIA) from MOEF&CC for proposed Sarai Kale Khan - Jungpura Stabling Yard RRTS alignment and Stabling yard facility project is not required. Therefore, as per national policies and regulatory framework, there is no need to prepare an EIA for the project.

D. EIA Preparation and Objectives of the EIA

17. This EIA has been prepared to fulfill ADB's SPS 2009 requirements, in the months of December 2020 to March 2021. It also complies with environmental safeguards requirements of India. The EIA aims to ensure good environmental practices. The specific objectives of the EIA study are to:

(i) Provide an environmental baseline description of the Project;
(ii) Identify and describe the potential environmental impacts of the Project;
(iii) Design mitigation measures to minimize adverse environmental impacts;
(iv) Describe the public consultation process and grievance redress mechanism;
(v) Provide an environmental and social management and monitoring plan for the project (including defining institutional responsibilities, capacity building and training, and the required budget); and
(vi) Provide due diligence on ongoing works.

E. Scope and Methodology of the EIA Study

18. The scope of this EIA is based on ADB's SPS 2009 requirements. The EIA includes an Environmental Management Plan (EMP) for project implementation and monitoring, consistent with the requirements of the ADB. The purpose of this EIA is to assess potential environmental, health, safety and social risks and impacts of the proposed intervention in Delhi and NCR region of India and propose suitable mitigation measures where required.

19. The EIA followed a number of steps:

(i) Review of available baseline reports, and technical reports/studies related to proposed Project;
(ii) Conduct field visits to collect primary or secondary data relevant to the project areas to establish the baseline environmental conditions;
(iii) Assess the potential impacts on environmental and social attributes due to the location, design, installation and operation of the Project through field investigations and data analysis;
(iv) Explore opportunities for environmental enhancement and identify measures;
(v) Prepare an environment management plan (EMP) outlining the measures for mitigating the impacts identified including the institutional arrangements;
(vi) Identify critical environmental and social parameters required to be monitored subsequent to the implementation of the project and prepare an environmental monitoring plan;
(vii) Carry out consultation with key stakeholders and administrative authorities to identify their perception on the project, introduce project components and anticipated impacts; and,

(viii) Disclose the draft EIA on ADB website and prepare project brief and/or FAQs in local language to be made publicly available at the offices of NCRTC.

20. This EIA study has been conducted based on review of detailed project report, primary data collected from site visits (including consultations) and secondary information collected from various sources. During site visit the specialists have conducted consultations with key stakeholders and local executive authorities for their opinions on the Project. The planned public consultations at key locations along the proposed alignment of the connecting line have also been conducted as part of impact assessment study. The results of the consultations as well as an evaluation of the institutional framework have been incorporated into this assessment.

F. Extent of EIA

21. The scope of this EIA is limited to the areas where project facilities will be installed i.e. alignment through which RRTS line will pass, and area where stabling yard facility will be located. This EIA has been prepared based on the proposed alignment, stabling yard facility and the nature of construction. It covers all activities viz. site clearance (tree cutting, shifting of utilities etc.), construction activities including material sourcing (borrowing, quarrying, and transportation) and operation (traffic movement). Though, corridor for purchase of property based on the safety requirement is considered 5m either side of edge of the viaduct/parapet, the corridor of direct impact that has been considered and studied is 10 meters on either side of the alignment. In addition, an area of indirect impact of up to 2 km on either side of the project alignment and 100m surrounding the station area and stabling yard site have been considered for a larger analysis of land use and other environmental features. Finally, an strip of about 25m (10m on the left + 5m pier width + 10m on the right) i.e. 12.5 m either side of the alignment has been considered as the direct impact zone and over 4km strip has been considered as the indirect impact zone. Information from the indirect impact zone has been taken to assess the broader environmental features in the project area such as terrestrial and aquatic ecology, soil, water, air, noise, and socio-economic aspects..

G. Structure of the EIA Report

22. In line with the requirements of the ADB's SPS 2009, this addendum to main EIA Report has been organized into sections on similar lines as that of main report which covers (i) project description; (ii) description of the baseline environment; and (iii) impact assessment and mitigation measures. A summary of key findings of the EIA is also presented in the Executive Summary. The EIA report has following contents:

Chapter I - Introduction
Chapter II - Policy, Legal, and Administrative Framework
Chapter III - Description of the Project
Chapter IV - Description of the Environmental Features
Chapter V - Anticipated Environmental Impacts and Mitigation Measures
Chapter VI - Analysis of Alternatives
Chapter VII - Consultations, Participation and Information Disclosure
Chapter VIII – Grievance Redress Mechanism
Chapter IX - Environmental Management Plan,
Chapter X - Conclusion and Recommendation.

23. Additional analysis and monitoring reports along with supporting documents are provided in Appendices compiled in a separate volume (Volume II – Appendices).

II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

24. India has well defined institutional and legislative framework. The legislation covers all components of environment viz. air, water, soil, terrestrial and aquatic flora and fauna, natural resources, and sensitive habitats. India has also signed various international conventions and protocols. The environmental legislations in India are framed to protect the valued environmental components and comply with its commitment to international community under above conventions and protocols. ADB has also defined its Environmental and Social Safeguard policy requirements. This assessment is about the applicability of above laws and regulations, conventions, protocols, and safeguards.

25. The laws, regulations, policies and guidelines applicable to this project based on the location, design, construction and operation are summarized in the subsequent sections in following order.

(i) National (India) Environmental Legislation and Legal Administrative Framework,
(ii) ADB Safeguard Policy Statement (SPS) 2009 Requirements, and
(iii) Summary of international treaties and applicability to the project.

A. The National (India) Environmental Laws and Regulations

26. The Government of India's environmental legal framework comprises a set of comprehensive acts and regulations aimed at conserving various components of the biological and physical environment including environmental assessment procedures and requirements for public consultation. The policies and requirements, which are most relevant in context of this project, are provided in Table 2 below:

Table 2: Summary of Relevant Environmental Legislation

Act	Objective	Responsible Institution
Environment (Protection) Act (1986) and Rules (1986)	To protect and improve the overall environment	MoEFCC
The Noise Pollution (Regulation and Control) Rules, 2000 (Amended 2002)	To provide for the prevention, control and abatement of noise pollution, and for the establishment of Boards to carry out these purposes.	CPCB
The Wildlife Protection Act (1972 and amended in 1993)	To protect wild animals and birds through the creation of National Parks and Sanctuaries	MoEFCC
The Water (Prevention and Control of Pollution) Act 1972 (Amended 1988) and Rules 1974	To provide for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water.	CPCB
The Air (Prevention and Control of Pollution) Act, 1981(Amended 1987) and Rules 1982	To provide for the prevention, control and abatement of air pollution, and for the establishment of Boards to carry out these purposes.	CPCB and State Transport Department/ Authorities
Solid Waste Management Rules, 2016	Provisions for collection, storage segregation, transportation, processing and disposal of municipal solid wastes.	State Pollution Control Board

Act	Objective	Responsible Institution
Hazardous Waste (Management, Handling and Trans-boundary Movement) Rules 2008 (Amended 2009),	To protection the general public against improper handling, storage and disposal of hazardous wastes	State Pollution Control Board
The Forest (Conservation) Act 1980 (Amended 1988) and Rules 1981 (Amended 2003)	To protect and manage forests	MoEFCC
Central Motor Vehicle Act (1988) and Rules (1988)	To control vehicular air and noise pollution. To regulate development of the transport sector, check and control vehicular air and noise pollution.	State Transport Department
Ancient Monuments and Archaeological Sites and Remains Act (1958)	Conservation of Cultural and historical remains found in India.	Archaeological Dept. GOI
Building and Other construction workers (Regulation and the Employment and conditions of service) Act, 1996	To regulate the employment and conditions of service of building and other construction workers and to provide for their safety, health and welfare measures	Ministry of Labour and Employment
Child labour (Prohibition and Regulation) Act, 1986	To regulate the employment of children including age limits, type of employment, timing of work, information disclosure and health and safety.	Ministry of Labour and Employment
The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013	The act states that the basic compensation for the Project Affected Persons (PAPs) should be provided according to the market value of the land as at the date of its acquisition. It also entitles PAPs to a hearing before acquisition.	Ministry of Rural Development / Department of Land Resources
The Delhi Preservation of Trees Act, 1994 (Delhi Act 11 of 1994)	Establishment of Tree authority was taken place in this act to check further deforestation and conserve trees in urban areas.	Department of Environment and Forest, Government of National Capital Territory of Delhi
Antiquities and Art Treasures Act (No. 52),1972	Control of moveable cultural property consists of antiquities and art treasures. Regulate the export and trade of antiquities and art.	Archaeologic al Dept. GOI
Construction and Demolition Waste Management Rules, 2016	Large generators (who generate more than 20 tons or more in one day or 300 tons per project in a month) shall submit waste management plan and get appropriate approvals from the local authority before starting construction or demolition or remodelling work,	State Pollution Control Board
The Delhi Ancient and	Preservation of Ancient and	Department

Act	Objective	Responsible Institution
Historical Monuments and Archaeological Sites and Remains Act, 2004	Historical Monuments and Archaeological Sites and Remains other than those declared to be of national importance and for the regulation of excavation of archaeological sites other than those declared to be of national importance in the National Capital Territory of Delhi.	of Archaeology, National Capital Territory of Delhi.
The Delhi Municipal Corporation Act, 1957	Sanitation and public health, including construction of latrines and urinals for labours, public safety and suppression of nuisances and also power, procedure, offences and penalties in case of non-compliance.	Municipal Corporation of Delhi
The Delhi Water Board Act, 1998	Water supply, sewerage and its disposal and drainage and other matters related to them, within the NCT of Delhi.	Delhi Water Board
The Delhi Development Act, 1957	To promote and secure the development of Delhi.	Delhi Development Authority

1.1 Relevant Policies

(i) National Conservation Strategy and Policy Statement on Environment and Development of 1992
(ii) National Environment Policy of 2006
(iii) Policy Statement for Abatement of Pollution of 1992
(iv) National Forest Policy of 1998
(v) National Policy of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013

1.2 Required Clearances/Permissions

27. For implementation of the “Project” required clearances/ permissions related to environment, social and forests have been summarized in Table 3.

Table 3: Applicable Permits and Clearances Required for the Project and Status (on 10th June 2021)

S. No.	Permissions/ Clearances	Acts/Rules/Notifications/ Guidelines	Concerned Agency	Responsibility / Status
A. Pre-construction Stage				
1.	Permission for felling of trees	Forest Conservation Act, 1980. Delhi Preservation of Trees Act, 1994. .	District Forest Office/State Forest Department for trees felling in forest areas and District Authorities in non-forests Areas (MCD/	NCRTC / Letter for tree cutting submitted to Dy. Conservator of Forest, Copy is given in Appendix - 8.

S. No.	Permissions/ Clearances	Acts/Rules/Notifications/ Guidelines	Concerned Agency	Responsibility / Status
			NDMC/DDA in case of NCT of Delhi	
B. Implementation Stage				
1.	Consent to Establish & Operate for Ready Mix Concrete plant & casting yard, setting of labor camps	Air (Prevention and Control of Pollution) Act 1981	DPCC for NCT of Delhi.	Contractor engaged by NCRTC/ Not yet due.
2.	Permission for withdrawal / dewatering of groundwater	Environment (Protection) Act, 1986	CGWA	Contractor engaged by NCRTC / Not yet due.
3.	Permission for sand mining from river bed	Environment (Protection) Act, 1986	Mining Department/ MoEFCC	Contractor engaged by NCRTC / Not yet due.
4.	Authorization for Disposal of Hazardous Waste	Hazardous Waste (Management and Handling) Rules 1989	DPCC for NCT of Delhi.	Contractor engaged by NCRTC / Not yet due.
5.	Disposal of bituminous and other wastes	Hazardous Waste (Management and Handling) Rules 1989	DPCC for NCT of Delhi.	Contractor engaged by NCRTC / Not yet due.
6.	Consent for disposal of sewage from labour camps.	Water (Prevention and Control of Pollution) Act 1974	DPCC for NCT of Delhi.	Contractor engaged by NCRTC / Not yet due.
7.	Pollution Under Control Certificate for various vehicles use for project	Central Motor and Vehicle Act, 1988	Department of Transport, State govt. authorised testing centres	Contractor engaged by NCRTC / Not yet due.
8.	Employing Labour/ workers	The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996	District Labour Commissioner	Contractor engaged by NCRTC / Not yet due.
9.	Roof Top Rain Water Harvesting (RWH)	Central Groundwater Authority (CGWA) Guidelines	Central Ground Water Authority	Contractor engaged by NCRTC / Not yet due.
10.	Permission for use of fresh water for construction	Environment (Protection) Act, 1986	MCD/ NDMC/DDA in case of NCT of Delhi,.	Contractor engaged by NCRTC / Not yet due.

S. No.	Permissions/ Clearances	Acts/Rules/Notifications/ Guidelines	Concerned Agency	Responsibility / Status
	and drinking purpose.			
11.	Quarry Operation	The Mines and Minerals (Development and Regulation) Act, 1957	State Department of Mines and Geology	Contractor engaged by NCRTC / Not yet due.

28. As per GoI EIA Notification 2006, all railways projects in India are exempted from requirements of preparing EIA, therefore environmental clearance for this "Project" is not required.

29. Before the start of civil works in any section of the project the project proponent (NCRTC) is required to obtain necessary clearances / permits from statutory authorities for that particular section.

1.3 Institutional Administrative Framework

30. The administrative framework for implementation and monitoring of proposed stabling yard and connecting line viaduct from Sarai Kale Khan RRTS station to Jungpura Stabling Yard involves various agencies. Brief note on role of the agencies involved for this connecting line and stabling yard project is mentioned in this addendum; for details on role kindly refer to EIA report of main line.

i. **Ministry of Environment, Forests and Climate Change (MoEFCC):** MoEFCC is apex body in India responsible for protection and enforcement of laws and regulations on environmental protection. RRTS being a rail based project, clearance/approval from MoEFCC is not required for the same.

ii. **Delhi Pollution Control Committee (DPCC):** The DPCC is the Delhi state government agency responsible to ensure the compliance to relevant standards related to discharges to the environment in the National Capital Territory of Delhi.

iii. **Central Ground Water Board (CGWB):** The CGWB is responsible for the development, dissemination of technologies, and monitoring of India's groundwater resources, including their exploration, assessment, conservation, augmentation, protection from pollution and distribution.

iv. **National Capital Region Transport Corporation (NCRTC):** National Capital Region Transport Corporation (NCRTC) is the implementing agency of the project.

v. **Central Water Commission:** Central Water Commission (CWC), an apex organization in the country in the field of Water Resources with its mission to promote integrated and sustainable development and management of India's Water Resources by using state-of-art technology and competency and coordinating all stake holders.

vi. **Delhi Development Authority (DDA):** The Delhi Development Authority (DDA), established in 1957 by the Government of India, is charged with developing the city to provide housing, commercial and recreational space, and infrastructure for Delhi's residents. The Authority's mandate is broad—"to promote and secure the development of Delhi" and it is involved in almost every activity related to land, housing, and infrastructure in Delhi.

vii. **Municipal Corporation of Delhi (MCD):** The Municipal Corporation of Delhi is an autonomous body that governed 8 of the 11 Districts of Delhi, in the state of Delhi, India.

B. ADB's Safeguard Policy Statement and Requirements

31. The Asian Development Bank has defined its Safeguard requirements under its 'Safeguard Policy Statement 2009 (SPS 2009). The prime objectives of safeguard policy are to: (i) avoid adverse impacts of projects on the environment and affected people, where possible; and (ii) minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible. This policy requires assessment, mitigation and commitment towards environmental protection. The extent of assessment depends on the category of the project. ADB's SPS 2009 classify an infrastructure investment project depending on following three categories.

(i) **Category A:** A proposed project is classified as category A if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An environmental impact assessment is required.

(ii) **Category B:** A proposed project is classified as category B if its potential adverse environmental impacts are less adverse than those of category A projects. These impacts are site-specific, none or very few of them are irreversible, and in most cases mitigation measures can be designed more readily than for category A projects. An initial environmental examination is required.

(iii) **Category C:** A proposed project is classified as category C if it is likely to have minimal or no adverse environmental impacts. No environmental assessment is required although environmental implications need to be reviewed.

C. Applied Standards

32. The project will follow national or international environment, health and safety standards whichever is more strict. International standards will include the IFC Environmental, Health, and Safety (EHS) General Guidelines (30 April 2007).

D. International and Regional Agreements and Conventions

33. India is a party and signatory to several international and regional environmental agreements to which the MOEFCC is the National Focal Point. Key international agreements that India is signatory to and relevant for the project are provided below:

(i) Convention Relative to the conservation of Flora and Fauna in their Natural State (1933)
(ii) International Plant Protection Convention (1951)
(iii) Convention on Wetlands of International Importance, Especially as Waterfowl Habitat (Ramsar, 1971)
(iv) Convention concerning the Protection of the World Cultural and Natural Heritage (Paris, 1972)
(v) Convention in International Trade in Endangered Species of Wild Fauna and Flora (Washington, 1973)
(vi) Convention on Migratory Species of Wild Animals (Bonn, 1979)
(vii) Convention on the Prior Informed Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (PIC or Rotterdam, 1990)
(viii) United Nations Framework Convention on Climate Change (Rio De Janeiro, 1992)

(ix) Convention on Biological Diversity (Rio De Janeiro, 1992)
(x) Protocol to the United Nations Convention on Climate Change (Kyoto, 1997)

34. The interventions proposed under the Project shall be implemented in compliance with applicable international/regional conventions and declarations to which India is a party.

III. DESCRIPTION OF THE PROJECT

A. Description of the Project Corridor

35. The Project involves construction of an elevated viaduct of 1.35 km from Sarai Kale Khan RRTS Station to stabling yard at Jungpura (connecting line) and the stabling yard at Jungpura. It is an extended part of Delhi-Ghaziabad-Meerut RRTS corridor. The connecting line alignment will originate from Sarai Kale Khan RRTS station and terminate at stabling yard at Jangpura. The Yard will be instrumental in essential operational and maintenance facilities including Operational Control Centre (OCC) and Back Up Control Centre (BCC), a commuter station, housing for operation staff and associated facilities.

36. Figure 2 shows the alignment of the connecting line from Sarai Kale Khan RRTS station to the stabling yard.

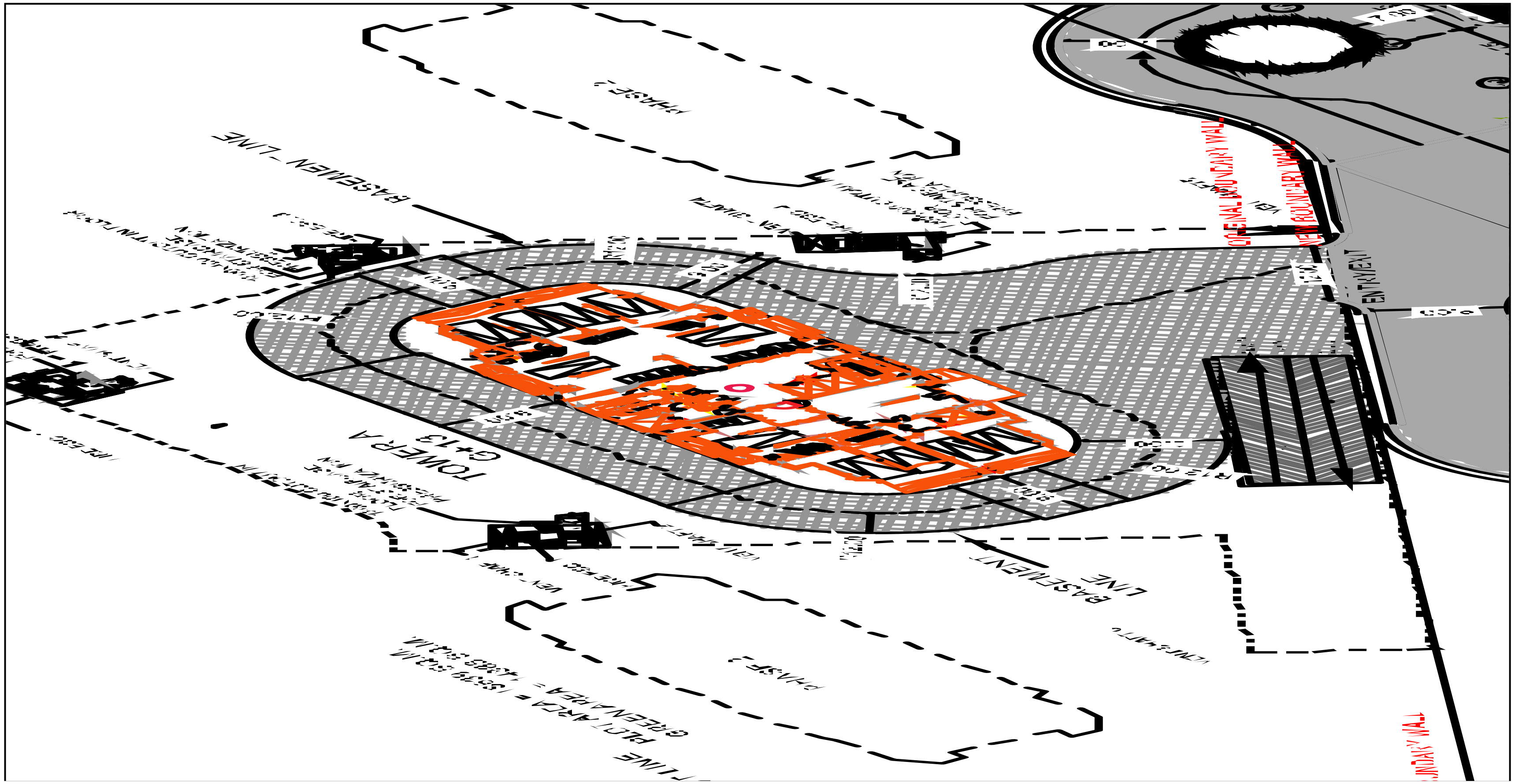
Figure 2: Alignment of Sarai Kale Khan - Jungpura RRTS (Stabling Yard alignment)

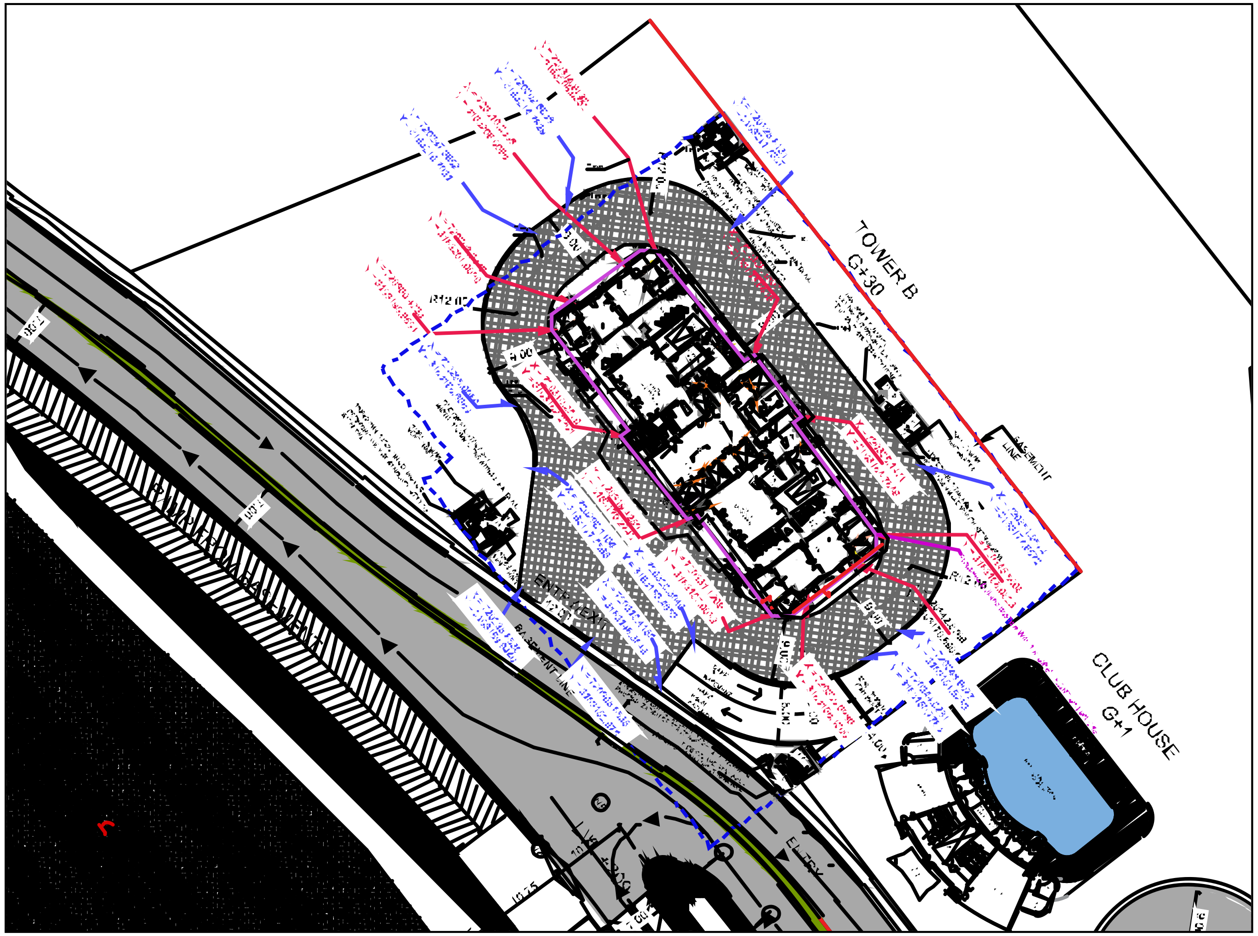
37. The proposed connecting line and the at grade commuter station in stabling yard is to access the operational and administrative facilities proposed at stabling yard. Ministry of Housing & Urban Affairs have already allotted 12 Ha. of land to NCRTC; approval in principle received for 5.21ha and balance land is under active consideration for approval. In stabling yard complex, facility buildings are proposed for operational and administrative set up for RRTS operations. The RRTS operational facility will include stabling yard, one RRTS station, three operational buildings with associated facilities. The area details of various operational buildings are given in Table-4 and the layout is given in Figure 3.

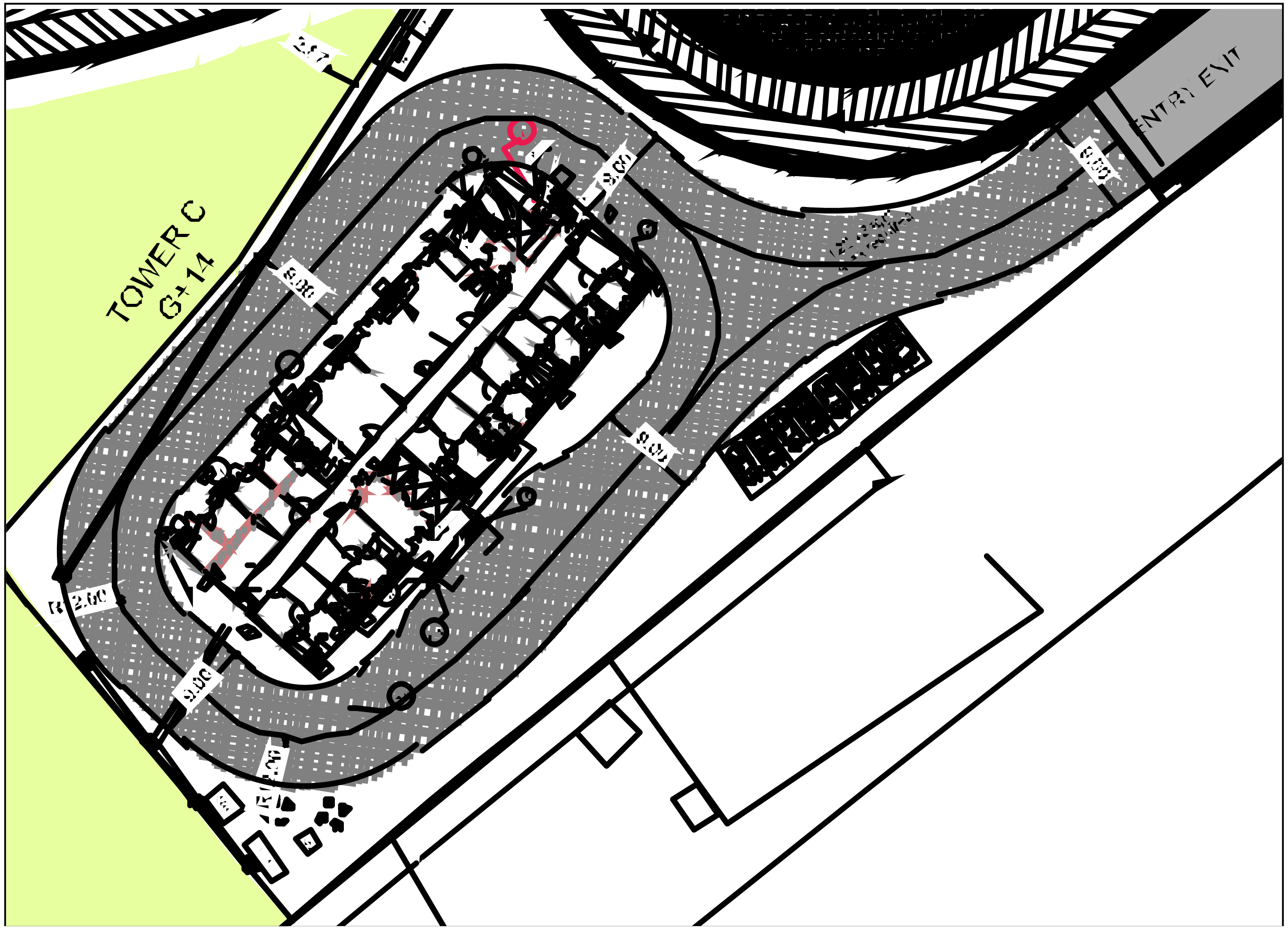
Table 4: Ground Coverage of Operational Buildings and Facility at Stabling Yard

Building/Facility	Ground Coverage Area (Sq.m.)	Ground Coverage Area (Ha.)
Tower A	8350.01	0.8350
Tower B	8077.88	0.8077
Tower C	2734.67	0.2734
Club	1170.94	0.1170
Operational Facilities (Stabling Yard)	30000	3.0000
Total	**50333.5**	**5.0333**

Figure 3: Facilities proposed at Stabling Yard




TOWER B
G+30
CLUB HOUSE
G+1
EASEMENT LINE


TOWER C
G+14
ENTRY EXIT
9.00
9.00
9.00
9.00
9.00
R 12.00

B. Planning and Design Criteria for the connecting line viaduct

38. The entire connecting line is on an elevated viaduct which crosses obligatory locations such Barapullah Flyover and other existing structures . Figure 4 to Figure 7 show the general arrangement of obligatory crossings over different civil structures.

Figure 4: General Arrangement of Obligatory Crossings over DMRC Tunnel (Stabling Yard alignment)

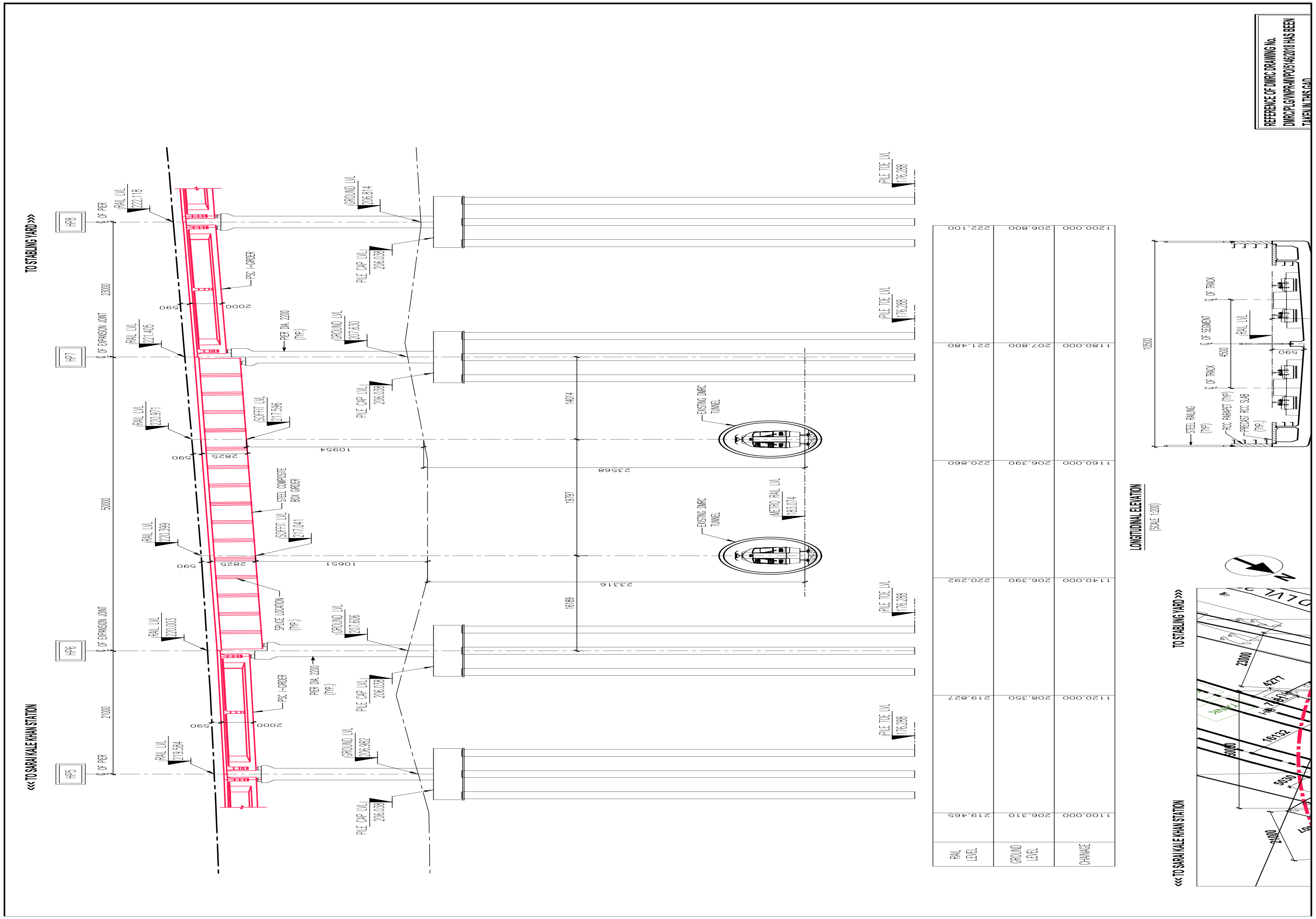


Figure 5: General Arrangement of Obligatory Crossings over Underpass and Mathura Road Near Hindustan Prefab Limited (HPL) at Jungpura

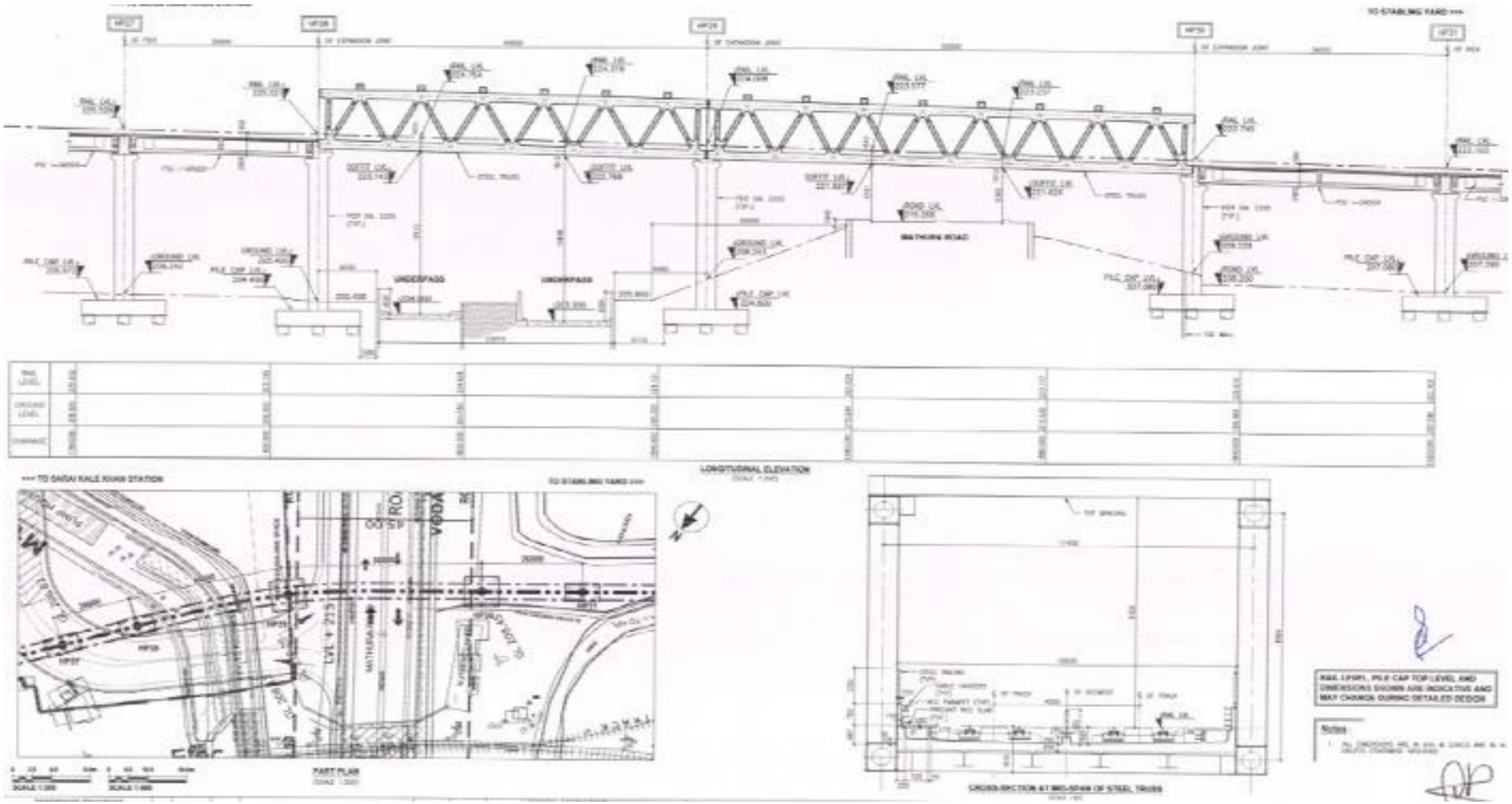


Figure 6: General Arrangement of Obligatory Crossings over Barapulla Flyover (Stabling Yard alignment)

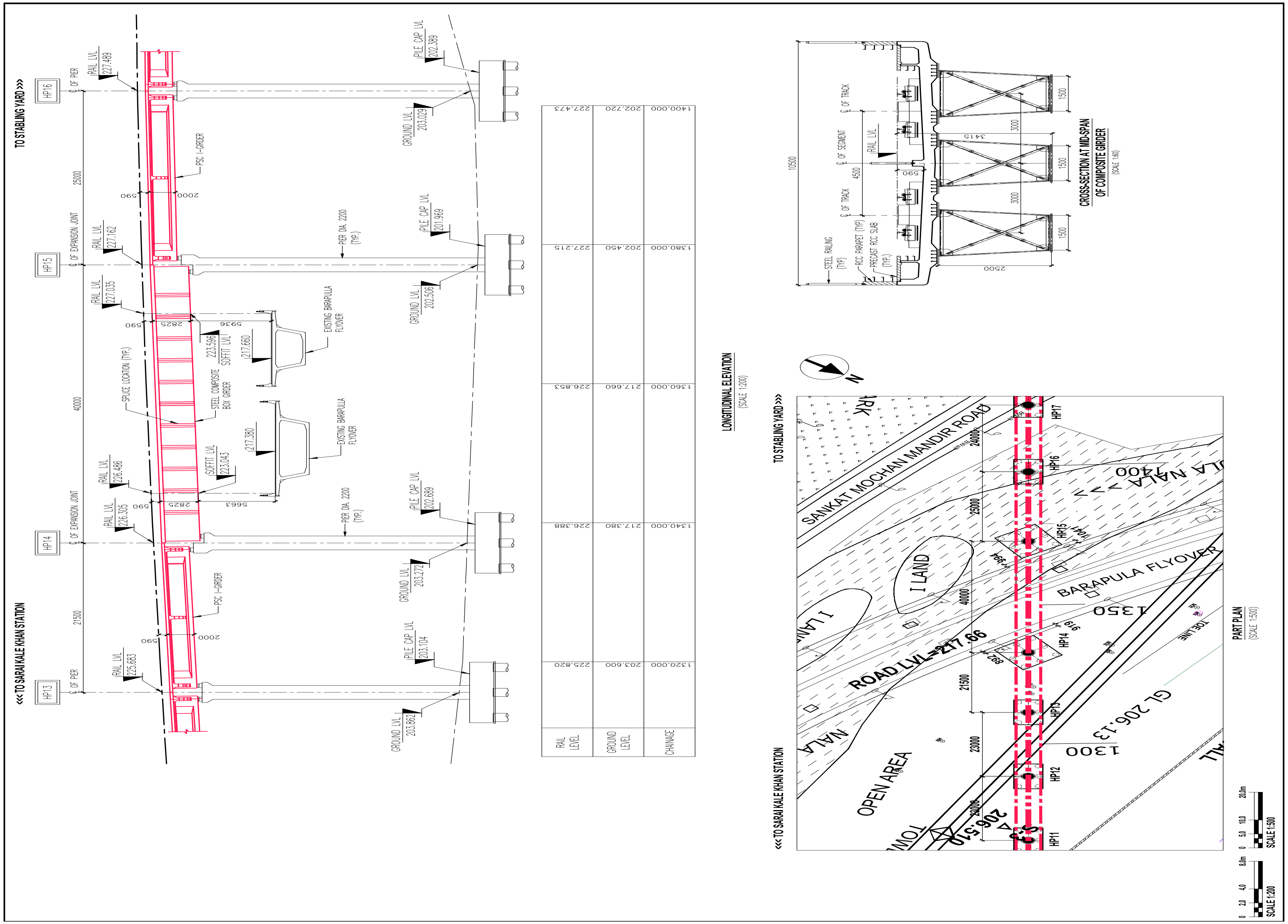
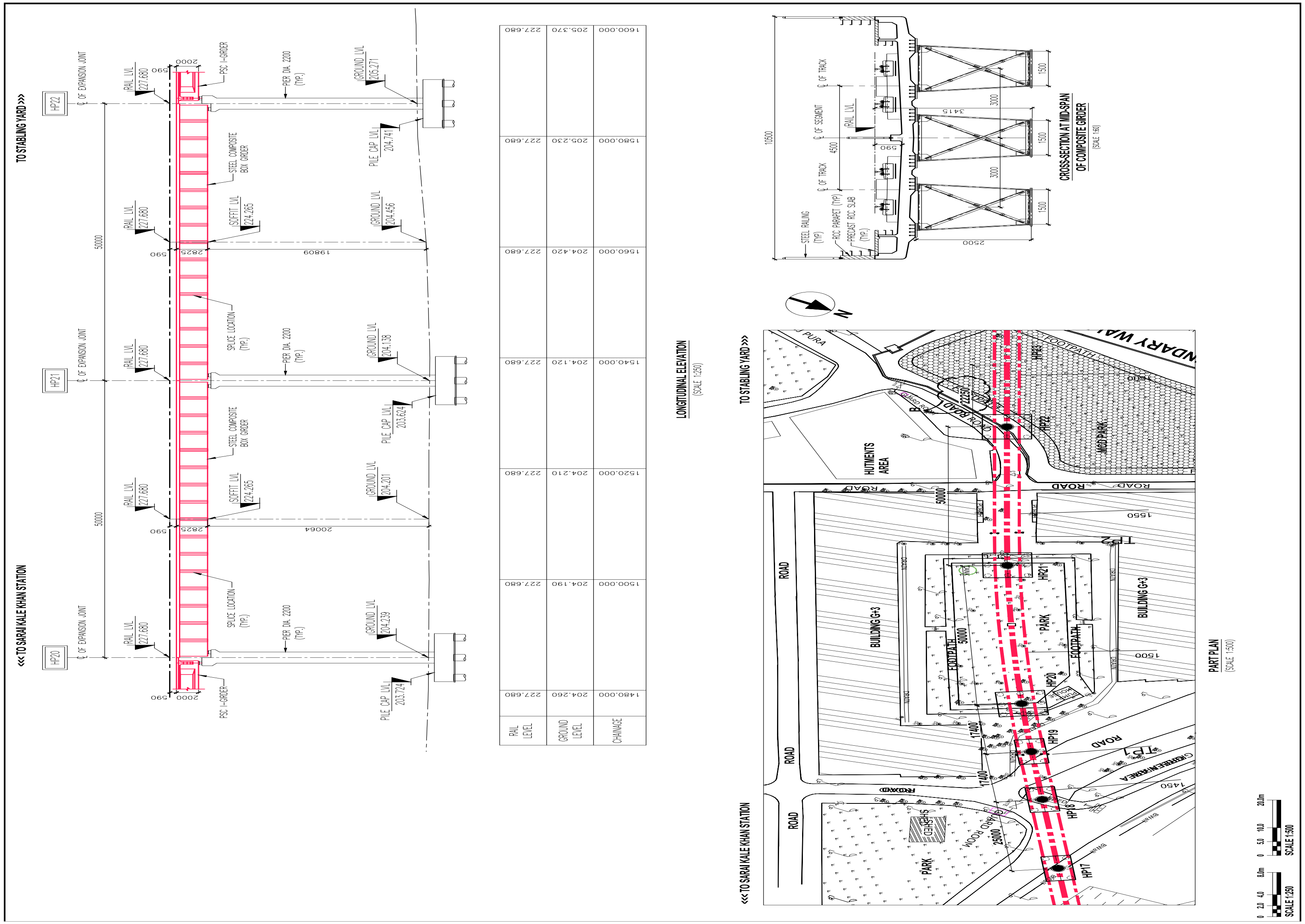


Figure 7: General Arrangement of Obligatory Crossings over Siddharth Extension (Stabling Yard Alignment)



39. No station is proposed between Sarai Kale Khan RRTS station and Jungpura Stabling Yard as the prime objective of this line is to connect Sarai Kale Khan RRTS station to Stabling Yard at Jungpura. Stabling yard at Jungpura will act as buffer for main depots to provide rolling stock in the initial phase of daily operations of RRTS corridors. It shall also have minor maintenance facilities. A at-grade commuter station is also planned at stabling yard so as to pass on the benefits of RRTS to the people in nearby localities and also for the use by RRTS operation/maintenance crew.

4.1 Power Requirements and Sources of Power

40. Electricity is required for operation of RRTS system for running of trains, station services (e.g. lighting, lifts, escalators, signaling & telecom, firefighting etc.) and workshops, depots & other maintenance infrastructure within premises of RRTS system. The power requirements of a RRTS system are determined by peak-hour demands of power for traction and auxiliary applications. Following is the requirement of Power Demand for Stabling Yard line:

(i) The power required for the stabling yard shall be drawn from the Receiving Sub-station located near Sarai Kale Khan which is the power supply source for the main line also.
(ii) For power demand of the RRTS line, there would be two trains (01 in UP line and 01 in DN line) as per data taken from operation wing. The load of 01 train (6 coach) will be - 7720kVA as per data taken from Rolling Stock.
(iii) Hence, tentative Power demand envisaged for trains on Stabling Yard line comes out to - 15440kVA (Approx. 15.4MVA) as on date 09.02.2021.

41. The power supply permission is already in place as a part of Delhi-Meerut RRTS main line. Power demand for Stabling Yard is already considered during planning stage as part of main RRTS corridor.

C. Construction Methodology

42. The project involves construction of an elevated viaduct. Construction of the viaduct is proposed to be done by precast girder using tandem lifting method. In this type of construction, the precast girder will be lifted using a set of cranes and will be placed over the piers. The spans will be in the range of 19 to 72m. The viaduct superstructure will be supported on single cast-in-place RC pier. The shape of the pier follows the flow of forces. For the standard spans, the pier gradually widens at the top to support the bearing under the box webs. At this preliminary design stage, the size of pier is found to be 2.0 m diameter of circular shape for most of its height so that it occupies the minimum space at ground level. The orientation and dimensions of the piers for the continuous units or steel girder (simply supported span) have to be carefully selected to ensure minimum occupation at ground level traffic. Since the vertical and horizontal loads will vary from pier to pier, this will be catered to by selecting the appropriate structural dimensions. At some locations, the superstructure shall be provided with steel girders.

43. The project is in pre-construction stage and details of construction vehicles and equipment for Stabling Yard activities will be provided once finalized. The tentative list equipment/construction vehicles to be used for Package 9A (Multistoried Residential Towers at Jangpura) include:

- Batching plant (30 cum/hr): 1 no.
- TM: 5 no.
- Boom placer: 1 no.
- Concrete pump: 2no.
- Backhoe: 1 no.
- Tractor: 3 no.

- Anti smog gun: 2 no.
- DG set[3] of capacity 50 to 75 kva.

D. Water for Construction

44. Water demand during construction stage for connecting line to stabling yard is calculated based on the estimated labours and works involved; as given in Table -5.

Table 5: Water Demand during construction stage of Connecting Line

Demand	Approx. number (labour)	Liter/person/day	Water requirement Kilo Litre per Day (KLD)
Domestic	200	135	27
Construction Works	-	-	60
Total	**200**		**87**

45. Wherever available, water requirement for construction and operation of RRTS rail will be met through the municipal water supply. In case use of ground water required, necessary permits will be obtained from CGWA and water will be treated to meet the standards.

E. Construction Camps

46. The Contractors engaged by NCRTC will establish construction camps as per terms and conditions of construction contract for the project. Locations of the camps will be finalized after mobilization of contractor and in consultation with NCRTC and the civic bodies. The construction camps shall be set up by the respective contractors for which land will also be arranged by themselves outside the RRTS alignment. The contractor will not be permitted to set up camp for his workmen etc. in the area provided by NCRTC for casting yard/batching plant. However, the contractors are required to follow all the prevailing regulation including requirements of the ADB's SPS 2009 in setting up/maintenance of their construction camp, preparation of labor management plan, and it shall be done as per the approval of the concerned authorities. The contractor will also be required to consider the existence of environmentally and socially sensitive receptors like water reservoir, residential, institutional and hospital area when selecting the location of the camp to avoid impacts on these.

F. Land Requirement

47. As per the land acquisition proposal prepared by NCRTC, the estimated land requirement for this stabling yard including other facilities is 18.9621 Ha which will be developed in phases. Out of 18.9621 Ha, 17.21 Ha pertains to MoHUA, balance pertains to DDA, DJB, SDMC and DUSIB. NCRTC identified the abandoned factory premises of M/s Hindustan Prefab Limited (HPL) at Jangpura as the likely site for the above stabling yard and approached Ministry of Housing and Urban Affairs (MoHUA), Govt. of India, for the allotment of 17.21 Ha land for setting up of stabling yard including operation building, offices and residential buildings etc . Ministry of Housing & Urban Affairs have already allotted 12 Ha. of land to NCRTC and approval in principle issued for 5.21 Ha. Other departments have also been agreed in principle to transfer the balance land.. Table 6 presents the details of tentative land acquisition for the connecting line. It is pertinent to mention that no declination of property value is expected due to RRTS construction rather an increase in property value is expected due to RRTS due to planned integration of Delhi-Meerut, Delhi-Alwar, Delhi Panipat RRTS corridors at Sarai Kale Khan and also the provision of an RRTS station at Jungpura stabling yard which will enhance the connectivity of the area with other places. In addition commercial

---

[3] Installation of DG set of capacity 50 to 75 kva has also been provisioned similar ongoing work of RRTS. Therefore, similar provision shall also be required for this section.

development associated with this Multi Model Integration (MMI) will enhance economic potential of nearby area including Siddhartha Extension.

Table 6: Details of land requirement for RRTS line from Sarai Kale Khan to stabling yard at Jungpura

Sl. No.	Land Ownership	Area (Hectare)
1	Government Land with Occupancy Tenants	0.0432
2	Government Land	1.7089
3	Government Land for Stabling Yard and Staff Quarter	17.21
	Total	**18.9621**

Note:- All the approvals are in place for above land

G. Implementation Plan and Schedule

48. The construction of connecting line viaduct is included in the already awarded contract for the construction of elevated viaduct in Delhi. The construction of stabling yard complex will be implemented by dividing it in 2-3 item rate contract package. The exact modality will be decided on finalization of designs/plans for the entire stabling yard complex. The detailed design of facilities at stabling yard will comply with applicable national standards and international guidelines on emergency response planning (fire, flood, earthquake etc), solid and liquid waste management, storm water drainage, traffic management, parking plan, structural safety and associated utilities implementation. The connecting line and stabling yard complex is expected to be commissioned in June 2025 along with the commissioning of the entire RRTS corridor.

H. Associated Works

49. For facilitating the construction of the connecting line many associated activities/works such as relocation of transmission lines, electrical installations, water/sewer/drainage lines etc. are required. This are included in the project design as part of the project. The development of stabling yard connecting line will involve shifting of following utilities identified within the alignment:

- 2 nos. poles of 220 kv transmission line
- 4 nos. of 33 kv transmission line.

IV. DESCRIPTION OF THE ENVIRONMENT

50. The collection of current baseline information on biophysical, social, and economic aspects of the project area provides an important reference for conducting an EIA. The description of environmental settings includes the characteristic of area in which the project activities would occur and likely to be affected by project related impacts. Compiled existing baseline conditions include primary data on air quality, water quality, noise, soil, ecology and biodiversity, and socio-economic aspects. Secondary data were also collected from published source and various government agencies.

51. The data on water, air, noise quality and biodiversity were collected through field monitoring. Locations of the sampling were selected with due consideration to environmental sensitivity along the project line alignment and as agreed upon with the client. The sampling was carried out at multiple locations representing different land uses i.e. institutional, residential and silent zone. The environmental monitoring was carried out by NABL accredited laboratory “Ultra Testing & Research Laboratory”, Delhi in the month of January 2021 for baseline air, water and Noise parameters. Climatological data was collected from site and secondary data from India Meteorological Department. Efforts have been made to compile the

available data from literature, books, maps and reports. The methodology adopted for data collection is highlighted wherever necessary. Environmental attributes and frequency of baseline surveys are presented in Table 7 and environment parameters monitoring locations are presented in Table 8 and shown in Figure 8. The baseline parameters are selected as specified by regulatory agencies in India and number and locations of the sampling are selected with due consideration to environmental sensitivity along the project line alignment and as agreed upon with the client. The detailed analysis reports received from the monitoring laboratory are provided in Appendix 2, whereas summary findings from the reports are discussed in respective sections.

Table 7: Environmental Attributes and Frequency of Monitoring

S. No	Attribute	Parameter	No. of Samples	Source
LAND ENVIRONMENT				
1	Geology	Geological Status	---	Literature review
2	Seismology	Seismic Hazard	---	Literature review
WATER ENVIRONMENT				
3	Ground Water	Physical, Chemical and Biological parameters	One	Onsite Sampling/ Monitoring
4	Surface Water	Physical, Chemical and Biological parameters	One	Onsite Sampling/ Monitoring
AIR, NOISE AND METEOROLOGY				
5	Ambient Air Quality	PM 2.5, PM10, SO_2, NO_x, CO, HC, NMHC	Two	Onsite Sampling/ Monitoring
6	Noise	Noise levels in dB (A) Leq, Lmax, Lmin, L_{10}, L_{50}, L_{90}	Four	Onsite Sampling/ Monitoring
SOCIO-ECONOMIC				
7	Socio-economic aspects	Socio-economic profile	Once	Field Studies, Literature review.
ECOLOGY				
8	Trees	Number	Once	Field Studies and submitted tree cutting application

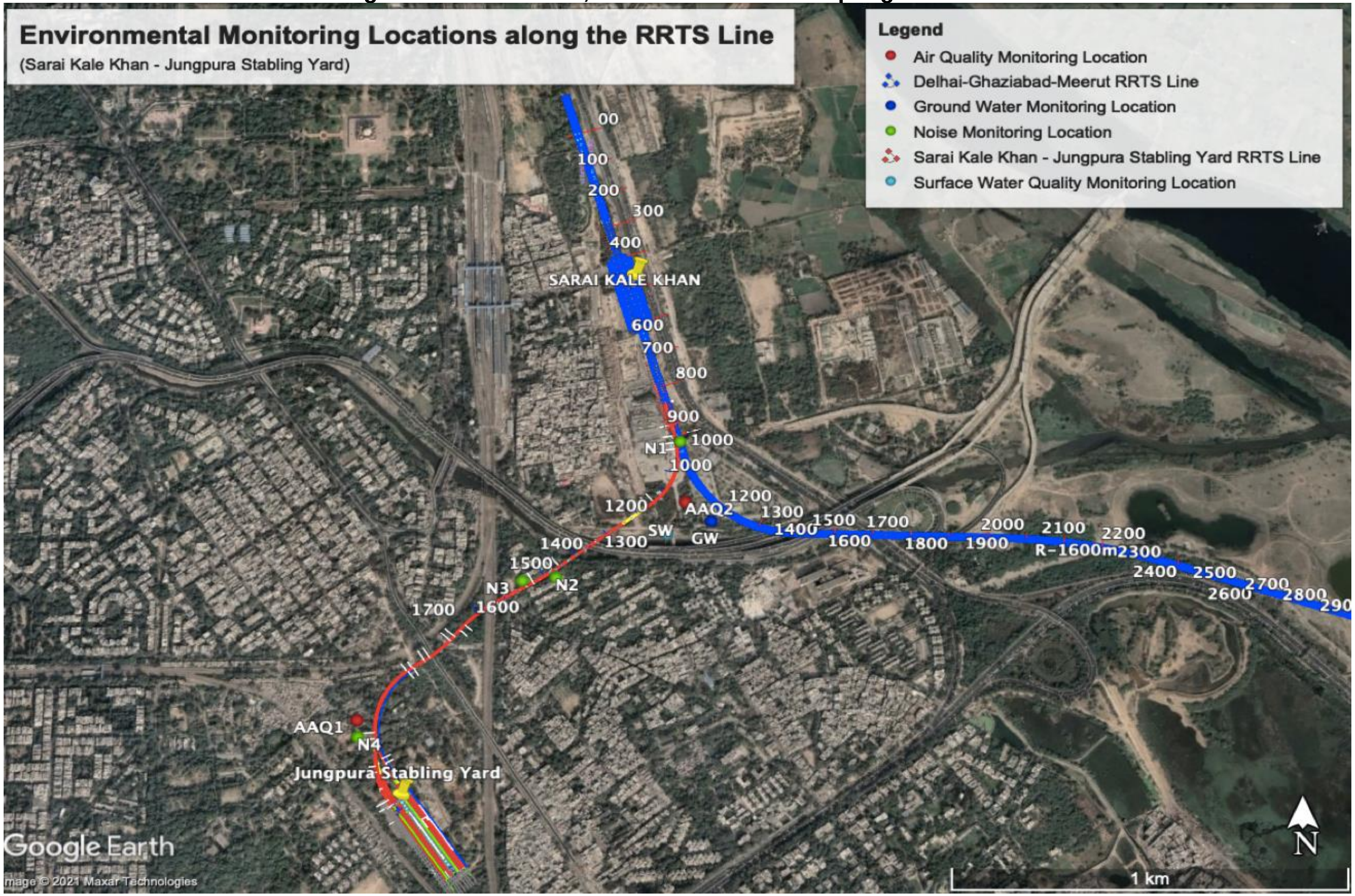
Source: EIA consultant field survey.

Table 8: Details of Sampling / Monitoring Locations

S. No	Monitoring Requirement	No of samples/ Locations	Location	Distance & Direction (w.r.t project site)
1.	AAQ Monitoring – PM10, PM2.5, SO_2, NOx, CO, HC, NMHC	02	*1.* AQ1 – Jungpura Stabling Yard *2.* AQ2 – Near Sarai Kale Khan	AQ1-Within Stabling Yard campus on RHS of alignment AQ2-Within RoW on RHS of alignment
2.	Ground Water Sampling for Analysis – General Chemical & Micro Parameters	01	*1.*GW1 – Sarai Kale Khan	From borewell at NCRTC site office for Delhi-Meerut RRTS line
3	Surface Water Sampling for Analysis	01	*1.*SW1 – Sarai Kale Khan	Downstream of alignment crossing from drain approx.

S. No	Monitoring Requirement	No of samples/ Locations	Location	Distance & Direction (w.r.t project site)
	- General Chemical & Micro Parameters			15m on LHS of proposed alignment
4.	Noise Level Monitoring – 24 Hourly	04	*1.* N1 – Sarai Kale Khan *2.* N2 – Siddharth Nagar (At Rooftop of building) *3.* N3 – Siddharth Extension Park *4.* N4 – Jungpura	N1-Within RoW on RHS of alignment N2- 10m from proposed RoW on LHS of alignment N3- 4m from proposed RoW on RHS of alignment N4-Within stabling yard campus on RHS of alignment

Figure 8: Ambient Air, Noise and Water Sampling Locations



52. The baseline of physical and biological baseline environment of connecting line are similar as detailed out in EIA report Delhi-Meerut RRTS corridor due to presence of connecting line alignment within 2 km distance of main line. The brief on environment parameters relevant for assessment of impacts from implementation of connecting line are mentioned in this section and for detailed baseline on environment please refer to EIA report of main line.

A. Physical Environment

1.1 Water Resources

53. **Open** wells, shallow tube wells and borewells are main source of the water supply in the project area covered by the alluvium. Their discharges vary anywhere from 18 to 25 cubic meters per hour for about 2 to 3 meters draw downs in the open wells to about 162 per cubic meter per hour for about 8-12 meters draw downs in the deep tube wells tapping granular zones about 70-100 meters in aggregate thickness. As far as ground water quality is concerned, there are few fresh water pockets in the north-east and the south-east corners of NCR area. The drain carries waste water from village and unauthorized residential colonies in the Nizamuddin area of Delhi. The flow of water is low in drain and water quality is poor quality. The drain water is not supporting important aquatic species habitat and ecologically not sensitive. Table 9 details of drain (nalla), crossed by to the Sarai Kale Khan - Jungpura RRTS corridor.

Table 9: List of water bodies being crossed by the Stabling Yard RRTS line

S. No.	Description	LHS/ RHS	Chainage in km	Offset in meter	Coordinates		Section Type
					X (Latitude)	Y (Longitude)	
1	Drain Crossing	Crossing	1.35	0	28°34’56.25"N	77°15'26.14"E	Elevated

54. **Surface Water Quality:** The collected samples were analyzed as per the Bureau of Indian Standards (BIS) limits (IS 2296, revised 1992, 2012) for different water uses. Surface water sample were collected at below location (at one location) from open wastewater drain. The Physico-chemical characteristics of surface water sample collected are summarized in Table 10 and laboratory testing report is provided in Appendix 2. The sampling was carried out in January 2021.

Table 10: Surface Water Quality (Open wastewater drain)

S.No	Parameter	Test Method	Results	Units	Tolerance Limit as per IS:2296					Surface Water Quality Standards*
					Class A	Class B	Class C	Class D	Class E	Class V
1	pH	IS:3025(Part-11)	7.47	-	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-9
2	Odour	IS-3025(Part-05)	Obj.	-	Unobj.	-	-	-	-	-
3	Colour	IS:3025(Part-04)	<5.0	Hazen	10	300	300	-	-	>200
4	Turbidity	IS:3025(Part-10)	68.3	NTU	-	-	-	-	-	-
5	Conductivity @25°C	IS:3025(Part-14)	1388	µs/cm.	-	-	-	1000	2250	-
6	Total Suspended Solid	IS:3025(Part-17)	144	mg/l	-	-	-	-	-	-
7	Total Alkalinity (as $CaCO_3$)	IS:3025(Part-23)	310	mg/l	-	-	-	-	-	>1500
8	Biological Oxygen Demand (Max.) (at 27^0C for 3 days)	IS:3025(Part-44)	16	mg/l	2	3	3	-	-	>7
9	Dissolved Oxygen (as O_2) Min.	IS:3025(Part-38)	5.8	mg/l	6	5	4	4	-	<4
10	Calcium(as Ca)	IS:3025(Part-40)	56.00	mg/l	80	-	-	-	-	-
11	Magnesium(as Mg)	IS:3025(Part-46)	34.02	mg/l	24	-	-	-	-	-

S.No	Parameter	Test Method	Results	Units	Tolerance Limit as per IS:2296					Surface Water Quality Standards*
					Class A	Class B	Class C	Class D	Class E	Class V
12	Chloride(as Cl),Max	IS:3025(Part-32)	136.98	mg/l	250	-	-	-	600	>500
13	Iron(as Fe),Max	IS:3025(Part-53)	2.90	mg/l	0.3	-	50	-	-	>5
14	Fluoride(as F),Max	IS:3025(Part-60)	0.12	mg/l	1.5	1.5	1.5	-	-	-
15	Phenolic Compound (as C_6H_5OH)	IS: 3025 (Part-43)	<0.001	mg/l	0.002	0.005	0.005	-	-	>0.1
16	Bicarbonate	IS:3025(Part-51)	378.20	mg/l	-	-	-	-	-	-
17	Total Hardness (as $CaCO_3$)	IS:3025(Part-21)	280.00	mg/l	300	-	-	-	-	-
18	Sulphate (as SO_4)Max	IS:3025(Part-24)	88.17	mg/l	400	-	400	-	1000	-
19	Phosphate (as P)	IS:3025(Part-31)	6.80	mg/l	-	-	-	-	-	-
20	Sodium (as Na)	IS:3025(Part-45)	97.19	mg/l	-	-	-	-	-	-
21	Free Ammonia	IS: 3025 (Part-34)	<1.0	mg/l	-	-	-	1.2		>3.1
22	Total Dissolved Solid	IS:3025(Part-16)	916	mg/l	500	-	1500	-	2100	-
23	Oil & Grease	IS:3025(Part-39)	5.60	mg/l	-	-	0.1	0.1	-	>1
24	Manganese (as Mn)	IS:3025(Part-59)	<0.1	mg/l	0.5	-	-	-	-	>2

S.No	Parameter	Test Method	Results	Units	Tolerance Limit as per IS:2296					Surface Water Quality Standards*
					Class A	Class B	Class C	Class D	Class E	Class V
25	Total Chromiun (as Cr)	IS:3025(Part-52)	<0.05	mg/l	0.05	0.05	0.05	-	-	-
26	Zinc (as Zn)	IS:3025(Part-49)	1.46	mg/l	15	-	15	-	-	>1163
27	Potassium (as K)	IS:3025(Part-45)	4.27	mg/l	-	-	-	-	-	
28	Nitrate (as NO_3),Max	IS: 3025 (Part-34)	8.49	mg/l	20	-	50	-	-	>11.3
29	Cadmium (as Cd)	IS-3025(Part-41)	<0.01	mg/l	0.01	-	0.01	-	-	>5
30	Lead (as Pb)	IS:3025(Part-47)	<0.01	mg/l	0.1	-	0.1	-		>2.5
31	Total Nitrogen(as N)	IS: 3025 (Part-34)	27.16	mg/l	-	-	-	-	-	>20
32	Boron (as B)	IS:3025(Part-57)	0.15	mg/l	-	-	-	-	2	-
33	Copper (as Cu)	IS:3025(Part-42)	<0.01	mg/l	1.5	-	1.5	-	-	>400
34	Chemical Oxygen Demand (asO_2)	IS-3025(Part-58)	152.00	mg/l	-	-	-	-	-	>20
35	Arsenic (as As)	IS:3025(Part-37)	<0.01	mg/l	0.05	0.2	0.2	-		-
36	Aluminum (as Al)	IS: 3025 (Part-55)	<0.01	mg/l	**-**	**-**	**-**	**-**	**-**	**-**
37	Mercury(as Hg)	IS-3025(Part-48)	<0.001	mg/l	0.001	**-**	**-**	**-**	**-**	**>0.2**
38	Cyanide	IS-3025(Part-27)	<0.01	mg/l	0.05	0.05	0.05	**-**	**-**	**-**

S.No	Parameter	Test Method	Results	Units	Tolerance Limit as per IS:2296					Surface Water Quality Standards*
					Class A	Class B	Class C	Class D	Class E	Class V
39	Sodium Absorption Ratio	APHA	2.53	-	-	-	-	-	26	-
40	Total Coli Form	IS:1622	$8.1×10^3$	MPN/100ml	50	500	5000	-	-	>1000
Class A-Drinking water without conventional treatment but after disinfection. Class B-Water for outdoor bathing. Class C-Drinking water with conventional treatment followed by disinfection. Class D-Water for fish culture and wild life propagation. Class E-Water for irrigation, industrial cooling and control waste disposal.										

Source: Field monitoring conducted by the Consultant

**Note-Surface Water Quality Regulation In Eastern Europe, Caucasus and Central Asia (EECCA) Countries, 2008*

55. **Ground Water Quality:** The Ground water samples were collected from borewell at one location (Figure 8) along the proposed alignment for analysis of Physico-chemical characteristics. Sampling was done in January 2021.

56. The collected samples were analyzed as per the Bureau of Indian Standards (BIS) limits (IS 10500-91, revised 2003) for drinking water. The Physio-chemical characteristics of ground water samples collected are summarized in Table 11 and laboratory-testing report is provided in Appendix 2.

Table 11: Physico-chemical Characteristics of Ground Water along the Proposed Alignment

S.No	Parameter	Test Method	Results	Units	Acceptable Limit	Permissible Limit in the Absence of Alternate Source
1	pH	IS:3025(Part-11)	7.18	-	6.5-8.5	-
2	Conductivity	IS:3025(Part-14)	3172	µs/cm.	-	-
3	Colour	IS:3025(Part-04)	<5.0	Hazen	5	15
4	Odour	IS-3025(Part-05)	Agreeable	-	Agreeable	Agreeable
5	Taste	IS:3025(Part-07)	Agreeable	-	Agreeable	Agreeable
6	Turbidity	IS-3025(Part-10)	<1.0	NTU	1	5
7	Total Hardness (as $CaCO_3$)	IS:3025(Part-21)	610	mg/l	200	600
8	Calcium(as Ca)	IS:3025(Part-40)	128.00	mg/l	75	200
9	Magnesium(as Mg)	IS:3025(Part-46)	70.47	mg/l	30	100
10	Chloride(as Cl)	IS:3025(Part-32)	381.58	mg/l	250	1000
11	Iron(as Fe)	IS:3025(Part-53)	0.77	mg/l	0.3	No Relaxation
12	Fluoride(as F)	IS:3025(Part-60)	0.37	mg/l	1	1.5
13	Free Residual chlorine	IS:3025(Part-26)	<0.1	mg/l	0.2	1
14	Total Dissolved Solid	IS:3025(Part-16)	1840	mg/l	500	2000
15	Phenolic Compound (as C_6H_5OH)	IS: 3025 (Part-43)	<0.001	mg/l	0.001max	0.002 Max
16	Anionic Detergents (as MBAS)	Annex K of IS 13428	<0.1	mg/l	0.2	1.0
17	Bicarbonate	IS:3025(Part-51)	683.20	mg/l	-	-
18	Sodium (as Na)	IS:3025(Part-45)	270.25	mg/l	-	-
19	Potassium (as K)	IS:3025(Part-45)	3.77	mg/l	-	-
20	Sulphate (as SO_4)	IS:3025(Part-24)	258.14	mg/l	200	400
21	Nitrate (as NO_3)	IS: 3025 (Part-34)	14.88	mg/l	45	No Relaxation
22	Alkalinity	IS:3025(Part-23)	560	mg/l	200	600
23	Chloramines (as Cl_2)	IS:3025(Part-26)	< 1.0	mg/l	4	No Relaxation
24	Cadmium (as Cd)	IS-3025(Part-41)	<0.001	mg/l	0.003	No Relaxation
25	Lead (as Pb)	IS:3025(Part-47)	<0.01	mg/l	0.01	No Relaxation

S.No	Parameter	Test Method	Results	Units	Acceptable Limit	Permissible Limit in the Absence of Alternate Source
26	Total Chromium (as Cr)	Annex J of IS-13428	<0.01	mg/l	0.05	No Relaxation
27	Copper (as Cu)	IS:3025(Part-42)	<0.01	mg/l	0.05	1.5
28	Total Ammonia	IS: 3025 (Part-34)	<0.5	mg/l	0.5	No Relaxation
29	Nickel (as Ni)	IS:3025(Part-54)	<0.01	mg/l	0.02	0.2
30	Zinc	IS:3025(Part-49)	1.89	mg/l	5	15
31	Manganese (as Mn)	IS:3025(Part-59)	<0.1	mg/l	0.1	0.3
32	Boron (as B)	IS:3025(Part-57)	0.17	mg/l	0.5	1
33	Selenium (Se)	IS:3025(Part-56)	<0.01	mg/l	0.01	No Relaxation
34	Sulphide (as H_2S)	IS:3025(Part-29)	<0.05	mg/l	0.05	No Relaxation
35	Arsenic (as As)	IS:3025(Part-37)	<0.01	mg/l	0.01	0.05
36	Molybdenum (as Mo)	IS-3025(Part-2)	<0.01	mg/l	0.07	No Relaxation
37	Mercury(as Hg)	IS-3025(Part-48)	<0.001	mg/l	0.001	No Relaxation
38	Barium (as Ba)	Annex F of IS 13428	<1.0	mg/l	0.7	No Relaxation
39	Aluminium (as Al)	IS: 3025 (Part-55)	<0.01	mg/l	0.03	0.2
40	Silver (as Ag)	Annex J of IS 13428	<0.01	mg/l	0.1	No Relaxation
41	Polychlorinated biphenyls	APHA 6630	<0.0001	mg/l	0.0005	No Relaxation
42	Polynuclear aromatic hydrocarbons	APHA 6440	<0.0001	mg/l	0.0001	No Relaxation
43	Mineral Oil	IS: 3025 (Part-39)	<0.5	mg/l	0.5	No Relaxation
44	Cyanide	IS-3025(Part-27)	<0.01	mg/l	0.05	No Relaxation
MICROBIOLOGICAL REQUIREMENT						
45	E.coli	IS:1622	Absent	E.coli/100 ml	Absent	Absent
46	Coli form	IS:1622	Absent	MPN/100 ml	Absent	Absent

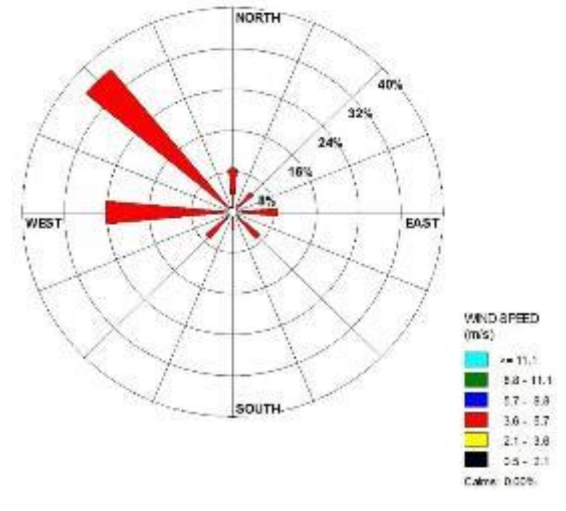
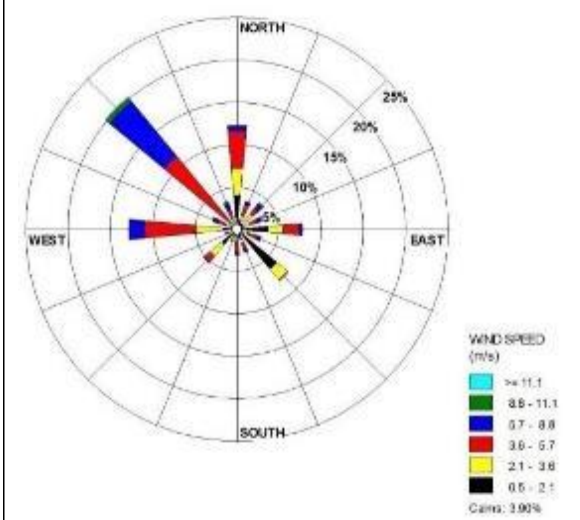
Source: Field monitoring conducted by the Consultant

57. The test results of the ground water samples collected along the proposed alignment shows that most of the parameters analyzed were within the CPCB permissible standards. However, total Hardness, Calcium, Magnesium, Chloride, Iron, Total Dissolved Solid, Sulphate, Alkalinity, are higher than the Acceptable limits of CPCB but lies within Permissible limit of CPCB. Higher levels of hardness and TDS could be due to higher mineral content in the ground water especially calcium and magnesium. All other parameters are well within the desirable limits.

58. **Wind:** Wind speed and wind direction play a major role in the dispersion of air pollutants. The stronger the winds the greater will be the dilution and dissipation of pollutants. The average wind speed during winter, summer, monsoon and post monsoon season is 8.6, 11.6, 10.2 and 6.5 kmph; respectively. The highest wind speed has been recorded in the month of June followed by May. North-West and West are predominant wind directions. The

calm conditions in the project region (wind speed 0-1.8 kmph) region occur about 31% in day time 19% during night time. As per onsite data generated for the month of May 2012, the highest recorded wind speed was 16.2 kmph. The dominant wind directions were same as mentioned above. As per onsite data generated for the month of January 2021, the highest recorded wind speed was 6 kmph. The dominant wind directions were same as mentioned above. Figure 9 show the wind rose diagram in the project area.

Figure 9: Wind Rose Diagrams in the Project Area

	
IMD Wind-rose diagram (2012)	Onsite Wind-rose diagram (2018)

1.2 Ambient Air Quality

59. In order to establish baseline conditions, the atmospheric concentrations of air pollutants were monitored during January 2021 by setting up ambient air quality monitoring stations. Two monitoring locations (Table 15) were selected to generate the representative samples for air quality covering residential, institutional and industrial area along the corridor. The monitoring locations were selected along the alignment to represent ambient air quality of the project area. Locations of air monitoring stations are shown on a map in Figure 8.

60. The monitoring was carried out for Particulate Matter (PM10 and PM2.5), Sulphur Dioxide (SO2), Nitrogen Dioxide (NO2), Carbon Monoxide (CO), Hydro Carbons and Non-methane Hydro carbons (NMHC). Respirable Dust Sampler 460 BL was deployed to monitor RPM, SPM, SO2 and NOx. The sampler was placed to obtain 24 hourly average values of the above said parameters with continuous sampling and based on hourly concentrations. The parameters were monitored and analyzed as per CPCB (Central Pollution Control Board) and NAAQS (National Ambient Air Quality Standards) as well as World Bank EHS Guidelines for air emission.

61. One grab sample[4] was collected for 1 hr. at each monitoring station for analyzing CO and the spot concentration of CO was recorded using Indicator Tube Technique. The sampling for Particulate Matter (PM10 and PM2.5), Sulphur Dioxide (SO2), Nitrogen Dioxide (NO2) was done for 24 hrs. at each location with change of filter paper and reagent after 8 hrs. The results of air quality measured in the study area in comparison are given in Table 12 and, and laboratory testing report is provided in Appendix 2. Figure 10 present the graphical distribution of ambient air quality. The data presented is average for 24 hours.

[4] A small representative subset of a larger quantity, concentration or measurement that is taken at a specific time.

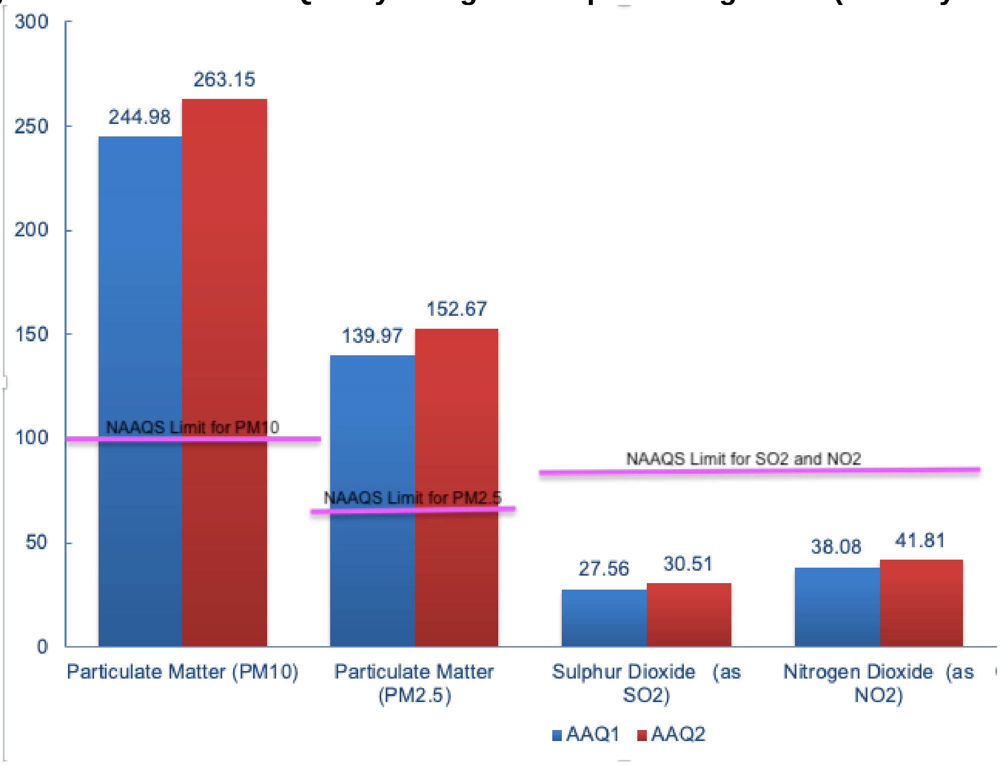
Table 12: Field Air Quality Monitoring Locations

Monitoring Station code	Location	Distance & Direction (w.r.t project site)	Coordinates	Sampling Date
AAQ1	Jungpura, Near Stabling Yard	Within Stabling Yard campus on RHS of alignment	28°34'39.4"N 77°15'04.7"E	12-13/01/2021
AAQ2	Near Sarai Kale Khan	Within RoW on RHS of connecting line alignment	28°38'58.1"N 77°15'37.3"E	12-13/01/2021

Table 13: Air Quality Monitoring results (January 2021)

S. No	Parameters	Test Method	AAQ 1	AAQ 2	Units	Sampling Collection Duration		Limits as per NAAQS	World Bank EHS Guideline
1	Particulate Matter (PM_{10})	IS:5182 (Part-23)	244.98	263.15	µg/m^3	24hr.		100.0	50
2	Particulate Matter ($PM_{2.5}$)	IS:5182 (Part-24)	139.97	152.67	µg/m^3	24hr.		60.0	25
3	Sulphur Dioxide (as SO_2)	IS:5182 (Part-2)	27.56	30.51	µg/m^3	24hr.		80.0	20
4	Nitrogen Dioxide (as NO_2)	IS:5182(Part-6)	38.08	41.81	µg/m^3	24hr.		80.0	40
5	Carbon monoxide(as CO)	IS:5182(Part-10)	0.69	1.15	mg/m^3	1hr.		4.0	-
6	Lead(as Pb)	IS:5182 (Part-22)	< 0.1	<0.1	µg/m^3	24hr.		1.0	-
7	Ozone (as O_3)	IS:5182 (Part-9)	20.47	23.16	µg/m^3	1 hr.		180.0	-
8	Ammonia (as NH_3)	IS:5182 (Part-25)	26.44	29.11	µg/m^3	24hr.		400.0	-
9	Nickel (as Ni)	CPCB Guideline	< 1.0	< 1.0	ng/m^3	24hr.		20.0	-
10	Mercury (as HG)	USEPA Method	<0.1	<0.1	µg/m3	24hr.		-	-
11	Arsenic (as As)	CPCB Guideline	< 0.1	< 0.1	ng/m^3	24hr.		6.0	-
12	Hydrocarbon (as HC)	IS:5182 (Part-17)	< 1.0	< 1.0	ppm	24hr.		-	-
13	Hydrogen Fluoride(as HF)	IS:5182 (Part-13)	< 1.0	< 1.0	ppm	24hr.		-	-

Figure 10: Status of Air Quality along the Proposed Alignment (January 2021)



Source: EIA consultant field survey

62. Results of the ambient air monitoring show that PM10 and $PM_{2.5}$ values in all the monitored locations are much higher than the permissible level of NAAQS (100µg/m^3 and 60µg/m^3) as well as IFC (WB EHS Guideline) standards. A maximum value of 152.67µg/m^3 and a minimum value of 139.97 µg/m^3 was observed for PM2.5 in the study area while for PM10, a maximum value of 263.15µg/m^3 and a minimum value of 244.98 µg/m^3 was observed. The SOx and NOx values recorded at all the study areas are lower than the permissible limit. The range of SOx varied from 27.56 µg/m^3 to 30.51 µg/m^3 while NOx varied from 38.08 µg/m^3 to 41.81 µg/m^3. The CO is within permissible limit while HC and heavy metal values at all locations were below the detectable limits.

63. The air quality of the region is poor. The NCR has been experiencing poor air quality during winter since the past few years. The higher values of PM10 and PM2.5 are due to: the heavy vehicular traffic along the main road comprising buses, cars, trucks, tempo (3 wheelers), motorbikes and rickshaws and pollution from burning of crop residues in neighboring areas. In addition, sampling was carried out in winter when there was less wind and the effects of inversion prevented pollutants from dispersing in the atmosphere. This RRTS has been planned considering improvement in air quality as one of the objectives. All the other parameters are well below the permissible limits. The RRTS project incorporates all the mitigation measures during the construction and operational phase thereby not deteriorating the existing air quality.

1.3 Acoustics Environment Quality

64. **Noise Levels**: The ambient noise level sampling was conducted along the alignment with an objective to establish the baseline noise levels and assess the impacts of total noise expected due to the proposed Stabling Yard line. Noise monitoring was conducted at four locations during the month of January 2021 as shown in Figure 8. Table 14 show details of the noise monitoring locations and noise land use/zone under GOI NAAQS and the World

Bank – Environment, Health and Safety (WB-EHS) guidelines. As shown in table 14 noise monitoring zones include residential, industrial as well commercial land use locations.

65. Sampling duration was taken on hourly basis in order to have an assessment of the Day and Night time noise levels. The results of the noise quality have been reported as L_{eq}, L_{day},L_{night}, L_{10}, L_{50} and L_{90}. The noise levels so obtained are summarized in Table 15 and presented graphically in Figure 11 and 12. The laboratory testing report is provided in Appendix 2.

Table 14: Noise Monitoring locations

Station Code	Area	Representative Land use (GOI/IFC)	Monitoring location	Distance & Direction (w.r.t. project site)	Monitoring Date
N1	Sarai Kale Khan (ISBT)	Commercial for both GOI and WB-EHS	At Ground level	Within RoW on RHS of alignment	12/01/2021
N2	Siddhartha Extn.	Residential for both GOI and WB-EHS	At Top Roof	15m from proposed RoW on LHS of alignment	12/01/2021
N3	Siddhartha Extn.	Residential for both GOI and WB-EHS	At Ground level	4m from proposed RoW on RHS of alignment	12/01/2021
N4	Stabling Yard	Industrial for both GOI and WB-EHS	At Ground level	Within stabling yard campus on RHS of alignment	12/01/2021

Table 15: Hourly equivalent Noise levels, dB(A) (January 2021)

Location Code	N1	N2	N3	N4
Day 7:00	82.8	66.6	73.6	72.4
8:00	86.4	67.5	76.6	71.8
9:00	90.2	69.9	75.4	75.1
10:00	96.8	67.8	75.2	73.4
11:00	93.3	70.2	77.1	75.7
12:00	86.2	69.9	75.4	76.3
13:00	82.4	70.7	76.7	77.4
14:00	78.1	67.6	73.5	75.1
15:00	85.1	76.4	72.5	71.3
16:00	87.2	67.9	77.5	67.6
17:00	90.0	69.2	75.6	68.7
18:00	94.2	67.9	82.4	70.5
19:00	89.7	66.9	74.7	67.7
20:00	87.1	66.0	80.5	66.7
21:00	84.7	63.6	79.2	64.1
Night 22.00	78.9	60.4	68.5	63.3
23:00	78.5	58.2	66.3	57.8
24 :00	74.3	66.5	65.6	61.0
1:00	72.6	65.2	63.9	57.7

Location Code		N1	N2	N3	N4
2:00		73.0	65.3	63.0	58.5
3:00		74.2	63.9	66.3	58.0
4:00		75.5	62.4	63.9	56.8
5:00		79.9	65.9	67.6	58.0
6:00		80.4	69.2	69.4	67.2
Maximum		96.8	76.4	82.4	77.4
Minimum		72.6	58.2	63.0	56.8
Ld		89.9	69.5	77.1	73.0
Ln		77.3	65.1	66.5	61.4
L10		92.4	70.1	78.7	75.5
L50		83.8	67.2	74.1	67.7
L90		74.2	62.7	64.4	57.8
Leq		88.0	68.3	75.3	71.1
Noise limits (GOI)	**Day**	65	55	55	75
	Night	55	45	45	70
Noise limits (WB-EHS)	**Day**	70	55	55	70
	Night	70	45	45	70

Figure 11: Hourly Measured Noise Level along the Proposed Alignment (January 2021)

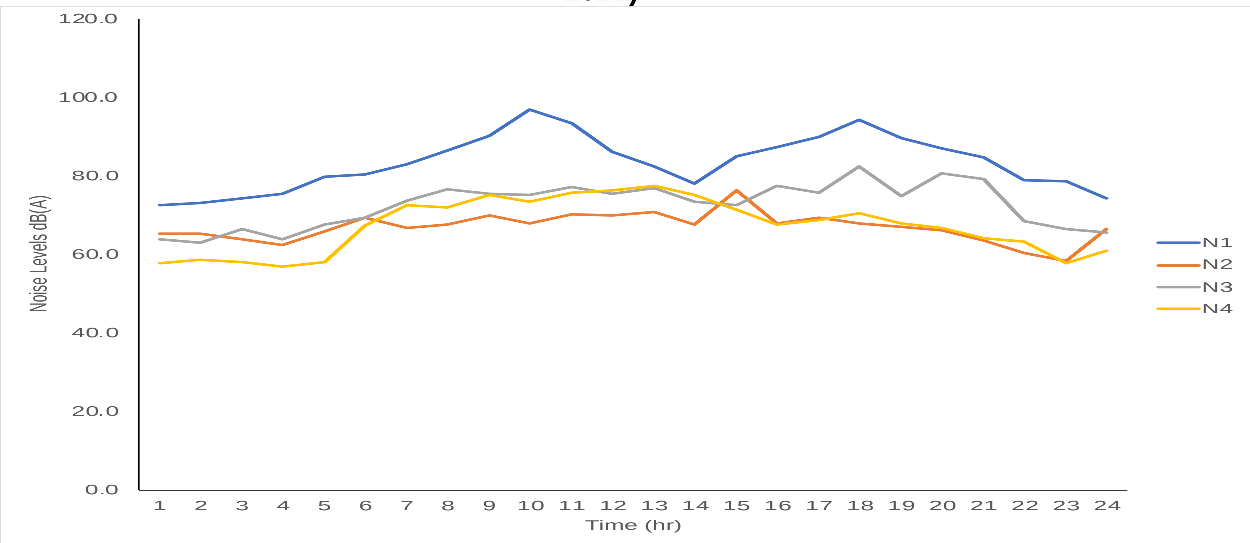
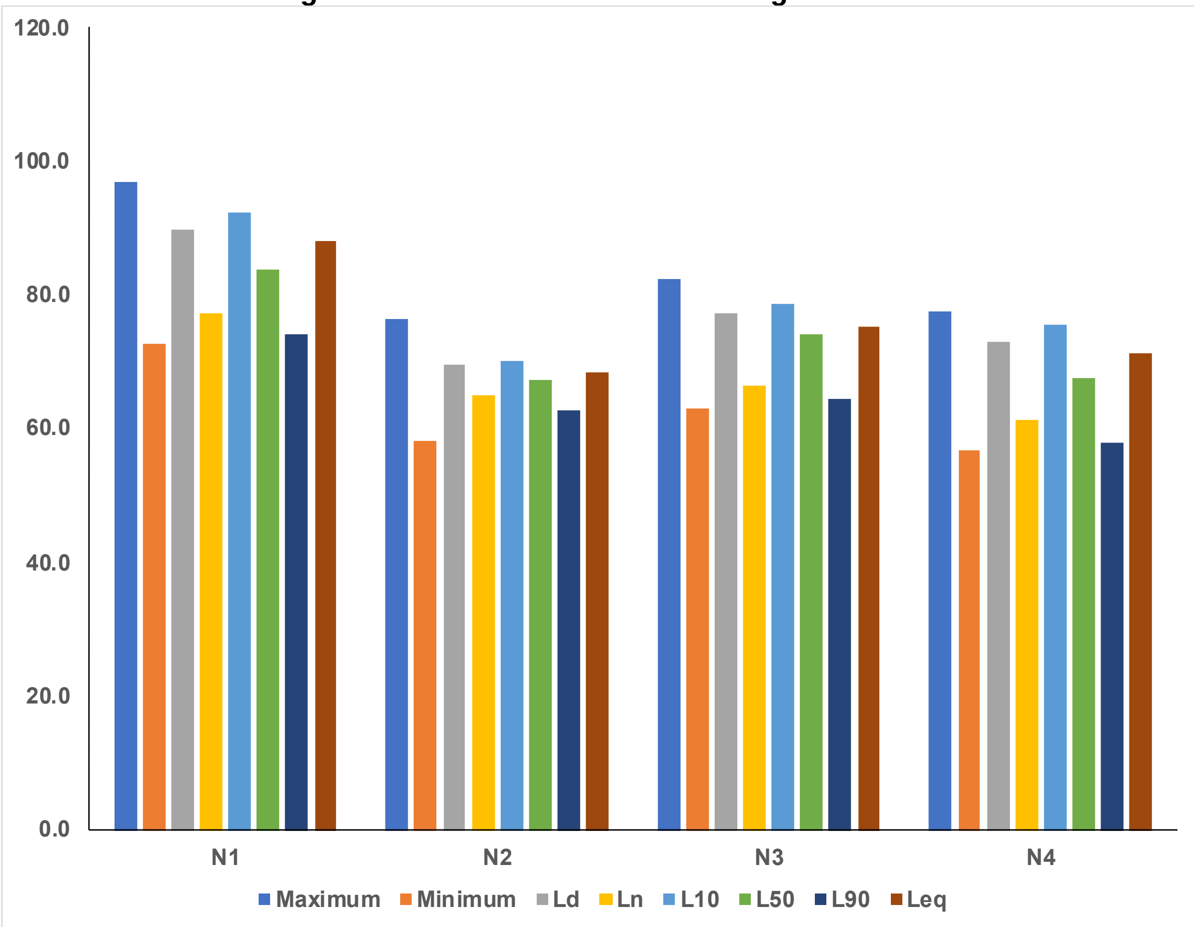


Figure 12: Noise levels at monitoring locations



66. Monitoring results shows that noise levels at all the monitored locations are higher than the permissible limits for all zones for both GOI NAAQS limits as well as WB – EHS guideline limits except for N4 where the night time noise level is just below the limit under WB-EHS guidelines. Vehicular traffic is observed as the main source of noise along the project alignment.

B. Ecological Environment

67. In order to assess the ecological baseline of the project area an assessment has been carried out in and around the project area. The field assessment included inventory of flora and fauna survey (identification and documentation of specifies and conservation status). The methodology adapted and findings of the surveys are discussed in subsequent sections.

2.1 Biodiversity Assessment Methodology

68. **Desk Review and Screening**: The purpose of the desk study was to identify habitats and species of conservation value that may not have been present or apparent during the field surveys (e.g. season specific plants). Desk study was carried out by referring to literature related to ecology and biodiversity of the region or other related areas encompassing the proposed site. Literature review was also undertaken by collecting and stating research papers and reports specific to the region.

69. **Flora & Fauna Survey**: Field study was carried out in January 2021. Tree inventory has been carried out along the proposed alignment. Tree with Girth at Breast Height (GBH) 30 cm have been counted. Apart from tree survey, a list of trees, shrubs, herbs, climber and grasses was prepared from literature review to create the detailed account of local vegetation that may not have been encountered during the field study. Being in an urban area the biodiversity values of the trees to be removed along the project alignment is low. Trees with GBH < 30 cm are considered young trees which will be considered for transplantation.

70. **Observations:** Observations were made for all possible habitats, trees and fauna species in and around the site (except microorganisms). All possible landscape features and areas in the site were visited to collect the required amount of data. The observations recorded are site, time and season specific observations.

2.2 Eco-Sensitive Zones

71. There are no environmentally sensitive zones within the direct impact zone of the proposed RRTS line. The key biodiversity area is the Okhla Bird Sanctuary which is located approximately 4.5km south of the project alignment. Further details on the sanctuary are given in EIA report for Delhi -Meerut RRTS line.

72. As per notification dated 09/08/2015 published in MOEF&CC "Notification declaring Eco-sensitive Zone (ESZ) around Okhla Bird Sanctuary in the State of Uttar Pradesh and National Capital Territory of Delhi", the extent of Eco-sensitive Zone is upto 1.27 km from the boundary of Okhla Bird Sanctuary. Therefore, the proposed RRTS line does not lie in the eco-sensitive zone of Okhla Bird Sanctuary and hence clearance /approval from the concerned authority is not required.

2.3 Floral Diversity

73. Site visits were conducted in and around the project area in January 2021. It included walk through surveys along the project alignment and recording of vegetation seen. Additional literature reviews were conducted to seek information on floristic/vegetation diversity and create a detailed account of local vegetation that may not have been encountered during the walk through surveys. Although most of the proposed Stabling Yard alignment passes through urban/city area.

74. Most of the trees observed were old mature trees. The estimated land requirement for stabling yard including other facilities is 18.9621, whereas approx. 1272 are envisaged to be cut/transplanted as per preveling Govt. mandate. The number of trees to be cut will be verified after joint inspection with concerned authority as part of tree permission before start of tree cutting. The trees include commonly observed native and non-native species like Siris, Safeda, Ber, Kanji, Pipal, Papri, Sheesham, Kner, Tulip, Ashok, Amaltash, Sagwan, Champa, Satadu, Shahtoot and Babool etc. are the dominating species to be affected. The tree species in the corridor of impact of proposed alignment is given in Appendix-6. Compensatory afforestation equal to 10 times the number of trees cut -shall be done at a location decided appropriate to compensate the impact and to make it better than present, in consultation with the concerned authorities . The application for tree cutting / trimming at project site from Ch. 950 to Ch. 1650 has been submitted on 17.08.2020 to South Forest Division, New Delhi and compensatory plantation will be done as per the guidelines of state. Emphasis will be given for the plantation of native trees. All sanctions for tree cutting/transplantation are in place.

2.4 Faunal diversity

75. To study faunal diversity and richness in the area, random sightings were recorded during the walk through surveys. For reptiles, stone lifting was done; rock crevices and wall space of structures in the site were checked. Amphibians were searched near the stagnant

water pools of the drain, no aquatic species were recorded due to high pollution level in drain water. Insects were observed on underside of leaves, nests, rock crevices, bushes and other places. Common birds include Indian Peafowl, Asian Koel, Rose ringed Parakeet, Rock Pigeon, Eurasian Collared dove, house crow, common myna, little brown dove, house sparrow, common babbler, baya weaver, Indian spotted eagle, pond heron sp. has been reported from the project area of influence.

76. There is no endangered faunal species were reported from urban environment along the project alignment.

C. Socio-economic Environment

3.1 Socio-Economic Survey

77. A socio-economic survey was undertaken for the proposed RRTS alignment to assess the socio-economic conditions of project-affected families/people and to examine the impacts of the proposed RRTS alignment on their conditions. The alignment is passing through Sidhartha extension Colony. Before finalization of alignment NCRTC has explored three options and found one option which is technically most viable and at the same time affecting minimum possible numbers of households/flats, alternative analysis is given in para 24 of the report. Sidhartha extension is surrounded from all the four side by Ring Road (eastern side), Norther Railway GT rout (western side), Barapula Nala (north side) and Ashram market (south side). The colony has only one connectivity with main ring road. Since the colony is surrounded by Ring Road, Barapula elevated road, Mathura Road and railway trunk route the baseline air and noise pollution levels are very high. Noise monitoring locations and base line data of January 2021 given in Table 14 & 15 noise levels is ranging between 58.2 dB(A) to 82.4 dB(A) against the noise limit of GOI and World bank EHS of 45 dB(A) to 55 dB(A). Considering high base line values of noise CRRI was assigned to carry out noise and vibration levels studies and remedial measures for mitigation due to any rise of these levels due to RRTS operations. CRRI report also indicated noise level between 63.3 dB(A) to 99.7 dB(A).

There are two blocks consisting of 4-flats each totaling to 8-flats are required to be purchased/acquired for the safety of residence of these flats (safety consideration has been considered based on the DMRC Para 1.1.4 and NCRTC letter para 1.1.5, copy attached in Appendix-12) NCRTC has purchased 4-flats by Feb-2022 and in the process of purchasing of balance 4-flats. 4- flats have total 14 male/female/children as residents.

Resident Welfare Association (RWA) and Sidhartha Extension, Senior Citizen Welfare Forum (SESCWF) are in continuous correspondence with NCRTC. NCRTC is regularly addressing their concern. The details are given in this report. A joint meeting of ADB, NCRTC, RWA & SESCWF was also held on 6th Jan 2022 and its minute of meeting are also enclosed in the report. The main concern is limited to noise, vibration and shadow effect on the flats which will be created after construction of via duct. Since they have been living in noise level more than approx. 100% over the standard level, they are concerned that operation of RRTS will enhance it further. CRRI has suggested mitigation measures in their report and accordingly cost implication as suggested by CRRI has been considered in this report. Further NCRTC has given assurance though various correspondences to restrict noise and vibration levels within the base line levels. Regarding effect of shadow, the study has been carried out by the M/S Green Tree Building Energy Pvt Ltd. Which is enclosed in Appendix-13. The study brought out that net effect of shadow caused after construction of viaduct is limited to the average hours of shaded blocks due to viaduct is only 0.37 hours (22 Minutes). Sidhartha Extension, Senior Citizen Welfare Forum (SESCWF) have also shown their concern that after construction of RRTS, the value of their property will decrease. Consultant “M/S Neeraj Kapoor” has been appointed to carry out the real estate projection of Sidhartha Extension and the report is expected shortly. They have been also appraised that corridor of impact has been taken in the line of Delhi Metro Rail Corporation norms i.e., 5mt from the edge of the viaduct. Accordingly, all the property falling within this zone are being purchased/acquired by NCRTC. The land for construction of viaduct foundation and pier passing through Sidhartha Extension colony belongs to South Delhi Municipal Corporation (SDMC) and same has been transferred to NCRTC by SDMC. Therefore, no addition land is required for construction of viaduct and 8-flats needs to be purchased for the safety of the resident falling under the zone of impact. In addition, the impact on the Project affected people falling under alignment have also been studied and which is the part of RP. .

78. The project will impact 11 households and 69 Displaced Person (DPs), which includes 37 male (53.6%) and 32 female (46.4%). The average household size is 8 and the sex ratio among the DPs is 865. 89% of the DPs belong to general category of caste and only 11% belong to Other Backward Class (OBC). Of the total Displaced House (DHs) 89 % are Hindu by religion while, the other 11% are Sikh. Not a single DP is found vulnerable. Findings of the socio-economic study have been separately provided in the Resettlement Plan.

3.2 Archaeological Sites and Cultural Resources

79. There are no archaeological sites and cultural sites of local or national importance within and 250m radius of stabling yard campus and from the centre line of the connecting line alignment.

3.3 Sensitive Receptors

80. An inventory of receptors such as schools, colleges, hospitals, places of worship, monuments/statue structures etc. within 150 m on either side of connecting line for Stabling Yard alignment was carried out. In total there are 7 location of receptors within 150m were identified, the list is provided in Table 16.

Table 16: Details of Sensitive Receptors with in 150m from RRTS alignment

S. No.	Description	LHS/ RHS	Chainage in km	Offset in meter	Coordinates		Section Type
					X (Latitude)	Y (Longitude)	
1	ISBT	RHS	0+900	50	28°35'6.83"N	77°15'31.18"E	Elevated
2	Barapulla Flyover & Nalla Crossing	Crossing	1+350	0	28°34'56.10"N	77°15'25.82"E	Elevated
3	Siddhartha Extn.	LHS & RHS	1+480	7	28°34'53.88"N	77°15'22.43"E	Elevated
4	Railway Crossing	Crossing	1+680	0	28°34'50.75"N	77°15'16.64"E	Elevated
5	Highway Crossing	Crossing	1+810	0	28°34'46.35"N	77°15'10.93"E	Elevated
6	Hindustan Prefab Limited (Not operational)	RHS	1+830	50	28°34'43.70"N	77°15'7.43"E	Elevated
7	Hindustan Prefab Limited (Not operational)	RHS	2+000	0	28°34'31.66"N	77°15'8.41"E	Elevated

V. ANTICIPATED IMPACTS AND MITIGATION MEASURES

A. Methodology

81. The methodology of assessing environmental impacts from the project entailed clearly identifying the environmental components that will be impacted, type of impacts, assessment area where the impacts will be felt and defining the criteria for assessing the significance of each type of impact. After defining these aspects, a screening of project impacts during design and pre-construction, construction and operation stages of the project was carried out to identify the minor, moderate and major impacts to guide development of mitigation measures and ensure that there are no or minimal residual impacts.

82. **Identification of environmental components.** This includes identifying the valued environmental components (VEC) of the physical, biological, and human environments that are at risk of being impacted by the project. The VECs for this project which are based on the environmental baseline are:

(i) **Physical environment** – air quality, land and soil, surface water quality and quantity, and groundwater quality and quantity
(ii) **Biological environment** – terrestrial and aquatic vegetation, mammals, avifauna, and ecologically important areas
(iii) **Social environment** – private land and buildings, public infrastructure including utility structures, noise and vibration levels, cultural/heritage buildings, and occupational health and safety for the construction workers and local community living within the vicinity of the project area.

83. **Type of impact on the VECs:** The type of impact can be described as:
(i) **Positive:** Improvement in the quality of the VECs because of the project
(ii) **Negative:** Degradation or reduction in the quality of the VECs because of the project
(iii) **Neutral:** No noticeable change in VECs

84. **Area of impact assessment.** The area covered for assessing **direct project impacts** for environment effect purpose include:
(i) An average of 25m corridor along the RRTS elevated section. This includes 10m on the left, 5m pier width and 10m on the right
(ii) An average of 100m surrounding the station locations for both elevated and at grade station
(iii) Upto 100m surrounding to the stabling yard

85. In addition, a 4km strip throughout the project alignment was studied for **indirect impacts**.

86. **Significance of impacts**. The assessment of the significance of the impacts on the VECs requires understanding the (i) sensitivity of each VEC within the project context; (ii) duration of impact; (iii) area of impact; and (iv) severity of impact. The following sections elaborate the

(i) **Sensitivity of VEC**: The sensitivity of a VEC can be determined by the existing conditions of the VEC within the project area and existence of important VEC's within the project areas. Sensitivity of each VEC is described as high, medium or low as described below. Based on baseline conditions in the project area and sensitivity criteria, the level of sensitivity of each VEC is provided in table 16.

(a) **Low:** No environmentally important areas (such as protected areas, natural or critical habitat areas, heritage sites, places of worship etc.) are located within the direct and indirect impact zone. The quality of existing conditions of VECs are good or fair.

(b) **Medium:** There are one or more environmentally important areas within the indirect impact zone of the project area. The quality of existing conditions of VECs are good or fair.

(c) **High:** There are one or more environmentally important areas within the direct impact zone of the project area. The quality of existing conditions of the VECs are poor or degraded (such as poor air quality, high noise levels, poor water quality).

Table 17: Sensitivity of VECs in the project area

VEC	Sensitivity level	Remarks
1. Physical environment		
1.1 Air quality	High	The project area suffers from extremely poor air quality including extremely high PM_{10} and $PM_{2.5}$ levels especially during the dry winter months due to a combination of: i) burning of crop residue in agricultural fields in nearby states; ii) emissions from heavy traffic on the highway; and iii) pollutants being trapped due inversion layer of air created by the cooler winter temperatures
1.2 Surface water quality	Low	The proposed RRTS line does not cross any major river or water body. The surface water quality monitoring was carried at Nalla near Barapulla Flyover and it is extremely poor.
1.3 Surface water quantity	Low	Water for construction and operation will be taken from approved source
1.4 Ground water quality	Low	No groundwater pollution is expected as no station is part of the proposed project
1.5 Ground water quantity	Low	Water for construction and operation will be taken from approved source
1.6 Land degradation and pollution	Low	Land requirement is kept minimum for construction zone and right of way during operation
2. Biological environment		
2.1 Trees, terrestrial and aquatic vegetation	Low	About 1272 trees infringing the planned development of stabling yard land and the connecting line needs to be removed. However, none of these are endangered species or comprise primary natural forests
2.2 Terrestrial fauna (mammals, birds, insects)	Low	There are no ecologically important wildlife in the largely urbanized project area.
2.3 Aquatic fauna (fishes, migratory birds) and ecologically important areas	Low	No surface water body with ecological sensitive receptor is crossed by proposed alignment.
3. Social environment		
3.1 Private land and buildings	Medium	The project passes through urbanized area requiring the acquisition of Govt. land shown in

VEC	Sensitivity level	Remarks
		table 6 with 3 occupancy tenants. In addition 8 flats owned by individual households falling within 5m from the edge of viaduct are also need to be purchased/acquired for safety reasons. However, if flat owners wants to stay there after construction and during operation, they will be shifted temporarily at the cost of NCRTC once willingness given by the flat owners.
3.2 Public property/infrastructure/ utility structures	Medium	Electrical utilities and drainage lines will require shifting.
3.3 Noise	High	The existing baseline noise levels in the project area are above the GOI permissible limits and WB-EHS limits
3.4 Vibration	Medium	There are few structures located near the elevated section.
3.5 Occupational health and safety	Medium	The project area already experiences some road and railway track safety issues due to the heavy traffic plying
3.6 Public health and safety	Medium	Same as above
3.7 Physical cultural resources (PCR)	Low	There are no religious places to be displaced for the proposed alignment

87. **Duration of the impact:** Duration means the time dimension of the impact on the VECs. The terms permanent, temporary and short-lived are used to describe the duration of impact:

(a) **Short-lived:** The impact disappears promptly
(b) **Temporary:** The impact is felt during one project activity or, at most, during the construction period of the project
(c) **Permanent:** The impacts are felt throughout the life of the infrastructure

88. **Area of impact:** The area of impact entails the spatial scale of impact on one or more of the VECs. The terms regional, local and limited are used to describe the area of impact:

(a) **Limited**: The impact is felt within the direct impact zone
(b) **Local**: The impact is felt within the indirect impact zone
(c) **Regional**: The impact is felt beyond the indirect impact zone

89. **Severity of impact**. The severity or seriousness of an impact entails understanding the repercussion or risks posed by the impact. This is a subjective criteria which is defined as high, medium or low as below:

(a) **High:** The severity of impact is high if grave repercussions are expected as a result of the impact due to any of the following or similar situations: the impact will be felt by a large number of people or receptors; the receptors are highly sensitive; the impacts will cause serious health issues; there is already a history of complaints from the project area and people have raised significant concerns during public consultation; some of the VEC in the project area already severely degraded and maybe further worsened by the project; there will be a significant change in one or more VEC because of the project

(b) **Medium:** The severity of impact is medium due to any of the following or similar situations: the impact will be felt by a small number of people; some receptors are affected but they are not sensitive; the impact will not cause serious health issues;

some concerns were raised during public consultations, but they were not significant; there will be minor changes in one or more VEC because of the project

(c) **Low:** The severity of impact is low due to any of the following or similar situations: the impact will not be felt by anyone; no or limited receptors are affected; no concerns were raised during public consultations; there will be no noticeable changes in one or more VEC because of the project.

90. Based on the rating of duration, area and severity of impact as described above the overall significance of each impact as major, moderate or minor was determined as demonstrated in table 18 below.

Table 18: Criteria for rating the significance of impacts

Significance	Sensitivity of VEC	Duration	Area	Severity
Minor	Medium or Low	Short lived or temporary	Limited or local or regional	Low
	Low	Permanent	limited	low
Moderate	High or Medium	Temporary	Limited or local or regional	Medium
	Medium	permanent	Limited	Medium
Major	High	Permanent or temporary	Limited or local or regional	High
	Medium and high	Permanent	Local or regional	Medium

91. **Screening of impacts**: Based on the rating criteria provided in table 18, environmental impacts anticipated during the project design and pre-construction stage, construction stage and operation stage were screened for their level of significance as demonstrated in table 19 below. The screening was carried out for impacts that are expected without mitigation. Hence, it guided the identification of impacts that need mitigation and clearly point out significant/major negative impacts that need to be prioritized for mitigation.

92. The significance of each environmental impact or project activity is indicated by the colors of the cells in the last column of the table 19. Red indicates major impact, orange indicates moderate impact, yellow indicates minor impact and green indicates positive impact. The following section discusses the details of impacts on each of the VECs in line with identification of major, moderate, minor impacts in the screening matrix. Major impacts have been given priority for identification of mitigation measures to ensure that there are minimal or no residual impacts.

Table 19: Screening of Environmental Impacts

VEC/Sensitivity	Impact/Activity	Project stage	Duration	Area	Severity	Significance of impact
1. Physical environment						
1.1 Air quality (Medium sensitivity)	Location of project line and stabling yard facility, design of train, energy type	D	+ve permanent	+ve Local, regional	+ve medium	+ve
	Dust, PM, emissions from construction equipment and vehicles	C	-ve temporary	-ve Limited	-ve medium	-ve moderate
	Emissions from train operation and road traffic	O	+ve permanent	+ve Limited	+ve low	+ve
1.2 Surface water quality (Low sensitivity)	Location of stabling yard could lead to water pollution from waste water generated	D	-ve permanent	-ve Local	-ve low	-ve minor
	Pollution from liquid and solid waste from camps and construction activities;	C	-ve temporary	-ve Limited	-ve low	-ve minor
	Pollution from liquid and solid waste from associated facilities like stabling yard and stations ; pollution of the already degraded Nalla	O	-ve permanent	-ve Local	-ve low	-ve minor
1.3 Surface water quantity (Low sensitivity)	Use of water at station, and stabling yard	D	-ve permanent	-ve Local	-ve low	-ve minor
	Extraction of water for construction works and use in camps	C	-ve temporary	-ve limited	-ve low	-ve minor
	Extraction of water for use in stabling yard	O	-ve permanent	-ve Limited	-ve medium	-ve minor
1.4 Ground water quality (moderate sensitivity)	Location of station and stabling yard and inclusion of sewage treatment or waste water facilities	D	-ve permanent	-ve Local	-ve medium	-ve moderate
	Pollution from liquid and solid waste from camps and construction activities;	C	-ve temporary	-ve Limited	-ve low	-ve moderate
	Pollution from sewage and liquid waste from stabling yard	O	-ve permanent	-ve Local	-ve medium	-ve moderate
1.5 Ground water quantity	Location of stabling yard	D	-ve permanent	-ve Local	-ve medium	-ve moderate

VEC/Sensitivity	Impact/Activity	Project stage	Duration	Area	Severity	Significance of impact
(Low sensitivity)	Extraction of ground water for construction works and use in camps	C	-ve temporary	-ve limited	-ve medium	-ve moderate
	Extraction of ground water for use in stabling yard	O	-ve permanent	-ve Limited	-ve medium	-ve moderate
1.6 Land degradation/ pollution (Medium sensitivity)	Location of stabling yard	D	-ve permanent	-ve Limited	-ve low	-ve minor
	Solid waste from construction works and camps, muck disposal	C	-ve temporary	-ve Local	-ve medium	-ve Moderate
	Waste and pollution from stabling yard	O	-ve permanent	-ve Limited	-ve low	-ve minor
2. Biological environment						
2.1 Trees, terrestrial and aquatic vegetation (Low sensitivity)	Location of project alignment and stabling yard in areas with vegetation and trees	D	-ve permanent	-ve Limited	-ve low	-ve minor
	Removal of trees, shrubs, grasses and aquatic vegetation	C	-ve permanent	-ve Limited	-ve low	-ve minor
	Growth of the compensated trees	O	+ve permanent	+ve Limited	+ve medium	+ve
2.2 Terrestrial fauna (mammals, birds, insects) (Low sensitivity)	None	D	N	N	N	N
	Removal or death of mammals (mostly domestic animals) and insects	C	-ve permanent	-ve Limited	-ve low	-ve minor
	None	O	N	N	N	N
2.3 Aquatic fauna (fishes, migratory birds) and ecologically important areas (Low sensitivity)	Location of the project alignment west of the Okhla Bird Sanctuary	D	N	N	N	N
	Deterioration of water quality and other aquatic fauna due to siltation and pollution of water during construction of foundation and piers inside water.	C	N	N	N	N
	None	O	N	N	N	N
3. Social environment						
3.1 Private land and buildings (Low sensitivity)	Location requiring acquisition of private land and removal of private structures/buildings	D	-ve permanent	-ve Local	-ve low	-ve minor

VEC/Sensitivity	Impact/Activity	Project stage	Duration	Area	Severity	Significance of impact
	Acquisition of private land. Demolition of private buildings. Possible complaints, opposition from disgruntled or unhappy affected persons	C	-ve permanent	-ve Local	-ve low	-ve minor
	Increase in value of land and property. Easier access to some areas and property.	O	+ve permanent	+ve Local	+ve low	+ve minor
3.2 Public property/infrastructure/ utility structures (Medium sensitivity)	Location requiring acquisition of public land and removal of public structures/buildings and utility structures	D	-ve permanent	-ve Limited	-ve medium	-ve minor
	Acquisition of government land. Demolition of public buildings. Removal and shifting of utility structures. Possible complaints from local public due to disruption of utility services	C	-ve permanent	-ve Local	-ve medium	-ve minor
	None	O	N	N	N	N
3.3 Noise (Medium sensitivity)	Location near residential areas, sensitive receptors like place of ISBT at Sarai Kale Khan)	D	-ve permanent	-ve Limited	-ve medium	-ve moderate
	Disturbance caused to local residents from noise generated from construction activities, campsite activities using heavy equipment, movement of heavy duty trucks during day and night time. Noise levels exceeding standards. Complaints from local residents near construction sites.	C	-ve temporary	-ve Local	-ve medium	-ve moderate
	Noise levels exceeding baseline levels by more than 3dBA and causing disturbance to residents and identified receptors near project alignment and stabling yard	O	-ve permanent	-ve Limited	-ve medium	-ve moderate
3.4 Vibration	Location near residential areas and identified receptors	D	-ve permanent	-ve Limited	-ve low	-ve minor

VEC/Sensitivity	Impact/Activity	Project stage	Duration	Area	Severity	Significance of impact
(Medium sensitivity)	Vibration disturbance felt by local residents due to construction activities using heavy equipment and movement of heavy duty trucks during day and night time. Nearby buildings and sensitive receptors damaged or cracked. Complaints from local residents and local authorities near construction sites.	C	-ve temporary	-ve Limited	-ve medium	-ve moderate
	Vibration caused by RRTS operations felt by residents and sensitive receptors living near and above ground of the project alignment. Damage caused to structures near and above ground of the project alignment due to vibrations caused by RRTS operation.	O	-ve permanent	-ve limited	-ve medium	-ve moderate
3.5 Occupational health and safety (Medium sensitivity)	Design of safety features and systems for operation of the RRTS,	D	-ve permanent	-ve Limited	-ve medium	-ve moderate
	Death, accident or injury of construction workers, due to poor safety standards. Illness of construction workers due to poor hygiene, health and sanitary facilities at the construction sites and camp sites.	C	-ve temporary	-ve Limited	-ve medium	-ve moderate
	Accidents, injuries to RRTS operational staff	O	-ve permanent	-ve Limited	-ve medium	-ve moderate
3.6 Community health and safety (Low sensitivity)	Design of safety features and systems for public using the RRTS alignment	D	-ve permanent	-ve Limited	-ve low	-ve minor
	Accident, injury or death of public using the RRTS and passing through the stations. Health problems caused to people residing near the stations and depots because of ground water contamination caused by sewage/waste water from the station and stabling yard.	O	-ve permanent	-ve Limited	-ve low	-ve minor

VEC/Sensitivity	Impact/Activity	Project stage	Duration	Area	Severity	Significance of impact
3.7 Physical cultural resources (PCR) (Medium sensitivity)	Identification of heritage and archaeological sites and artefacts in the project area	D	-ve temporary	-ve Limited	-ve low	-ve minor
	Destruction and damage of PCRs including archaeological sites and artefacts	C	-ve temporary	-ve Limited	-ve low	-ve minor
	None	O	N	N	N	N

Note: +ve = positive impact; -ve = negative impact; AG = above ground; C = construction stage; D = design & pre-construction stage; N = neutral; O = operation stage; PC = pre-construction; UG = underground; VEC = valued environmental component

Major negative impact. oderate negative impact negative impact P e impacts

B. Impacts on Physical environment

1. Air quality

Design and pre-construction stage – positive impact

93. The project is designed to enable movement of people in a more efficient and environment friendly manner by using the train run on cleaner energy (electricity) as opposed to vehicles using pollution emitting petroleum-based fuels. Hence, the air quality within the local project influence area is expected to improve.

Construction stage - moderate negative impact

94. **Impact:** Deterioration in ambient air quality is expected during construction due to generation of dust from excavation and earthworks, exhaust and emissions from operation of equipment and movement of trucks transporting construction materials and equipment. However, the spatial scale of these impacts will be limited to the active project construction sites and locations that will be traversed by trucks transporting construction material. The severity of impacts are expected to be medium as only those people or receptors that are located within the immediate vicinity of the active construction sites and construction vehicle movement areas will experience the effects of dust and air pollution. These impacts will be experienced only during the construction stage. Based on this, the significance of impacts on air quality during construction is rated as moderate.

95. **Mitigation Measures:** Generation of dust can be controlled by optimizing the use of soil material from areas within the vicinity of the project area and avoiding transporting them from far distances. Regular spraying of water at the construction sites and vehicle movement areas must be carried out to control dust. All vehicles, equipment and machinery used for construction must be regularly maintained and emission test certificates updated to ensure that the emission levels are within the prescribed norms of CPCB. Unnecessary idling of equipment and vehicles will be avoided. Vehicles carrying earth, cement and other construction material shall be appropriately covered during transportation in order to avoiding spilling and blowing away of material along the road. Green belt development will also serve an effective way to reduce air pollution. Some of the effective species which absorb air pollutants are *Azadirachta indica, Terminalia chebula, Dalbergia sissoo, Albizia amara and Mangifera indica* are proposed under greenery development.

96. **Residual impact:** After implementation of the mitigation measures described above residual impacts are expected to be minor or negligible.

Operation stage – positive impact

97. The project is expected to result in modal shift of passengers from road to the project rail. With this it is expected that traffic on road (buses, cars and two/three wheelers) will reduce and there will be less traffic jams. Hence, overall the air quality within the project influence area will improve due to reduced emissions from road traffic.

98. The traffic studies carried out for Delhi-Meerut RRTS main line found that over the 29-year design life of the project from 2025 until 2054 there will be a net reduction of about 2.8 million tons of pollutants. Pollutants considered include PM, NOx, HC, CO and CO2.

2. Surface water quality and quantity

Design and pre-construction stage – minor negative impact

99. **Impact**: Location of the connecting line and stabling yard can have long term implications on the **quality of nearby water bodies** (river and ponds) due to discharge of sewage and waste-water generated from operation of stations area for connecting line and at the stabling yard. Since, there is no station proposed near drain crossing the connecting line. Hence, no waste water generation and discharge is anticipated in drain. However, without proper waste-water and sewage treatment facilities in the stabling yard, there is a risk of the surrounding environment mainly surface water bodies to receive the untreated waste-water. However, the stabling yard at Jungpura is not located near any fresh water stream, river or pond. Hence, there is no surface water pollution risk from the stabling yard. Hence, the severity of the impact is low.

100. Similarly, the location of the stabling yard also has long term implications on the **quantity of water**. However, considering that this is a risk on the local water supply system and not for the surface water bodies in the project area, the risks related to water quantity needs is discussed below under impacts on local utility services.

101. **Mitigation Measures**: The risk of water pollution from the stabling yard can easily be mitigated by including a proper sewage treatment system such as a septic tank within the design of the stabling yard facility. It is expected that other forms of waste-water such as from washing and cleaning will not have any toxic chemicals or severely polluting properties. Hence, they could be released into the connecting urban drainage facilities. Monitoring of waste-water generated from the stations during the initial stages of project operation will be required to be carried out to confirm that the water does not contain any harmful pollutants.

102. **Residual impact**: With the inclusion of septic tanks and other sewage treatment measures in the stabling yard and provision for monitoring the grey water discharged from it, the residual impact is expected to be minor and negligible.

Construction stage - minor negative impact

103. **Impact:** Water demand will be high during project construction for meeting drinking and domestic water requirements for the camp sites as well as construction activities in the construction sites along the RRTS alignment and stabling yard. If the project depends on the local water supply system this will cause a strain on the local water supply and may result in inadequate or no water for the local residents.

104. Pollution of water bodies near the project site due to release/disposal of liquid and solid waste generated from construction activities and campsite may occur. No rivers/water bodies are transverse by the proposed alignment except a Nalla (Open Sewer Drain) having poor water quality.

105. Considering that spatial scale of these impacts is limited to the vicinity of the project construction sites and the effects will be felt only during the construction period, the overall significance of impacts on surface water quality and quantity is rated as low.

106. **Mitigation measures**: The project will avoid relying on local water supply system for meeting water needs for construction activities and camp sites to the extent possible. The wastewater generated in labour camp will be managed by providing septic tanks/soak pits, to be constructed after Consent to Establish & Operate from pollution control committee. The septic tanks will be constructed of with impermeable chambers and will be cleaned time to time through approved service provider. Sufficient volume of water for construction purpose will be sourced from approved sources in the project area with due approvals from concerned authorities. If water is required to be sourced from the local water supply system, it will be done with prior approvals and quantities extracted must avoid any negative impact on the residents living in the vicinity of project area.

107. Liquid waste that will be generated from piling works such as polymer muck shall be disposed in designated disposal areas. Disposal areas for all solid wastes generated from construction activities will be selected in co-ordination with the local municipal and environmental authorities.

108. **Residual impact:** After implementation of the mitigation measures described above residual impacts are expected to be minor.

<u>Operation stage – minor negative impact</u>

109. **Impact**: As discussed in the design and pre-construction stage, the stabling yard can have long term implications on the **<u>quality of nearby water bodies</u>** (river and ponds) due to discharge of sewage and waste-water generated from operation of the connecting line from toilet facility at station and stabling yard.

110. The connecting line alignment is crossing waste water drain at Ch 1.350, there is no station proposed in between on this alignment. The stabling yard is not located near any stream, river or pond. Hence, there is no surface water pollution risk from the connecting line and stabling yard.

111. The risk of pollution from waste-water and sewage is limited to stabling yard only. The severity of the impact is low as no receiving receptor (waterbody/river) will be affected is located within the immediate vicinity of the stabling yard campus. The pollution impact though small in spatial scale will be long term. Hence, the overall significance of the impact is rated as low.

112. **Mitigation Measures**: The toilet at station areas will be connected with city sewage network to collect generated wastewater for treatment at common STP. At the stabling yard, package type sewage treatment plants of adequate capacity shall be installed. It is expected that other forms of waste-water such as from washing and cleaning will not have any toxic chemicals or severely polluting properties. Hence, they could be released into the connecting urban drainage facilities. Monitoring of waste-water generated from the stabling yard during the initial stages of project operation will be required to be carried out to confirm that the water does not contain any harmful pollutants.

113. **Residual impact**: The recommended mitigation measures can be easily implemented and infact sewage treatment systems (mainly septic tanks) have already been included in the stabling yard design. The operation stage environmental monitoring plan includes requirements for monitoring the effluent quality from the stabling yard. Hence, the residual impact is expected to be minor and negligible.

3. Ground water quality and quantity

<u>Design and pre-construction stage – moderate negative impact</u>

114. **Impact**: Location of stabling yard can have long term implications on the **<u>quality of ground water</u>** in the project area due to discharge of sewage and waste-water generated from it.

115. The stabling yard at Jungpura will include the facilities for washing trains, operating and maintaining locos and trains, workshops and office. These facilities will generate liquid wastes including sewage, oil, grease and chemicals. Oil spillage during change of lubricants, cleaning and repair processes, in the stabling yard is a common occurrence.

116. The communities living near the stabling yard areas that rely on ground water for domestic purposes could face problems of ground water contamination if there are no proper

sewage and waste-water treatment facilities in the yard. There is potential for surface water bodies also to get polluted from polluted ground water channels that are linked to them. The connecting line alignment is crossing waste water drain with no pier casting work in water reservoir area. Since there is no surface water body near the yard, hence the risk of surface water pollution through ground water connections also does not exists for the yard.

117. The risk of ground water pollution from sewage and waste-water exists in stabling yard of the project. The severity of the impact is considered moderate (considering the scale of project) due to the possibility of harmful pollution that may affect human health. The depots may release chemical and petroleum waste into the ground water which could affect communities nearby that rely on ground water for domestic purposes. Pollution from raw sewage may negatively affect ground water. The pollution impact in terms of spatial scale will be localized within the project influence area (direct and indirect impact zone). However, in the absence of mitigation measure the pollution impact will be long term. Hence, the overall significance of the impact is rated as moderate.

118. The project area enjoys good supply of ground water resources. However, the location and design of water supply system can have long term implications on the **quantity of ground water resources**. The continuous extraction of large quantities of ground water can result in reduced supply of ground water for the communities living in and around the project that rely on ground water for domestic purposes. Considering that the project area is linear and small and is not located near densely populated settlement the severity of the impacts could be moderate and long term. Hence, without mitigation the significance of the overall impacts on ground water quantities is also rated as moderate.

119. **Mitigation Measures**: The risk of ground water pollution from the stabling yard can easily be mitigated by including a sewage treatment facilities and waste – water treatment facilities in the yard. NCRTC will arrange to prepare a detailed storm water drainage plan, wastewater management plan and sewage treatment system to be included in the final design of Stabling yard facilities.

120. For treating effluents generated in the yard, the effluent treatment system will include oil and grease traps. The collected oil and grease will then be provided to authorized collectors to avoid any soil, underground/ surface water contamination. The detailed design of plant for treatment of waste water generated from stabling yard will be included in final design of stabling yard facilitates.

121. The risk of depleting ground water resources can be addressed by sourcing water from existing water supply systems (municipality) with adequate capacity. Tube wells to extract ground water can be installed and quantities of water extracted will be in accordance with the CGWA approval and will avoid any negative impacts on ground water resources.

122. Monitoring of ground water quality in areas in and near the stations and depots will be required in operation stage environmental monitoring.

123. **Residual impact**: With the implementation of the mitigation and monitoring measures described above it is expected that the residual impacts will be minor.

Construction stage - moderate negative impact

124. **Impact:** As described under impacts on surface water, there will be a high demand for water during construction to meet drinking and domestic water needs for the camp sites as well as construction activities in the construction sites along the RRTS alignment and yard location. If the project depends on the local water supply system this will cause a strain on the local water supply and may result in inadequate or no water for the local residents.

125. There may be pollution of ground water from toilets in the construction camp sites. Construction workers themselves may get sick if sourcing drinking water from wells. Local communities living near the camp site may get sick too if they are sourcing drinking water or water for domestic use from the ground water supplies. There may also be depletion in ground water resources if (approx. 27 kld) large quantities of water are extracted for domestic use by workforce during construction phase, no ground water will be used for construction activities.

126. These impacts of pollution and depletion of ground water quantities will be felt only during the construction period and will be limited to the vicinity of the project construction sites and camp sites. Hence, the overall significance of impacts on ground water quality and quantity is rated as moderate.

127. **Mitigation measures**: Camps will not be located immediately next to communities. For construction camps that extract ground water for drinking and domestic purposes it will be ensured that the tube well and septic tanks are located far away from each other to avoid cross contamination.

128. If ground water extraction is needed for construction purposes it will be done with appropriate approvals from CGWA and quantities extracted will follow the requirements of the approval or avoid any negative impact on the residents living in the vicinity of project area.

129. **Residual impact:** After implementation of the mitigation measures described above residual impacts are expected to be minor.

Operation stage – moderate negative impact

130. **Impact**: Operation of stabling yard can have long term implications on the **quality of ground water** in the project area due to discharge of sewage and waste-water generated from operation of the yard. The communities living near the yard area that rely on ground water for domestic purposes could face problems of ground water contamination if there are no proper sewage and waste-water treatment facilities in the yard. There is potential for surface water bodies to also get polluted from polluted ground water channels that are linked to them. Since, there is no surface water body near the proposed stabling yard, hence the risk of surface water pollution through ground water connections also does not exist for the yard.

131. The risk of ground water pollution from sewage and waste-water exists in stabling yard of the project. The severity of the impact is considered moderate (considering the scale of project) due to the possibility of harmful pollution that may affect human health. The depots may release chemical and petroleum waste into the ground water which could affect communities nearby that rely on ground water for domestic purposes. Pollution from raw sewage may negatively affect ground water. The pollution impact in terms of spatial scale will be localized within the project influence area (direct and indirect impact zone). However, in the absence of mitigation measure the pollution impact will be long term. Hence, the overall significance of the impact is rated as moderate.

132. The project area enjoys good supply of ground water resources. However, poor design of water supply systems for the yard can have long term implications on the **quantity of ground water resources**. Water requirements at yard is estimated to be about 87,000 liters per day for including water requirement for drinking.

133. The continuous extraction of large quantities of ground water for activities can result in reduced supply of ground water for the communities living in and around the project that rely on ground water for domestic purposes. Given that ground water resources are not constrained and most of the communities along the project alignment have organized water supply systems (such as the municipal water supply network) the significance of the overall impacts on ground water quantities is rated as moderate.

134. **Mitigation Measures**: The risk of ground water pollution from the yard can easily be mitigated by including sewage treatment facilities and wastewater treatment facilities in yard's design. Wastewater treatment plants will be installed at yard having oil and grease interceptors connected with the wastewater treatment plant which is capable of removing petroleum contaminants and can meet national standards. Oil traps in heavy machinery areas will be created to collect oil based materials. Similarly, sedimentation basins would be established prior to the water discharge point to reduce the sedimentation load in the storm water. Since RRTS rail is operated through electricity, there will be lesser risk of pollution from petroleum based fuels.

135. The risk of depleting ground water resources can be addressed by sourcing water from existing water supply systems (municipality) with adequate capacity. Tube wells to extract ground water can be installed and quantities of water extracted will be in accordance with the CGWA approval and will avoid any negative impacts on ground water resources. Rainwater harvesting structures have been included in the design of station to help conserve and store water. Sewerage and storm water drainage in the depots will be designed to enable treatment and reuse. The groundwater level is high at proposed Stabling yard, Jangpura complex. Hence, the possibility of rainwater harvesting structure will be explored and implemented following geo-technical study results.

136. Monitoring of ground water quality in areas in and near the yard will be required during operation stage environmental monitoring.

137. Recharging of ground water resources if required could be done by:

- (i) re-injecting the pumped discharge back into the ground.
- (ii) Temporary cut-off walls: If there is a concern that permanent cut-off walls will affect the long term groundwater flow regime, due to the barrier effect, then it may be possible to use temporary cut-off techniques. For example, steel sheet-piles that can be withdrawn at the end of the project, or artificial ground freezing, which will eventually thaw and allow groundwater flow to pass.
- (iii) Localized groundwater cut-off walls: Where there is a specific receptor to be protected, such as a wetland or sensitive structure, it may be possible to install a localized section of cut-off wall or grout curtain between the dewatering system and the receptor, to reduce the drawdown at the receptor.
- (iv) Protection of individual receptors: If there are only a small number of isolated receptors, it may be more cost effective to simply fix or prevent the problem directly at the receptor, for example by underpinning the foundations of a sensitive structure, or by providing a new piped water supply to replace a well where lowering of water levels has reduced the yield.

138. **Residual impact**: With the implementation of the mitigation and monitoring measures described above it is expected that the residual impacts will be minor.

4. Land degradation and pollution

Design and pre-construction stage – minor negative impact

139. **Impact**. The location of the connecting line , stabling yard and its associated facilities can have long term implications on the generation of waste/trash and polluting land in the immediate vicinity of the project area. The waste management systems and linkage with existing local waste management systems will play an important role in ensuring that waste generated from the project do not end up in the areas near the project site. This problem if not managed will be limited to the project vicinity. Though it will be a long-term problem the severity of the impact in terms of causing health problems to the general public and serious

environmental issues is minor. Hence, overall the significance of land degradation and pollution impacts during pre-construction stage is considered minor.

140. **Mitigation Measures**: The problem of waste can easily be mitigated by including provisions for trash and waste management in the design of the project and linking up with existing local municipal waste management systems.

141. **Residual impact**: The residual impacts after mitigation are expected to be none or minimal.

Construction stage – moderate negative impact

142. **Impact:** Construction activities will generate large quantities of soil/debris and muck from excavation works for constructing the piles/piers and stabling yard. The proposed alignment will have elevated tracks and at grade stabling yard.

143. Approximately 20000 cum of muck is expected to be generated from excavation works for the piers in the elevated section and various buildings in the stabling yard.

144. In addition, about 5000 cum of construction and demolition (C&D) waste is likely to be generated from dismantling the existing structures and pavement. C&D wastes include concrete, stones and dirt generated during excavation from piles, residual cement bags, residual steel scrap, excess construction material stacked at site etc. It is a waste stream that is separate and distinct from residential and commercial waste.

145. Given the quantity of muck, excavated material and C&D waste that will be generated, their improper disposal can cause problems of land pollution and degradation.

146. Domestic waste, medical waste and other solid waste will be generated in the construction camps. Other facilities required for construction such as yard and other service facilities will also generate construction waste including hazardous wastes such as metal scraps, chemicals, fuels and lubricants. These wastes if not managed or disposed in the right manner can end up polluting the areas and water bodies near the project site.

147. These impacts are expected to occur within the project influence area (direct and indirect impact zone). They will be limited to the construction stage. The severity of the impacts is expected to be medium since the number and scale of receptors is limited. Hence, overall significance of impacts on land pollution and degradation is rated as moderate.

148. **Mitigation**: A number of mitigation measures have been proposed for managing the spoil, muck, construction waste and campsite wastes. Before construction works begin, the Contractor will be required to develop a Waste Management Plan (WMP) for approval by the General Consultants (GC). The WMP must include the following or more items:

(i) Identification of disposal sites including seeking permission from relevant authorities
(ii) Estimation of different types and total quantities of waste that will be generated
(iii) Estimation of waste types and quantities that could be reused for the project
(iv) Estimation waste quantities that will need temporary storage and identification of sites for temporary storage
(v) Identification of transport means and route for disposing the different types of waste to disposal sites and others.
(vi) Identifying the means to store or treat or transport hazardous wastes securely and avoid leakages into the open environment

(vii) Establishing linkages with waste recycling agents such as for metal scrap and used oils and lubricants etc.
(viii) Developing waste management plan and facilities for camp sites and linking up with local municipal waste management systems where appropriate
(ix) Maintenance of waste registers to record all waste management operations including production, storage, transport, treatment, disposal and others.

149. For managing the C & D waste, MoU is signed with IL&FS Environmental Infrastructure Service Limited, who have been managing three C&D plant in Delhi. The processed C&D plants will help to convert the waste into a usable form for construction and use as fill material. To the extent possible and subject to meeting quality requirements excavated muck and processed C&D waste will be used for land filling in the stabling yard and stabling yard alignment areas. The excess muck and C&D waste will be disposed off at locally approved sites. Identification of the disposal sites is under process in consultation with relevant local authorities.

150. Soil erosion by runoff will be controlled by installing proper drainage systems using contour information. Excavated muck will be promptly transported to filling or disposal site so as not to hurdle in the progress of work and also minimize the need. Stockpiling of the excavated muck will be avoided or minimized to reduce the need for storage space and room for dispersion of the material into the environment. The excavated muck shall be disposed regularly and proper records will be maintained on the quantities and locations of disposal.

151. For managing hazardous waste, the "Hazardous Waste (management, handling and trans-boundary movement) rules, 2007 and amendment 2008" shall be followed. Chemicals classified as hazardous chemicals under "Manufacture, Storage and Import of Hazardous Chemical Rules, 1989 of Environment (Protection) Act, 1986 shall be disposed off in a manner in compliance with the procedure given in the rules under the aforesaid act.

(i) The Contractor shall identify the nature and quantity of hazardous waste generated as a result of his activities and shall file a 'Request for Authorization' with respective State Pollution Control Committee along with a map showing the location of storage area.
(ii) Outside the storage area, the Contractor shall place a 'display board', which will display quantity and nature of hazardous waste, on date. Hazardous Waste needs to be stored in a secure place.
(iii) It shall be the responsibility of the Contractor to ensure that hazardous wastes are stored, based on the composition, in a manner suitable for handling, storage and transport. The labelling and packaging is required to be easily visible and be able to withstand physical conditions and climatic factors.
(iv) The Contractor shall approach only Authorized Recyclers of Hazardous Waste for disposal of Hazardous Waste, under intimation to the Employer.

152. In addition to the measures described in the paras above the contractor will be required to follow the requirements in the approved WMP. Specific protocols for the storage, transport, re-use, treatment and disposal of all types waste will be followed and no waste will be released into the surrounding environment.

153. **Residual impact**: Implementation of the mitigation measures will require careful planning, documentation and monitoring. It is expected that residual impacts will not be significant if all the mitigation measures are properly implemented.

<u>Operation stage – minor negative impact</u>

154. **Impact**: There can be long term implications on the generation of waste/trash and other forms of pollutants in the project area. The waste management systems under the

operational plan for the yard and linkage with existing local waste management systems authorities will play an important role in ensuring that waste generated do not end up in the areas near the project site. Activities in the yard which will entail cleaning and maintenance of trains will result in the generation of solid and liquid waste some of which will be hazardous (fuel, oils, lubricants, chemicals). The release of these liquid waste untreated into the surrounding environment will cause contamination of the surrounding land.

155. The problem of pollution and degradation of land will be limited to stabling yard associated with connecting line. Though it will be a long-term problem , the severity of the impact in terms of causing health problems to the general public and serious environmental issues is minor. Hence, overall the significance of land degradation and pollution during operation stage is considered minor.

156. Hazardous materials, including solvents, coolants, acids, and alkalis, may be used in locomotives and train cars maintenance activities. While unlikely, polychlorinated biphenyls (PCB) could be found in some electrical equipment (for example: transformers and capacitors), and asbestos could be present in some parts such as wheel bearing and seals.

157. **Mitigation Measures**: The design of the project ~~(~~will be required to have adequate waste management systems for both solid and liquid waste include sewage and hazardous wastes. Wastes from project will include dry and wet garbage and floor sweepings. Adequate sanitary facilities will be required for temporary storage of refuse within the yard. The storage containers for this purpose should not exceed 50 liters and must be equipped with side handles to facilitate easy handling. To avoid bad odor and accumulation of fly attracting materials, garbage containers should be washed at frequent intervals and have a proper lid**.**

158. Wastewater treatment plants will be installed at adequate locations in project areas (at stabling yard and Station) having oil and grease interceptors connected with the wastewater treatment plant which is capable of removing petroleum contaminants and can meet national standards. Oil traps in heavy machinery areas will be created to collect oil based materials. The stations will be equipped with proper garbage disposal facilities and toilet facilities including signage prohibiting the open dumping of trash.

159. Use of hazardous materials such as asbestos and PCBs will not be permitted.

160. **Residual impact**: Implementation of the mitigation measures described above will require adequate budget provisions under the RRTS operational budget to cover the costs for waste storage and transport and cleaning staff. Subject to the allocation of adequate budget for the waste management activities, the residual impacts are expected to be minor.

C. Impacts on Biological environment

1. Trees and vegetation

<u>Design and pre-construction stage – minor negative impact</u>

161. **Impact:** Most of the connecting line passes through open area of the city having thin vegetation cover with shrubs and few trees. The stabling yard is proposed on government land of industrial landuse, an abandoned prefab elements manufacturing plant owned by Government.

162. In terms of numbers of trees approximately 1272 trees will need to be removed for construction of the Phase-I of Stabling Yard and the connecting line. Other vegetation in the form of shrubs and grasses will also need to be removed along the elevated alignment section.

163. In relation to the scale of the project, the number of trees and amount of vegetation required to be removed is small. Hence, the overall significance of the impacts and trees and vegetation from the project design point of view is found to be minor.

164. **Mitigation**: Best efforts have been made to minimize removal of trees (together with reducing land acquisition needs) and vegetative cover by locating the alignment along the center of the highway.

165. **Residual impacts**: Since the project design includes a provision for compensatory afforestation of trees at a ratio of 1:10, the impacts of tree removal will be fully mitigated.

<u>Construction stage – minor negative impact</u>

166. **Impact:** 1272 trees will be removed for construction of the Phase-I of Stabling Yard and the connecting line. Other vegetation in the form of shrubs and grasses will also be removed along the elevated alignment section and stabling yard complex. The number of trees to be removed in relation to the scale and size of the project is not significant and only those trees within the direct project impact zone will be identified after joint version and will be cut. However, the removal of the trees is a permanent activity, (the removed trees cannot continue growing afterwards) the overall significance of the impact during construction stage is considered minor due to small scale of the project.

167. **Mitigation:** NCRTC has already submitted application for permission from the local municipal authority/forest department to cut trees at the project site. To compensate loss of trees as per provisions of Delhi state forestry department requirements, for each tree felled ten trees will be compensated. In total of approximately 12720 trees will be planted. For the connecting line elevated viaduct from Sarai Kale Khan to Jangpura land has been allotted by Land & Development Office (LDO) and compensatory afforestation will be carried out by Delhi Development Authority (DDA). For the land required for compensatory afforestation in lieu of the trees to be cut for stabling yard and connecting line, NCRTC had submitted its application to MoHUA/DDA and the land for plantation has also been received by DDA. Efforts will be made to minimize the cutting of trees through transplantation of young trees. Emphasis will be given for the plantation of native trees.

168. In addition to the compensatory plantation, green belt area can be developed for the total length of elevated corridor using native shrubs, herbs and grasses. A central ribbon area will be planted with small tree species, which grows up to height of 4-5m. The peripheral ribbons will be planted with grasses and perennial herbs interspersed with medicinal plants like *Tulasi, Vinca, Evolvulus, Hemidiscus* etc. Appropriate shade loving and light loving trees could be preferred depending on the location. Thus, the green belt will provide aesthetic view of elevated track and also helps to serve as dust and noise absorbent barrier.

169. **Residual impact**: The trees that will be planted to compensate for the trees removed will still be young (at sapling stage) during the construction stage, and the "like for like" replacement of the trees removed will not be in effect yet. Hence, there will initially be minor impacts due to tree removal. However, this impact will be fully mitigated after the replanted trees have established themselves during operation stage as discussed below.

<u>Operation stage - positive impact</u>

170. 12720 saplings that would be planted during construction stage will be maintained through proper watering and protection. A survival rate of at least 85% will be maintained. It is expected that the newly planted trees will start providing the ecosystem services similar to that of the trees removed by the 15^{th} year or so after plantation. Considering a minimum survival rate of 85% (10812 trees) the net increase in the number of trees because of the project is expected to be about 9540. Considering that the quantity and value of other forms

of vegetation (young trees (< 30cm GBH), shrubs and aquatic plants) that will be removed is minimal, it is expected that the compensatory plantation will fully mitigate the impacts of tree removal and there will be no residual impacts.

2. Terrestrial fauna

<u>Design and pre-construction stage – neutral</u>

171. There are no endangered or protected terrestrial faunal species in the project area and most of the project alignment is located along the road and urban areas. Hence the design stage impacts on terrestrial fauna is rated to be neutral with no positive or negative impacts.

<u>Construction stage – minor negative impact</u>

172. **Impact:** As stated above, there are no endangered or protected species in the project area. Considering that the project alignment is located mainly in habitation area and urban centers, the types of fauna present in the project area is limited to stray animals, about few species of birds and some insects.

173. Construction activities may result in killing of insects, rodents and other smaller animals during excavation works for the elevated section and stabling yard of the project alignment. Similar impacts may also be caused by clearing of trees and vegetation. Trees for removal could include trees that have nesting birds. This may result in destruction of nests and chicks. Due to these potential impacts, it cannot be stated that there will be no impacts. Hence, the overall significance of impacts on fauna during project construction is considered minor.

174. **Mitigation:** Before the felling of trees, the trees will be inspected for presence of nests. If any trees have nests, the nests will be transferred to another nearby tree. This activity of transferring the nests will be done under the guidance of the local forestry or wildlife authority. The contractor will be prohibited from intentionally killing or hunting animals or birds in the project area.

175. **Residual impact**: Given the overall low level of risk on impacts on terrestrial fauna it is expected that there will be no residual impacts.

<u>Operation stage – neutral</u>

176. No noticeable positive or negative impacts on terrestrial fauna is expected to occur during operation of the RRTS.

3. Aquatic fauna and Ecologically important areas

<u>Design and pre-construction stage – neutral</u>

177. **Impact:** The Stabling Yard RRTS alignment neither crosses nor located near any waterbody supporting aquatic species and having ecological importance. Therefore, no noticeable positive or negative impacts on aquatic fauna is expected to occur due to this RRTS line.

<u>Construction stage – neutral</u>

178. The Stabling Yard RRTS alignment does not cross nor located near any fresh waterbody supporting habitat of aquatic species or ecological sensitive receptor. Therefore, no noticeable positive or negative impacts on aquatic fauna is expected to occur during construction due to this RRTS line.

Operation stage – neutral

179. No noticeable positive or negative impacts on aquatic fauna is expected to occur during operation connecting line for Stabling Yard.

D. Impacts on Social Environment

1. Private land and buildings

Design and pre-construction stage – minor negative impact

180. **Impact.** The project will require acquisition of land (permanent and temporary) for the construction of the proposed Sarai Kale Khan - Jungpura Stabling Yard connecting line. Land required includes both government as well as private land.

181. As per the land acquisition proposal prepared by NCRTC, the total land required for various components of the project is estimated as 18.9621ha. All land acquired will be government land. Table 20 presents the details of tentative land acquisition.

Table 20: Land Acquisition Requirements under the Project

Sl. No.	Type of Ownership	Area (Ha)
1	Government Land with Occupancy Tenants	0.0432
2	Government Land under Connecting Line	1.7089
3	Government Land for Stabling Yard and Staff Quarter	17.21
	Total	18.9621

Source: Resettlement Plan for the connecting alignment for stabling yard

182. The severity of impact is high as there are high risks of people complaining about low compensation rates or delays in payment. In addition, payment of compensation for title holders has to be done through the district administration and the timelines for payment is often beyond the control of the project team. Given these factors the significance of impacts on acquisition of land and property is considered as major.

183. **Mitigation**: The land acquisition and resettlement & rehabilitation activities of the project will be governed by the general principles, which are based on The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013. The land acquisition and resettlement impacts have been assessed under in the resettlement plan (RP). Affected people 69 (11 households) will be compensated as per the provisions of the approved RP which will have an entitlement matrix.

184. **Residual impact**: Successful payment for acquisition of private structures requires several conditions. These include: adequate capacity and manpower of the local district administration to compile required data and disburse payments on time to affected people; provision of appropriate legal documents demonstrating ownership of property by affected people; no disputes or court cases regarding property ownership and others. Given this there may be some residual impacts wherein payment of compensation to some affected people may be severely delayed.

Construction stage – minor negative impact

185. **Impact:** The contractor will demolish structures and start construction on acquired land. In compliance with the ADB's SPS construction works can only take place on land that

has been fully compensated and structures maybe demolished only after full compensation has been paid to the structure owner. Hence, the risk of forceful acquisition or eviction of affected people for project construction is low.

186. However, there are risks of affected people being disgruntled due to various reasons such as: delays in receiving compensation; disputes or court cases regarding land ownership; being unsatisfied with the compensation amount; etc. Such disgruntled people may file complaints against the project causing delays in project construction.

187. Given the small number of affected people, the significance of impacts on acquisition of land and property during construction is also considered as minor.

188. **Mitigation**: To avoid having disgruntled affected people or raising of grievances and complaints against the project the following measures are being taken and will continue to be taken during project construction:

- (i) Conduction of regular public consultation to keep public informed on the entitlement matrix, compensation rates, schedule of compensation payment
- (ii) Distribute information leaflets on entitlement matrix and compensation rates
- (iii) Expedite the payments of compensation by timely provision of budget
- (iv) Regularly coordinate and follow up with local district authorities to expedite payments in accordance with the entitlement matrix
- (v) Provide human resource support to local district authorities if appropriate to expedite the release of payments to affected people

189. **Residual impact**: As described above successful payment for acquisition of private land and structures requires several conditions, some of which are beyond the control of NCRTC. Given this there may be some residual impacts wherein payment of compensation to some affected people may be severely delayed.

<u>Operation stage – major positive impact</u>

190. Opening of the RRTS, property values will rise around the alignment. The large daily influx of RRTS riders will have a large influence on its surrounding area, especially around the stations. This will lead to increase in property values depending on distance from each station. The same applies to commercial properties as well.

2. Public infrastructure and utility structures

<u>Design and pre-construction stage – minor negative impact</u>

191. **Impact:** The alignment will pass through properties, drains/nalas, and utility services such as sewer, water pipes, storm water drains, telephone cables, overhead electrical transmission lines, electric pipes, roads, traffic signals and others. These public structures and utility services are essential and will need to be maintained in working order during different stages of construction.

192. Timely shifting of utilities and dismantling of public structures will affect the construction schedule and project costs. Hence, proper planning and advanced actions (permissions and clearances) will need to be taken for shifting utility and private structures. Utility structures that need shifting include:

- (i) 2 nos. poles of 220 kv transmission line
- (ii) 4 nos. of 33 kv transmission line’’

193. Shifting of utilities is a challenging activity that requires several steps in seeking approval from the respective utility agencies. Poor planning and coordination and lack of information sharing to the local public could result in delays in the project schedule and increase project costs. Since the project alignment is not located in a densely populated area, there is a low risk of receiving complaints from the local public. Hence, the overall significance of impact is rated as minor.

194. **Mitigation:** Shifting of high tension power lines will be done by the respective utility agency. A proper HAZOP study & risk analysis will be conducted during preconstruction stage for transfer for high tension power with concurrence from the concerned agency. Similar studies will need to be conducted for water supply and se lines with the concurrence with concern agencies.

195. NCRTC will be responsible for shifting the low tension power lines and water pipe lines. NCRTC has prepared a utility shifting plan and allocated adequate budget for this activity. Close coordination will be carried out by the PIU and PMOs for timely and safe shifting to utilities in order to minimize community, health and safety risks from shifting to these utilities.

196. **Residual impact**: The residual impact is expected to minor as eventually the utilities will be shifted and all services and public structures will be restored.

Construction stage – minor negative impact

197. **Impact:** Given the amount of utilities that need shifting (2 electric lines) and the area that the project alignment passes through, it is likely that there will be very minor disruption in utility services and inconveniences to the local public.

198. Also, this risk is limited to the construction stage only, hence, the significance of the impacts on local people from utility shifting is rated as minor.

199. **Mitigation:** The agency for high tension power lines will ensure continued supply of power during project construction. The PIU and PMOs will be required to follow the utility shifting plan and conduct close coordination with the utility agencies and local authorities. Advanced actions will be taken and best efforts will be made to ensure that there is no disruption in any type of service.

200. Prior to the actual execution of work at site, detailed investigation of all utilities and location will be undertaken well in advance by making trench pit to avoid damage to any utility. While planning for diversion of underground utility services e.g. sewer lines, water pipe lines, cables etc., during construction of RRTS alignment, the following guidelines will be adopted:

(i) Utility services shall be kept operational during the entire construction period and after completion of project. All proposals should, therefore, ensure uninterrupted supply of utility services.
(ii) The elevated viaduct does not pose any serious difficulty in negotiating the underground utility services, especially those running across the alignment. In such situation, the spanning arrangement of the viaduct may be suitably adjusted to ensure that no foundation need be constructed at the location, where utility is crossing the proposed RRTS alignment. In case of utility services running along the alignment either below or at very close distance, the layout of piles in the foundations shall be suitably modified such that the utility service is either encased within the foundation piles or remains clear of them.

201. **Residual impact**: With the implementation of the mitigation measures described above the residual impact is expected to minor.

<u>Operation stage – Neutral</u>

202. All activities on shifting of utility structures and restoration of normal utility services and public services will be completed. There are residential building of Sidhartha Extension is connected with road from side i.e. front and back side. There will be no hindrance on entry and exit gate of the residential building from the project alignment. The traffic on the road will not be diverted due to operation of RRTS line. Hence, there will be no positive or negative impacts during operation of the RRTS.

3. Noise and disturbance

<u>Design and pre-construction stage – moderate negative impact</u>

203. **Impact:** The connecting line will run through urban areas of Delhi city. While this is necessary for maximizing benefits for the public and making the project economically viable it also poses high risks in terms of generating noise and disturbance for people living/working and commuting close to the project alignment.

204. As discussed in chapter IV, C section 3.3 about 7 locations of receptor have been identified to be located within 150 m on either side of the project alignment. This does not include any educational institute, hospital and place of worship. An assessment study on noise level increase due to project undertaken by CRRI (Central Road Research Institute) is given in Appendix –4. The additional mitigation measures include installation of noise barrier in Siddartha Extn residential area are proposed to reduce noise and vibration impacts based on this assessment study.

205. The proposed measures incorporation of noise reducing design features in the railway tracks and rolling stock. The complete system excluding depot shall be of ballast less track. Additional measures including provisions and budget for noise barriers within the project design stage has been ensured to avoid long-term significant noise related impacts to residents and sensitive receptors along the project alignment. If mitigation measures are not taken care of during project design stage the noise impacts can be long term and affect a large number of people and sensitive receptors. Based on this the risks related to noise during the pre-construction stage is considered as moderate. Above all NCRTC shall be liable to maintain noise and vibration levels attributed to RRTS system within the existing level/limits. Studies has proven that sound proof windows glass panel are very effective, if required at some location despite of all mitigation measures glass panels shall be used. Similarly vegetative barrier along railway line can also be considered in case of higher noise levels.

206. **Mitigation**: A number of measures are being taken in project design to minimize and mitigate noise impacts. These include:

(i) conduction of further noise assessment before the start of construction works for the main RRTS alignment
(ii) reviewing the current railway track design and identifying design features that will help to reduce noise and vibration during operation
(iii) reviewing the specifications for rolling stocks and ensure requirements include features that will help reduce noise and vibration
(iv) including provision for noise barriers at locations where the noise levels are expected to exceed baseline levels by more than 3dB(A). Noise barriers are expected to reduce noise levels by 20 – 22 dB(A).
(v) requirement for operation stage noise monitoring in the operation stage environmental monitoring plan

207. **Residual impacts**: Additional noise assessments will be carried out and proposed design features of the tracks and rolling stock specifications will be reviewed before starting the installation of tracks and procurement of rolling stock. One of the purposes of the review is to identify design modification options to help reduce noise levels. Given these efforts it expected that residual impacts will not be significant.

Construction stage – moderate negative impact

208. **Impacts:** Noise will be generated from various types of construction activities, movement of trucks transporting construction material and equipment and potential traffic congestion of vehicles plying on the road.

209. **Noise Due to Operation of Construction Equipment:** The major source of noise during construction phase are due to operation of various construction equipment. Typical noise levels from representative equipment are included in Table 21. The levels are based on the EPA Report[5] measured data from railroad construction equipment taken during the 1976 Northeast Corridor Improvement Project, the FHWA Roadway Construction Noise Model, and other measured data.

Table 21: Noise Levels Generated by the Operation of Various Construction Equipment

Equipment	Typical Noise Level 50 ft from Source, Dba
Air Compressor	80
Backhoe	80
Compactor	82
Concrete Mixer	85
Concrete Pump	82
Concreter Vibrator	76
Crane, Derrick	88
Crane, Mobile	83
Dozer	85
Generator	82
Grader	85
Impact Wrench	85
Jack Hammer	88
Loader	80
Paver	85
Pile-driver (Impact)	101
Pile-driver (Sonic)	95
Pneumatic Tool	85
Pump	77
Rail Saw	90
Rock Drill	95
Roller	85
Saw	76

[5] U.S. Environmental Protection Agency, "Noise from Construction Equipment and Operations, Building Equipment and Home Appliances," NTID300.1, 31 December 1971.

Equipment	Typical Noise Level 50 ft from Source, Dba
Shovel	82
Truck	84

Source: Federal Transport Association, Transit Noise and Vibration Impact Assessment Manual

210. **Noise due to increased vehicular movement:** During construction phase, there will be significant increase in vehicular movement for transportation of construction material. In addition to the noise mentioned above, there will also be background noise of the usual traffic resulting due to traffic congestion and confusion arising due to traffic diversion measures. Table 22 present the typical increase in ambient noise level due to increased vehicular movement.

Table 22: Increase in Noise Levels Due to Increased Vehicular Movement

Distance (m)	Ambient noise level dB (A)	Increase in noise level due to increased vehicular movement dB (A)
10	36	72
20	36	67
50	36	61
100	36	57
200	36	52
500	36	46
1000	36	42

211. As mentioned earlier, there will be significant attenuation due to various factors, e.g. absorption by construction material, air absorption, atmospheric inhomogeneities, and vegetative cover. Thus, no significant impact on this account is anticipated.

212. **Impacts of noise on labor:** The effect of high noise levels on the workers operating the heavy equipment has to be considered, as this may be particularly harmful. It is known that continuous exposures to high noise levels above 90 dB(A) affects the hearing acuity of the workers/operators and hence, should be avoided.

213. **Predicted Construction and Operational Stage Noise Levels:** Noise levels increase during construction stage of connecting line and RRTS operational stage are predicted following FTA general transit noise assessment procedure. The predicted results were compared with noise limits of WB-EHS or IFC guidelines and CPCB to assess impacts on 7 location of receptors identified within 150m of the connecting line alignment. The details of the inputs taken for modeling and results of noise level prediction study as per Federal Transit Administration (FTA), USA are provided in Appendix 3.

214. **Noise Assessment:** In addition to this study, NCRTC, has also assigned CRRI to conduct noise study. In particular for Siddhartha Extension these studies were carried out at two location firstly railway track and second at gate no. 3 of Siddhartha Extension. The complete details of both locations are given in their report. It is emphasized that existing parameter shall not exceed due to operation of RRTS. NCRTC is committed to monitor these parameters during construction and operation as well.

215. All necessary measures shall be taken to bring it at par/below of existing parameters if excess attributed to RRTS operation. The increase in noise during construction shall be mitigated appropriately to the possible extent. Further, holistic mitigation measures shall also be ensured by making following steps. (a) Maintaining the base line data, (b) System improvement like precast girder/ segments c) provision of 1500m radius of curve to lower the noise & vibration. d) Only three piers are coming in the alignment and construction of pile foundation in these locations will be expedite for minimum disturbance. e) Use of rotatory piling rig having low noise and vibration during construction. f) Activities of pile cap, pier and pier cap with minimum noise level and vibration level during construction.

216. CRRI vide their report has recommended to install 3 m height noise barrier in 125 m of viaduct length to reduce noise level during operational stage of connecting line. Above all NCRTC shall be liable to maintain noise and vibration levels within the limits. Studies has proven that soundproof windows glass panel are very effective, if required at some location despite of all mitigation measures glass panels shall be used. Similarly, vegetative barrier along railway line can also be considered in case of higher noise levels attributable to RRTS operations. Further; consultancy for "***carrying out shadow study due to construction of proposed viaduct in Sidhartha Extension"*** is assigned to consultant and report is enclosed in Appendix-13.

217. **Results of Noise Assessment**: Based on the above assessment, measurements and calculations, the combined noise levels were calculated based on existing noise levels and project noise levels at sensitive receptors. Noise impacts are analyzed for each of 7 identified location for receptors with in screening distance. It is observed that there is 1 sensitive receptor which will be moderately affected during operation stage of Stabling yard line. Noise modelling and analysis carried by CRRI also suggests the noise levels are expected to increase at Siddhartha Extension if mitigation measures are not adopted.

218. **Mitigation Measures**: There are many options that are used to reduce or mitigate operational noise from the trains. These include train speed, bogie design in built ballast less track design, signaling system, dumpers and shock observers and structure shape of viaduct etc.

219. Noise modelling study conducted by CRRI (Appendix 4) recommended 3m noise barrier for the length of 125m up & down direction at Siddhartha Extension as additional mitigation measures. Total noise absorption will be 20-22 dB(A) after installation of noise barrier. After installation of noise barrier, there will not be any noise or air born vibration problem to the resident of Siddhartha extension.

220. As discussed above, noise barriers are proposed at severally impacted locations. An indicative cost for the mitigation measures have been included in the EMP budget. Details of the noise barriers (type and locations) will be further analyzed and discussed at detailed design by general consultant and contractors and accordingly EMP will be updated.

Table 23: Details of Noise receptor's locations (During Operation Phase)

S.No.	Description	LHS/RHS	Chainage in km	Offset in feet	Existing Noise	Noise due to RRTS Operation	Combined Noise	Increase in Noise level during operation without mitigation measures Leq(h) or Ldn (dBA)	Expected reduction in noise by noise barrier (dBA)	Residual noise level after mitigation (noise barrier) (dBA)
1	ISBT Sarai Kale Khan	RHS	0+900	165	89.9	53.4	89.9	0.0	NA	NA
2	Barapulla Flyover & Nalla Crossing	Crossing	1+350	20	89.9	67.2	89.9	0.0	NA	NA
3	Siddhartha Extn.	LHS & RHS	1+480	23.1	69.5	66.3	70.7	1.7	20	50.7
4	Railway Crossing	Crossing	1+680	20	77.1	67.2	77.4	0.4	NA	NA
5	Highway Crossing	Crossing	1+810	20	77.1	67.2	77.4	0.4	NA	NA
6	Hindustan Prefab Limited	RHS	1+830	165	73	53.4	73.0	0.0	NA	NA
7	Hindustan Prefab Limited	RHS	2+000	20	73	67.2	73.7	1.0	NA	NA
	CPCB Limits	As per The Noise Pollution (Regulation & Control) Rules, 2010 of MoEFCC/CPCB : (Silence Zone)- Day Time: 50 Leq dB(A), Night Time: 40 Leq dB(A) (Residential Zone)- Day Time: 55 Leq dB(A), Night Time: 45 Leq dB(A) (Commercial Zone)- Day Time: 65 Leq dB(A), Night Time: 55 Leq dB(A) (Industrial Zone)- Day Time: 75 Leq dB(A), Night Time: 70 Leq dB(A)								
	IFC Limits	Noise Level Guidelines for Community Noise, World Health Organization (WHO), 1999 One hour L_{Aeq} (dBA) limits (Residential; Institutional; Educational Zone)- Day Time: 55 L_{Aeq} (dBA), Night Time: 45 L_{Aeq} (dBA) (Industrial; Commercial Zone)- Day Time: 70 L_{Aeq} (dBA), Night Time: 70 L_{Aeq} (dBA)								

221. **Residual impact:** With the design embedded measures such as ballast less track, bogie design, signaling system, dumpers and shock observers, structure shape of viaduct and installation of noise barriers as additional measure, long term noise impacts during operation due to RRTS system (though the generated levels are lesser than the existing levels) will be fully mitigated for all sensitive receptors including at (Siddhartha Extn.). The residual levels during operation will not cross the existing base line levels indicated in Table 23. However, the combined noise level during construction as given in Table-2 of Appendis-3 will increase from 17.5 to 25.5dB(A) around Sidharth Extension Apartment. All possible mitigation measures need to be taken to reduce the increase in noise level due to construction.

4. Vibration

Design and pre-construction stage – minor negative impact

222. **Vibrations:** The sources of the vibration during construction of a RRTS line is mainly due to operation of various construction equipment during construction phase and due to running of RRTS during operation phase. The RRTS project includes construction of elevated route only from Sarai Kale Khan to Stabling Yard at Jungpura and no underground tunnel work involved. The impacts of vibrations during operation are not anticipated for elevated section. The vibration impacts induced by increase noise levels in Siddharth Extn. due to train operations are not significant on application of Noise barriers as designed by CRRI. It has been concluded by CRRI that '*after installation of noise barrier, there will not be any noise or air born vibration problem to the resident of Siddhartha extension'*.

223. **Impact.** A section of project alignment will run through populated urban areas of Delhi. While this is necessary for maximizing benefits for the public and making the project economically viable, it also poses high risks in terms of causing vibration and disturbance for people living/working and commuting close to the project alignment and causing damage to structures near the project alignment.

224. As discussed in chapter IV, C section 3.3 about 7 locations of receptors have been found to be located within 150 m on either side of the project alignment. Incorporation of vibration reducing design features in the railway tracks and rolling stock within the project design stage is critical to ensure that there will be no long-term disturbance and damage to properties near the project alignment. If this is not taken care of during project design stage, the vibration impacts can be long term and require extra costs for fixing or compensating for damaged structures. However, the sensitive receptors along the Stabling yard line donot include any residential area, educational institutes, hospitals and places of worship. Hence, the risks related to vibration during the pre-construction stage is considered as minor.

225. A preliminary vibration analysis has been carried out to understand the impacts of the rapid rail operations on vibrations. Vibration modeling carried out as per Federal Transit Administration (FTA), USA for the project is presented in Appendix 5.

226. **Mitigation**: NCRTC understands that the risk of damages to structures and homes along the project alignment is a very serious one can have serious repercussions for the project. Hence, a number of measures to minimize and mitigate vibration impacts. These include:

(i) conduction of further vibration assessment before the start of construction works for the main RRTS alignment
(ii) reviewing the current railway track design and identifying design features that will help to reduce noise and vibration during operation
(iii) reviewing the specifications for rolling stocks and ensure requirements include features that will help reduce noise and vibration

(iv) requirement for operation stage vibration monitoring in the operation stage environmental monitoring plan

227. **Residual impacts**: Additional vibration assessments will be carried out and proposed design features of the tracks and rolling stock specifications will be reviewed before starting the installation of tracks and procurement of rolling stock. One of the purposes of the review is to identify design modification options to help reduce vibration levels. Given these efforts it expected that residual impacts will not be significant.

Construction stage – moderate negative impact

228. **Impact:** The project alignment (Stabling Yard line) is not located in densely populated urban areas, except a small segment crossing Siddhartha Extn. Hence, the risk of disturbances during construction work and potential damage to properties nearby is low. There could also be injuries and death of construction workers or local people living/commuting near the construction sites due to vibration related damages and instabilities caused by the project activities. Due to these reasons there is a risk of complaints being filed by the local people and attracting negative media attention. There are no old structures/ buildings along this Stabling Yard line. Even though the risks are limited to the construction stage the severity of the risks are moderate, hence the overall significance of vibration related impacts during construction stage is rated as moderate.

229. **Predicted Vibration Levels during RRTS Construction:** In order to evaluate the construction stage vibration levels from the project construction activities, vibration modeling has been done in accordance with the FTA guideline. The details of the modeling and results of Vibration Level Predication as per Federal Transit Administration (FTA) from the project are provided in Appendix 5.

230. Modeling carried out for sensitive receptor locations show that all the predicted levels are well below the threshold levels for different land uses set by FTA except at 5 receptor locations where the vibration levels are expected to be higher than the threshold value during construction stage. The receptors are located in elevated sections. Details of all receptors are given in Table 24.

Table 24: Vibration Impacted Receptors During Construction

S.No.	Description	Chainage	X (Latitude)	Y (Longitude)	Section Type	Pile driver (impact)	Construction Vibration Damage Criteria, PPV (in/s)	Exceedance from FTA Criteria
1	ISBT	0+900	28°35'6.83"N	77°15'31.18"E	Elevated	0.037981	0.5	-
2	Barapulla Flyover & Nalla Crossing	1+350	28°34'56.10"N	77°15'25.82"E	Elevated	0.900017	0.5	Exceedance due to Pile Driver (impact)
3	Siddhartha Extn.	1+480	28°34'53.88"N	77°15'22.43"E	Elevated	0.725067	0.5	Exceedance due to Pile Driver (impact)

S.No.	Description	Chainage	X (Latitude)	Y (Longitude)	Section Type	Pile driver (impact)	Construction Vibration Damage Criteria, PPV (in/s)	Exceedance from FTA Criteria
4	Railway Crossing	1+680	28°34'50.75"N	77°15'16.64"E	Elevated	0.900017	0.5	Exceedance due to Pile Driver (impact)
5	Highway Crossing	1+810	28°34'46.35"N	77°15'10.93"E	Elevated	0.900017	0.5	Exceedance due to Pile Driver (impact and vibratory)
6	Hindustan Prefab Limited	1+830	28°34'43.70"N	77°15'7.43"E	Elevated	0.037981	0.5	-
7	Hindustan Prefab Limited	2+000	28°34'31.66"N	77°15'8.41"E	Elevated	0.900017	0.5	Exceedance due to Pile Driver (impact and vibratory)

231. **Mitigation**: A number of measures will be taken in the project to manage vibration impacts during construction. These include:

(i) Pre-construction detailed building condition and stability surveys for identifying structures that are weak and at risk of getting damaged because of project construction works. Development of support and rehabilitation measures for identified weak structures.

(ii) Preparation of a vibration monitoring plan by the contractor prior to starting construction works. The monitoring plan will pay special attention to the 5 receptors identified to be at high risk. The monitoring plan will include: i) setting of threshold limits (recommended limit is 2.5mm/s) that should not be exceeded and procedures to be followed in case they are exceeded; ii) requirements for monitoring vibration levels at regular intervals throughout the construction period; iii) identification of locations where vibration monitoring should be carried out; iv) information dissemination on vibration monitoring plan with construction workers.

(iii) At the receptor locations listed in Table 24 no impact piling will be carried out for construction works. Only bored piling which generates a maximum vibration level of 2.2mm/second will be carried out at these locations and all other locations.

232. The PCRs will be protected and preserved to the extent possible by engineering measures and where it is necessary these will be shifted and relocated in coordination with local authorities and local communities.

233. Following the data in Table 24 the expected vibration levels construction is lower than internationally accepted 5mm/s. However, to be on the safe side and as practice in ongoing metro projects in NCR, the contractor will be required to ensure that vibration levels at the 5 locations of receptor do not exceed 2.5 mm/s.

234. **Residual impacts**: With the above recommended mitigation and monitoring measures it is expected that there will be no vibration related residual impacts during project construction.

Operation stage – moderate negative impact

235. **Impact:** The project alignment (Stabling yard line) do not run through densely populated urban areas of Delhi city. However, there are significant risks related to long term vibration and disturbance for people living/working and commuting near the project alignment and causing damages to structures near the project alignment. Hence, it is extremely important to fully mitigate the risks at the project design stage. CRRI vide their report has recommended to install 3 m height noise barrier in 125 m of viaduct length. It has been concluded by CRRI that '*after installation of noise barrier, there will not be any noise or air born vibration problem to the resident of Siddhartha extension*'.

236. In order to evaluate the operations stage vibration impacts from the stabling yard line, vibration modeling has been done as per the FTA guideline. The details of the modeling and results are provided in Appendix 5.

237. **Categorization as per FTA:** According to FTA Ground-Borne Vibration Impact Criteria, all residential buildings are categorized in "Vibration Category 2: Residential".

238. The proposed Stabling Yard RRTS alignment will have a design speed of 95 kmph and operating speed of 85kmph with a frequency of 7 trains during peak hour for the year 2025. As per the Vibration screening procedure, residential land use, within 70 meter (229 ft) from the rail centerline is identified as potentially affected location. The details of vibration sensitive receptors within the applicable screening distance is given in Table 25. As can be seen there are no educational institutes, hospitals, religious places, concert halls, television and recording studios, theatres and old cultural and heritage sites exist along the project alignment.

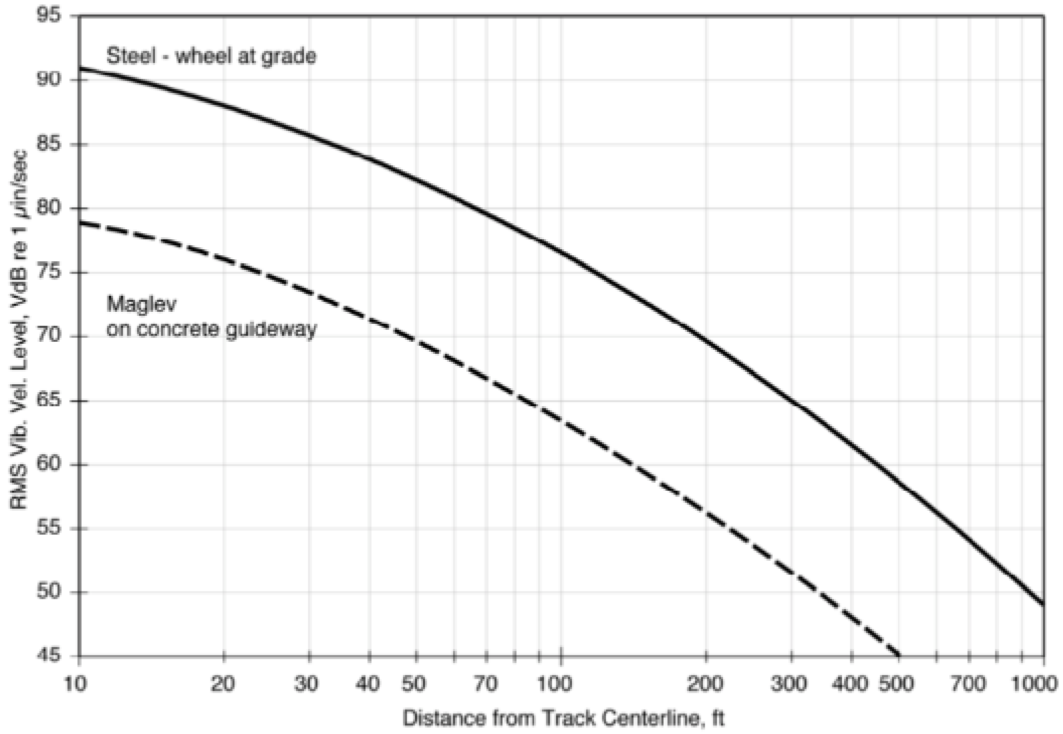
Table 25: Vibration Sensitive Receptors along the alignment

S.No.	Sensitive Receptor Type	Number	Category as per FTA	Screening Distance in meter
1	Siddhartha Extn.	24	Category 2: Residential	70

239. **Base Curve:** The generalized projection curves for high-speed trains are shown in figure 13. The curves represent typical ground surface vibration levels assuming equipment in good condition and speeds of 150 mph. The levels must be adjusted to account for factors such as different speeds, equipment, and geologic conditions.

a. Speed adjustment: -3.5 VdB for speed of 160 kmph
b. Wheel condition: Assume wheels in good condition. No adjustment is applied.
c. Track system: Assume rails are in good condition. No adjustment.
d. Track structure: -10 VdB for viaduct
e. Propagation: 0, Normal propagation is considered, as the underlying soil is fine sand/ fine silt upto a depth of 40 meter from the ground surface throughout the alignment.
f. Foundation coupling: 1-2 Story Masonry: -7 VdB, 2-4 Story Masonry: -10 VdB.
g. Receiver location: 1-5 floors above grade: -2 dB/floor, 5-10 floor above grade: -1 dB/floor
h. Floor response: No adjustment.

Figure 13: Generalized Ground-Borne Vibration Curve



240. **Predicted Vibration levels during operation of proposed Stabling Yard Alignment:** The procedure adopted for prediction of vibration levels is as per the FTA guideline. The vibration levels were obtained from the base curve shown in Figure 13 and necessary corrections were undertaken wherever applicable. All the predicted levels were well below the threshold levels for different land uses set by FTA except at nine locations. The location of impacted receptors is presented in table 25 and modeling results are presented in Appendix 5.

241. **Mitigation Measures**: Based on Figure 13 it can be seen that vibration is generally caused from rail-wheel interaction and this can be reduced by minimizing any surface irregularities on the wheel and rail. In addition, it is proposed that the rail tracks will have a floating slab track bed, elastomeric pad and rail pad. These features will help to reduce the vibration levels by over 15 VdB. The rolling stock will have stainless steel bodies equipped with air springs and vertical hydraulic damper to maintain level at all possible loadings, smoother ride, and minimize vibration and noise.

242. NCRTC has conduct detailed studies on the noise and vibration impacts through CRRI focusing on: i) assessing the condition of buildings along the project alignment and identify structures that are vulnerable; ii) making recommendations for the design of tracks and viaduct works to avoid damages to structures along the project alignment during construction and operation of the RRTS, if required. The vibration impacts induced by increase noise levels in Siddharth Extn. due to train operations are not significant with application of embedded measures in design of RRTS system, track & boggies and installation of noise barriers as designed by CRRI.

243. **Residual impact**. Based on the information above and table 26 all vibration related impacts during operation stage are going to be fully mitigated with application of design embedded measures and additional mitigation measures of noise barrier at the location of Sensitive Receptor. The design measures mentioned in rail and track specifications will be further reviewed and reconfirmed during the operation stage.

Table 26: Vibration Impacted Receptors due to Operation of RRTS

S.No.	Description	LHS/RHS/ Crossing	Chainage in km	Section Type	Distance (ft)	Estimated Vibration Level, VdB	Ground Borne Vibration Threshold levels as per FTA, VdB	Vibration Level Exceedance, VdB	Reduction with mitigation measures	Residual vibration level after mitigation VdB
1	Barapulla Flyover & Nalla Crossing	Crossing	1+350	Elevated	20	73.5	72	1.5	-15	58.5
2	Siddhartha Extn.	LHS & RHS	1+480	Elevated	23.1	74.5	72	2.5	-15	59.5
3	Railway Crossing	Crossing	1+680	Elevated	20	73.5	72	1.5	-15	58.5
4	Highway Crossing	Crossing	1+810	Elevated	20	73.5	72	1.5	-15	58.5
5	Hindustan Prefab Limited	RHS	2+000	Elevated	20	73.5	72	1.5	-15	58.5

5. Occupational health and safety

Design and pre-construction stage – moderate negative impact

244. **Impact:** The project (Stabling Yard connecting line) is an infrastructure development project that will require the use of several types of equipment and machinery, large number of workers and will ultimately cater to movement of a large number of public. Construction stage occupational health and safety (OHS) risks will be restricted to the construction stage and is discussed in the next section. The main risks which need to be addressed during the design stage is the provision of health and safety design features and facilities in the stations, trains and depot to create a safe and healthy working environment for the operational staff during operation stage of the project.

245. Inclusion of health and safety design features in project design is a permanent activity. It may have room for revision and improvement during operations, however, it will be limited. In terms of spatial scale health and safety requirements is limited to the stabling and project RRTS alignment line. Though injuries and accidents of operational staff can have grave consequences, the chances of them occurring are low provided India has good experience in managing similar rapid transit projects. Hence, the overall significance of the OHS risks during design stage is considered moderate.

246. **Mitigation**: The project design will include state of art design features including on safety based on experiences from several metros under operation in India and other rapid transit projects around the world.

247. **Residual impact**: It is expected that there will be no residual impacts.

Construction stage – moderate negative impact

248. **Impact:** The project will involve construction activities including handling and transport of large quantities of material and operation of heavy machinery and equipment.

249. **Construction material:** RRTS construction is a material intensive activity. Large quantity of different construction materials will be required for construction of elevated connecting line. These shall be sourced from the nearest source. Quarry operations are independently regulated activities and outside the purview of the project proponent. It is, nonetheless, appropriate to give consideration to the environmental implications in selection of quarry sources since poorly run operations create dust problems, contribute noise pollution, ignore safety of their employees, or cause the loss of natural resources. So, the construction material shall be sourced only from legalized and approved quarries. Estimated quantities of construction materials are as follows:

- (i) Aggregate- 0.2 million cum
- (ii) Sand – 0.1 million cum
- (iii) Cement – 0.5 million tons
- (iv) Reinforcement steel – 0.05 million MT
- (v) Structural steel – 1000 MT

250. **Casting Yard and Batching Plant Impacts:** The project envisages use of many pre-cast components. For the manufacture of these components pre-casting yards will be established. During construction phase there would be establishment and operation of batching plant and casting yard which would be located in an area designated and allotted by respective district authorities away from habitation. The tentative locations of casting yards for various areas is presented in Table 27.

Table 27: Location of Casting Yard

Section	Location	Approx. Area (Ha)
Sarai Kale Khan to Stabling Yard at Jungpura	In Govt land at Gazipur	7.0

251. Outbreaks of malaria, typhoid, cholera etc. amongst the labour force; and given the current COVID-19 pandemic there is also a risk of construction workers being exposed to this and other communicable viral diseases, particularly given construction is directly within the urban area.

252. Health and safety risks for construction workers and community in the project area of the connecting line during construction and operational stage will be managed as per Health and Safety Management Plan (HSMP) and CEMP to be prepared following SHE manual and EMP. The health and safety risk of the project are detailed out in EIA report of Delhi-Meerut RRTS line. Additional health and safety protocols for prevention and control of the spread of COVID 19 and other communicable diseases shall be put in place in accordance with local/national guidelines and international best practices. For COVID-19 related health and safety risk, the contractor will be required to prepare and implement a COVID-19 Action Plan[6].

253. **Public Communications:** The project PIU have developed and implementing a public communication plan to inform the affected local government agencies and local communities and the general public about the project and project activities, duration of construction, health and safety mitigation measures under the project, and the Grievance Redress Mechanism (GRM) for handling complaints. The institutional arrangement and procedure on working of GRM are given in EIA report of Delhi-Meerut RRTS line.

<u>Operation stage – minor negative impact</u>

254. **Impact:** Poor health and safety features in project design could result in serious accidents such as collision, derailment, fire, power outages, or operation stoppage, individual (staff/passenger) struck in automatic doors etc. Considering that operations of the train and stabling yard is a long-term activity and the number of people using the Stabling Yard alignment is limited staff for RRTS operation and maintenance of NCRTC. Based on this the significance of health and safety risks for the common public during operation is rated as minor.

255. Other impacts on local communities could be caused be additional stress on resources required such as water, electricity and waste management for operating the stabling yard line.

256. Public facilities such as water supply, sanitation and washrooms are needed at the stabling yard. Water requirement for stabling yard would be for drinking, toilets, cleaning and also for other purpose like AC. The total water requirement will be 87 KLD for the connecting line and stabling yard out of which 25.5 KLD of wastewater will be generated.

257. The stabling yard at Jungpura will have following facilities: Washing Lines; Operation and Maintenance Lines, Workshop, and Offices. These facilities could generate wastewater

---

[6] For COVID-19 national restrictions for containing the spread of COVID-19 must be complied with and in developing the health and safety management plan Government of India (https://www.mygov.in/covid-19) and World Health Organization guidance (https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance) should be followed ensuring adequate sanitation and welfare facilities including for hand washing and personal protective equipment are provided to construction workers. Given the specialist nature of responding to COVID-19 public health officials/experts to be consulted.

and noise related issues. Problems anticipated at depot sites are: water supply, sewerage and drainage, oil pollution, sanitation, effluent pollution and noise pollution.

258. **Mitigation Measures**: Operation stage health and safety risks for common public will be managed by implementing all the plans mentioned below.

259. To avoid train collisions and ensure safe train separation, continuous speed monitoring and provisions for automatic brake application will be included in the loco design in case the train driver disregards warning signals. Speed limits will be enforced on sections having permanent and temporary speed restrictions. Automatic Train Protection and Automatic Train Supervision sub-systems will be installed in the trains.

260. In the unlikely event of simultaneous tripping of all the input power sources or grid failure, the power supply to stabling yard as well as to trains will be interrupted. A standby silent type DG set of adequate capacity at underground stations will sustain the following: essential lighting, signaling, and telecommunications, firefighting system, lift operation, and tunnel ventilation.

261. Water requirements for the stabling yard will be met through the public water supply system or purpose built tube wells after taking necessary approvals from CGWA. In case of use of ground water adequate treatment will be given before supplying for public use. Water supply arrangements will have to be made separately with proper drainage system for wastewater. Efforts will be made to conserve the water by recycling water in the system. Also, as an environmental conservation measure, rainwater-harvesting structure will also be constructed at stabling yard and along the viaduct.

262. Package type sewage treatment plant of adequate capacity will be installed in stabling yard for ensuring treatment of sewage. All wastewater generated from stations and depots will be collected and treated prior to disposal into municipal drains. Spilled oil if any will be trapped in oil and grease trap. For treating the effluents generated in the depot a waste water treatment system will include oil & grease traps. The trapped oil and grease will then be sold/given to authorized collectors, so as to avoid any soil, underground/ surface water contamination.

263. **Residual impacts**: With the implementation of all the mitigation measures described above, it is expected that community health and safety impacts including on local resources will be minimal during operation of the trains and stabling yard.

6. Physical and Cultural Resources

Pre-construction and Construction stage – minor negative impact

264. **Impact:** An assessment of the historical and archeological monuments along the proposed alignment of stabling yard line has been carried out and it is found that the proposed alignment or none of its portion is falling in the prohibited /regulated areas of monuments protected by Archeological Survey of India or Archeological Department of the State of Delhi.

265. Although there are no identified historical and archeological monuments along the alignment, considering the fact that Delhi is historical city, there is a small possibility that some artifacts may be buried along the alignment. Hence, during piling works for the elevated section the contractor may encounter artifacts.

266. **Mitigation:** A chance find procedure is included in the EMP to minimize impacts on historical / archeological artifacts, in case any are found during excavation work. NCRTC will inform and coordinate with Archaeological Survey of India (ASI) and state Archeological Departments if any ancient remains encountered during construction work.

267. **Chance heritage finds:** Although not reported there are possibilities that some artifacts may be found during piling and excavation work.

268. At least 30 days before the start of piling work, the contractor will coordinate with State Archeological department to reconfirm that there are no presence of any buried artifacts along the RRTS line alignment. No piling or excavation will be allowed unless cleared by the archeological Department.

269. **Residual impacts**: With the implementation of the mitigation measures described above, it is expected that impacts on the physical and cultural resources will be minimal.

E. Induced and Cumulative Impacts

1.1 Adverse induced and cumulative impacts

1.1.1 Noise & Vibration levels

270. The project is located in an urban area with the noise level above the permissible level due to vehicles movement and industrial activities. The construction of the proposed RRTS, specifically during site preparation, land clearing, excavation and earthworks may potentially cause an increase in noise and air pollution in the project area.

271. During project operations, due to existing high background noise levels along portions of the alignment caused by the existing volume of road traffic on highway and railway trains in the area and vicinities, receptors may experience a low to moderate noise impact close to connecting line alignment. This will be mitigated by an operating schedule, application of design embedded measures and erection of site specific noise attenuation panels at the identified locations such that the incremental noise levels from the project is considered not significant. Moreover, impacts will be addressed by the regular noise monitoring and inspection, proper maintenance and reconditioning of trains and tracks such as rail grinding, slip-slide detectors and maintenance or replacement of suspension system, brakes and wheels. Vibration levels associated with project operations (i.e., train passing by) will be largely imperceptible. Above all NCRTC shall be liable to maintain noise and vibration levels within the limits . Studies has proven that soundproof windows glass panel are very effective, if required at some location despite of all mitigation measures glass panels shall be used. Similarly, vegetative barrier along railway line can also be considered in case of higher noise levels. The vibration impacts induced by increase noise levels in Siddharth Extn. due to train operations are not significant on application of Noise barriers as designed by CRRI.

1.1.2 Water Quality

272. Water quality is not expected to be impacted by either construction or operation of the RRTS. Waste water treatment facilities will be installed at RRTS stabling yard. The environmental management plans of the project specify measures to prevent water quality impacts during construction. Cumulative impacts of project activities on water quality are expected to be null providing management measures to minimize construction impacts during construction and ensure effective waste water treatment is upheld. Similarly, cumulative impacts due to construction and operation of the RRTS on water quality are expected to be null.

1.1.3 Flooding and drainage

273. The stabling yard connecting line alignment is elevated and no section except in stabling yard are at grade. At grade station is proposed within stabling yard will be connected

with drainage system of appropriate design capacity. Hence RRTS operations are not expected to contribute in any way in flooding of the project area.

1.2 Positive induced and cumulative impact analysis

1.2.1 Change in Property Value at/near RRTS corridor:

274. Opening of the RRTS line, property values will rise around the alignment. The large daily influx of RRTS riders will have a large influence on its surrounding area, especially around the stations. This will lead to increase in property values depending on distance from each station. The same applies to commercial properties as well.

1.2.2 Economic Activity

275. The Project will provide fast and convenient rapid transit service and an added transportation alternative that will enhance connectivity to the wider transit network for residents and businesses facilitating economic growth of municipalities along the railway corridor. The closer a property is to a department center, the higher the property value. A Transit Oriented Development approach will lead to increased economic activity and value around RRTS stations.

1.2.3 Air Quality

276. The Project will reduce the use of personal vehicles, increase the transit mode share and will contribute to community re-development through the stimulation of future concentrated and mixed land use, as well as a positive business environment. It will contribute to environmental sustainability initiatives by reducing regional car trips, enhance community livability and reducing greenhouse gas (GHG) emissions. Project operation is expected to have a positive effect on air quality since the Project will use an RRTS train which is exhaust-free and quieter compared to diesel and locomotive-drawn multiple units and replace vehicular traffic from the adjacent road which use combustion engines. As such, the Project's contribution to the cumulative impacts on air quality particularly during the operation would be positive.

F. Expected Benefits from the Project

277. RRTS rail systems have an advantage over other modes of transport because they provide higher carrying capacity, faster, smoother, and safer travel, occupy less space, and are non-polluting and energy-efficient. The project will generate employment opportunity for skilled and semi-skilled during construction and operational stage.

VI. ANALYSIS OF ALTERNATIVES

A. Introduction

278. This chapter discusses the analysis of alternatives that have been considered for the this RRTS alignment. It also includes a discussion on "With" and "Without" project scenario. The methodology that has been adopted for the evaluation of the alternate alignment route for construction of the RRTS is based on engineering, economic, environmental and social considerations. The minimization of environmental impacts by considering design alternatives determines the extent of mainstreaming of the environmental component. An evaluation of the various alternative options has been done for arriving at the most route for the connecting line

from environmental, social and techno-economic considerations. This chapter looks at the decisions made during the project when alternatives were available and describes the rationale behind the decision.

B. “With” and “Without” Project Scenario

279. The ‘With’ and ‘Without’ project scenarios are analyzed with this backdrop of requirement of reliable quality infrastructure for sustained growth of NCR economy and consequent well-being of its inhabitants.

280. The project will have multiple benefits. It will reduce the travel time substantially between Meerut city and its sub urban areas. In addition, the project will provide other benefits like:

(i) Fast and safe connectivity, resulting in saving of fuel, travel time and total transportation cost to society;
(ii) Employment opportunity to people;
(iii) Development of local industry, agriculture and handicrafts;
(iv) Development of tourism and pilgrimage;
(v) Transporting, processing and marketing of agricultural products;
(vi) Reduction in accidents;
(vii) Reduction in pollution;
(viii) Opening up of opportunities for new occupations;
(ix) Better approach to Medical & Educational services
(x) Improved quality of life for people and soon.

281. Based on the above, it is envisaged that “With” project scenario, with its minor adverse impacts is more acceptable than the “Without” project scenario which would mean an aggravation of the existing problems. The potential benefits of the proposed RRTS are substantial and far-reaching both in terms of the geographical spread and time.

C. Alternatives of RRTS Alignment and Facilities

282. Alternate alignment options study for connecting line was carried out. Due to highly developed highways and railway line network along with continuous habitation around Jungpura area, the connecting line will mandatorily pass through settlement only on the lines of all mass transport systems all over world including metro lines to serve the purpose. Sarai Kale Khan is common point for operation of all the three envisaged RRTS corridors namely Delhi-Meerut, Delhi-SNB and Delhi-Panipat and all the corridors are originating on elevated station only, therefore connecting Sarai Kale Khan to Jangpura stabling yard through viaduct is only technical option. The connecting line alignment starts at chainage of km 0+950 and ends at km 23+000. The alignment crosses Delhi Metro at chainage of km 1+150, Barapulla flyover and nalla at chainage of km 1+400, Siddhartha Extn. at chainage of km 1+500 and Railway line at chainage of km 1+700. A length of 110 m of viaduct will pass through Sidhartha extension colony. Options study through/along Sidhartha Extension has also been carried out by NCRTC enclosed at Appendix-10.

283. The alignment of viaduct is also found most suitable from Engineering, Social and Environmental considerations. Based on the alignment survey data, it is concluded that the alignment through Siddharth Extension is shortest and will be met with the existing design of Delhi-Ghaziabad-Meerut RRTS corridor and will have to be created for faster and fairly comfortable movement of commuters. During the finalization of the alignment of the

connecting line, various alternate alignment options were explored so as to minimize the adverse impact on land acquisition and resettlement. The alignment /design finally adopted was found technically most suitable and impacting less to private properties. The private land was avoided as much as possible and the stabling yard is also accommodated in available government land. However, technical and engineering constraints were one of the major concerns during exploration of various alternatives. The selection of location of stabling yard was governed by the availability of Government owned land, which is premises of an abandoned factory and hence which does not have any resettlement impacts. The various options studied are described in the Appendix-10.

284. Option-III was preferred over other options to minimize resettlement impact on 16 residential flats of Siddhartha Extension. The alignment of the connecting line was finalized after considering merits and demerits of various alignment options. Due to the short distance between Sarai Kale Khan station and stabling yard, the alignment options are very limited and the final alignment passing through Sidharatha extension is the best possible technical option and thus acquisition of 8 residential flats is inevitable. The comparison of plans showing option-3 (new alignment) and option-1 (old alignment) at Siddharth Extension and the design of the preferred alignment is given in figure- 1, 2 and 3 in Appendix-10.

285. Land being one of the most precious commodities in India, elevated alignment is recommended for RRTS to keep the land requirement to bare minimum. This will also ensure that the execution of the project is not delayed due to litigations from private land owners. Timely and well planned execution will eventually prove economical as any delay in the construction results in cost escalation.

286. **Alignment of connecting Line:** The alignment for the proposed Sarai Kale Khan - Jungpura Stabling Yard RRTS line has been finalized after taking into account technical, environmental and social concerns, considerations of highway and railway traffic crossing, integration with the planned RRTS system and importantly, the overall economic and financial viability. The underlying principles for evaluation for each corridor, without affecting the overall usefulness of the corridor, are:

(i) Minimum or No private land acquisition,
(ii) Least disturbance to properties,
(iii) Minimum disturbance to people and
(iv) Minimum disturbance to ecology/ biodiversity.

287. In the analysis of alternatives, a comparison of scenarios with and without the project has also been made. Advantages and disadvantages have been spelt out and the analysis is quite exhaustive. These being the over-riding criteria, financial implications of these alternatives were not worked out.

288. **Location of Stabling Yard:** Several alternatives have been considered for stabling yard location. Based on techno-economic, social and land acquisition, and accessibility aspects one stabling yard at Jungpura is being finalized. The stabling yard planning is based on following assumptions:

(i) Enough space should be available for establishment of a stabling yard.
(ii) All inspection lines, workshop lines, stabling lines are designed to accommodate one train set of 12- Car each and space earmarked for future provision.
(iii) All Stabling lines are designed to accommodate one trains of 12- Car each.
(iv) All stabling lines are planned in the proposed depot-cum-workshop assuming adequate space availability. In case of space constraints, if any, stabling

facilities may need to be created at terminal stations or elsewhere to cater to the required stability facilities.

D. Conclusion

289. Based on the analysis of alternatives as discussed above, it is found that alignment for connecting line from Sarai Kale Khan RRTS station to proposed Stabling Yard at Jungpura is the only alignment based on technical, economical, social and environmental aspects during construction and operational stage of the project. The minor adverse impacts would be manageable to an acceptable level by implementing mitigation measures identified in the EMP. The EIA with EMP has been considered an acceptable and justified option.

VII. CONSULTATIONS, PARTICIPATION AND INFORMATION DISCLOSURE

A. Consultations

290. As required for “Category A” projects, consultations were conducted at the early stage of EIA preparation, mostly involving local communities and organizations. These stakeholders along with local leaders have been consulted at every stage of the project and feedback has been incorporated in the project design.

291. **Identification of Stakeholders:** Key stakeholders at central, state, district and local level have been consulted as part of the consultation process. Key stakeholders identified for the project are:

(i) Ministry of Environment, Forest and Climate Change, Delhi
(ii) Delhi Pollution Control Committee
(iii) Central Ground Water Authority
(iv) International NGO: World Wildlife Fund
(v) Local NGOs in Delhi
(vi) Delhi Development Authority
(vii) Municipal Corporation of Delhi

Table 28: Summary of Stakeholder Consultation

Sl. No.	Name and Designation	Issue discussed
1	Mr. U. W. Hood, Advisor/Project, NCRTC	Environmental studies and impact assessment under Sarai Kale Khan to Stabling Yard section, project proposal, alignment, detailed, design report, LA and R&R issues in the project,
2	Mr. Subodh Kumar, CPM, Delhi, NCRTC	Day to day coordination and progress, requirement of information and data and design of Delhi section
3	Mr. Raees Ahmad Khan, Dy. Chief Engineer, Delhi, NCRTC	Day to day coordination and progress, requirement of information and data and design of Delhi section
4	Mr. Manoj Kumar, Executive Engineer, Delhi, NCRTC	Day to day coordination and progress, requirement of information and data
5	Mr. Devansh Gautam, Engineering Associate, Delhi, NCRTC	Day to day coordination and progress, requirement of information and data

Sl. No.	Name and Designation	Issue discussed
6	Mr. Vikram Singh, Junior Engineer, Delhi, NCRTC	Day to day coordination and progress, requirement of information and data

1.2 Public Consultation

292. Consultations were held with key stakeholders, local communities and affected people during social and environment impact assessment study as well as will be continued during the process of land acquisition. During study preparation the consultation is limited to informal discussion and perception surveys including focused group discussions. Issues associated with environment, health and safety were also discussed during the consultation meetings as part of study. Besides this there are several informal consultation session and focused group discussions were organized as part of the project. Details of above public consultation meetings, list of participants, photographs and records are enclosed as Appendix 7.

293. The public consultation was carried out as part of impact assessment study (Social and Environment) at two locations in Siddhartha Ext, Pkt-C, Ward: Bhogal, District: South East Delhi on 4/12/2020 and 6/12/2020. The communities were informed in advance about consultation dates and agenda and were encouraged to attend consultation including female member(s) of their family. NCRTC is regularly interacting with residents of Sidhartha Extension, Senior Citizen Welfare Forum and RWA and keeping them well informed about the details of RRTS construction. Details of such meetings in chronological order are summarized in Table 29.

Table 29: Interaction with SCWF and RWA

Date	Meeting Hold with	Remarks
27.08.2020	Flat Owners-24 Nos	Concerns from RWA of Sidhatha Extension were addressed and formally communicated through letter dated 05.07.2021 and 17.08.2021 from NCRTC to Sr. Citizen Welfare Forum, copies of these are enclosed as Appendix-9. Copy of MOM conducted on 06.01.2022 enclosed in Appendix-11.
10.09.2020	Flat Owners-24 Nos	
30.09.2020	SERWA	
21.10.2020	Sr. Citizen Welfare Forum	
07.11.2020	Flat Owners-24 Nos	
10.11.2020	Sr. Citizen Welfare Forum	
10.11.2020	SERWA	
09.01.2021	Flat Owners-24 Nos	
12.06.2021	Flat Owners-24 Nos	
13.07.2021	Sr. Citizen Welfare Forum	
24.07.2021	Flat Owners-8Nos.	
14.08.2021	Flat Owners-8Nos	
06.01.2022	Sr. Citizen Welfare Forum along with ADB	

294. In addition to the individual consultation with project affected households (owners of 24 nos. flats and members of senior citizen welfare forum), a total of 20 persons (3 females and 17 males) were consulted in consultation meetings/focused group discussions. Some of the major issues that were discussed and feedback received from the individuals during the course of the consultations and measures to address the same are summarized in the below Table 30.

Table 30: Summary of Public Consultation

Sl. No.	Date and Location	Name of Participants	Professio n	Age (Yrs.)	Gender	Issues Discussed	Measures Taken
1	Date : 04-12-20 Locality: Siddhartha Ext,Pkt-C Ward: Bhogal District: South East Delhi	M.C.Gupta	Retired	76	M	• Problem with existing transport facilities. • Importance of RRTS project in transportation. • Negative impacts of the project (on environment & social) and mitigation measures along with preferred type of compensation, Problem if any foresee in case of displacement. • Alternate option in case of loss of livelihood. • Suggestion if any in case of relocation. • Participation of community in project planning and implementation. • Concerns regarding land acquisition, resettlement and compensation in construction of RRTS project	• No improvement of transport facilities in this area. Because the alignment is passing through this area is for maintenance yard of RRTS. It is not for use of passenger transportation. • Blockage of sunlight of flats. Greenery will be affected due to cutting of trees. Pollution will be increased. Playground of children and walking ground of Sr. citizen will be fully affected. • Health related problem will be rise due to disturbance from noise and vibration in construction, even operation stage. • Residents living in this block will be unsafe for all time. High risk of accidents during construction and operation stage, because it is passing very close to our houses and upon our buildings. • Building May cracked due to heavy vibration during construction. Approach road will be disrupting during construction. It will be hamper the services of school buses and emergency services like, Fire Ambulance etc. • Water level is only around 2M in this colony, so water logging will be a major issue during construction of RRTS pillars. • Depreciation of cost of flats. • NCRTC considering only 8 flats as affected flats. We are strongly
		M.M.Gupta	Retired	74	M		
		V.D.Sharma	Retired	70	M		
		Surjeet Singh	Retired	69	M		
		M.L.Ahuja	Retired	73	M		
		P.K.Saha	Retired	62	M		
		Mrs.K.Kapoor	Retired	69	F		
		Dr.Ajita	Researcher	52	F		
		Amarjeet Kaur Lamba	Teacher	48	F		

Sl. No.	Date and Location	Name of Participants	Profession	Age (Yrs.)	Gender	Issues Discussed	Measures Taken
							opposing this thought. Total 104 flats in this residential block. All are adjoining with each other, so if the 8 flats will be demolish then how rest will not be affected. • People suggesting that yard should be shifted at other place or alignment should be changed. • This is 36 years old colony Mostly retired peoples living in this pocket. Their sentiments attached with this colony. It should be regarded. • All 104 flats of this residential block should be considered as affected (In case there is no option to change the alignment). • A new access road should be constructed and connect it to Barapula exit point for smooth vehicle movement of this colony. (In case there is no option to change the alignment). • Park should be maintained properly after construction. (In case there is no option to change the alignment). • Safety issues must be taken under consideration during project planning and execution. • Local people must be consulted during construction and their issues (If any) should be solved immediately by project authority.
2	Date : 06-12-20	Ram Mehrotra	Service	56	M	• Problem with existing transport facilities.	• NCRTC should consider alternate alignment (If possible)
		Ashu Sharma	Business	42	M		
		Arvind Tirpathi	Business	50	M		

Sl. No.	Date and Location	Name of Participants	Professio n	Age (Yrs.)	Gender	Issues Discussed	Measures Taken
	Locality: Siddhartha Ext,Pkt-C Ward: Bhogal District: South East Delhi	Sukhvinder Sigh	Service	45	M	• Importance of RRTS project in transportation. • Negative impacts of the project Preferred type of compensation, Problem if any foresee in case of displacement. • Alternate option in case of loss of livelihood. • Suggestion if any in case of relocation. • Participation of community in project planning and implementation. • Concerns regarding land acquisition, resettlement and compensation in construction of RRTS project	• Compensation should be calculated as per the area and space occupied currently by the individual residents and the quality of construction of the flats. • If for some reasons, NCRTC is not able to reach the compensation amount to the satisfaction of the residents, then in that scenario; second option will be exercised of providing same size of flat and quality of construction to the affected residents. Same type of area/locality should be considered. • The residents should be given bank guarantee of the value of 1.5 times of the mutually agreed value of the flats between NCRTC and residents, in case of residents being required to be relocated while exercising second option. • The affected residents should be given better offer as compared to their present conditions. • All expenses related to relocation, furnished rental house, cost of shifting twice (once moving from Siddhartha Extn. to rental house and from rental house to new house) and other cost overrun expenses as compared to the present ones, would be borne by NCRTC till the handover of the newly built flats.
		Jitendra Kr Joshi	Business	58	M		
		Tarun Arya	Business	40	M		
		Nikhil Bhatnagar	Service	40	M		
		Dr.Arun Goel	Doctor	60	M		
		Manish Karn	Business	42	M		
		Sachin Lamba	Service	42	M		
		Dr.T.K.Chakarvarty	Doctor	64	M		

Sl. No.	Date and Location	Name of Participants	Professio n	Age (Yrs.)	Gender	Issues Discussed	Measures Taken
							• Adequate time to shift and prior information should be given to the affected persons.

295. NCRTC has addressed the issues raised by public and ensured people that adequate measures are incorporated in the design to minimize adverse environmental and social impacts.

B. Information Disclosure

296. Information disclosure will follow the procedure for ADB Category A projects disclosure requirements. It is the policy of the ADB to have environmental and social assessment reports made available/accessible to the general public.

297. The project EA will be responsible for the disclosure of this EIA in compliance to ADB's Communication Policy 2011 and ADB's SPS 2009. The draft Environmental Impact Assessment Report will be disclosed in the English language in the office of NCRTC. The report will also be made available to interested parties on request from the office of the NCRTC. Since this is Category A subproject, the draft EIA report will be disclosed to the public through the ADB website, 120 days before the approval of the project by ADB Board. The draft EIA report will also be made available to all stakeholders as part of the consultation process required under the SPS 2009. The final report will also be disclosed on ADB website.

298. NCRTC will ensure that meaningful public consultations, particularly with project affected persons are undertaken through the entire project cycle, the design, construction and operation phases.

VIII. GRIEVANCE REDRESS MECHANISM

299. A project-specific grievance redress mechanism (GRM) has been established to receive, evaluate and facilitate the resolution of displaced people's concerns, complaints and grievances related to the implementation of the project, particularly regarding the environmental management plan will be acknowledged, evaluated, and respond about the social and environmental performance. The Grievance Redressal Committee (GRC) at PMO level i.e. at CPM-Delhi office will be available to redress any grievances from the "Project". The details of GRM structures are as given in EIA report for Delhi-Meerut RRTS line.

IX. ENVIRONMENTAL MANAGEMENT PLAN

A. Introduction

300. The Environmental Management Plan (EMP) is the synthesis of all proposed mitigation and monitoring actions, set to a time-frame with specific responsibility assigned and follow-up actions defined. The information for the proponent, the contractor and the regulatory agencies to implement the project along with institutional mechanisms and reporting system are given in main EIA report.

301. This EMP (Table 32) consists of a set of mitigation, monitoring and institutional measures to be taken for the project to avoid, minimize and mitigate adverse environmental and social impacts and enhance positive impacts. The plan also includes the actions needed for the implementation of these measures. The major components of the Environmental Management Plan are:

- (i) Mitigation of potentially adverse impacts;
- (ii) Environmental monitoring and monitoring of EMP implementation during project implementation and operation; and
- (iii) Budget.

302. The office of Chief Project Manager, Delhi will be the Project Implementation Unit (PIU) for the implementation of the project

303. The external monitor consultant already engaged by NCRTC for the main line will monitor and report the implementation of environmental safeguards aspects of the project. The external environment monitor will be responsible for independent monitoring of the EMP implementation and will submit semi-annual reports to NCRTC PIU.

B. Mitigation Measures

304. The identified environmental issues and suggested mitigation measures with institutional arrangements for implementation, supervision and monitoring have been provided in a matrix format as presented in Table 32. This matrix together with NCRTC's SHE Manual will be part of the contractor's bidding documents. Key anticipated potential impacts and suggested mitigation measures specific to the project are summarized in following paragraphs. These mitigation measures will be implemented as part of the project.

4.1 Impacts

305. The key anticipated adverse environmental impacts from Sarai Kale Khan - Jungpura Stabling Yard RRTS line are:

- (i) Loss of about 1272 trees for construction of connecting line and phase-I of stabling yard.
- (ii) Increased local air pollution due to rock crushing, cutting and filling works, and chemicals from asphalt processing during construction.
- (iii) Risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological, and radiological hazards during project construction and operation.
- (iv) Dislocation or involuntary resettlement of people as there will be a need for land acquisition for elevated section.
- (v) Noise and vibration due to excavation machines, and materials hauling
- (vi) Increased noise and air pollution resulting from traffic volume during construction.
- (vii) Temporary impact on land and air environment due to locating construction camp;
- (viii) Temporary impact on land, air and water environment due to establishing and operating construction plants (Concrete & Hot Mix Plant and Diesel Generator [DG] sets);
- (ix) Impact on air quality, water quality, drainage, road users due to construction activities of project ;
- (x) Impact on land and water environment due to disposal of construction waste materials; and
- (xi) Impact on occupational health and safety due to all onsite and offsite construction works.
- (xii) Impacts on community health and safety due to construction activities and transport activities.

4.2 Mitigation Measures

4.2.1 Compensation for Loss of Land and Displacement of People

306. The project will require acquisition of about (including permanent and temporary) 1.186 ha. of land affecting a total of 8 private structures. The affected people will be compensated and assisted as per the provisions of Resettlement Plan (RP) for the proposed Sarai Kale Khan - Jungpura Stabling Yard RRTS line. Resettlement & Rehabilitation activities of

proposed RRTS rail project will be governed by the following general principles, which are based on The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013. The estimated land requirement for this stabling yard including other facilities is 18.9621 Ha which will be developed in phases. Out of 18.9621 Ha, 17.21 Ha pertains to MoHUA, balance pertains to DDA, DJB, SDMC and DUSIB. NCRTC identified the abandoned factory premises of M/s Hindustan Prefab Limited (HPL) at Jangpura as the likely site for the above stabling yard and approached Ministry of Housing and Urban Affairs (MoHUA), Govt. of India, for the allotment of 17.21 Ha land for setting up of stabling yard including operation building, offices and residential buildings etc . Ministry of Housing & Urban Affairs have already allotted 12 Ha. of land to NCRTC and approval in principle issued for 5.21 Ha. Other departments have also been agreed in principle to transfer the balance land.

4.2.2 Compensation for Loss of Trees

307. It is found that 1272 nos. of tree are getting affected due to the project . The application will be made to respective municipal authorities/corporations for tree cutting / trimming at project site and Compensatory plantation will be done as per the guidelines. As per guidelines for each tree felled, 10 plants will be planted. Emphasis will be given for the plantation of native trees. In total 12720 trees will be planted. Budget towards planting of trees have been included in the EMP cost.

4.2.3 Green Belt Development

308. In addition to the compensatory plantation, compensatory afforestation on 15 ha. land in consultation with forest department is proposed and green belt area will be developed under the elevated corridor using native shrubs, herbs and grasses. The design of the project shows that in the elevated section of the track, the lower edge of the track will be at 5.5 m height from the ground level with pillars at every 25 m interval, each pillar having 2 m diameter (generally). A central ribbon area will be planted with small tree species which grows up to height of 4-5 m. Thus, the green belt will provide aesthetic view of elevated track and also helps to serve as dust and noise absorbent barrier.

4.2.4 Water Supply and Sanitation

309. The water demand would be about 87 KLD and the same shall be supplied through municipal water supply or through groundwater after approval from concerned authority. It is also proposed to implement rainwater harvesting systems along Sarai Kale Khan - Jungpura Stabling Yard line and at stabling yard. This will conserve considerable quantity of water, which in turn will reduce the load on the municipal water supply system.

310. Runoff from the construction site can be a source of water pollution. Cement based products/ dust carried by the runoff from the land surface can pollute surface water bodies. Surface covers are proposed to be spread on the land to prevent dust settlement on the land surface. Proper sanitary facility will be made available for the construction workers. The construction workers drinking water demand will be fulfilled only through ground water. Efforts shall be made to reduce the wastage of water during construction by encouraging water recycling techniques. During the operation phase, adequate water supply and sanitation facilities would be made available at the stabling yard.

4.2.5 Oil Pollution Control

311. There should be provision for the collection of oil and grease generated from construction equipment and sent for their treatments. Wastewater treatment plant should be installed at yard having oil & grease interceptors in line with the wastewater treatment plant & capable for removing petroleum contaminants, oil & grease and will meet national standards.

Precautionary measures have been suggested to prevent these wastes moving in to ground or surface water bodies, as they are important sources of water for domestic use. Oil traps in the heavy machinery area are suggested to collect oil based materials. Similarly, sedimentation basins would be erected prior to the water discharge point to reduce the sedimentation load in the storm water. Since RRTS rail is operated through electricity, there will be less chance of oil pollution.

4.2.6 Noise Pollution Control

312. For elevated corridor, ballast less track structure is supported on two layers of rubber pads to reduce noise and vibrations. In addition, baffle wall as parapets will be constructed upto the rail level so as reduce sound levels. Noise at source will be controlled or reduced by incorporating suitable feature in the design of structures and layout of machines and by use of resilient mounting and dampers etc.

313. To reduce the harmful effects, the Contractor shall ensure that all powered mechanical equipment used in the Works shall be effectively sound-reduced using the most modern techniques available including but not limited to silencers. The workers shall be provided with ear mufflers. The Contractor shall construct acoustic screens or enclosures around any parts of the Works from which excessive noise may be generated. The Contractor shall ensure that noise generated by work carried out by the Contractor and his sub-Contractors during daytime and night time shall not exceed the maximum permissible noise limits. In the event of a breach of this requirement, the Contractor shall immediately re-deploy or adjust the relevant equipment or take other appropriate measures to reduce the noise levels and thereafter maintain them at levels which do not exceed the said limits. Such measures may include without limitation the temporary or permanent cessation of use of certain items of equipment. Vehicles used for transportation of construction materials would be equipped with proper silencers. Careful planning has been made to operate the construction equipment to have minimal disturbances. The construction equipment would be run only during the daytime and their noise would be monitored as per CPCB standards. A comprehensive noise assessment should be carried out prior to start of construction work to identify requirements of noise barriers and other mitigation measures at sensitive receptors along the alignment.

4.2.7 Vibration Control

314. The vibration is generally caused from rail-wheel interaction. This will be reduced by minimizing any surface irregularities on the wheel and rail. To minimize the vibration, shock absorbing pad has to be provided and there has to be a distance between rail seat assembly and concrete plinth.

315. During piling and other construction activities, there may be possibility of vibration occurrence and the monitoring shall be carried out for couple of readings and can be interpreted accordingly whether is there any adverse impact on the surrounding buildings and other structures. In this regard, any authorized monitoring agency shall be employed to carry out the set of analysis.

4.2.8 Soil/Debris Control

316. The construction activities will generate large quantity of soil/debris causing soil erosion during excavation. This can be mitigated by utilizing around 35 % of excavated soil for land filling purposes. Excavated soil shall be promptly transported so as not to hurdle in the progress of work. Stockpiling material will not be allowed at sites and the excavated material shall be placed in the approved dumping sites. The generated muck will undergo a methodology for disposal plan and to be adopted throughout project phase. The excavated muck may not be stored at site area for more than 48 hours. Periodically the excavated muck shall be disposed maintaining thorough record.

317. The Contractor is required to develop, institute and maintain a Waste Management Program (WMP) during the construction of the project for his works, which may include:

(i) Identification of disposal sites
(ii) Identification of quantities to be excavated and disposed off
(iii) Identification of split between waste and inert material
(iv) Identification of amounts intended to be stored temporarily on site location of such storage.
(v) Identification of intended transport means and route.
(vi) Obtaining permission, where required, for disposal.

318. Such a mechanism is intended to ensure that the designation of areas for the segregation and temporary storage of reusable and recyclable materials are incorporate into the WMP. The WMP should be prepared and submitted to the Engineer for approval. The Contractor shall handle waste in a manner that ensures they are held securely without loss or leakage thus minimizing potential for pollution. The Contractor shall maintain and clean waste storage areas regularly. The Contractor shall remove waste in a timely manner and disposed off at landfill sites after obtaining approval of the competent authorities namely Delhi Municipal Corporation etc. Burning of wastes is prohibited. The Contractor shall not burn debris or vegetation or construction waste on the site but remove it. The Contractor shall make arrangement to dispose of metal scrap and other saleable waste to authorized dealer and make available to the Employer on request, records of such sales. The Contractor selects suppliers having a voluntary and documented policy to reduce the volume and weight of packaging, and to select recyclable or biodegradable packaging. The Contractor establishes and maintains a waste register, which is at the disposal of the Engineer. This register will record all waste management operations: production, collection, transport, and treatment. The following aspects are documented in this register:

(i) Type of waste, using the nomenclature specified in this document
(ii) Waste quantities;
(iii) Name and address of the third party waste management facilities receiving waste or parties taking possession of the substances no longer considered as waste;
(iv) Name and address of waste transport contractors;
(v) Planned waste treatment.

319. The contractor files and maintains at the disposition of the Engineer the waste manifests for the collection, transport, treatment and/or elimination of waste. The waste register is established and available as of the Contractors mobilization to the Worksite. This register will be archived for at least 1 year after the provisional acceptance of the works.

320. The excavated top fertile soil is suggested to be preserved and used later for gardening and lawn establishment. Soil erosion by runoff will be controlled by installing proper drainage systems using contour information. Since there is small quantity of soil is generating from the alignment area, it is suggested to avoid bringing soil from outside the project boundary and to use the excavated mounds for filling low laying area where it is necessary. Thus, both cost and time saving suggestions have been made in land leveling and soil transportation.

4.2.9 Rain Water Harvesting

321. Roof top rain water harvesting can be carried out from the elevated section and at stabling yard as well. The rooftop of the elevated viaduct and stabling yard will become catchment area for rain. Rain water will be collected and stored in a tank or diverted into

artificial recharge tanks for further use for toilet flushing a floor washing etc.. This method is less expensive and very effective to augment the ground water level of the area. As per the rainfall characteristics, generally the annual rainwater harvesting potential for 1000 sqm roof area will be 7,68,000 liters.

322. To conserve and augment the storage of groundwater, it is suggested to construct rainwater harvesting structures of suitable capacity along the alignment and at stabling yard. The facility of rainwater harvesting and artificial recharge in the stabling yard will be designed based on the result of geo-technical study of the project area, as water level in the project area is high.

323. The excess storm water from the stabling yard campus will be guided and discharged into city storm water drain system after approvals from concerned authority. The storm water drainage system will be designed of capacity calculated with peak rainfall data.

4.2.10 Air Pollution Control

324. During the construction period, the impact on air quality will be mainly due to increase in PM_{10} along haul roads and emission from vehicles and construction machinery. Though the estimation of air quality during construction shows some impact on ambient air quality, nevertheless certain mitigation measures which shall be adopted to reduce the air pollution are presented below:

(i) The Contractor shall take all necessary precautions to minimize fugitive dust emissions from operations involving excavation, grading, and clearing of land and disposal of waste. He shall not allow emissions of fugitive dust from any transport, handling, construction or storage activity to remain visible in atmosphere beyond the property line of emission source for any prolonged period of time without notification to the Employer.

(ii) The Contractor shall use construction equipment to minimize or control of air pollution. He shall maintain evidence of such design and equipment and make these available for inspection by Employer.

(iii) Contractor’s transport vehicles and other equipment shall conform to emission standards fixed by Statutory Agencies of Government of India or the State Government from time to time. The Contractor shall carry out periodical checks and undertake remedial measures including replacement, if required, so as to operate within permissible norms.

(iv) The Contractor shall cover loads of dust generating materials like debris and soil being transported from construction sites. All trucks carrying loose material should be covered and loaded with sufficient free - board to avoid spills through the tailboard or sideboards.

(v) The temporary dumping areas shall be maintained by the Contractor at all times until the excavate is re-utilized for backfilling or as directed by Employer. Dust control activities shall continue even during any work stoppage.

(vi) The Contractor shall place material in a manner that will minimize dust production. Material shall be minimized each day and wetted, to minimize dust production. During dry weather, dust control methods must be used daily especially on windy, dry days to prevent any dust from blowing across the site perimeter.

(vii) The Contractor shall water down construction sites as required to suppress dust, during handling of excavation soil or debris or during demolition. The Contractor will make water sprinklers, water supply and water delivering equipment available at any time that it is required for dust control use. Dust screens will be used, as feasible when additional dust control measures are needed especially where the work is near sensitive receptors.

(viii) The Contractor shall provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from work sites such as construction depots and batching plants. At such facility, high-pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt.

4.2.11 Utility Restoration

325. The proposed Sarai Kale Khan - Jungpura Stabling Yard connecting alignment is of small in length and mostly crosses arterial roads and railway trucks, which serve Institutional, Commercial and Residential areas. Only storm water drains, telephone cables, electrical transmission lines, electric poles, traffic signals etc. exists along the proposed alignment. These utility services are essential and have to be maintained in working order during different stages of construction by temporary / permanent diversions or by supporting in position. As such, these may affect construction and project implementation time schedule /costs, for which necessary planning / action needs to be initiated in advance. Prior to the actual execution of work at site, detailed investigation of all utilities and location will be undertaken well in advance by making trench pit to avoid damage to any utility. While planning for diversion of underground utility services e.g. sewer lines, water pipe lines, cables etc., during construction of RRTS alignment, the following guidelines could be adopted:

(i) Utility services shall be kept operational during the entire construction period and after completion of project. All proposals should, therefore, ensure their uninterrupted functioning.

(ii) The elevated viaduct does not pose any serious difficulty in negotiating the underground utility services, especially those running across the alignment. In such situation, the spanning arrangement of the viaduct may be suitably adjusted to ensure that no foundation need be constructed at the location, where utility is crossing the proposed RRTS alignment. In case of utility services running along the alignment either below or at very close distance, the layout of piles in the foundations shall be suitably modified such that the utility service is either encased within the foundation piles or remains clear of them.

4.2.12 Disaster Management

326. Any unexpected event occurring due to sudden failure of the system like leakage of gas, external threats, internal disturbances, earthquakes, fire and accidents is termed as disaster. A Management Cell is proposed to act at a quick response in any emergency encountered.

327. For the proposed RRTS project all relevant safety codes, acts and regulations such as Electricity Act, Explosive Act, Public Liability Insurance Act, Safety Codes, Policies and Guidelines laid down by Ministry of Railways should be observed during various stages of the project to minimize risk and disaster. Through good design, operation and maintenance and regular inspection any unexpected risks and disaster can be minimized. Hazard has to be controlled by minimizing and mitigating the risk and disaster.

328. To prevent any unexpected accidents, overall ramp safety management system approach is required that involves Risk Analysis and Risk Management. Risk Analysis involves establishing the organization's risk profile and risk management encompasses the various measures that can be implemented to minimize accidents, control loss and transfer risk by insurance on the basis of the identified risk profile of an organization. New safety assessment methods are needed to assess the safety of new concepts.

329. Workers need to be trained to mitigate the risk. In addition, workers should follow the safety rules. Emergency medical aid has to be adopted in the event of accidents involving the hazardous substance. Good sanitation practices should be followed such as proper water supply, sanitation, drainage, health care and human waste disposal facilities etc. In addition, efforts shall be made to avoid any water spills, adopt disease control measures and employment of local labour.

330. NCRTC's Safety, Health and Environment (SHE) Manual is part of Tender documents and the contractors will implement this SHE Manual. This SHE has been formulated in accordance with all applicable legislation and Indian statutory requirements listed as well as the international standards and guidelines including ILO and ISO certificate.

4.2.13 Development and implementation of Subplans

331. As part of the construction environmental management plan, contractors need to develop various subplans as discussed in the EMP (item 10 during pre-construction stage). These plans are aimed at good environmental management practices and serve as guide documents. These subplans will form part of construction EMP be consistent with the contractor's SHE plan and will be included in the bid documents. Table 31 present some of the key plans to be developed by contractor and responsible party for it's approval.

Table 31: Contractors' Subplans and Approval Party

Plan	Description	Approvals		
		PIU	GC	ADB
1. Camp Management Plan	The plan will provide a layout map of the campsite and clearly show the access road, entry and exit and different facilities inside the camp. Facilities inside the camp may include contractor's office, residential quarters, toilets, health center, construction plants, storage areas etc. The plan will include information on waste management, supply of water for drinking and bathing, waste water and drainage management, traffic movement routes etc.	Yes	Yes	No
2. Muck Disposal Plan	The plan shall describe sources of muck generation (piling work for viaducts etc), type and quantity of muck generated from various sources, use of muck generated, method collection and transportation, transportation routes, disposal site location and design, approvals required for disposal sites, and treatment method. Recommendations provided in the EIA must be considered.	Yes	Yes	Yes
3. Waste Management Plan	The plan shall describe waste streams and amounts, describe recycling/reuse methods for each material, identify the waste destinations and transport modes, including what materials are being segregated on site for reuse or recycling, specify responsibilities for managing and disposal of waste. Describe special measures for material use and handling. Describe communication and	Yes	Yes	No

Plan	Description	Approvals		
		PIU	GC	ADB
	training to support and encourage participation from everyone on site.			
4. Traffic Management Plan	The plan shall be designed to ensure that traffic congestion and traffic safety impacts due to construction activities and movement of construction vehicles, haulage trucks, and equipment is minimized. The plan shall be prepared in consultation with traffic officials. The plan shall identify traffic diversion and management issues, traffic schedules, traffic arrangements showing all detours/lane diversions, modifications to signalling at intersections, necessary barricades, warning/advisory signs, road signs, lighting, and other provisions to ensure that adequate and safe access is provided to motorists and other road users in the affected areas. Pre-construction access road surveys will also form part of the TMP. The plan shall also include locations for pedestrian crossings and conditions for the management of these crossings, including the use of flagmen.	Yes	Yes	Yes
5. Occupational and Community Health and Safety Plan	Consistent with international standards (e.g., World Bank Group Environmental, Health, and Safety Guidelines, 2007) and Labor Code of India. The Plan shall address health and safety hazards associated with construction activities (e.g., excavations, piling etc.), use of heavy equipment, transport of materials and other hazards associated with various construction activities. The document to be read together with the Camp Management Plan. Recommendations provided in the EIA must be considered.	Yes	Yes	Yes
6. Labor and Working Conditions Management Plan	This will include: policy/legal framework information (including labor and OHS requirements of national legislation, ADB SPS 2009), workforce induction and information on rights, child and forced labor, equal opportunity, migrant workers, promotion of local employment opportunities, labor union, worker accommodation requirements, provision for retrenchment plans, workforce grievance mechanism, security personnel (Voluntary Principles on Security and Human Rights), etc. Contractor needs to ensure that the core labor requirements are cascaded down across the entire contracting chains, including sub-contractors and suppliers of core materials. The plan shall also be in	Yes	Yes	Yes

Plan		Description	Approvals		
			PIU	GC	ADB
		compliance with IFC Guidance Note “Workers’ accommodation: processes and standards”.			
7.	Code of Conduct	The Contractor shall prepare a Code of Conduct that outlines camp rules articulating acceptable behaviours of the workforce with local communities. Associated induction training will be provided to ensure rules are well understood and enforced.	Yes	Yes	Yes
8.	Emergency Response Plan	This plan shall prescribe measures to prevent, mitigate, respond to and recover from emergency events that could occur due to project activities such as accidents, spills of hazardous substances, fire, extreme weather events, and others; measures to prevent, mitigate, respond to and recover from emergency events that could occur due to project activities such as accidents during lunching (e.g., collapse, electrocution, etc.), release of toxic gas during excavation, spills of hazardous substances, fire, floods, and other events.	Yes	Yes	No
9.	Construction Vibration Management Plan	Detailing the procedures for vibration surveys, monitoring and control. Such details shall include; procedures to complete condition surveys (for all properties indicated in this EIA), Measurement locations and methods; Method statements for works likely to induce vibrations, including programs of trial construction sections to determine the likely magnitude of vibrations at defined distances from the vibration source, in sufficient detail for the contractor to develop a final method for constructing the works without excessive vibration; Description of the instrumentation and equipment to be used; Copies of the instruction manuals and the laboratory calibration and test equipment certification; The resumes of the vibration monitoring technical support personnel, sufficient to define details of relevant experience; Procedures for data collection and analysis; Frequency of measurements; Means and methods of providing warnings when the specified construction vibration limits are reached; and Action plans to be implemented in the event the specified construction vibration limits are reached. The generalized plans of action shall comprise the positive measures by the	Yes	Yes	Yes

Plan	Description	Approvals		
		PIU	GC	ADB
	Contractor to control vibrations using alternative construction methods.			
10. Storm Water Drainage Management Plan	This plan shall prescribe measures to prevent, mitigate, respond to storm water management at project site during construction that could occur due to project activities such as excavation works, stacking of material, extreme weather events, and others; measures to prevent, mitigate, flooding of project and site and near by areas due to project activities. The plan should be prepared in consultation with local stakeholders and community considering rainfall and monsoon season.	Yes	Yes	Yes

C. Environmental Monitoring and Reporting Program

332. Environmental Monitoring Plan (EMoP) is a companion document of the EMP. EMoP contains parameters, location, sampling and analysis methods, frequency, and compared to standards or agreed actions that will indicate non-compliances and trigger necessary corrective actions. More specifically, the objectives of the EMoP are:

- (i) Ensure that impacts do not exceed the established legal standards
- (ii) Check the implementation of mitigation measures in the manner described in the EIA report
- (iii) Monitor implementation of the EMP
- (iv) Provide an early warning of potential environmental damage
- (v) Check whether the proposed mitigation measures have been achieved the intended results, and or/ other environmental impacts occurred

333. The monitoring plan will be used for performance monitoring of the project. A monitoring plan defining all parameters to be monitored, with tentative location, project stages for measurements, implementation and institutional responsibility for different environmental components is prepared for all stages of project and presented in Table 33.

Table 32: Environmental Management Plan Matrix

Note: This EMP Matrix will form part of the contract document together with NCRTC's Safety, Health & Environment (SHE) Manual Conditions of Contract (CoC) for all contractors. This EMP has been aligned with the SHE CoC wherever possible, and in places, cross-referencing has been resorted to. GC – General Consultants; GoD- Government of Delhi; MOHUA – Ministry of Housing and Urban Affairs; NCRTC – National Capital Region Transport Corporation.

Activity/Valued Environment Component	Impact	Mitigation Measure	Responsibility	
			Implementation	**Supervision**
A. DESIGN AND PRE-CONSTRUCTION STAGE				
I. Physical environment				
1. **Surface water quality and quantity.** Location of alignment/ stabling yard near rivers and streams	- Pollution of river from release of raw sewage and untreated waste-water	- Inclusion of septic tanks or other sewage treatment system within the design of the station facility.	PIU	MOHUA/NCRTC
2. **Ground water quality and quantity**. Generation of sewage, other waste-water and hazardous liquids from operation of stabling yard. Excessive use of ground water for project operations.	- Pollution of ground water from release of raw sewage and untreated waste- water from the stabling yard. - Depletion of ground water resources because of the Sarai Kale Khan - Jungpura Stabling Yard line and stabling yard.	- Inclusion of septic tanks/ other sewage treatment system the design of station. - Inclusion of septic tanks/ other sewage treatment systems in the design of the stabling yard. - Inclusion of waste-water treatment plants equipped with provisions to trap oil, grease and lubricants etc. in the design of the project. - Water supply system in stabling yard plan to include water conservation and recycling schemes such as rainwater harvesting, recycling of treated waste water. - Water supply plan to account for availability of local water resources and avoiding adding stress.	PIU	MOHUA/NCRTC
3. **Land degradation and pollution.** Generation of solid waste, trash and other wastes from operation of the project.	- Pollution and degradation of land near the alignment and stabling yard	- The project component design to include a proper waste management plan including linking up with local municipal waste management systems	PIU	MOHUA/NCTRC

Activity/Valued Environment Component	Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
II. Biological environment				
4. Trees, terrestrial and aquatic vegetation	- Removal of about 1272 trees - Loss of additional shrubs and grasses	- Preparation of compensatory plantation at the ratio of 1:10 in coordination with Forestry officials. - Allocation of adequate budget to support 1:10 compensatory plantation - Locally suitable tree species to be proposed along the station borders in coordination with local forestry officials. - Additional greening plan to be prepared for the total length under the elevated corridor - Additional measures will be taken to transplant the mature trees along the alignment.	PIU, PMO	MOHUA/NCRTC, GNCTD
5. **Aquatic fauna (fishes, migratory birds) and ecologically important areas**. Project alignment does not crosses nor located in the vicinity of any ecologically important area	- No direct negative impacts are anticipated.	- Extra measures to be taken to ensure that solid and untreated liquid waste from these station do not enter the Nalla near Barapulla Flyover.	PIU, PMO	NCRTC/MOHUA
III. Social environment				
6. Private land and buildings. Land acquisition	- Acquisition of 1.186 ha of land affecting 8 private structures. - Change in landuse from agricultural land to industrial land especially for the stabling yard.	- LA will be carried out as per the provision of GOI and ADB policies. - The affected people will be compensated and assisted as per the provisions of Resettlement Plan (RP). - Resettlement & Rehabilitation activities of RRTS rail project will be governed by The Right to Fair	PIU, PMOs, GC, Resettlement NGO, District Collector	GoUP/MOHUA

Activity/Valued Environment Component	Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
		Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013. - Permission will be sought from competent authority for conversion of landuse from agricultural land to industrial land.		
7. **Public property/infrastructure/ utility structures**. Shifting of electric lines, water pipes, sewage lines, gas pipes and telecom lines	- Inconveniences to local public due to disruption of utility services - Filing of complaints by local public affected by disrupted utility services - Health impacts to local public caused by disruption of electricity and water especially during the extremely hot summer months - Damage to private property from utility shifting activities	- Develop utility shifting plan with provision for back up utility services when main lines are being removed in coordination with utility authorities and allocate adequate budget for implementing the plan - Shifting utilities following the utility shifting plan. - Closely coordinate with utility authorities to expedite shifting and avoid delays and inconveniences to public - Keep public updated through public meetings and local media on schedule for shifting of utilities and project grievances redress measures - Ensure project grievance redress mechanism is functioning - Promptly respond to complaints related to utilities	PIU, PMOs, GC, / Contractor	MOHUA/NCRTC/ GoUP
8. **Noise.** Finalizing noise reducing features in design of the tracks, trains and stabling yard	- Disturbance to residents living near alignment from operation of trains and stabling yard - Potential disturbances to 7 locations of receptors identified	- Conduct further noise level monitoring to reconfirm the findings and recommendations before construction stage - Recommend additional measures to mitigate increased noise levels of >3dBA for 1 sensitive receptor	PMO, GC, Noise & Vibration Consultant	PMO, GC

Activity/Valued Environment Component	Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
	within impact zone of construction - 1 sensitive receptor will be moderately impacted where noise levels will increase by >3dBA from baseline levels	- Review railway track design and refine design to include noise reducing design features - Review rolling stock design and refine design to include noise reducing design features - Include provision and budget for installing noise barriers near severely impacted sensitive receptors		
9. **Vibration**. Finalizing design features of the tracks, trains and stabling yard to maintain minimal vibration levels during operation	- Cracks and damages in structures located near rail alignment particularly structures located near the pilling works - Disturbance and annoyance to people living and working near the rail alignment	- Conduction of pre-construction building inventory to identify structures that are weak and at risk of getting damaged - Develop and implement building support and rehabilitation measures for weak buildings identified - Track design to include floating slab track bed, elastomeric pad and rail pad - Review railway track design and revise design to further reduce operational vibration - Rolling stock to be equipped with air springs and vertical hydraulic damper - Review rolling stock specifications and revise it to include requirements for further reducing operational vibration - Prepare vibration monitoring plan to be implemented during construction and set overall trigger limits with more stringent limit of 2.5mm/s near sensitive receptors	PMO, GC, Noise & Vibration Consultant, Contractor	PMO, GC

Activity/Valued Environment Component	Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
10. **Occupational health and safety for RRTS operational staff**. - Finalizing occupation health and safety features in design of trains, tracks and associated stabling yard.	- Unsafe and hazardous working conditions inside the tracks and stabling yard. - Accidents and injuries to operational staff	- Include health and safety features in design of stations, tracks and trains - Station and Stabling yard to have adequate numbers of toilets separate for male and female staff - Train design to include emergency features such as emergency brake and exit - Prepare health and safety plan for the project	PIU, PMO	NCRTC/MOHUA
11. **Community health and safety**. - Finalizing community health and safety plan during project construction works - Finalizing health and safety features in design of trains, tracks and stabling yard.	- Accidents and injuries of local community people due to poor health and safety standards of project construction works - Accidents and injuries to passengers using the train during operation stage - Collision of trains and derailment, fire power outages, stopping of train services during operation stage	- Before construction works begin, the contractor will prepare the following plans for approval by the GC, PIU and/or ADB (refer to table 30). These plans must be consistent with requirements of the SHE. 1) Camp management plan including health and safety, resource supply, waste management etc. 2) Muck disposal plan 3) Waste Management plan 4) Traffic management plan 5) Occupational and community Health and Safety plan 6) Labor and working conditions management plan 7) Code of Conduct for construction workers 8) Emergency response plan 9) Construction noise and vibration management plan 10) Strom Water Management Plan - In addition to the above the PIU must prepare a public communications	Contractor	PIU, GC, External monitor

Activity/Valued Environment Component	Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
		plan to regularly keep the public informed on the project - The project design to include passenger friendly and safety features such as: clear signage on entry, exit, prohibited areas etc; clear public announcements; presence of adequate housekeeping and customer service staff; automatic fare collection system - Station and trains to have emergency response system and facilities such as emergency escape routes, fire alarm, fire extinguisher etc. - Security surveillance systems including CCTV		
B. CONSTRUCTION STAGE				
I. Physical environment				
12. Air quality and GHGs - Excavation works for elevated sections. (total of 12960 m^3 of material will be excavated) - Operation of equipment, machinery and construction vehicles - Hauling of excavated material	- Generation of dust from excavation works; transport of excavated material (in uncovered trucks), re-suspension of dust from road surface - Generation of exhaust and emissions from operation of equipment and machinery -	- Water sprinkling to be carried out as per SHE Conditions of Contract at regular interval (to be mutually decided by the contractor and NCRTC) - The trucks/dumpers carrying the excavated material will be covered using tarpaulin/similar covering materials. - Truck tires will be washed to remove excess soil clinging to it. - Regular maintenance of construction equipment and machinery; have upto date pollution under control (PUC) for all vehicles	Contractor	PIU, PMO, GC, External Monitor

Activity/Valued Environment Component	Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
		- Avoid unnecessary idling of equipment and vehicles		
13. Surface water quality and quantity - Use of water for project – construction - Release of construction waste (solid and liquid) into nearby water bodies	- Pollution of water bodies due to release/disposal of liquid and solid waste generated from construction activities and campsites - Worsening of the quality of the already highly polluted Nalla near Barapulla flyover	- Proper disposal of all solid wastes generated from construction activities will be selected in co-ordination with the local municipal and environmental authorities. - Monitoring of waste-water generated from the stations during the initial stages of project operation to confirm that the water does not contain any harmful pollutants. - Creation of settling ponds for cleaning of polymer muck generated from piling works before releasing waste-water into the environment - No disposal of untreated waste water in the Nalla near Barapulla flyover.	Contractor	GC, External Monitor
14. Ground water quality and quantity - Generation of domestic solid and liquid waste from construction camps - Release of chemicals, fuels, lubricants and other hazardous wastes - Generation of sewage from construction camps - Generation of waste water from construction camps, batching plant, casting yard and other construction sites	- Pollution of ground water due to release of sewage - Pollution of ground water due to release of waste -water contaminated with fuels, oils, chemicals from construction camps and construction sites	- Provide septic tanks/soak pit connected to toilet in construction camps - Avoid placing toilets and septic tanks near tube wells inside construction camp - Camps must be located far from local settlements - All fuels, chemicals and other hazardous liquid waste will be collected and re-used or sold/given to recycling agents	Contractor	PMO, GC, External Monitor

Activity/Valued Environment Component	Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
15. Land degradation/ pollution - Generation of about 12960 cum of excavated material and muck and about 5000 cum of C&D waste - Generation of domestic solid and liquid waste from construction camps - Release of chemicals, fuels, lubricants and other hazardous wastes - Generation of sewage from construction camps - Generation of waste water from construction camps, batching plant, casting yard and other construction sites	- Pollution and degradation of areas located near the construction sites, construction camps, casting yards	- Implement the muck disposal management plan - Implement the waste management plan for managing C&D waste and domestic wastes from construction camps - Use excavated material and muck for filling of the stabling yard to the extent possible - Establish and operate C&D processing plants - Re-use the C&D waste for project construction works to the extent possible - In coordination with local authorities identify suitable areas for disposing muck and C&D waste - Preserve top soil of the yard areas and reuse the soil for landscaping purposes - Minimize stock piling and temporary storage of excavated material and muck near construction sites - Prohibit dumping of any excavated materials, C&D waste and wastes from construction camps in any unauthorized locations - Handle hazardous wastes and materials in compliance with the Hazardous waste rules 2007 and hazardous chemicals rules	Contractor NCRTC for disposing C&D waste	PIU, PMO, GC, External Monitor
II. Biological environment				
16. Trees, terrestrial and aquatic vegetation	- Loss of about 1272 trees and some vegetative	- Implement the compensatory plantation plan at the ratio of 1:10 in coordination with Forestry officials.	Forestry Department, Delhi	NCRTC, external monitor

Activity/Valued Environment Component	Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
- Clearing and removal of trees for constructing the rail alignment and stabling yard	cover (shrubs and grasses)	- Maintain the newly planted sapling by regular watering and protection from cattle - Implement additional greening (potted plants, vertical gardens etc.) of stations and alignment along elevated corridor	Development Authority (DDA), Delhi PIU	
17. Terrestrial fauna (mammals, birds, insects)	- Killing of animals and birds by construction workers - Destruction of bird nests during removal of trees	- Transfer nests to other trees nearby if there are any nests in trees to be removed - Contractor's workers to be banned from any illegal hunting or killing of animals and birds	Forestry Department, PMO	PIU, PMO, GC, External Monitor
18. Aquatic fauna (fishes, migratory birds) and ecologically important areas - Project alignment does not crosses nor located in the vicinity of any ecologically important area	- No negative impacts are anticipated.	- Avoid construction of the piers inside a caisson in the section crossing waste water drain (Nalla) near Barapulla flyover, if feasible - Carry out hydraulic piling or bore piling not impact hammering for establishing piers in the water - Avoid constructing inside the Nalla during the rainy season to minimize siltation - If any wildlife species are found in the construction site, they will be carefully transferred to safe locations under the guidance of the Environment Expert (external monitor) and the local forestry/wildlife agency.	Contractor	PIU, PMO, GC, External Monitor
		III. Social environment		
19. Government Land and Private buildings	- Damage to property - Disgruntled affected people	- Regular information dissemination through information leaflets, local media and other means	PIU, PMOs, GC, Resettlement	GNCTD /MOHUA

Activity/Valued Environment Component	Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
- Acquiring 1.186 ha of land (permanent & temporary) - Demolishing private structures	- Filing of complaints against the project - Negative media coverage	- Conduct regular public consultation - Closely coordinate with local district officials to expedite payment of compensation and provide required support - Maintain a fully functioning GRM and keep public and affected people inform on channels to submit grievances - LA will be carried out as per the provision of GOI and ADB policies. - The affected people will be compensated and assisted as per the provisions of the approved Resettlement Plan (RP). - Resettlement & Rehabilitation activities of RRTS rail project will be governed by The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.	NGO, District Collector	
20. Public property/infrastructure/ utility structures	- Inconveniences to local public due to disruption of utility services - Filing of complaints by local public affected by disrupted utility services - Health impacts to local public caused by disruption of electricity and water especially during the extremely hot summer months	- Implement utility shifting plan - Provide back-up utility services when main lines are being removed in coordination with utility authorities - Closely coordinate with utility authorities to expedite shifting and avoid delays and inconveniences to public - Keep public updated through public meetings and local media on schedule for shifting of utilities and project grievances redress measures	PIU, PMOs, GC, / Contractor	MOHUA/NCRTC/ GNCTD

Activity/Valued Environment Component	Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
	- Damage to private property from utility shifting activities	- Ensure project grievance redress mechanism is functioning - Promptly respond to complaints related to utilities		
21. **Noise**. - Construction activities using heavy equipment - Movement of heavy trucks transporting construction materials - Increased traffic caused by traffic jams and honking on the road to project alignment - Operation of construction camps, casting yard, batching plant	- Disturbance to large numbers of people living in communities near the project construction site - Significant increase of noise >3dB(A) for 1 sensitive receptors located near project sites - Filing of complaints by the local community	- Use of modern equipment that are less noise generating - Add noise mufflers to noisy equipment - Install acoustic screens and enclosures around noisy activities - Avoid using multiple noisy equipment at the same time - Monitor noise levels at construction sites to check compliance with WB-EHS and GOI standards - If noise levels are exceeded, contractor will immediately make adjustments to construction activity to bring noise levels within standards - Operate heavy duty noisy equipment only during night time hours in non-residential areas that have offices and commercial activities during the daytime hours	Contractor	PIU, PMO, GC, External Monitor
22. **Vibration**. - Construction activities using heavy equipment - Movement of heavy trucks transporting construction materials - Operation of construction camps, casting yard, batching plant	- Disturbance to large numbers of people living in communities near the project construction site - Damage to properties and utility structures including identified 5 locations of receptors near construction site	- Implement approved vibration monitoring plan with special emphasis on weak structures that were identified during pre-construction - Ensure vibration levels don't exceed 2.5mm/s near 5 identified locations of receptors - Carry out Hydraulic or bore piling method which generates a	Contractor, PIU, PMO	PIU, PMO, GC, External Monitor

Activity/Valued Environment Component	Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
	- Filing of complaints by the local community	maximum vibration of 2.2 mm/second will be used to prevent damages to structures. No impact piling will be done - Rehabilitate or compensate for damaged properties		
23. Occupational health and safety of construction workers - Construction activities including excavation, tunneling and working at heights - Operation of heavy equipment - Driving of heavy trucks for transporting construction material and wastes - Operation of construction camps	- Injury and death of workers caused by hazardous working conditions such as working at heights, inside tunnels - Illnesses and health problems of workers due to several reasons listed below - Lack of proper facilities for clean drinking water, toilets, waste management and poor hygienic condition in camp sites - Working in extreme temperatures (>40°C) - Prolonged dusty conditions at construction site - Excessive working hours - Handling hazardous chemicals and materials - Lack of proper PPE	- Within 30 days upon issuance of Notice to Proceed the contractor will appoint a Health and Safety Officer (HSO) and environmental focal person; - HSO will engage with NCRTC-Environment Specialist to discuss the EMP including need for revisions and reporting formats and timeline; EMP will be consistent with SHE requirements - As part of updated EMP for approval by GC prepare a contract specific health and safety plan consistent with the EMP and SHE requirements - HSO will submit for NCRTC approval an action plan to secure all permits and approvals required for operation of construction plants and equipment and specific activities such as handling hazardous materials - HSO will submit for approval of NCRTC the construction camp layout before its establishment - Provision of PPE to all workers - Install fall prevention and protection measures at all construction sites such as: installing guardrails with	Contractor	PIU, PMO, GC, External Monitor

Activity/Valued Environment Component	Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
		mid rails, provision of safety harness. - Mandatory and regular safety briefings for all workers - Only qualified to operate heavy equipment and machinery - Avoid works during extreme temperatures (>40°C) and have heat stress management procedures - Regular sprinkling of water in dusty work sites - Limit exposure of workers to noise levels greater than 85dB(A) to less than 8 hours. Provide ear protection devices to workers carrying out noisy work - Working hours to be limited to national labor regulation limits - Provision proper storage facilities of hazardous chemicals and materials and protection facilities for workers handling them - Construction camps to be provided with safe drinking water, waste management facilities, proper toilets and hygienic environment and good housing material - Employment of full-time medical staff at construction camps and medical supplies to be well stocked. Ambulance to be available at campsite at all times - Well-stocked first aid kit to be available at all construction sites		

Activity/Valued Environment Component	Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
		- Collaborative linkages to establishes with nearest hospital for treating workers with serious injuries or illnesses - Regular health checks for construction workers		
24. **Community health and safety**.	- Accidents and injuries to people living near the construction sites - Inconveniences to communities living near construction sites for example due blocking of access routes, disruption of utility services due to excavation works - Inconveniences caused to traffic plying on the road near project alignment due to traffic jams or unsafe conditions caused by project construction - Extra burden on local resources such as water supply, electricity because of their use in construction sites and camps - Health problems such as malaria, COVID-19, HIV/AIDs, and STDs	- Implement the following approved plans: 1) Camp Management Plan 2) Emergency Response Plan for camp sites and construction sites 3) traffic management plan 4) code of conduct for construction workers 5) muck disposal and management plan 6) construction waste disposal and management plan 7) public communication plan to regularly keep the public informed on project activities including on the project GRM - Follow the project GRM to address all local complaints - Conduct health screening of construction workers before recruitment to ensure no workers with contagious diseases including COVID-19, HIV, AIDs and STDs are recruited - Conduct awareness campaigns on COVID-19, HIV, AIDs and STD for construction workers as well as local public near the construction site	Contractor, PIU, PMO	PIU, PMO, GC, External Monitor

Activity/Valued Environment Component	Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
	brought by construction workers - Social conflicts between workers and local communities - Complaints from local people against the project	- Ensure all construction sites and camps have clear signs with clear demarcation of prohibited zones such as areas where overhead construction works are going on, or areas where underground tunneling works are going on		
25. Physical cultural resources (PCR) - Chance find procedures	- Destruction of historical artefacts that maybe buried along the alignment	- If any artefacts are found during excavation works, immediately inform the Archaeology Department and follow their guidance on next steps	PMO, Contractor, GC	GC, External Monitor
C. OPERATION STAGE				
I. Physical environment				
26. Surface water quality and quantity.	- Pollution of already heavily polluted Nalla near Barapulla flyover from release of raw sewage and untreated waste- water	- Inclusion of septic tanks or other sewage treatment system within the design of the stabling yard facility.	NCRTC	MOHUA, External Monitor
27. Ground water quality and quantity - Generation of sewage and contaminated waste water from the stabling yard	- Pollution of ground water due to release of sewage and untreated waste-water containing fuels, oils, chemicals from the stabling yard -	- Maintain functional septic tanks in stabling yard or linkage with municipal sewage pipes and municipal sewage treatment systems. - Maintain waste-water treatment plants equipped with provisions to trap oil, grease and lubricants etc. in the yard - Implement water conservation measures such as waste-water recycling and rainwater harvesting in the yard	NCRTC	MOHUA, External Monitor

Activity/Valued Environment Component	Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
		- If using ground water for the stations and depots seek required approval from CGWA and ensure quantities of water extracted is in accordance with approved limits - Water supply plan to account for availability of local water resources and avoiding adding stress		
28. Land degradation/ pollution - Operation of the stabling yard	- Pollution and degradation of land near the project alignment due to improper disposal of waste generated in the yard including hazardous chemicals, solvents, fuels and other materials	- Stabling yard wastes to be disposed at nearest land fill sites or linked with the municipal waste management system - management systems and waste recycling agencies - Only treated waste-water from the Sarai Kale Khan - Jungpura Stabling Yard line and associated facilities to be released into the environment - No disposal of solid or liquid wastes, sewage and hazardous chemicals, fuels and lubricants from the project components in the surrounding environment	NCRTC	MOHUA, External Monitor
		II. Biological environment		
29. Trees and vegetation	- Net loss in biodiversity because of the project	- Maintain the trees planted through regular watering and protection from cattle - Ensure a survival rate of at least 85% for the trees planted during construction stage - Maintain the green spaces (potted plants, vertical gardens etc.) created in the elevated station and alignment	NCRTC	MOHUA, External monitor

Activity/Valued Environment Component	Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
		III. Social environment		
30. Noise - Operation of trains and working in stabling yard	- Disturbance and annoyance to residents living near the elevated section and station - Significant increase in noise (>3dBA) for 1 receptors - Complaints from local people due to excessive noise - Negative media attraction because of excessive noise and disturbance - Disturbance to local community living or working near the yard	- Monitor noise levels at identified sensitive receptors during first year of operation - Monitor noise levels at communities near the yard - Conduct public consultations with communities living near the yard to check if the RRTS operations are disturbing them - Check whether noise barriers are effective in reducing noise levels as anticipated for 1 receptor near train alignment - Identify and implement additional noise reducing measures near sensitive receptors where incremental noise levels are still >3dB(A) from baseline levels - Inform general public on noise management measures taken under the project	NCRTC	MOHUA, External Monitor
31. **Vibration**. Operation of trains and station	- Disturbance and annoyance to people living and working near the rail alignment	- Monitor vibration levels generated by train operations with specific emphasis at identified sensitive receptors and weak structures during first year of operation - Continue monitoring vibration levels as the number of trains and frequency increases - If any damages to structures are noticed due train operation immediately take remedial measures such as strengthening the structure or relocating and	NCRTC	MOHUA, External Monitor

Activity/Valued Environment Component	Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
		compensating the owner of the building		
32. **Occupational health and safety** of operations staff for managing trains, tracks and yard.	- Accidents and injury to staff - Health problems for staff caused by hazardous working conditions	- Prepare emergency preparedness and response plan for stabling yard and trains - Conduct regular drills for staff in implementing emergency response plan - Provision of PPE to operations staff including loco drivers, station staff, track engineers, electric technicians - Conduct regular training to staff health and safety - Deploy adequate security personnel in yard	NCRTC	MOHUA, External Monitor
33. Community health and safety - Operation of the trains - Operation of the yard	- Accidents and injuries to passengers using the train and yard - Collision of trains and derailment, fire power outages, stopping of train services - Stress on local resources (water, electricity etc.) due to extraction on these resources for operating the trains and stabling yard facility	- Automatic brake application included as a safety feature in locos - Back up generators of adequate capacity will be provided for un-interrupted lighting, signaling, telecommunications, fire fighting, lift operation, tunnel ventilation etc. - Station design to include passenger friendly and safety features such as: clear signage on entry, exit, prohibited areas etc; clear public announcements; presence of adequate housekeeping and customer service staff; automatic fare collection system - Station and trains to have emergency response system and facilities such as emergency escape	NCRTC	MOHUA, External Monitor

Activity/Valued Environment Component	Impact	Mitigation Measure	Responsibility	
			Implementation	Supervision
		routes, fire alarm, fire extinguisher etc. - Regular safety drills for operational staff on emergency response procedures - Internal environment control system for trains and stations - Security surveillance systems including CCTV - Supply of treat ground water for public use in yard - Installation of rain-water harvesting facilities in the station to help conserve water - Installation of rain-water harvesting and waste water recycling facilities in the yard to help conserve water - Release of treated waste water from the yard into the environment		

Table 33: Environmental Monitoring Plan

Environmental Features	Aspect to be Monitored	Time and Frequency of Monitoring	Location	Monitoring Cost (INR)	Responsible party (Implementation/ Supervision)
Pre-Construction stage					
Noise	Noise levels	24 hours continuous noise monitoring at sensitive locations	Project Site (3 locations)	3000*3*=9000	Contractor & NCRTC
Air	Emission of dust and particulate matter as PM2.5 and PM10, NOx and SOx, CO	24 hours continuous monitoring once	Project Site (2 locations)	8000*2=16000	Contractor & NCRTC

Environmental Features	Aspect to be Monitored	Time and Frequency of Monitoring	Location	Monitoring Cost (INR)	Responsible party (Implementation/ Supervision)
Vibrations	PPV mm/s	Once prior to start of construction.	At key structure locations (1 Location, Siddhartha Extn.)	50000	Contractor & NCRTC
			Sub-Total	**75000**	
Construction stage					
Noise	Noise levels in dB(A)	Quarterly (12 samples in total on hourly basis for 24 hours)	Project Site (3 locations of baseline monitoring)	3000*12 =36000	Contractor & NCRTC
Air	Emission of dust and particulate matter as PM2.5 and PM10, NOx and SOx, CO	Quarterly (6 samples in total hourly basis for 24 hours)	Project Site (2 locations of baseline monitoring)	8000*6=48000	Contractor & NCRTC
Water	DO, Turbidity, Conductivity, pH, E.Coli, TSS, Oil and Grease and TDS	Quarterly (4 samples in total)	Ground water at construction camps	4000*4=16000	Contractor & NCRTC
Occupational Health and Safety	As specified in project OHS plan prepared by Contractor	Project site Weekly	Project Site	Project Cost	Contractor & NCRTC
			Sub-Total	**100000**	
Operation Stage					
Occupational Health and Safety	As specified in project OHS plan prepared by Contractor	Line and Stabling yard Monthly	Project Site	Project Cost	NCRTC
Water	DO, Turbidity, Conductivity, pH, E.Coli, TSS, Oil and Grease and TDS	Six monthly	Ground water at Stabling yard	4000*6*1=24000	NCRTC
	DO, BOD, COD, heavy metals, Turbidity, Conductivity, pH, E.Coli, TSS, Oil and Grease and TDS	Six monthly	Effluent from Station locations and depot	4000*6*1=24000	NCRTC

Environmental Features	Aspect to be Monitored	Time and Frequency of Monitoring	Location	Monitoring Cost (INR)	Responsible party (Implementation/ Supervision)
Noise	Noise levels in dB(A)	At least 2 times in a year for 3 years	Alignment, Stabling yard	3000*3*2 =18000	NCRTC
Air	Emission from DG sets (SPM, NOx and SOx)	At least 2 times in a year for 3 years	Project site	8000*3*2=48000	NCRTC
Vibrations	PPV mm/s	Once within in 6 months operation start.	At key structure locations (1 Location, Siddhartha Extn.)	50000	NCRTC
			Sub-Total	**164000**	
			Grand Total	**264000**	

Note: the cost estimate is tentative.

D. Environmental Management Budget and Resources

334. The cost of all compensation and rehabilitations works will be an integrated part of the overall project cost, which will be borne by the project. The preliminary estimated cost[7] of the environmental management plan including implementation and monitoring is US$ 0.56 million (INR 41.22 million) as detailed in Table 34.

Table 34:Cost of EMP Implementation*

Sl. No.	Item/Particular	Cost Rs. Lakh
1.	Tree Plantation 12720 trees @ Rs.2000/- per tree	254.40
2.	Green Belt at Stabling yard	15.00
3.	Noise barriers	130.20
4.	Environmental monitoring (Air, Noise, vibration, Water, Waste Water, Solid waste, during construction and operation)	2.64
5	Additional fees, if payable ,to already engaged external monitor consultant	10.00
	Total	**412.24**

- *Note: (i).Cost estimate is tentative and subject to change following detailed design provisions.*

  (ii).Cost of provisioning of Ballastless track for noise and vibration reduction is Rs.1200 Lakh per kilometer

X. CONCLUSION AND RECOMMONDATION

A. Conclusions

335. The proposed Sarai Kale Khan - Jungpura Stabling Yard RRTS line and the stabling yard are not located in any environmentally sensitive or protected areas. The alignment neither passes through nor lies within 250m from any of the state or nationally protected archaeological monument. For the Phase-I, about 1272 trees will be cut These will be compensated at the rate of 10 trees for every tree removed. Best efforts will be made to transplant trees. Hence, no significant ecological impacts are envisaged.

336. Key environmental risks under the project include: 1) health and safety risks for the construction workers and local residents living along the project alignment and traffic that will play on the existing road and 2) noise and vibration impacts during construction and operation of the RRTS. The first risk will exist only during project construction stage and adequate health and safety requirements have been included in the EMP and SHE manual to mitigate it.

337. Analysis of noise impacts show that 7 location of receptors during construction stage and operation stage are at risk of experiencing an increase in noise levels greater than 3 dB(A) from baseline levels. A number of mitigation measures on use of most modern (less noisy equipment), adjusting timing of use of noisy equipment, use of mufflers on noisy equipment and installation of acoustic screens have been proposed to minimize construction related noise. During operation, noise barriers that will reduce noise levels from 20 – 22 dB(A) are

[7] This EMP budget estimate shall be updated as per requirement based on recommendations in Shadow Study of viaduct in Sidhartha Extension and other requirements, if any.

proposed to be installed near the 1 sensitive receptor to avoid an increase in long term noise levels beyond 3 dB(A).

338. Preliminary analysis of vibration impacts following the FTA guidelines show that adverse impacts are expected mainly during construction stage. About 5 receptors are at risk of experiencing vibration levels above the threshold for causing damage during construction stage. To mitigate this risk, it is recommended that only bored piling (not impact piling) is used for boring works. Long term vibration impacts from operation of the RRTS is expected to be fully mitigated through integration of vibration dampening features in the rail tracks such as floating slab track bed, elastomeric pads and rail pads. In addition, the rolling stock will be made of stainless steel bodies equipped with air springs and vertical hydraulic damper.

339. Best available technology and best management practices are built-in to the project design. All project components will be implemented and monitored in line with the ADB's SPS 2009 requirements and standards of India. The proposed project institutional set up includes adequate personnel to implement, monitor and report on environment safeguards.

B. Recommendations

340. The construction of connecting line viaduct is included in already awarded contract package no.6 for the elevated section in Delhi area which includes NCRTC's SHE manual and requires the contractor to prepare contract specific EMP~~.~~ The same is the case with the already awarded contract package for the construction of multi-story staff quarters . In future bidding packages, NCRTC shall ensure that the SHE manual and requirement to prepare a contract specific EMP is included in the bidding documents.

341. Although there are no major changes in the Project design and location are anticipated, this EIA may need updating for any change in design prior to start of civil works or during construction stage.

APPENDICES

Provided in a Separate Volume
(Volume 2 – Appendices)

Appendix 1: Rapid Environmental Assessment (REA) Checklist

Instructions:

(i) The project team completes this checklist to support the environmental classification of a project. It is to be attached to the environmental categorization form and submitted to the Environment and Safeguards Division (SDES), for endorsement by Director, SDES and for approval by the Chief Compliance Officer.

(ii) This checklist focuses on environmental issues and concerns. To ensure that social dimensions are adequately considered, refer also to ADB's (a) checklists on involuntary resettlement and Indigenous Peoples; (b) poverty reduction handbook; (c) staff guide to consultation and participation; and (d) gender checklists.

(iii) Answer the questions assuming the "without mitigation" case. The purpose is to identify potential impacts. Use the "remarks" section to discuss any anticipated mitigation measures.

Country/Project Title:	IND / Stabling yard RRTS connecting line from Sarai Kale Khan – Stabling Jungpura
Sector Division:	SATC

Screening Questions	Yes	No	Remarks
A. Project Siting Is the project area adjacent to or within any of the following environmentally sensitive areas?			The Project involves construction of 1.35km RRTS line.
▪ Cultural heritage site		X	
▪ Protected Area		X	
▪ Wetland		X	
▪ Mangrove		X	
▪ Estuarine		X	
▪ Buffer zone of protected area		X	
▪ Special area for protecting biodiversity		X	
B. Potential Environmental Impacts Will the Project cause…			
▪ encroachment on historical/cultural areas; disfiguration of landscape by road embankments, cuts, fills, and quarries?		X	The topography of the project area is mainly plain. There is no encroachment of historical places.
▪ encroachment on precious ecology (e.g. sensitive or protected areas)?		X	Only cutting of 1272 trees is involved. Attempts have been made to minimize the cutting of trees.

Screening Questions	Yes	No	Remarks
▪ alteration of surface water hydrology of waterways crossed by roads, resulting in increased sediment in streams affected by increased soil erosion at construction site?		X	The proposed RRTS alignment does not crosses any major water body. It crosses a Nalla (Open Sewer Drain) near Barapulla flyover.
▪ deterioration of surface water quality due to silt runoff and sanitary wastes from worker-based camps and chemicals used in construction?		X	Adequate sanitary facilities will be provided at construction camps, which will be set-up away from habitat and water bodies. No harmful ingredients are likely to be used in the construction activities. As such, no impact on surface water quality is anticipated due to construction.
▪ increased local air pollution due to rock crushing, cutting and filling works, and chemicals from asphalt processing?	X		Localised air pollution level is likely to increase for short duration during construction period due to construction vehicle movement and concrete batching and processing. The concrete batching plant (casting yard) will be located away from habitat areas with adequately high stack for effective dispersion of likely emissions. Dust separation measures like spraying of water on unpaved vehicle movement areas are proposed to minimise the dust generation.
▪ risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological, and radiological hazards during project construction and operation during project construction and operation?	X		Workers may get exposed to dust and noise during construction activities. However, the exposure levels are likely to be short and insignificant. Workers will be provided requisite Personal Protective Equipments to minimise such exposure and associated harmful occupational health effects. As such, no occupational health hazard is anticipated during operation phase.
▪ noise and vibration due to blasting and other civil works?		X	No blasting is involved. No significant noise generation is expected during construction activities except normal construction equipment's operational noise. These noise levels will be impulsive in nature and its impact will be confined within few meters of either side of the project alignment. All stationary noise making sources equipment like DG set, compressors will be installed with acoustic enclosures. Provision of noise barriers will be made wherever noise level is likely to increase beyond the prescribed ambient noise levels
▪ dislocation or involuntary resettlement of people?	X		Yes. The project-affected persons are expected to be very less. There will be need for small land acquisition. This aspect will be addressed as per Govt. rules and ADB"s Social Safeguard Policies (SPS 2009) separately.
▪ dislocation and compulsory resettlement of people living in right-of-way?	X		Compensation as per Govt. rules and alternate site for shops to be provided for the displaced persons.

Screening Questions	Yes	No	Remarks
▪ disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable groups?		X	No such impact is anticipated.
▪ other social concerns relating to inconveniences in living conditions in the project areas that may trigger cases of upper respiratory problems and stress?		X	No such social concern is expected. Concern may arise during construction stage due to increase in ambient air pollution level, which is expected to be localised and temporary in nature. This aspect will be effectively controlled with the proposed dust suppression and other mitigation measures.
▪ hazardous driving conditions where construction interferes with pre-existing roads?	X		Hazardous driving condition may arise around construction areas. To minimize the impact suitable traffic management plan will be designed and implemented by the contractor to prevent any hazardous driving condition in above situations.
▪ poor sanitation and solid waste disposal in construction camps and work sites, and possible transmission of communicable diseases (such as STI's and HIV/AIDS) from workers to local populations?		X	Proper provisions for sanitation, health care (drinking water supply and periodic health check-ups) and solid waste disposal facilities will be made at each construction camp. Awareness will be created amongst the workers about hygiene and health protection.
▪ creation of temporary breeding habitats for diseases such as those transmitted by mosquitoes and rodents?		X	No such condition is anticipated.
▪ accident risks associated with increased vehicular traffic, leading to accidental spills of toxic materials?		X	Adequate safety measures will be adopted to avoid accidents during construction and operation stages. Measures, like signage, speed control; crash barriers will be taken close to sensitive locations such as schools, temple or hospitals.
▪ increased noise and air pollution resulting from traffic volume?		X	Increase in noise and air pollution is expected during construction phase but is likely to be confined within few meters of either side of the project alignment. Adequate mitigation measures will be adopted to minimise the same. During operation stage, RRTS will provide a comfortable travel and provide pollution free alternate mode for commuters.
▪ increased risk of water pollution from oil, grease and fuel spills, and other materials from vehicles using the road?	X		This possibility is minimal but cannot be ruled out. Controlled construction activities and proper drainage system will reduce this possibility.
▪ social conflicts if workers from other regions or countries are hired?		X	Most of the workers will be hired locally.
▪ large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)?		X	Most of the workers will be hired locally. The small construction camps are unlikely to cause any significant burden on social infrastructure and services.

Screening Questions	Yes	No	Remarks
▪ risks to community health and safety due to the transport, storage, and use and/or disposal of materials such as explosives, fuel and other chemicals during construction and operation?		X	The construction material (aggregate from approved quarries, borrow earth, bitumen) will be sourced from nearby and approved sources. No explosive or chemicals are likely to be used. Bitumen waste if any generated during construction and garbage from stations will either be recycled or disposed of in controlled manner.
▪ community safety risks due to both accidental and natural causes, especially where the structural elements or components of the project are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation and decommissioning.		X	No such impacts are anticipated. Adequate awareness will be created amongst people and workers through information disclosure, safety signage and public consultation about safety aspects.

A Checklist for Preliminary Climate Risk Screening

Country/Project Title: IND / RRTS connecting line from Sarai Kale Khan to Stabling Yard, Jungpura
Sector: Transport
Subsector: Urban Transport
Division/Department: SATC / SARD

Screening Questions		Score	Remarks[1]
Location and Design of project	Is siting and/or routing of the project (or its components) likely to be affected by climate conditions including extreme weather-related events such as floods, droughts, storms, landslides?	0	The topography of project area is plain. There is no presence of Aravali ridges in project corridor and surroundings although these are prominent in other parts of NCR region. The project region falls in Zone IV i.e. a region of high seismic hazard zone. The region experiences extreme cold and extreme hot temperatures during winter and summer seasons respectively. The impacts can be mitigated by adopting IS codes in design of different components of RRTS. The area is not subject to natural hazards like tropical cyclone winds, storm surges, tsunami or volcanic eruptions.
	Would the project design (e.g. the clearance for bridges) need to consider any hydro-meteorological parameters	1	Project design will consider hydrometeorological parameters to lessen the impact of RRTS on flooding.

[1] If possible, provide details on the sensitivity of project components to climate conditions, such as how climate parameters are considered in design standards for infrastructure components, how changes in key climate parameters and sea level might affect the siting/routing of project, the selection of construction material and/or scheduling, performances and/or the maintenance cost/scheduling of project outputs.

	(e.g., sea-level, peak river flow, reliable water level, peak wind speed etc)?		
Materials and Maintenance	Would weather, current and likely future climate conditions (e.g. prevailing humidity level, temperature contrast between hot summer days and cold winter days, exposure to wind and humidity hydro-meteorological parameters likely affect the selection of project inputs over the life of project outputs (e.g. construction material)?	1	Project inputs will likely be assessed in view of diverse future climate conditions in the regions.
	Would weather, current and likely future climate conditions, and related extreme events likely affect the maintenance (scheduling and cost) of project output(s) ?	1	Extreme events will likely affect the maintenance of the project.
Performance of project outputs	Would weather/climate conditions, and related extreme events likely affect the performance (e.g. annual power production) of project output(s) (e.g. hydro-power generation facilities) throughout their design life time?	1	Extreme events will likely affect the performance of the project.

Options for answers and corresponding score are provided below:

Response	Score
Not Likely	0
Likely	1
Very Likely	2

Responses when added that provide a score of 0 will be considered <u>low risk</u> project. If adding all responses will result to a score of 1-4 and that no score of 2 was given to any single response, the project will be assigned a <u>medium risk</u> category. A total score of 5 or more (which include providing a score of 1 in all responses) or a 2 in any single response, will be categorized as high-risk project.

Result of Initial Screening (Low, Medium, High): <u>Medium</u>

Other Comments:____

Prepared by: ____**<u>xxxxxx</u>**____________

Appendix 2: Details of Environmental Monitoring

ULTRA TESTING & RESEARCH LABORATORY

(An ISO 9001:2015, OHSAS 45001:2018, 14001:2015 (EMS) Certified)
Laboratory: C-43, Sector-88, Phase-II, Noida, U.P.
Ph.: No.: +91-9971912476, 9350952231
E-mail: ultraresearchlab@gmail.com
Website: http://www.ultralabnoida.com

Ultra Lab

TC-8198

TEST REPORT

Ambient Air Quality Analysis
Discipline/Group-Chemical/Atmospheric Pollution

Report Code: AAQ-13012021-01 **Date :19/01/2021**

Issued To : **ES SAFEGUARDS COMPLIANCE SERVICES PVT. LTD. 501,SKYLAND APARTMENTS,SECTOR-56 GURGAON-122001**

Project Name	: Delhi-Meerut RRTS Alignment in NCR Region
Sample Drawn On	: 12/01/2021 To 13/01/2021
Sample Drawn By	: UTRL
Sample Description	: Ambient Air
Sampling Location	: Near Stabling Yard
Latitude/ Longitude	: N 28° 34' 39.4" , E 77° 15' 04.7"
Analysis Duration	: 13/01/2021 To 19/01/2021
Average Flow Rate of PM_{10} (m^3/min.)	: 1.20
Average Flow Rate of Gases (lpm)	: 1.0
Sampling Instrument Used	: Respairable Dust Sampler (PM10) Fine Particulate : Sampler (PM2.5) With Gaseous Attachment.
Ambient Temperature	: 16°C
Weather Condition	: Clear

TEST RESULT

S.No	Parameters	Test Method	Result	Units	Limits as per NAAQS
1	Particulate Matter (PM_{10})	IS:5182 (Part-23)	244.98	µg /m³	100.0
2	Particulate Matter ($PM_{2.5}$)	IS:5182 (Part-24)	139.97	µg /m³	60.0
3	Sulphur Dioxide (as SO_2)	IS:5182 (Part-2)	27.56	µg /m³	80.0
4	Nitrogen Dioxide (as NO_2)	IS:5182(Part-6)	38.08	µg /m³	80.0
5	Carbon monoxide(as CO)	IS:5182(Part-10)	0.69	mg /m³	4.0
6	Lead(as Pb)	IS:5182 (Part-22)	<0.1	µg /m³	1.0
7	Ozone (as O_3)	IS:5182 (Part-9)	20.47	µg /m³	180.0
8	Ammonia (as NH_3)	IS:5182 (Part-25)	26.44	µg /m³	400.0

End Of Report

Note:-

1. The results given above are related to the tested sample, for various parameters, as observed at the time of sampling. The customer asked for the above tests only.
2. This test report will not be used for any publicity/legal purpose.
3. The test samples will be disposed off after two weeks from the date of issue of test report, unless until specified by the customer.
4. The Report can not be used as evidence in a court of law without the written approval of the lab.

For Ultra Testing & Research Laboratory

Checked By

(Authorized Signatory)

TECHNICAL MANAGER

ULTRA TESTING & RESEARCH LABORATORY

Assuring you of best our services at all times.

ULTRA TESTING & RESEARCH LABORATORY
(An ISO 9001:2015, OHSAS 45001:2018, 14001:2015 (EMS) Certified)
Laboratory: C-43, Sector-88, Phase-II, Noida, U.P.
Ph.: No.: +91-9971912476, 9350952231
E-mail: ultraresearchlab@gmail.com
Website: http://www.ultralabnoida.com

TEST REPORT

Ambient Air Quality Analysis

Report Code: AAQ-13012021-01 **Date :19/01/2021**

Issued To : **ES SAFEGUARDS COMPLIANCE SERVICES PVT. LTD. 501,SKYLAND APARTMENTS,SECTOR-56 GURGAON-122001**

Project Name	: Delhi-Meerut RRTS Alignment in NCR Region
Sample Drawn On	: 12/01/2021 To 13/01/2021
Sample Drawn By	: UTRL
Sample Description	: Ambient Air
Sampling Location	: Near Stabling Yard
Latitude/ Longitude	: N 28° 34' 39.4" , E 77° 15' 04.7"
Analysis Duration	: 13/01/2021 To 19/01/2021
Weather Condition	: Clear

TEST RESULT

S.No	Parameters	Test Method	Result	Units	Limits as per NAAQS
9	Nickel (as Ni)	CPCB Guideline	< 1.0	ng /m^3	20.0
10	Mercury (as Hg)	USEPA Method	<0.1	µg /m3	-
11	Arsenic (as As)	CPCB Guideline	< 0.1	ng /m^3	6.0
12	Hydrocarbon (as HC)	IS:5182 (Part-17)	< 1.0	ppm	-
13	Hydrogen Fluoride(as HF)	IS:5182 (Part-13)	< 1.0	ppm	-

Note:- **End Of Report**

1. The results given above are related to the tested sample, for various parameters, as observed at the time of sampling. The customer asked for the above tests only.
2. This test report will not be used for any publicity/legal purpose.
3. The test samples will be disposed off after two weeks from the date of issue of test report, unless until specified by the customer.
4. The Report can not be used as evidence in a court of law without the written approval of the lab.

For Ultra Testing & Research Laboratory

Checked By (Authorized Signatory)

ULTRA TESTING & RESEARCH LABORATORY TECHNICAL MANAGER

Assuring you of best our services at all times.

ULTRA TESTING & RESEARCH LABORATORY
(An ISO 9001:2015, OHSAS 45001:2018, 14001:2015 (EMS) Certified)
Laboratory: C-43, Sector-88, Phase-II, Noida, U.P.
Ph.: No.: +91-9971912476, 9350952231
E-mail: ultraresearchlab@gmail.com
Website: http://www.ultralabnoida.com
Ultra Lab
TC-8198

TEST REPORT

Ambient Air Quality Analysis
Discipline/Group-Chemical/Atmospheric Pollution

Report Code: AAQ-13012021-02 **Date :19/01/2021**

Issued To	: **ES SAFEGUARDS COMPLIANCE SERVICES PVT. LTD. 501,SKYLAND APARTMENTS,SECTOR-56 GURGAON-122001**
Project Name	: Delhi-Meerut RRTS Alignment in NCR Region
Sample Drawn On	: 12/01/2021 To 13/01/2021
Sample Drawn By	: UTRL
Sample Description	: Ambient Air
Sampling Location	: Near Saraikalekhan
Latitude/ Longitude	: N 28° 34' 58.1" , E 77° 15' 37.3"
Analysis Duration	: 13/01/2021 To 19/01/2021
Average Flow Rate of PM_{10} (m^3/min.)	: 1.30
Average Flow Rate of Gases (lpm)	: 1.0
Sampling Instrument Used	: Respairable Dust Sampler (PM10) Fine Particulate : Sampler (PM2.5) With Gaseous Attachment.
Ambient Temperature	: 16°C
Weather Condition	: Clear

TEST RESULT

S.No	Parameters	Test Method	Result	Units	Limits as per NAAQS
1	Particulate Matter (PM_{10})	IS:5182 (Part-23)	263.15	µg /m^3	100.0
2	Particulate Matter ($PM_{2.5}$)	IS:5182 (Part-24)	152.67	µg /m^3	60.0
3	Sulphur Dioxide (as SO_2)	IS:5182 (Part-2)	30.51	µg /m^3	80.0
4	Nitrogen Dioxide (as NO_2)	IS:5182(Part-6)	41.81	µg /m^3	80.0
5	Carbon monoxide(as CO)	IS:5182(Part-10)	1.15	mg /m^3	4.0
6	Lead(as Pb)	IS:5182 (Part-22)	<0.1	µg /m^3	1.0
7	Ozone (as O_3)	IS:5182 (Part-9)	23.16	µg /m^3	180.0
8	Ammonia (as NH_3)	IS:5182 (Part-25)	29.11	µg /m^3	400.0

End Of Report

Note:-

1 The results given above are related to the tested sample, for various parameters, as observed at the time of sampling. The customer asked for the above tests only.

2 This test report will not be used for any publicity/legal purpose.

3 The test samples will be disposed off after two weeks from the date of issue of test report, unless until specified by the customer.

4 The Report can not be used as evidence in a court of law without the written approval of the lab.

For Ultra Testing & Research Laboratory

Checked By

(Authorized Signatory)

ULTRA TESTING & RESEARCH LABORATORY TECHNICAL MANAGER

Assuring you of best our services at all times.

Ultra Lab

ULTRA TESTING & RESEARCH LABORATORY

(An ISO 9001:2015, OHSAS 45001:2018, 14001:2015 (EMS) Certified)
Laboratory: C-43, Sector-88, Phase-II, Noida, U.P.
Ph.: No.: +91-9971912476, 9350952231
E-mail: ultraresearchlab@gmail.com
Website: http://www.ultralabnoida.com

TEST REPORT

Ambient Air Quality Analysis

Report Code: AAQ-13012021-02 **Date :19/01/2021**

Issued To : **ES SAFEGUARDS COMPLIANCE SERVICES PVT. LTD.**
501,SKYLAND APARTMENTS,SECTOR-56
GURGAON-122001

Project Name	: Delhi-Meerut RRTS Alignment in NCR Region
Sample Drawn On	: 12/01/2021 To 13/01/2021
Sample Drawn By	: UTRL
Sample Description	: Ambient Air
Sampling Location	: Near Stabling Yard
Latitude/ Longitude	: N 28° 34' 58.1" , E 77° 15' 37.3"
Analysis Duration	: 13/01/2021 To 19/01/2021
Weather Condition	: Clear

TEST RESULT

S.No	Parameters	Test Method	Result	Units	Limits as per NAAQS
9	Nickel (as Ni)	CPCB Guideline	< 1.0	ng /m^3	20.0
10	Mercury (as Hg)	USEPA Method	<0.1	µg /m3	-
11	Arsenic (as As)	CPCB Guideline	< 0.1	ng /m^3	6.0
12	Hydrocarbon (as HC)	IS:5182 (Part-17)	< 1.0	ppm	-
13	Hydrogen Fluoride(as HF)	IS:5182 (Part-13)	< 1.0	ppm	-

Note:- **End Of Report**

1 The results given above are related to the tested sample, for various parameters, as observed at the time of sampling. The customer asked for the above tests only.

2 This test report will not be used for any publicity/legal purpose.

3 The test samples will be disposed off after two weeks from the date of issue of test report, unless until specified by the customer.

4 The Report can not be used as evidence in a court of law without the written approval of the lab.

For Ultra Testing & Research Laboratory

Checked By

(Authorized Signatory)

ULTRA TESTING & RESEARCH LABORATORY TECHNICAL MANAGER

Assuring you of best our services at all times.

Ultra Lab

ULTRA TESTING & RESEARCH LABORATORY

(An ISO 9001:2015, OHSAS 45001:2018, 14001:2015 (EMS) Certified)
Laboratory: C-43, Sector-88, Phase-II, Noida, U.P.
Ph.: No.: +91-9971912476, 9350952231
E-mail: ultraresearchlab@gmail.com
Website: http://www.ultralabnoida.com

TEST REPORT

Metrological Report
Discipline/Group-Chemical/Atmospheric Pollution

Report Code: **M-13012021-01** **Issue Date: 18/01/2021**

ISSUED TO : **ES SAFEGUARDS COMPLIANCE SERVICES PVT. LTD.**
501,SKYLAND APARTMENTS,SECTOR-56
GURGAON-122001

Project Name	: Delhi-Meerut RRTS Alignment in NCR Region
Monitoring Date	: 12/01/2021 To 13/01/2021
Sample Drawn By	: UTRL
Sampling Hours	: 10.00 am -10 am (24 Hours)
Sampling Location	: Sarai Kale Khan
Latitude & Logitude	: N 28°35'5.6" , E 077°15'34.4"
Sample Description	: Weather Monitoring

Test Parameter

S.No.	Time	Wind Direction	Wind speed Km/h	Temprature °C	Humidity %	Rainfall (CM)
1	10:00:00	SW	4	14	75	0
2	11:00:00	SW	3	16	62	0
3	12:00:00	WSW	5	17	51	0
4	13:00:00	WSW	4	19	57	0
5	14:00:00	SW	2	18	61	0
6	15:00:00	SW	5	19	62	0
7	16:00:00	SW	6	18	63	0
8	17:00:00	SW	2	18	67	0
9	18:00:00	WSW	1	17	74	0
10	19:00:00	WSW	3	16	81	0
11	20:00:00	SW	4	14	87	0
12	21:00:00	SW	5	13	92	0
13	22:00:00	SW	3	13	94	0
14	23:00:00	SW	5	12	94	0
15	00:00:00	SW	4	12	94	0
16	01:00:00	SW	3	11	95	0
17	02:00:00	SW	4	11	95	0
18	03:00:00	SW	2	11	94	0
19	04:00:00	SW	5	10	93	0
20	05:00:00	WSW	5	10	92	0
21	06:00:00	WSW	[illegible]	9	90	0
22	07:00:00	WSW	3	9	89	0
23	08:00:00	SW	4	11	89	0
24	09:00:00	SW	4	12	86	0

SW-South Westerly ,WSW-West South Westerly

Note:- **End Of Report**

1. The results given above are related to the tested sample, for various parameters, as observed at the time of sampling .The customer asked for the above tests only.
2. This test report will not be used for any publicity/legal purpose
3. The test samples will be disposed off after two weeks from the date of issue of test report, unless until specified by the customer.
4. The Report can not be used as evidence in a court of law without the written approval of the lab.

For Ultra Testing & Research Laboratory

Tarun
Checked By

Assuring you of best our services at all times.

(Authorized Signatory)

ULTRA TESTING RESEARCH LABORATORY TECHNICAL MANAGER

ULTRA TESTING & RESEARCH LABORATORY

(An ISO 9001:2015, OHSAS 45001:2018, 14001:2015 (EMS) Certified)
Laboratory: C-43, Sector-88, Phase-II, Noida, U.P.
Ph.: No.: +91-9971912476, 9350952231
E-mail: ultraresearchlab@gmail.com
Website: http://www.ultralabnoida.com

Ultra Lab

TC-8198

TEST REPORT

Water Sample Analysis
Discipline/Group-Chemical/Water

Report Code: W-13012021-01 **Issue Date: 19/01/2021**

ISSUED TO : **ES SAFEGUARDS COMPLIANCE SERVICES PVT. LTD.
501,SKYLAND APARTMENTS,SECTOR-56
GURGAON-122001**

Project Name	: Delhi-Meerut RRTS Alignment in NCR Region
Sample Drawn On	: 13/01/2021
Sample Drawn By	: UTRL
Sample Description	: Ground Water
Sampling Location	: Sample Collected from Saraikalekhan Project Site
Latitude/ Longitude	: N 28^0 34' 58.2" , E 77^0 15' 37.4"
Sample Quantity	: 2.0 Litre
Sampling Procedure	: IS 3025(Part-01)
Analysis Duration	: 13/01/2021 to 19/01/2021

RESULTS

S.No	Parameter	Test Method	Results	Units	Acceptable Limit	Permissible Limit in the Absence of Alternate Source
1	pH	IS:3025(Part-11)	7.18	-	6.5-8.5	-
2	Conductivity	IS:3025(Part-14)	3172	µs/cm.	-	-
3	Colour	IS:3025(Part-04)	<5.0	Hazen	5	15
4	Odour	IS-3025(Part-05)	Agreeable	-	Agreeable	Agreeable
5	Taste	IS:3025(Part-07)	Agreeable	-	Agreeable	Agreeable
6	Turbidity	IS-3025(Part-10)	<1.0	NTU	1	5
7	Total Hardness (as $CaCO_3$)	IS:3025(Part-21)	610	mg/l	200	600
8	Calcium(as Ca)	IS:3025(Part-40)	128.00	mg/l	75	200
9	Magnesium(as Mg)	IS:3025(Part-46)	70.47	mg/l	30	100
10	Chloride(as Cl)	IS:3025(Part-32)	381.58	mg/l	250	1000
11	Iron(as Fe)	IS:3025(Part-53)	0.77	mg/l	0.3	No Relaxation
12	Fluoride(as F)	IS:3025(Part-60)	0.37	mg/l	1	1.5
13	Free Residual chlorine	IS:3025(Part-26)	<0.1	mg/l	0.2	1
14	Total Dissolved Solid	IS:3025(Part-16)	1840	mg/l	500	2000
15	Phenolic Compound (as C_6H_5OH)	IS: 3025 (Part-43)	<0.001	mg/l	0.001max	0.002 Max
16	Anionic Detergents (as MBAS)	Annex K of IS 13428	<0.1	mg/l	0.2	1.0

Contd. To report W-13012021-01 (Page 1 of 2)

ULTRA TESTING & RESEARCH LABORATORY ★ TECHNICAL MANAGER

Assuring you of best our services at all times.

Ultra Lab

ULTRA TESTING & RESEARCH LABORATORY

(An ISO 9001:2015, OHSAS 45001:2018, 14001:2015 (EMS) Certified)
Laboratory: C-43, Sector-88, Phase-II, Noida, U.P.
Ph.: No.: +91-9971912476, 9350952231
E-mail: ultraresearchlab@gmail.com
Website: http://www.ultralabnoida.com

TC-8198

17	Bicarbonate	IS:3025(Part-51)	683.20	mg/l	-	-
18	Sodium (as Na)	IS:3025(Part-45)	270.25	mg/l	-	-
19	Potassium (as K)	IS:3025(Part-45)	3.77	mg/l	-	-
20	Sulphate (as SO_4)	IS:3025(Part-24)	258.14	mg/l	200	400
21	Nitrate (as NO_3)	IS: 3025 (Part-34)	14.88	mg/l	45	No Relaxation
22	Alkalinity	IS:3025(Part-23)	560	mg/l	200	600
23	Chloramines (as Cl_2)	IS:3025(Part-26)	< 1.0	mg/l	4	No Relaxation
24	Cadmium (as Cd)	IS-3025(Part-41)	<0.001	mg/l	0.003	No Relaxation
25	Lead (as Pb)	IS:3025(Part-47)	<0.01	mg/l	0.01	No Relaxation
26	Total Chromium	Annex J of IS-13428	<0.01	mg/l	0.05	No Relaxation
27	Copper (as Cu)	IS:3025(Part-42)	<0.01	mg/l	0.05	1.5
28	Total Ammonia	IS: 3025 (Part-34)	<0.5	mg/l	0.5	No Relaxation
29	Nickel (as Ni)	IS:3025(Part-54)	<0.01	mg/l	0.02	0.2
30	Zinc	IS:3025(Part-49)	1.89	mg/l	5	15
31	Manganese (as Mn)	IS:3025(Part-59)	<0.1	mg/l	0.1	0.3
32	Boron (as B)	IS:3025(Part-57)	0.17	mg/l	0.5	1
33	Selenium (Se)	IS:3025(Part-56)	<0.01	mg/l	0.01	No Relaxation
34	Sulphide (as H_2S)	IS:3025(Part-29)	<0.05	mg/l	0.05	No Relaxation
35	Arsenic (as As)	IS:3025(Part-37)	<0.01	mg/l	0.01	0.05

End Of Report

Note:-

1. The results given above are related to the tested sample, for various parameters, as observed at the time of sampling. The customer asked for the above tests only.
2. This test report will not be used for any publicity/legal purpose.
3. The test samples will be disposed off after two weeks from the date of issue of test report, unless until specified by the customer.
4. The Report can not be used as evidence in a court of law without the written approval of the lab.

For ULTRA TESTING & RESEARCH LABORATORY

TECHNICAL MANAGER

Checked By

(Authorized Signatory)

Assuring you of best our services at all times.

Ultra Lab

ULTRA TESTING & RESEARCH LABORATORY

(An ISO 9001:2015, OHSAS 45001:2018, 14001:2015 (EMS) Certified)
Laboratory: C-43, Sector-88, Phase-II, Noida, U.P.
Ph.: No.: +91-9971912476, 9350952231
E-mail: ultraresearchlab@gmail.com
Website: http://www.ultralabnoida.com

TEST REPORT

Water Sample Analysis

Report Code: W-13012021-01 **Issue Date: 19/01/2021**

ISSUED TO	: **ES SAFEGUARDS COMPLIANCE SERVICES PVT. LTD. 501,SKYLAND APARTMENTS,SECTOR-56 GURGAON-122001**
Project Name	: Delhi-Meerut RRTS Alignment in NCR Region
Sample Drawn On	: 13/01/2021
Sample Drawn By	: UTRL
Sample Description	: Ground Water
Sampling Location	: Sample Collected from Saraikalekhan Project Site
Latitude/ Longitude	: N 28° 34' 58.2" , E 77° 15' 37.4"
Sampling Procedure	: IS 3025(Part-01)
Analysis Duration	: 13/01/2021 to 19/01/2021

Results as per IS 10500:2012

S.No	Parameter	Test Method	Results	Units	Acceptable Limit	Permissible Limit in the Absence of Alternate Source
Parameters Concerning Toxic Substances:						
36	Molybdenum (as Mo)	IS-3025(Part-2)	<0.01	mg/l	0.07	No Relaxation
37	Mercury(as Hg)	IS-3025(Part-48)	<0.001	mg/l	0.001	No Relaxation
38	Barium (as Ba)	Annex F of IS 13428	<1.0	mg/l	0.7	No Relaxation
39	Aluminum (as Al)	IS: 3025 (Part-55)	<0.01	mg/l	0.03	0.2
40	Silver (as Ag)	Annex J of IS 13428	<0.01	mg/l	0.1	No Relaxation
41	Polychlorinated biphenyls	APHA 6630	<0.0001	mg/l	0.0005	No Relaxation
42	Polynuclear aromatic hydrocarbons	APHA 6440	<0.0001	mg/l	0.0001	No Relaxation
43	Mineral Oil	IS: 3025 (Part-39)	<0.5	mg/l	0.5	No Relaxation
44	Cyanide	IS-3025(Part-27)	<0.01	mg/l	0.05	No Relaxation
MICROBIOLOGICAL REQUIREMENT						
45	E.Coli	IS:1622	Absent	E.Coli/100ml	Absent	Absent
46	Coli form	IS:1622	Absent	MPN/100 ml	Absent	Absent

End of Report

Note:-

1 The results given above are related to the tested sample, for various parameters, as observed at the time of sampling. The customer asked for the above tests only.

2 This test report will not be used for any publicity/legal purpose.

3 The test samples will be disposed off after two weeks from the date of issue of test report, unless until specified by the customer.

4 The Report can not be used as evidence in a court of law without the written approval of the lab.

For ULTRA TESTING & RESEARCH LABORATORY

Checked By

(Authorized Signatory)

ULTRA TESTING & RESEARCH LABORATORY TECHNICAL MANAGER

Assuring you of best our services at all times.

ULTRA TESTING & RESEARCH LABORATORY
(An ISO 9001:2015, OHSAS 45001:2018, 14001:2015 (EMS) Certified)
Laboratory: C-43, Sector-88, Phase-II, Noida, U.P.
Ph.: No.: +91-9971912476, 9350952231
E-mail: ultraresearchlab@gmail.com
Website: http://www.ultralabnoida.com

Ultra Lab

TC-8198

TEST REPORT

Ambient Noise Report

Discipline/Group-Chemical/Atmospheric Pollution

Report Code: N-13012021-01 **Issue Date: 18/01/2021**

ISSUED TO : **ES SAFEGUARDS COMPLIANCE SERVICES PVT. LTD.**
501,SKYLAND APARTMENTS,SECTOR-56
GURGAON-122001

Project Name	: Delhi-Meerut RRTS Alignment in NCR Region
Monitoring Date	: 12/01/2021 To 13/01/2021
Sample Drawn By	: UTRL
Sampling Location	: Sarai Kale Khan (ISBT)
Latitude & Logitude	: N 28°35'5.6" , E 077°15'34.4"
Sample Description	: Ambient Noise
Sampling Time	Every 60 minutes (24 Hours)
Sampling Protocol	: UTRL/STP/Noise
Weather Condition	: Clear
Analysis Duration	: 13/01/2021 To 18/01/2021

TEST RESULT

S.No	Time(Hrs)	Day Time (07.00-22.00)			Limits as per The Noise Pollution (Regulation & Control)Rules, 2010 of MoEFCC / CPCB) Zone -Commercial	
		Min dB(A)	Max dB (A)	Leq dB(A)	DAY*	NIGHT*
1	07:00:00	70.6	85.7	82.8	65	55
2	08:00:00	69.1	89.4	86.4		
3	09:00:00	76.7	93.1	90.2		
4	10:00:00	75.6	99.8	96.8		
5	11:00:00	70.2	96.3	93.3		
6	12:00:00	74.1	89.1	86.2		
7	13:00:00	71.7	85.2	82.4		
8	14:00:00	73.5	80.3	78.1		
9	15:00:00	70.2	88.0	85.1		
10	16:00:00	69.7	90.2	87.2		
11	17:00:00	72.5	93.0	90.0		
12	18:00:00	73.4	97.2	94.2		
13	19:00:00	74.1	92.7	89.7		
14	20:00:00	69.6	90.1	87.1		
15	21:00:00	67.1	87.7	84.7		
		Leq 10		93.8		
		Leq 50		87.1		
		Leq 90		82.6		
		Leq Day Mean dB(A)		90.0		

Contd. To report Code: N-13012021-01 Page 1 of 2)

ULTRA TESTING & RESEARCH LABORATORY ★ TECHNICAL MANAGER

Assuring you of best our services at all times.

ULTRA TESTING & RESEARCH LABORATORY

(An ISO 9001:2015, OHSAS 45001:2018, 14001:2015 (EMS) Certified)
Laboratory: C-43, Sector-88, Phase-II, Noida, U.P.
Ph.: No.: +91-9971912476, 9350952231
E-mail: ultraresearchlab@gmail.com
Website: http://www.ultralabnoida.com

Ultra Lab

TC-8198

16	22:00:00	66.5	81.8	78.9	65.0	55.0
17	23:00:00	61.8	81.5	78.5		
18	00:00:00	60.3	77.2	74.3		
19	01:00:00	62.1	75.4	72.6		
20	02:00:00	61.5	75.9	73.0		
21	03:00:00	60.2	77.1	74.2		
22	04:00:00	59.6	78.5	75.5		
23	05:00:00	68.8	82.7	79.9		
24	06:00:00	69.7	83.2	80.4		
Leq 10				80.0		
Leq 50				75.5		
Leq 90				73.0		
Leq Night Mean dB(A)				77.3		

Note:-

Ends Of Report

IFC/World Bank's EHS Guidelines for Noise Level

	Residential	Commercial/Industrial
Day Time : Leq dB (A)	55	70
Night Time : Leq dB (A)	45	70

Note: MoEFCC – Ministry of Environment Forest and Climate Change;
CPCB – Central Pollution Control Board

1 The results given above are related to the tested sample, for various parameters, as observed at the time of sampling .The customer asked for the above tests only.
2 This test report will not be used for any publicity/legal purpose.
3 The test samples will be disposed off after two weeks from the date of issue of test report, unless until specified by the customer.
4 The Report can not be used as evidence in a court of law without the written approval of the lab.

For Ultra Testing & Research Laboratory

Checked By

(Authorized Signatory)

TECHNICAL MANAGER

ULTRA TESTING & RESEARCH LABORATORY

Assuring you of best our services at all times.

ULTRA TESTING & RESEARCH LABORATORY
(An ISO 9001:2015, OHSAS 45001:2018, 14001:2015 (EMS) Certified)
Laboratory: C-43, Sector-88, Phase-II, Noida, U.P.
Ph.: No.: +91-9971912476, 9350952231
E-mail: ultraresearchlab@gmail.com
Website: http://www.ultralabnoida.com

TC-8198

TEST REPORT

Ambient Noise Report

Discipline/Group-Chemical/Atmospheric Pollution

Report Code: N-13012021-02 **Issue Date: 18/01/2021**

ISSUED TO : **ES SAFEGUARDS COMPLIANCE SERVICES PVT. LTD.**
501,SKYLAND APARTMENTS,SECTOR-56
GURGAON-122001

Project Name	: Delhi-Meerut RRTS Alignment in NCR Region
Monitoring Date	: 12/01/2021 To 13/01/2021
Sample Drawn By	: UTRL
Sampling Location	: Sidarth Nagar Extension (At top Roof)
Latitude & Logitude	: N 28°34'53.0" , E 077° 15'22.5"
Sample Description	: Ambient Noise
Sampling Time	Every 60 minutes (24 Hours)
Sampling Protocol	: UTRL/STP/Noise
Weather Condition	: Clear
Analysis Duration	: 13/01/2021 To 18/01/2021

TEST RESULT

S.No	Time(Hrs)	Day Time (07.00-22.00)			Limits as per The Noise Pollution (Regulation & Control)Rules, 2010 of MoEFCC / CPCB) Zone -Residential	
		Min dB(A)	Max dB (A)	Leq dB(A)	DAY*	NIGHT*
1	07:00:00	55.9	69.4	66.6	55	45
2	08:00:00	59.5	70.2	67.5		
3	09:00:00	58.7	72.7	69.9		
4	10:00:00	57.8	70.6	67.8		
5	11:00:00	58.5	73.1	70.2		
6	12:00:00	59.7	72.7	69.9		
7	13:00:00	58.2	73.6	70.7		
8	14:00:00	60.7	70.1	67.6		
9	15:00:00	63.7	79.3	76.4		
10	16:00:00	56.5	70.7	67.9		
11	17:00:00	57.8	72.1	69.2		
12	18:00:00	58.6	70.6	67.9		
13	19:00:00	57.1	69.7	66.9		
14	20:00:00	58.7	68.6	66.0		
15	21:00:00	55.9	66.2	63.6		
Leq 10				70.5		
Leq 50				67.9		
Leq 90				66.2		
Leq Day Mean dB(A)				70.0		

Contd. To report Code: N-13012021-02 Page (1 of 2)

ULTRA TESTING & RESEARCH LABORATORY TECHNICAL MANAGER

Assuring you of best our services at all times.

Ultra Lab

ULTRA TESTING & RESEARCH LABORATORY

(An ISO 9001:2015, OHSAS 45001:2018, 14001:2015 (EMS) Certified)
Laboratory: C-43, Sector-88, Phase-II, Noida, U.P.
Ph.: No.: +91-9971912476, 9350952231
E-mail: ultraresearchlab@gmail.com
Website: http://www.ultralabnoida.com

TC-8198

16	22:00:00	55.1	62.7	60.4	55.0	45.0
17	23:00:00	53.1	60.5	58.2		
18	00:00:00	54.8	69.4	66.5		
19	01:00:00	53.5	68.1	65.2		
20	02:00:00	52.8	68.2	65.3		
21	03:00:00	53.4	66.7	63.9		
22	04:00:00	53.1	65.1	62.4		
23	05:00:00	54.7	68.7	65.9		
24	06:00:00	63.5	71.6	69.2		
Leq 10				**67.1**		
Leq 50				**65.2**		
Leq 90				**60.0**		
Leq Night Mean dB(A)				**65.1**		

Note:-

IFC/World Bank's EHS Guidelines for Noise Level

****Ends Of Report****

	Residential	Commercial/Industrial
Day Time : Leq dB (A)	55	70
Night Time : Leq dB (A)	45	70

Note: MoEFCC – Ministry of Environment Forest and Climate Change;
CPCB – Central Pollution Control Board

1. The results given above are related to the tested sample, for various parameters, as observed at the time of sampling .The customer asked for the above tests only.
2. This test report will not be used for any publicity/legal purpose
3. The test samples will be disposed off after two weeks from the date of issue of test report, unless until specified by the customer.
4. The Report can not be used as evidence in a court of law without the written approval of the lab.

For Ultra Testing & Research Laboratory

Checked By

(Authorized Signatory)

ULTRA TESTING RESEARCH LABORATORY
TECHNICAL MANAGER

Assuring you of best our services at all times.

ULTRA TESTING & RESEARCH LABORATORY

Ultra Lab

(An ISO 9001:2015, OHSAS 45001:2018, 14001:2015 (EMS) Certified)
Laboratory: C-43, Sector-88, Phase-II, Noida, U.P.
Ph.: No.: +91-9971912476, 9350952231
E-mail: ultraresearchlab@gmail.com
Website: http://www.ultralabnoida.com

TC-8198

TEST REPORT

Ambient Noise Report

Discipline/Group-Chemical/Atmospheric Pollution

Report Code: N-13012021-03 **Issue Date: 18/01/2021**

ISSUED TO **: ES SAFEGUARDS COMPLIANCE SERVICES PVT. LTD. 501,SKYLAND APARTMENTS,SECTOR-56 GURGAON-122001**

Project Name	: Delhi-Meerut RRTS Alignment in NCR Region
Monitoring Date	: 12/01/2021 To 13/01/2021
Sample Drawn By	: UTRL
Sampling Location	: Sidarth Nagar Extension
Latitude & Logitude	: N 28°34'52.7",E 77° 15'19.3"
Sample Description	: Ambient Noise
Sampling Time	Every 60 minutes (24 Hours)
Sampling Protocol	: UTRL/STP/Noise
Weather Condition	: Clear
Analysis Duration	: 13/01/2021 To 18/01/2021

TEST RESULT

S.No	Time(Hrs)	Day Time (07.00-22.00)			Limits as per The Noise Pollution (Regulation & Control)Rules, 2010 of MoEFCC / CPCB) Zone -Residential	
		Min dB(A)	Max dB (A)	Leq dB(A)	DAY*	NIGHT*
1	07:00:00	58.2	76.5	73.6	55	45
2	08:00:00	59.7	79.6	76.6		
3	09:00:00	56.2	78.4	75.4		
4	10:00:00	58.7	78.2	75.2		
5	11:00:00	58.4	80.1	77.1		
6	12:00:00	56.5	78.4	75.4		
7	13:00:00	57.1	79.7	76.7		
8	14:00:00	58.9	76.4	73.5		
9	15:00:00	58.5	75.4	72.5		
10	16:00:00	58.1	80.5	77.5		
11	17:00:00	60.4	78.5	75.6		
12	18:00:00	57.5	85.4	82.4		
13	19:00:00	58.6	77.7	74.7		
14	20:00:00	59.5	83.5	80.5		
15	21:00:00	59.4	82.2	79.2		
Leq 10				**80.0**		
Leq 50				**75.6**		
Leq 90				**73.5**		
Leq Day Mean dB(A)				**77.1**		

Contd. To report Code: N-13012021-03 Page (1 of 2)

ULTRA TESTING & RESEARCH LABORATORY TECHNICAL MANAGER

Assuring you of best our services at all times.

Contd. To report Code: N-13012021-03 Page (2 Of 2)

16	22:00:00	55.6	71.4	68.5	55.0	45.0
17	23:00:00	54.1	69.2	66.3		
18	00:00:00	55.2	68.4	65.6		
19	01:00:00	53.8	66.7	63.9		
20	02:00:00	53.2	65.8	63.0		
21	03:00:00	53.8	69.2	66.3		
22	04:00:00	54.5	66.7	63.9		
23	05:00:00	55.2	70.5	67.6		
24	06:00:00	58.7	72.2	69.4		
Leq 10				68.7		
Leq 50				66.3		
Leq 90				63.7		
Leq Night Mean dB(A)				65.6		

Note:-

Ends Of Report

IFC/World Bank's EHS Guidelines for Noise Level

	Residential	Commercial/Industrial
Day Time : Leq dB (A)	55	70
Night Time : Leq dB (A)	45	70

Note: MoEFCC – Ministry of Environment Forest and Climate Change;
CPCB – Central Pollution Control Board

1 The results given above are related to the tested sample, for various parameters, as observed at the time of sampling .The customer asked for the above tests only.

2 This test report will not be used for any publicity/legal purpose

3 The test samples will be disposed off after two weeks from the date of issue of test report, unless until specified by the customer.

4 The Report can not be used as evidence in a court of law without the written approval of the lab.

For Ultra Testing & Research Laboratory

Checked By

(Authorized Signatory)

ULTRA TESTING & RESEARCH LABORATORY TECHNICAL

ULTRA TESTING & RESEARCH LABORATORY
(An ISO 9001:2015, OHSAS 45001:2018, 14001:2015 (EMS) Certified)
Laboratory: C-43, Sector-88, Phase-II, Noida, U.P.
Ph.: No.: +91-9971912476, 9350952231
E-mail: ultraresearchlab@gmail.com
Website: http://www.ultralabnoida.com

Ultra Lab

TC-8198

TEST REPORT

Ambient Noise Report

Discipline/Group-Chemical/Atmospheric Pollution

Report Code: N-13012021-04 **Issue Date: 18/01/2021**

ISSUED TO : **ES SAFEGUARDS COMPLIANCE SERVICES PVT. LTD.
501,SKYLAND APARTMENTS,SECTOR-56
GURGAON-122001**

Project Name	: Delhi-Meerut RRTS Alignment in NCR Region
Monitoring Date	: 12/01/2021 To 13/01/2021
Sample Drawn By	: UTRL
Sampling Location	: Stabling Yard
Latitude & Logitude	: N 28°34'38.7" , E 077°15'04.1"
Sample Description	: Ambient Noise
Sampling Time	Every 60 minutes (24 Hours)
Sampling Protocol	: UTRL/STP/Noise
Weather Condition	: Clear
Analysis Duration	: 13/01/2021 To 18/01/2021

TEST RESULT

S.No	Time(Hrs)	Day Time (07.00-22.00)			Limits as per The Noise Pollution (Regulation & Control)Rules, 2010 of MoEFCC / CPCB) Zone -Residential	
		Min dB(A)	Max dB (A)	Leq dB(A)	DAY*	NIGHT*
1	07:00:00	59.6	75.3	72.4	55	45
2	08:00:00	58.3	74.7	71.8		
3	09:00:00	56.5	78.1	75.1		
4	10:00:00	53.7	76.4	73.4		
5	11:00:00	55.2	78.7	75.7		
6	12:00:00	59.7	79.3	76.3		
7	13:00:00	60.8	80.4	77.4		
8	14:00:00	58.3	78.1	75.1		
9	15:00:00	59.6	74.2	71.3		
10	16:00:00	57.2	70.4	67.6		
11	17:00:00	53.5	71.6	68.7		
12	18:00:00	56.8	73.4	70.5		
13	19:00:00	50.7	70.7	67.7		
14	20:00:00	48.9	69.7	66.7		
15	21:00:00	48.1	67.1	64.1		
Leq 10				**76.1**		
Leq 50				**71.8**		
Leq 90				**67.1**		
Leq Day Mean dB(A)				**73.0**		

Contd. To report Code: N-13012021-04 Page 1 of 2

ULTRA TESTING RESEARCH LABORATORY ★ TECHNICAL MANAGER

Assuring you of best our services at all times.

Ultra Lab

ULTRA TESTING & RESEARCH LABORATORY

(An ISO 9001:2015, OHSAS 45001:2018, 14001:2015 (EMS) Certified)
Laboratory: C-43, Sector-88, Phase-II, Noida, U.P.
Ph.: No.: +91-9971912476, 9350952231
E-mail: ultraresearchlab@gmail.com
Website: http://www.ultralabnoida.com

TC-8198

16	22:00:00	51.3	66.2	63.3	55.0	45.0
17	23:00:00	49.2	60.5	57.8		
18	00:00:00	50.4	63.8	61.0		
19	01:00:00	51.7	60.1	57.7		
20	02:00:00	49.5	61.2	58.5		
21	03:00:00	48.7	60.8	58.0		
22	04:00:00	47.8	59.5	56.8		
23	05:00:00	48.7	60.7	58.0		
24	06:00:00	49.1	70.2	67.2		
Leq 10				**64.1**		
Leq 50				**58.0**		
Leq 90				**57.5**		
Leq Night Mean dB(A)				**61.4**		

Ends Of Report

Note:-

IFC/World Bank's EHS Guidelines for Noise Level

	Residential	Commercial/Industrial
Day Time : Leq dB (A)	55	70
Night Time : Leq dB (A)	45	70

Note: MoEFCC – Ministry of Environment Forest and Climate Change;
CPCB – Central Pollution Control Board

1 The results given above are related to the tested sample, for various parameters, as observed at the time of sampling .The customer asked for the above tests only.

2 This test report will not be used for any publicity/legal purpose

3 The test samples will be disposed off after two weeks from the date of issue of test report, unless until specified by the customer.

4 The Report can not be used as evidence in a court of law without the written approval of the lab.

For Ultra Testing & Research Laboratory

Checked By

(Authorized Signatory)

ULTRA TESTING & RESEARCH LABORATORY TECHNICAL MANAGER

Assuring you of best our services at all times.

ULTRA TESTING & RESEARCH LABORATORY
(An ISO 9001:2015, OHSAS 45001:2018, 14001:2015 (EMS) Certified)
Laboratory: C-43, Sector-88, Phase-II, Noida, U.P.
Ph.: No.: +91-9971912476, 9350952231
E-mail: ultraresearchlab@gmail.com
Website: http://www.ultralabnoida.com

Ultra Lab

TC-8198

TEST REPORT

Surface Water Sample Analysis
Discipline/Group-Chemical/Water

Report Code: WW-13012021-01 **Issue Date: 19/01/2021**

ISSUED TO : **ES SAFEGUARDS COMPLIANCE SERVICES PVT. LTD.**
501,SKYLAND APARTMENTS,SECTOR-56
GURGAON-122001

Project Name	: Delhi-Meerut RRTS Alignment in NCR Region
Sample Drawn On	: 13/01/2021
Sample Drawn By	: UTRL
Sample Description	: Surface Water
Sampling Location	: Sample Collected from Saraikalekhan (Nala)
Latitude/ Longitude	: N 28^{0} 34' 57.6" , E 77^{0} 15' 34.3"
Sampling Procedure	: IS 3025(Part-01)
Sample Quantity	: 2.0 Litre
Analysis Duration	: 13/01/2021 To 19/01/2021

RESULTS

S.No	Parameter	Test Method	Results	Units	Tolerance Limit as per IS:2296				
					Class A	Class B	Class C	Class D	Class E
1	pH	IS:3025(Part-11)	7.47	-	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
2	Odour	IS-3025(Part-05)	Obj.	-	Unobj.	-	-	-	-
3	Colour	IS:3025(Part-04)	<5.0	Hazen	10	300	300	-	-
4	Turbidity	IS:3025(Part-10)	68.3	NTU	-	-	-	-	-
5	Conductivity @25°C	IS:3025(Part-14)	1388	µs/cm.	-	-	-	1000	2250
6	Total Suspended Solid	IS:3025(Part-17)	144	mg/l	-	-	-	-	-
7	Total Alkalinity (as $CaCO_3$)	IS:3025(Part-23)	310	mg/l	-	-	-	-	-
8	Biological Oxygen Demand (Max.)	IS:3025(Part-44)	16	mg/l	2	3	3	-	-
9	Dissolved Oxygen (as O_2) Min.	IS:3025(Part-38)	5.8	mg/l	6	5	4	4	-
10	Calcium(as Ca)	IS:3025(Part-40)	56.00	mg/l	80	-	-	-	-
11	Magnesium(as Mg)	IS:3025(Part-46)	34.02	mg/l	24	-	-	-	-
12	Chloride(as Cl),Max	IS:3025(Part-32)	136.98	mg/l	250	-	-	-	600
13	Iron(as Fe),Max	IS:3025(Part-53)	2.90	mg/l	0.3	-	50	-	-
14	Fluoride(as F),Max	IS:3025(Part-60)	0.12	mg/l	1.5	1.5	1.5	-	-
15	Phenolic Compound (as C_6H_5OH)	IS: 3025 (Part-43)	<0.001	mg/l	0.002	0.005	0.005	-	-
16	Bicarbonate	IS:3025(Part-51)	378.20	mg/l	-	-	-	-	-

Contd. To report Code: WW-13012021-01

ULTRA TESTING RESEARCH LABORATORY
TECHNICAL MANAGER

Assuring you of best our services at all times.

ULTRA TESTING & RESEARCH LABORATORY
(An ISO 9001:2015, OHSAS 45001:2018, 14001:2015 (EMS) Certified)
Laboratory: C-43, Sector-88, Phase-II, Noida, U.P.
Ph.: No.: +91-9971912476, 9350952231
E-mail: ultraresearchlab@gmail.com
Website: http://www.ultralabnoida.com

Ultra Lab

TC-8198

Contd. To report Code: WW-13012021-01

17	Total Hardness (as $CaCO_3$)	IS:3025(Part-21)	280.00	mg/l	300	-	-	-	-
18	Sulphate (as SO_4)Max	IS:3025(Part-24)	88.17	mg/l	400	-	400	-	1000
19	Phosphate (as P)	IS:3025(Part-31)	6.80	mg/l	-	-	-	-	-
20	Sodium (as Na)	IS:3025(Part-45)	97.19	mg/l	-	-	-	-	-
21	Free Ammonia	IS: 3025 (Part-34)	<1.0	mg/l	-	-	-	1.2	
22	Total Dissolved Solid	IS:3025(Part-16)	916	mg/l	500	-	1500	-	2100
23	Oil & Grease	IS:3025(Part-39)	5.60	mg/l	-	-	0.1	0.1	-
24	Manganese (as Mn)	IS:3025(Part-59)	<0.1	mg/l	0.5	-	-	-	-
25	Total Chromiun (as Cr)	IS:3025(Part-52)	<0.05	mg/l	0.05	0.05	0.05	-	-
26	Zinc (as Zn)	IS:3025(Part-49)	1.46	mg/l	15	-	15	-	-
27	Potassium (as K)	IS:3025(Part-45)	4.27	mg/l	-	-	-	-	-
28	Nitrate (as NO_3),Max	IS: 3025 (Part-34)	8.49	mg/l	20	-	50	-	-
29	Cadmium (as Cd)	IS-3025(Part-41)	<0.01	mg/l	0.01	-	0.01	-	-
30	Lead (as Pb)	IS:3025(Part-47)	<0.01	mg/l	0.1	-	0.1	-	
31	Total Nitrogen(as N)	IS: 3025 (Part-34)	27.16	mg/l	-	-	-	-	-
32	Boron (as B)	IS:3025(Part-57)	0.15	mg/l	-	-	-	-	2
33	Copper (as Cu)	IS:3025(Part-42)	<0.01	mg/l	1.5	-	1.5	-	-
34	Chemical Oxygen Demand (asO_2)	IS-3025(Part-58)	152.00	mg/l	-	-	-	-	-
35	Arsenic (as As)	IS:3025(Part-37)	<0.01	mg/l	0.05	0.2	0.2	-	

End Of Report

Remarks:-

Class A-Drinking water without conventional treatment but after disinfection.

Class B-Water for outdoor bathing.

Class C-Drinking water with conventional treatment followed by disinefection.

Class D-Water for fish culture and wild life propagation.

Class E-Water for irrigation, industrial cooling and control waste disposal.

Note:-

1 The results given above are related to the tested sample, for various parameters, as observed at the time of sampling. The customer asked for the above tests only.
2 This test report will not be used for any publicity/legal purpose.
3 The test samples will be disposed off after two weeks from the date of issue of test report, unless until specified by the customer.
4 The Report can not be used as evidence in a court of law without the written approval of the lab.

Checked By

For ULTRA TESTING & RESEARCH LABORATORY

TECHNICAL MANAGER

(Authorized Signatory)

Assuring you of best our services at all times.

ULTRA TESTING & RESEARCH LABORATORY
(An ISO 9001:2015, OHSAS 45001:2018, 14001:2015 (EMS) Certified)
Laboratory: C-43, Sector-88, Phase-II, Noida, U.P.
Ph.: No.: +91-9971912476, 9350952231
E-mail: ultraresearchlab@gmail.com
Website: http://www.ultralabnoida.com

TEST REPORT

Surface Water Sample Analysis

Report Code: WW-13012021-01 | Issue Date: 19/01/2021

ISSUED TO : ES SAFEGUARDS COMPLIANCE SERVICES PVT. LTD.
501,SKYLAND APARTMENTS,SECTOR-56
GURGAON-122001

Project Name	: Delhi-Meerut RRTS Alignment in NCR Region
Sample Description	: Surface Water
Sampling Location	: Sample Collected from Saraikalekhan (Nala)
Analysis Duration	: 13/01/2021 To 19/01/2021

RESULTS

S.No	Parameter	Test Method	Results	Units	Tolerance Limit as per IS:2296				
					Class A	Class B	Class C	Class D	Class E
36	Aluminum (as Al)	IS: 3025 (Part-55)	<0.01	mg/l	-	-	-	-	-
37	Mercury(as Hg)	IS-3025(Part-48)	<0.001	mg/l	0.001	-	-	-	-
38	Cyanide	IS-3025(Part-27)	<0.01	mg/l	0.05	0.05	0.05	-	-
39	Sodium Absorption Ratio	APHA	2.53	-	-	-	-	-	26
40	Total Coli Form	IS:1622	8.1×10^3	MPN/100ml	50	500	5000	-	-

End Of Report

Remarks:-

Class A-Drinking water without conventional treatment but after disinfection.

Class B-Water for outdoor bathing.

Class C-Drinking water with conventional treatment followed by disinefection.

Class D-Water for fish culture and wild life propagation.

Class E-Water for irrigation, industrial cooling and control waste disposal.

Note:-

1 The results given above are related to the tested sample, for various parameters, as observed at the time of sampling. The customer asked for the above tests only.
2 This test report will not be used for any publicity/legal purpose.
3 The test samples will be disposed off after two weeks from the date of issue of test report, unless until specified by the customer.
4 The Report can not be used as evidence in a court of law without the written approval of the lab.

For ULTRA TESTING & RESEARCH LABORATORY

Checked By

(Authorized Signatory)

ULTRA TESTING & RESEARCH LABORATORY TECHNICAL

Assuring you of best our services at all times.

Appendix 3: Noise Analysis

Noise During Construction

Construction noise and vibration often generates complaints from the community, even when construction is for a limited timeframe. Public concerns about construction noise and vibration increase considerably with lengthy periods of heavy construction on major projects as well as prevalence of nighttime construction (often scheduled to avoid disrupting workday road and rail traffic). Noise and vibration complaints typically arise from interference with people's activities, especially when the adjacent community has no clear understanding of the extent or duration of the construction. Misunderstandings can arise when the community thinks a contractor is being insensitive, and the contractor believes it is performing the work in compliance with local ordinances.

Noise impacts from construction may vary greatly depending on the duration and complexity of the project. Qualitative Construction Noise Assessments may be required for projects with less than a month of construction time in a noise-sensitive area. Quantitative Construction Noise Assessments may be required for projects with a month or more of construction in noise-sensitive areas or if particularly noisy equipment will be involved.

Typical noise levels from representative equipment are included in Table 1. The levels are based on an EPA Report,([2]) measured data from railroad construction equipment taken during the 1976 Northeast Corridor Improvement Project, the FHWA Roadway Construction Noise Model, and other measured data.

Table 1: Construction Equipment Noise Emission Levels

Equipment	Typical Noise Level 50 ft from Source, dBA
Air Compressor	80
Backhoe	80
Ballast Equalizer	82

[2] U.S. Environmental Protection Agency, "Noise from Construction Equipment and Operations, Building Equipment and Home Appliances," NTID300.1, 31 December 1971.

Ballast Tamper	83
Compactor	82
Concrete Mixer	85
Concrete Pump	82
Concreter Vibrator	76
Crane, Derrick	88
Crane, Mobile	83
Dozer	85
Generator	82
Grader	85
Impact Wrench	85
Jack Hammer	88
Loader	80
Paver	85
Pile-driver (Impact)	101
Pile-driver (Sonic)	95
Pneumatic Tool	85
Pump	77
Rail Saw	90
Rock Drill	95
Roller	85
Saw	76
Scarifier	83
Scraper	85
Shovel	82
Spike Driver	77
Tie Cutter	84
Tie Handler	80
Tie Inserter	85
Truck	84

Predicted Noise levels during construction:

The FTA general transit noise assessment procedure was adopted for construction noise levels predictions. Equivalent noise levels were calculated for each instrument by the following equation:

$$L_{eq.equip} = L_{emission} + 10\log(Adj_{Usage}) - 20\log(\frac{D}{50}) - 10G\log(\frac{D}{50})$$

where:

$L_{eq,equip}$ = $L_{eq(t)}$ at a receiver from the operation of a single piece of equipment over a specified time period, dBA

$L_{emission}$ = noise emission level of the particular piece of equipment at the reference distance of 50 ft, dBA

Adj_{Usage} = usage factor to account for the fraction of time that the equipment is in use over the specified time period

D = distance from the receiver to the piece of equipment, ft

G = a constant that accounts for topography and ground effects

Then decibel addition of two noisiest equipment operating at the same time was performed.

The equivalent noise levels for the two noisiest pieces of equipment(worst case scenario), to be used in each phase of construction, were determined. The equivalent noise levels were summed using decibel addition to get the combined equivalent noise levels. The noise levels were compared with FTA's General Assessment Criteria for Construction Noise and India's National Ambient Noise Standards as given in below table.

1-Hour Leq (dBA)				
Land Use	**FTA's General Assessment Criteria for Construction Noise**		**CPCB (India) National Ambient Noise Standards**	
	Day	**Night**	**Day**	**Night**
Residential	90	80	55	45
Commercial	100	100	65	55
Industrial	100	100	75	70

There are total 7 sensitive receptors identified with in 150m from the centre line along the proposed RRTS. The combined noise (existing noise and construction noise) levels during construction are with in criteria set by FTA for construction noise for 6 receptors but much higher then the National Ambient Noise Standards (CPCB limits) except at one location i.e. Siddharth Apartments at chainage of km 1.5. So necessary mitigation measures should be adopted during each phase of construction activity. 6 sensitive recepots will be severly impacted during construction.The details of severly impacted sensitive receptors is given in Table 2. The predicted noise levels (without mitigation measures) during construction at different sensitive receptors can be calculated by following curve:

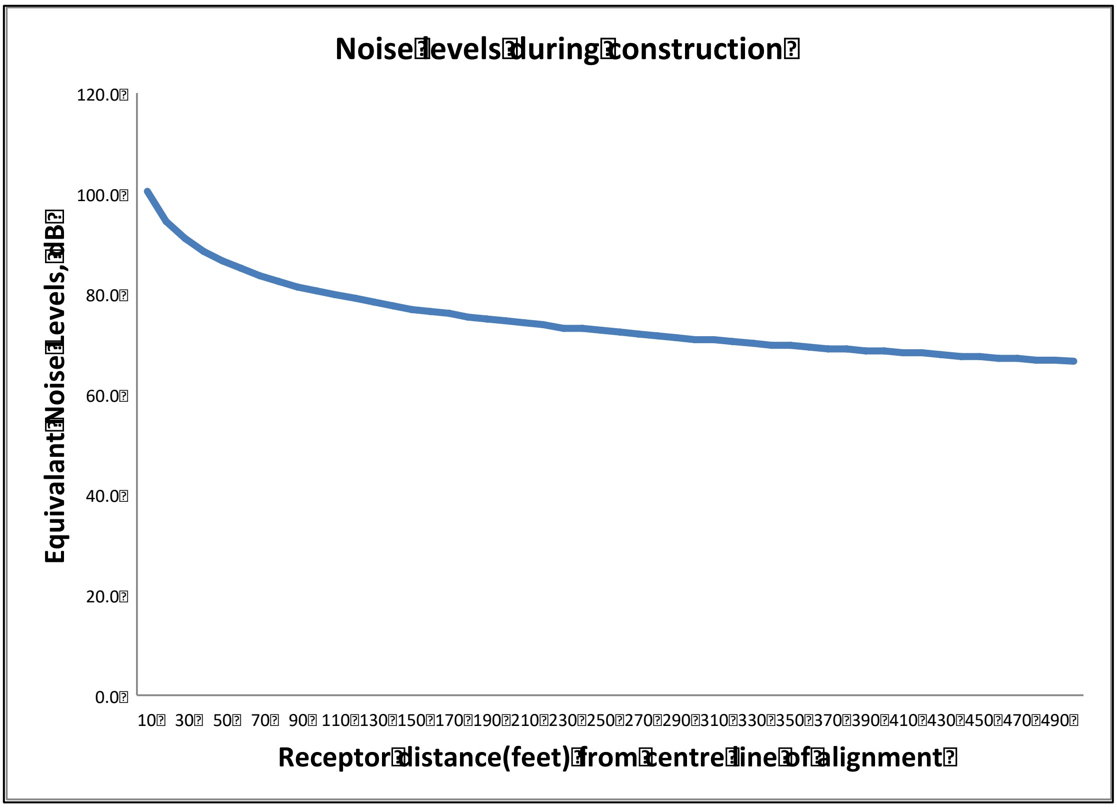


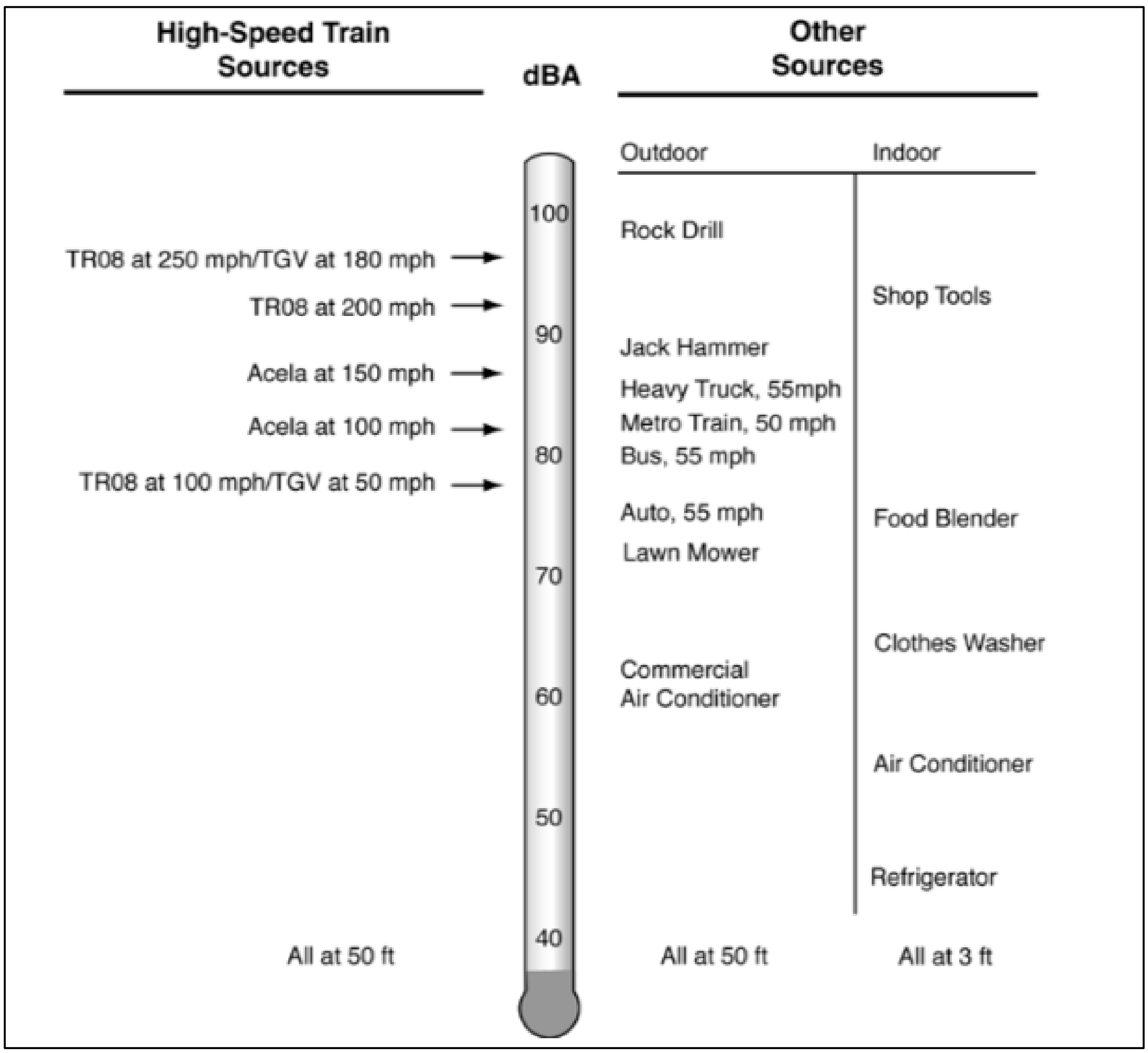
Table 2: Noise levels at sensitive receptors along the proposed RRTS alignment during Construction

S.No.	Description	LHS/ RHS	Chainage in KM	Offset in feet	Coordinates		Section Type	Landuse	Existing Noise Levels, Leq (hr) dBA	Noise level during construction, Leq (hr) dBA	Combined Noise	Increase in Noise level due to construction without mitigation measures Leq(h) or Ldn (dBA)	Type of Impact
					X (Latitude)	Y (Longitude)							
1	ISBT	RHS	0+900	165	28°35'6.83"N	77°15'31.18"E	Elevated	Commercial	89.9	76.6	90.1	0.2	No Impact
2	Barapulla Flyover & Nalla Crossing	Crossing	1+350	20	28°34'56.10"N	77°15'25.82"E	Elevated	Commercial	89.9	94.5	95.8	5.9	Severly Impacted
3	Siddharth Apartments	LHS & RHS	1+480	23.1	28°34'53.88"N	77°15'22.43"E	Elevated	Residential	69.5	95	95	25.5	Severly Impacted
4	Railway Crossing	Crossing	1+680	20	28°34'50.75"N	77°15'16.64"E	Elevated	Commercial	77.1	94.5	94.6	17.5	Severly Impacted
5	Highway Crossing	Crossing	1+810	20	28°34'46.35"N	77°15'10.93"E	Elevated	Commercial	77.1	94.5	94.6	17.5	Severly Impacted
6	Hindustan Prefab Limited	RHS	1+830	165	28°34'43.70"N	77°15'7.43"E	Elevated	Commercial	73	76.6	78.2	5.2	Severly Impacted
7	Hindustan Prefab Limited	RHS	2+000	20	28°34'31.66"N	77°15'8.41"E	Elevated	Commercial	73	94.5	94.5	21.5	Severly Impacted

Noise levels during operation of Sarai Kale Khan - Jungpura Stabline Yard RRTS line:

The universal descriptor used for environmental noise is the A-weighted sound level. It describes the level of noise measured at a receiver at any moment in time and is read directly from noise-monitoring equipment, with the weighting switch set on "A." Typical A-weighted maximum sound levels for high- speed ground transportation and other sources are shown in Figure 1. The high-speed ground transportation sources are described further in Section 2.2.

Figure 1: Typical A-Weighted Maximum Sound Level for High-speed rail system



SOURCES OF HIGH-SPEED TRAIN NOISE

The total wayside noise generated by a high-speed train passby consists of several individual noise- generating mechanisms, each with its own characteristics of source location, strength, frequency content, directivity, and speed dependence. These noise sources can be generalized into three major regimes:[3]

Regime I: propulsion or machinery noise

Regime II: mechanical noise resulting from wheel-rail interactions and/or guideway vibrations

Regime III: aerodynamic noise resulting from airflow moving past the train, including the pantograph (a jointed framework conveying a current to a train from overhead wires).

For a conventional train with a maximum speed of up to approximately 125 mph, propulsion and mechanical noise are sufficient to describe the total wayside noise. The aerodynamic noise component begins to be an important factor when the train speed exceeds approximately 160 mph.

The general equation for the prediction of the A- weighted sound level at various distances from the track can be expressed as follows:

$L_A = L_A(ref) + C_d + C_a + C_g + C_b$

Where:
$L_A(ref)$ = a known A-weighted sound level at some reference distance ref from the source
C_d = adjustment factor for attenuation because of divergence
C_a = adjustment factor for excess attenuation because of atmospheric absorption
C_g = adjustment factor for excess attenuation from ground effects
C_b = adjustment factor for excess attenuation because of obstacles such as barriers, berms, and buildings.

Sometimes a portion of the source-to-receiver path is not through the air but rather through the ground or through structural components of the receiver’s building. These are called Ground-borne and structure-borne noise propagation.

For train noise, however, the rolling noise from wheel-rail interactions, as well as

[3] B. Barsikow and B. Müller. *Wayside Noise Generated by the German High-Speed Transport Systems, ICE and Transrapid*, 72nd Annual Meeting of the Transportation Research Board, Washington, DC, 1993.

some types of aerodynamic noise, is complicated because the sources do not radiate sound equally well in all directions. This unequal radiation is known as source directivity, which is a measure of the variation in a source's radiation with direction. Studies have shown that wheel- rail noise can be modeled by representing the source as a line source (or continuous row of point sources) with dipole directivity.[4] A dipole radiation pattern has also been observed in the turbulent boundary layer near the sides of a train.[5] Typically, a dipole source radiates a directivity pattern such that the sound pressure is proportional to the cosine of the angle between the source orientation and the receiver. Consequently, wheel-rail noise is propagated more efficiently to either side of a moving train than in front, above, or behind it.

In addition to geometric spreading, sound energy is attenuated by molecular absorption by the air. Although this effect is often neglected for urban rail transit projects where noise impacts are typically limited to distances of one-quarter mile or less, atmospheric absorption can become more significant for high-speed rail projects, particularly where noise projections are required for receptors located at greater distances in open areas with low ambient sound levels. In such cases, it is appropriate to include attenuation for atmospheric absorption to avoid over predicting noise levels and impacts from high-speed train operations. Sound absorption in the air is a function of temperature, humidity, and atmospheric pressure as well as the frequency content of the sound. For the purpose of predicting sound attenuation as a result of atmospheric absorption (Ca), the methods contained in the American National Standards Institute Standard S1.26-1995 or the International Standards Organization (ISO) Standard 9613-2 can be applied. For purposes of rough estimation, atmospheric absorption can be taken to be 1 dBA per 1,000 ft for "standard day" conditions (temperature of 59 °F and relative humidity of 70 percent), assuming that the A-weighted sound level for trains is most influenced by noise in the 500- to 1,000-hertz frequency range.

Land Use Category for FTA Criteria

---

[4] E. J. Rathe. Railway noise propagation. Journal of Sound and Vibration, 51, 371-388 (1977).

[5] W. F. King. "On the boundary layer contribution to wayside noise generated by high-speed tracked vehicles," Inter-Noise '94 Proceedings, pp. 175-180 (1994).

Table 3: Land Use Category for FTA Criteria

Land Use Category	Land Use Type	Noise Matric, dBA	Description of Land Use Category
1	High Sensitivity	Outdoor, Leq (1hr)	Land where quiet is an essential element of its intended purpose. Example land uses include preserved land for serenity and quiet, outdoor amphitheatres and concert pavilions, and national historic landmarks with considerable outdoor use. Recording studios and concert halls are also included in this category. The noise metric, $L_{eq(1hr)}$ is used for all category 1 and 3 land uses where nighttime sensitivity is not a factor.
2	Residential	Outdoor, Ldn	This category is applicable all residential land use and buildings where people normally sleep, such as hotels and hospitals. The noise metric L_{dn} is a used for all category 2 land uses where nighttime sensitivity is a factor. This noise metric includes a 10- dB penalty for nighttime noise.
3	Institutional	Outdoor, Leq (1hr)	This category is applicable to institutional land uses with primarily daytime and evening use. Example land uses include schools, libraries, theaters, and churches where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material. Places for meditation or study associated with cemeteries, monuments, museums, campgrounds, and recreational facilities are also included in this category. Category 3 land uses are considered less noise-sensitive than category 1 land uses.
For transit analyses, $L_{eq(1hr)}$ is computed for the noisiest hour of transit- related activity during which human activities occur at the noise- sensitive location.			

Parks – Most parks used primarily for active recreation such as sports complexes and bike or running paths are not considered noise-sensitive. However, some parks (even some in dense urban areas) are primarily used for passive recreation such as reading, conversation, or meditation. These places, which may be valued as havens from the noise and rapid pace of everyday city life, are treated as noise-sensitive, and are included in land use category 3. Consult the state or local agency with jurisdiction over the park on questions about how the park is used, and visit the park to observe its use, if possible.

Screening Distances for Noise Assessment: As per the FTA guideline for screening distances, screening distance should be taken as 200 feet for Regime II and 350 feet for Regime III for the projects running along the existing highway corridor. As a factor of safety and on conservative side, a screening distance of 350 feet from centerline of the alignment is considered in this study for noise impact analysis.

Noise Source Levels for RRTS

The general equation relating SEL to speed for each speed regime at the reference distance (50 ft) is defined as:

$$SEL = SEL_{ref} + K \log (S/S_{ref}) + 10 \log (len/len_{ref})$$

where S = train speed in miles per hour, SEL_{ref} = Reference sound exposure level, S_{ref} = Reference speed, K = Speed constant

The sound exposure level for RRTS with a speed of 100 mph (160 kmph) at a distance of 50 feet was calculated and is given below:

Table 4: Noise Exposure Level at 50 feet for 160 kmph RRTS

Without Noise Barrier			
	Regime 1 (Propulsion Noise)	Regime 2 (Rolling Noise)	Remarks
SEL_{ref} ,dBA	86	93	
K	3	17	
S, mph	100	100	
S_{ref}, mph	20	90	

L_{ref}, feet	70	664	
L_{en}, feet	144.32	432.96	
SEL ,dBA	91.24	91.92	
Shielding Correction	4	4	Will change due to topography of the tracks
V, trains per hour	15	15	
Hourly L_{eq} at 50 ft	71.40	72.08	
Daytime L_{eq} at 50 ft	71.40	72.08	
Daynight L_{eq} at 50 ft	66.63	67.31	
L_{dn} at 50 ft	70.61	69.74	
Total Hourly L_{eq} at 50 ft	74.76		Propulsion and Rolling combined
Total L_{dn} at 50 ft	73.21		Propulsion and Rolling combined

The combined noise levels were calculated based on existing noise levels and project noise levels at sensitive receptors. Noise impacts are analysed for each sensitive receptor with in screening distance. There are 4 sensitive receptors which will be severely impacted if mitigation measures are adopted. So, mitigation measures proposed in EMP should be properly implemented to reduce the project noise impacts at these sensitive receptor locations.

The combined noise levels were calculated based on existing noise levels and project noise levels at sensitive receptors. Noise impacts are analysed for each sensitive receptor with in screening distance. There are 1 sensitive receptors which will be impacted if proper mitigation measures are not adopted.

Table 5: Project Noise Impacts at sensitive receptors during Operation

S.No.	Description	LHS/RHS	Chainage in km	Offset in feet	Existing Noise	Noise due to RRTS Operation	Combined Noise	Increase in Noise level during operation without mitigation measures Leq(h) or Ldn (dBA)	Expected reduction in noise by noise barrier (dBA)	Residual noise level after mitigation (noise barrier) (dBA)
1	ISBT Sarai Kale Khan	RHS	0+900	165	89.9	53.4	89.9	0.0	NA	NA
2	Barapulla Flyover & Nalla Crossing	Crossing	1+350	20	89.9	67.2	89.9	0.0	NA	NA
3	Siddhartha Extn.	LHS & RHS	1+480	23.1	69.5	66.3	70.7	1.7	20	50.7
4	Railway Crossing	Crossing	1+680	20	77.1	67.2	77.4	0.4	NA	NA
5	Highway Crossing	Crossing	1+810	20	77.1	67.2	77.4	0.4	NA	NA
6	Hindustan Prefab Limited	RHS	1+830	165	73	53.4	73.0	0.0	NA	NA
7	Hindustan Prefab Limited	RHS	2+000	20	73	67.2	73.7	1.0	NA	NA

Appendix 4: CRRI Study on Noise and Vibration

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

National Capital Region Transport Corporation (NCRTC) – a Joint Sector company of Govt of India and States of Delhi,Haryana, Rajasthan and U.P, under the administrative control of Ministry of Housing and Urban Affairs, is mandated for implementing the Regional Rapid Transit System (RRTS) project across the NCR of India, ensuring a balanced and sustainable urban development through better connectivity and access.

Delhi – Meerut Corridor

Delhi–Meerut Regional Rapid Transit System (Delhi–Meerut RRTS) is an 82 km long under-construction, semi-high speed rail corridor connecting Delhi-Ghaziabad-Meerut. It is one of the three rapid-rail corridors planned under Phase-I of Regional Rapid Transport System (RRTS) project of National Capital Region Transport Corporation (NCRTC). With maximum speed of 160 km/h (99.42 mph), the distance between Delhi and Meerut will be covered in around 62 min (1.03 h).[4] The project will cost ₹30,274 crore (US$4.4 billion) and is expected to start operations by 2025.

The estimated 82 km long Delhi-Meerut Corridor would be passing through one of the most densely populated sections of the National Capital Region connecting Delhi to Uttar Pradesh.

The corridor would be beneficial for the development of the region and help connect the large number of townships and centres of economic activity that are already planned along this corridor.

One yard has been finalised in Jangpura, which is passing through Siddhartha Extension. Limited train will go to yard at Jangpura from Sarai Kale Khan via Siddhartha Extension.

- Total length in Siddhartha Extension = 125m
- Number of train pass by less than 25 Numbers in 24 hours

- Speed of the train will be less than 80km/h at Siddhartha Extension

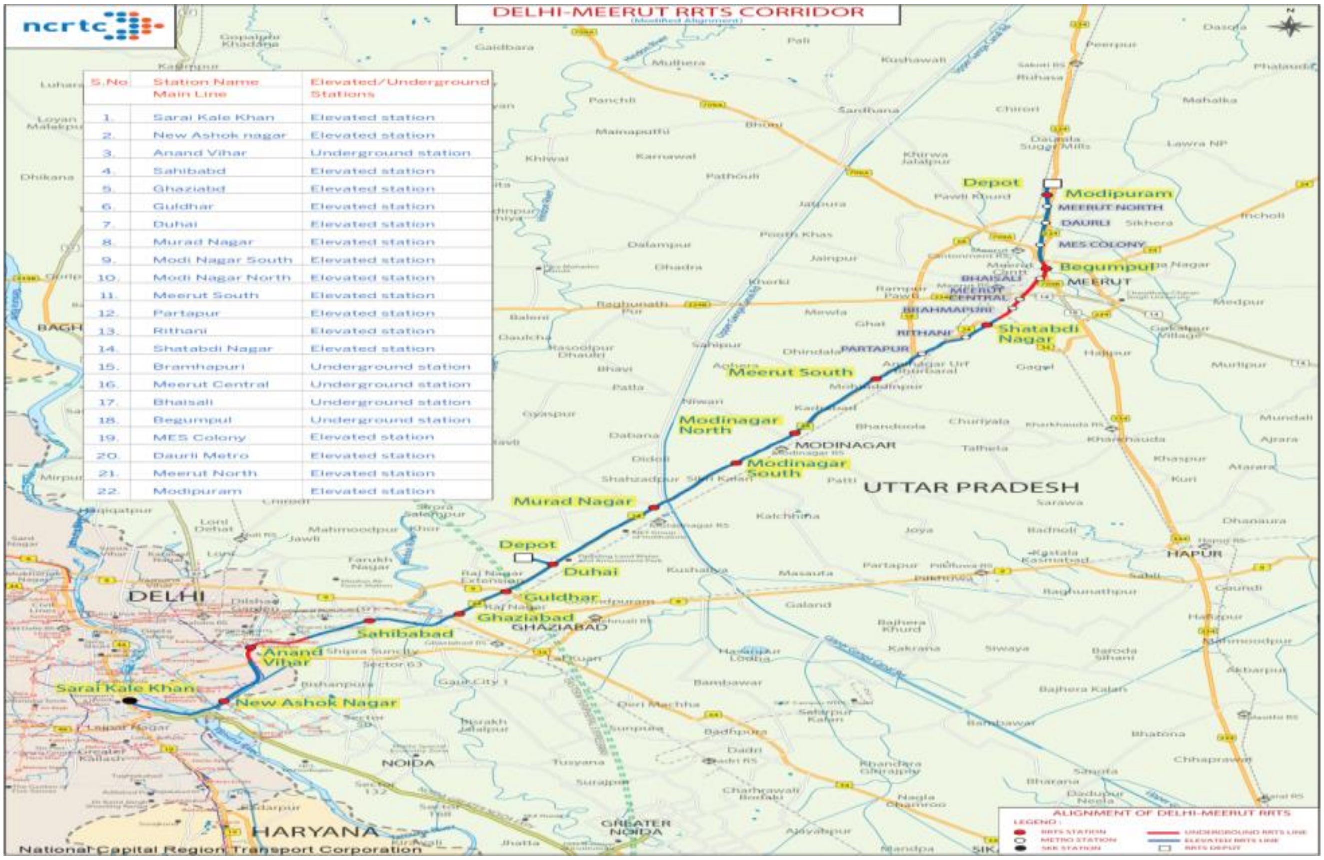


Fig No. 1.1: Route Alignment Delhi-Meerut

Fig No. 2.2: Train Alignment

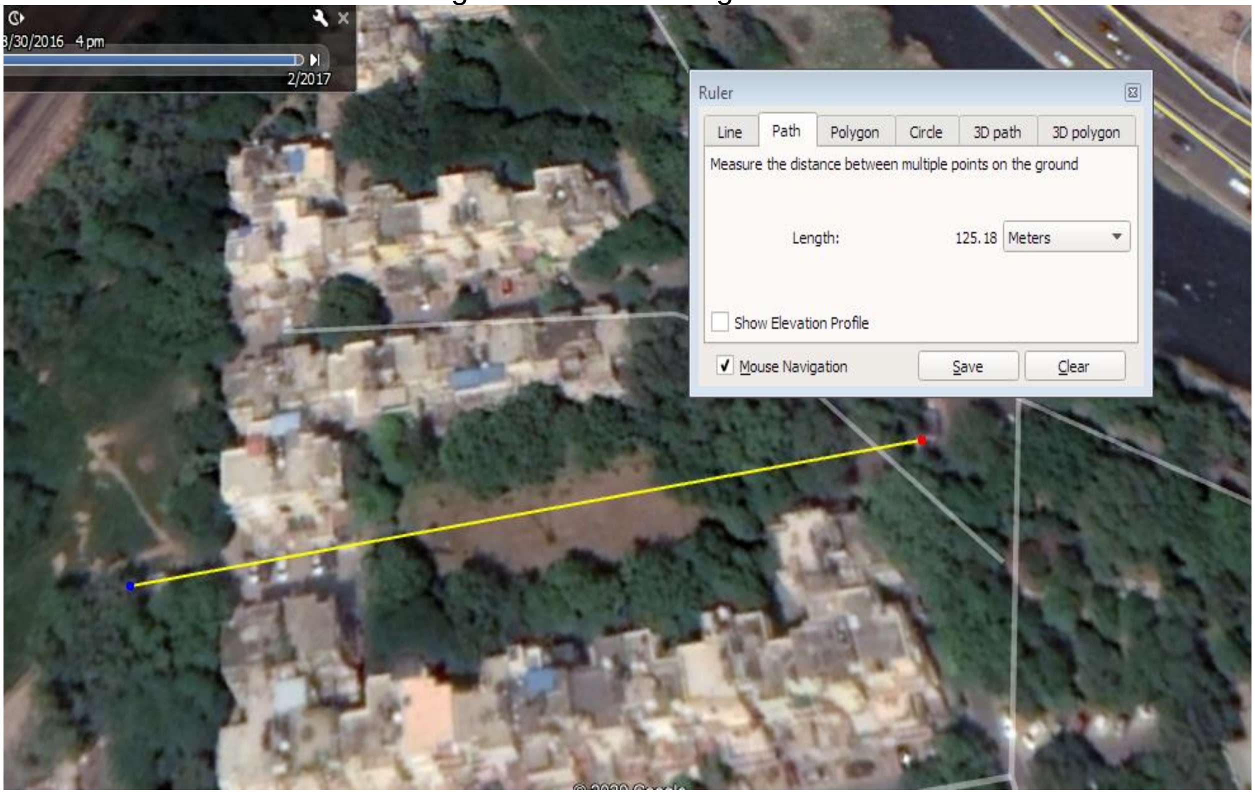


Fig no. 1.3: Total Length of Alignment in Siddhartha Extension

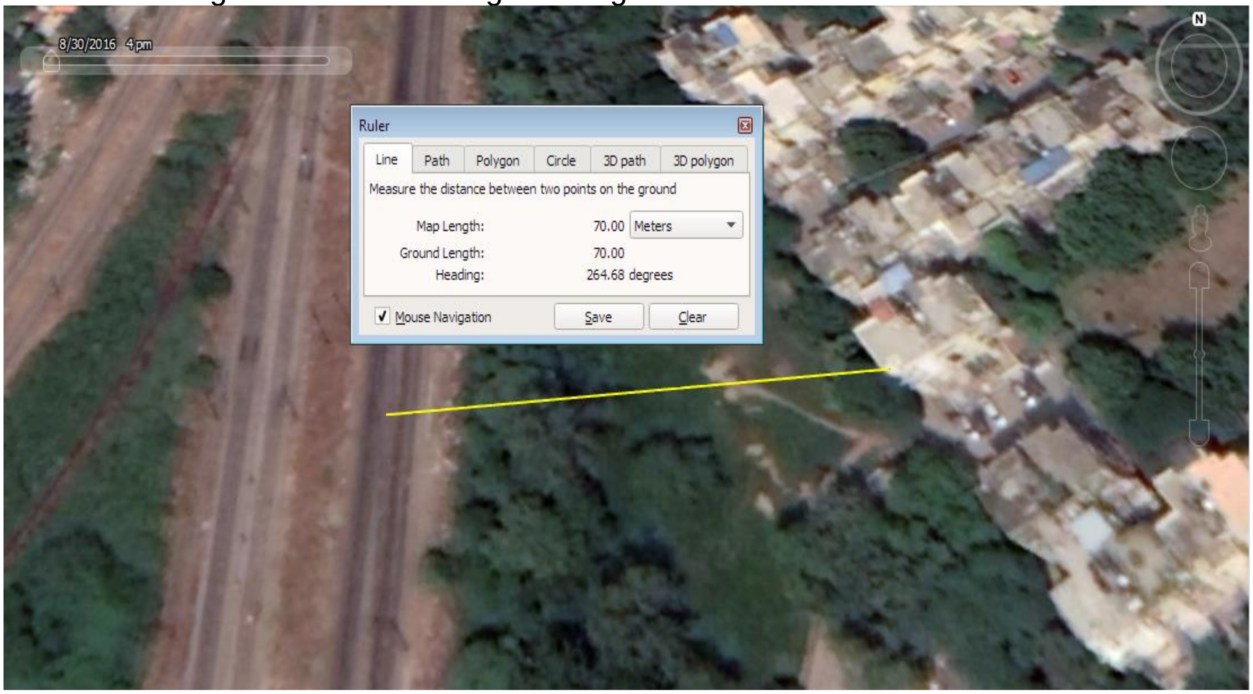


Fig No. 1.4: Horizontal distance between railway track and Siddhartha Extension building

1.2 NEED OF THE STUDY

The increasing railway network to cater the increasing travel demand in Delhi & NCR leads to certain externalities in the form of noise pollution. The newly proposed NCRTC Delhi-Meerut alignment passes in some portion in close vicinity to the residential colonies causing concern among its residents. Continuous operation of train during daytime as well as night time is bound to cause annoyance and sleep disturbances among the residents, but if number of pass by trains is very limited that noise exposure due to train may be negligible. In order to mitigate the extreme effects of the train it becomes imperative that suitable meditative measures in the form of noise barrier be proposed and implemented.

1.3 OBJECTIVES AND SCOPE

Objectives

1. To monitor the various noise parameters (L1, L10, L50, L90, SEL, Leq, Lmax, Lmin)at mentioned locations along the Siddhartha extension corridor
2. Noise mapping
3. Noise mitigation measures, if required

1.4 METHODOLOGY

Figure 1.5 shows the methodology adopted for the study. Primary data collection involved photography along the entire corridor along with Noise data may be collected along the corridor. Secondary data was collected from the NCRTC. Based on the estimates arrived at, suitable remedial measures in the form of Noise Barriers are proposed.

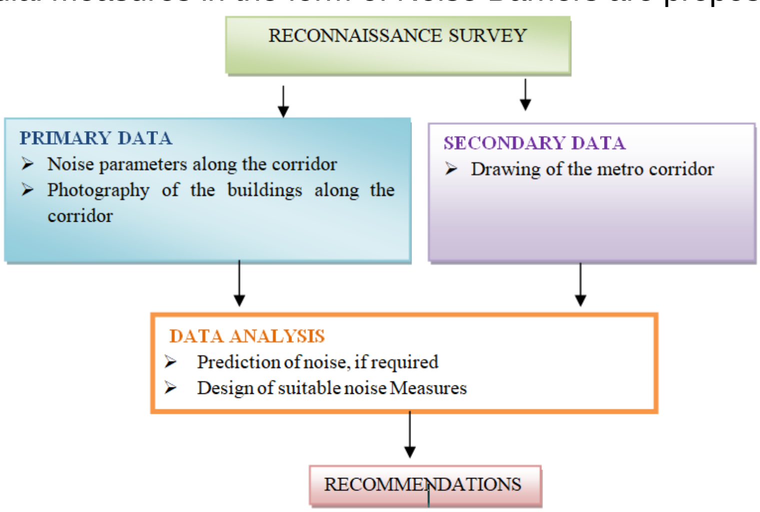


Fig 1.5 Methodology

1.5 INSTRUMENTATION

Instrumentation:

- Sound book for noise measurement and sound recording.

Table 1.4 Details of Instrumentation used

S.No	Instrument/ Sensor	Make	Model	Serial No	Calibration Details	
					Calibration Date	Calibration due date
1	Multi-channel analyser	Sinus Germany	Sound book MK28BE	07316/6CK CA53945	July 2020	August 2021
2	Multi-channel analyser	Sinus Germany	Sound book Quadro E	06297/3FK CA44860	February 2020	March 2021
3	Microphone (2 Nos)	GRAS	46AE	240439/246233 etc	May 2010	June 2021

CHAPTER 2: LITERATURE REVIEW

2.1 BACKGROUND

2.1 Noise

In simple terms, noise is unwanted sound. Sound is a form of energy which is emitted by a vibrating body and on reaching the ear causes the sensation of hearing through nerves. Noise may be continuous or intermittent. Sounds produced by all vibrating bodies are not audible. The frequency limits of audibility are ranging from 20 Hz to 20,000 Hz. Therefore, noise may be of high frequency or of low frequency which is undesired for a normal hearing. For example, the typical cry of a child produces sound, which is mostly unfavourable to normal hearing and considered as a noise. The discrimination and differentiation between sound and noise also depends upon the habit and interest of the person/species receiving it, the ambient conditions and impact of the sound generated during that particular duration of time. There could be instances that, excellently rendered musical concert for example, may be felt as noise and exceptional music as well during the course of the concert. Sounds of frequencies less than 20 HZ are called infrasonic and greater than 20,000 Hz are called ultrasonic.

The sources of noise may vary according to daily activities. The sources may be domestic (movement of utensils, cutting and peeling of fruits/vegetables etc.) natural (shores, birds/animal shouts, wind movement, sea tide movement, waterfalls etc.), commercial (vendor shouts, marriages, laboratory, machinery etc.), transportation (road traffic, rail traffic and air traffic), industrial (generator sets, boilers, plant operations, trolley movement, pumps, motors etc.). Transportation vehicles are the worst offenders, with aircraft, railroad stock, trucks, buses, automobiles, and motorcycles all producing excessive noise.

2.2 Impact of Noise

Annoyance

It creates annoyance to the receptors due to sound level fluctuations. The periodic sound due to its irregular occurrences causes displeasure to hearing and causes annoyance.

Physiological effects

The physiological features like breathing amplitude, blood pressure, heart-beat rate, pulse rate, blood cholesterol are affected.

Loss of hearing

Long exposure to high sound levels cause loss of hearing. This is mostly unnoticed, but has an adverse impact on hearing function.

Human performance

The working performance of workers/human will be affected as they will be losing their concentration.

Nervous system

It causes pain, ringing in the ears, feeling of tiredness, thereby effecting the functioning of human system.

Sleeplessness

It affects the sleeping thereby inducing the people to become restless and lose concentration and presence of mind during their activities

Damage to material

The buildings and materials may get damaged by exposure to infrasonic / ultrasonic waves and even get collapsed.

2.3 Noise Monitoring - An Overview

The noise is measured in terms of sound pressure levels (SPL) and common unit of measurement is decibel, dB. The community (ambient) noise levels are measured in the A - weighted SPL, abbreviated dB(A). This scale resembles the audible response of human ear. Sounds of frequencies from 800 to 3000 HZ are covered by the A - weighted scale, dB(C) and dB(Z). The variations in the emission of noise levels in a particular environment can be accessed from the statistical distribution of noise levels in that environment (Fig 2.1). The statistical distribution curve defines the terms such as L_{10}, L_{50} and L_{90} etc. The Sound levels exceeding 10%, 50% and 90% of the total time intervals during a particular period are designated as L_{10}, L_{50} and L_{90} respectively. From figure, it can be seen that, 90% of the sound levels are about 64 dB(A). Local disturbances increased the sound levels (L_{10}) to 76 dB(A), i.e., during 10% of the total time. L_{90} represents the background noise levels.

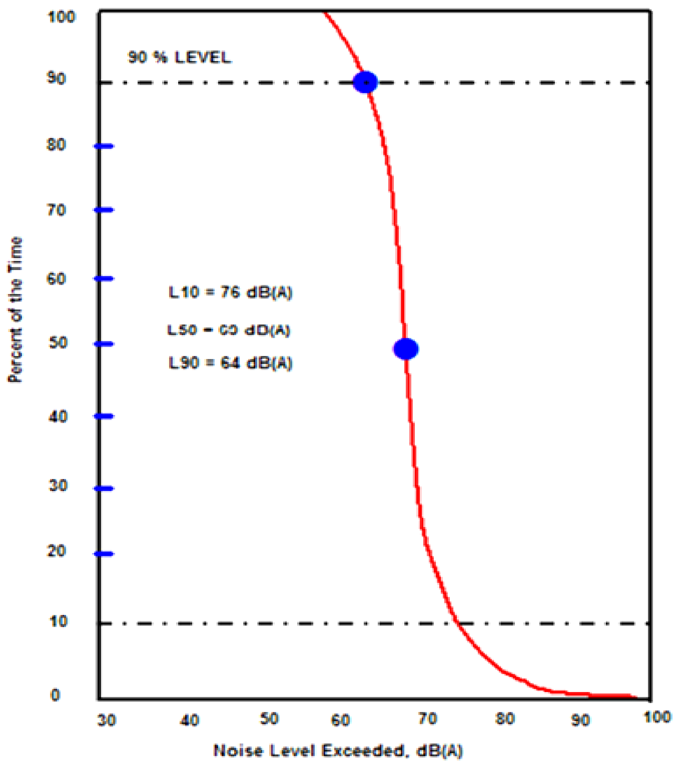


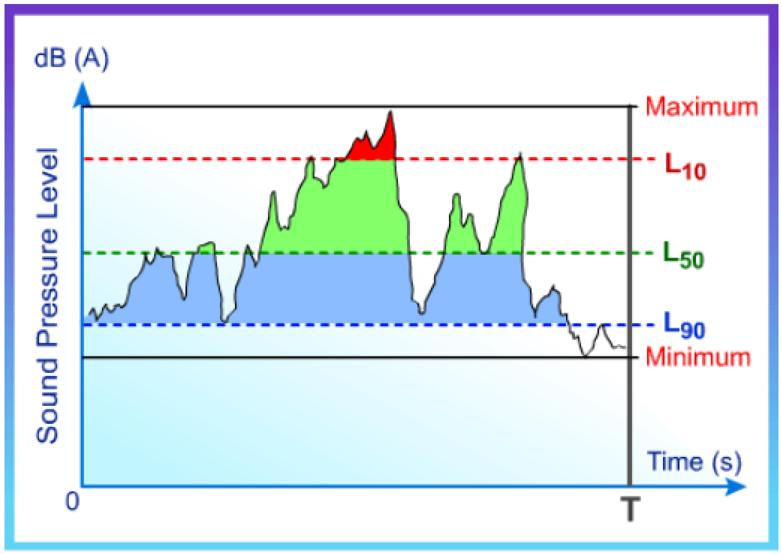
Fig. 2.1: Statistical distribution of noise levels, L_{10}, L_{50} and L_{90}

The commonly used values of n for the n-percent exceeded level, Ln, are 10, 50 and 90. L_{10} is the level exceeded for 10% of the time. For 10% of the time, the sound or noise has a sound pressure level above L_{10}. For the rest of the time, the sound or noise has a sound pressure level at or below L_{10}.

L_{50} is the level exceeded for 50% of the time. It is statistically the mid-point of the noise readings. It represents the median of the fluctuating noise levels.

L_{90} is the level exceeded for 90% of the time. For 90% of the time, the noise level is above this level. It is generally considered to be representing the background or ambient level of a noise environment.

For a varying sound, L_{10} is greater than L_{50} which in turn is greater than L_{90}. The following graph illustrates L_{10}, L_{50} and L_{90} (Fig. 2.2).



Please note that $L_{10} > L_{50} > L_{90}$ for the same sound or noise.

Fig. 2.2: Elaboration of statistical distribution of noise levels, L_{10}, L_{50} and L_{90}

L_{eq} the time averaged sound level; L_{max}, the maximum sound pressure level; L_{Peak} the maximum peak pressure level; L_E the sound exposure level; L_n the statistical levels for the measurement (6 different L_n values). The Broadband measurements are weighted with time and frequency according to the set-up of the instrument. The Broadband measurement can be weighted with A, C or Z frequency weighting. The Time Weightings of F, S and I can be applied to the Broadband measurements as required. The duration of the measurement can either be manual, selected from a pre-set list or defined by the user as required. The measurements can also be set to automatically repeat a set number of times. This function can be essential for environmental noise applications where the measurement duration is for example 1 hour throughout a 24 hour period. The instrument can be set to measure for 1 hour and to repeat until 24 measurements have been stored.

A-frequency-weighting is mandated by the international standard IEC 61672 to be fitted to all sound level meters. A-weighting is only really valid for relatively quiet sounds and for pure tones as it is based on the 40-phon Fletcher–Munson curves which represented an early determination of the equal-loudness contour for human hearing. The old B- and D-frequency-weightings have fallen into disuse, but many sound level meters provide for

C frequency-weighting and its fitting is mandated — at least for testing purposes — to precision (Class one) sound level meters. D-frequency-weighting was specifically designed for use when measuring high level aircraft noise in accordance with the IEC 537 measurement standard. The large peak in the D-weighting curve is not a feature of the equal-loudness contours, but reflects the fact that humans hear random noise differently from pure tones, an effect that is particularly pronounced around 6 kHz. This is because individual neurons from different regions of the cochlea in the inner ear respond to narrow bands of frequencies, but the higher frequency neurons integrate a wider band and hence signal a louder sound when presented with noise containing many frequencies than for a single pure tone of the same pressure level. Following changes to the ISO standard, D-frequency-weighting should now only be used for non-bypass engines and as these are not fitted to commercial aircraft but only to military ones A-frequency-weighting is now mandated for all civilian aircraft measurements.

Z or ZERO frequency-weighting was introduced in the International Standard IEC 61672 in 2003 and was intended to replace the "Flat" or "Linear" frequency weighting often fitted by manufacturers. This change was needed as each sound level meter manufacturer could choose their own low and high frequency cut-offs (–3dB) points, resulting in different readings, especially when peak sound level was being measured. As well, the C-frequency-weighting, with –3dB points at 31.5Hz and 8 kHz did not have a sufficient band pass to allow the sensibly correct measurement of true peak noise (L_{pk}).

B- and D-frequency-weightings are no longer described in the body of the standard IEC 61672 : 2003, but their frequency responses can be found in the older IEC 60651, although that has been formally withdrawn by the International Electro-technical Commission in favor of IEC 61672 : 2003. The frequency weighting tolerances in IEC 61672 have been tightened over those in the earlier standards IEC 179 and IEC 60651 and thus instruments complying with the earlier specifications should no longer be used for legally required measurements.

The most commonly used Frequency Weightings that you will see on a modern sound level meter or noise dosimeter are ‘A’, ‘C’ and ‘Z’ and below is a brief explanation of each of these.

It is very important that you measure the noise levels using the correct frequency weighting as it is not possible to convert from one to another after the measurement has been made. This is why a sound level meter such as the Cirrus optimus will measure all three Frequency Weightings at the same time, saving you time and removing the risk of measuring the wrong parameter.

'C' Weighting

'C' Weighting is a standard weighting of the audible frequencies commonly used for the measurement of Peak Sound Pressure level.

Measurements made using 'C' weighting are usually shown with dB(C) to show that the information is 'C' weighted decibels or, for example, as LCeq, LCPeak, LCE etc. where the C shows the use of 'C' Weighting.

'Z' Weighting

Z weighting is a flat frequency response between 10Hz and 20kHz ±1.5dB excluding microphone response.

Measurements made using 'Z' weighting are usually shown with dB(Z) to show that the information is 'Z' weighted decibels or, for example, as LZeq, LZFmax, LZE etc. where the Z shows the use of 'Z' Weighting.

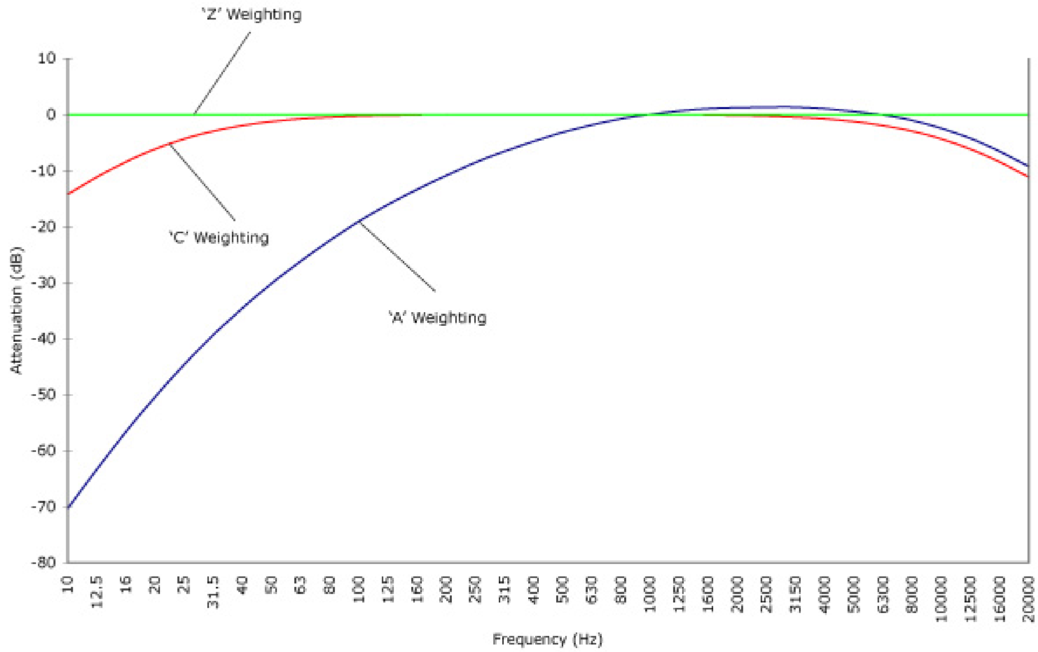


Fig. 2.3: Frequency Weighting Curves - 'A', 'C' & 'Z'

Addition and Subtraction of different Noise

More than one sound at their levels may be added or subtracted as figures given below:

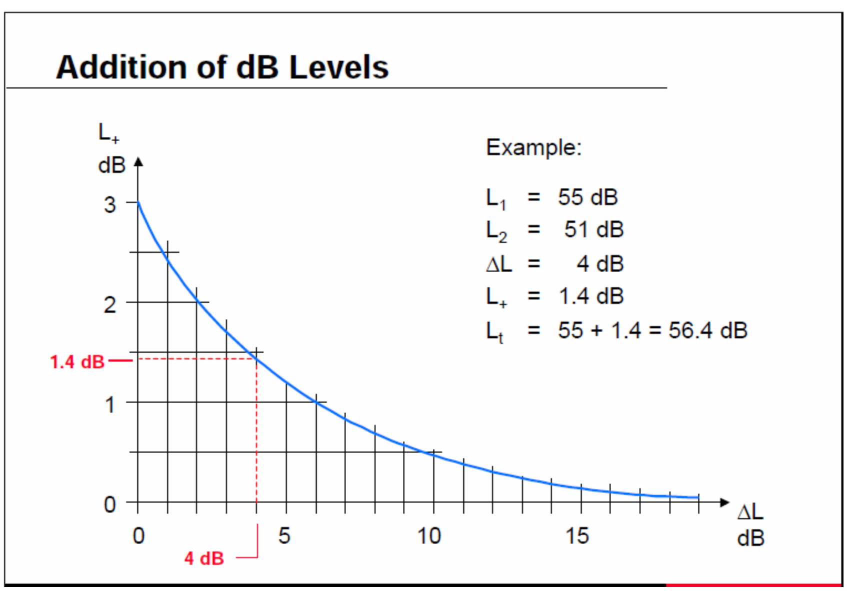


Fig. 2.4a: Addition of sound pressure levels

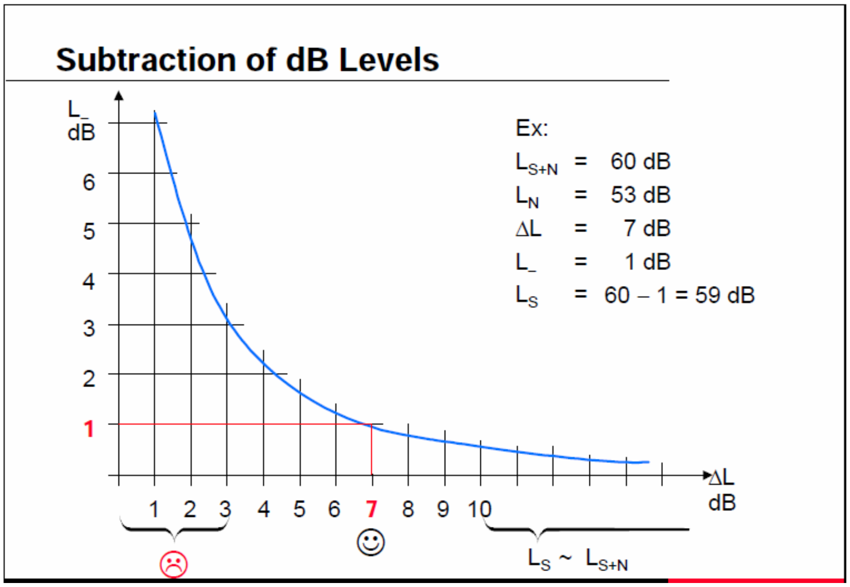


Fig. 2.4b: Subtraction of sound pressure levels

A. 2.4.1: Addition graph

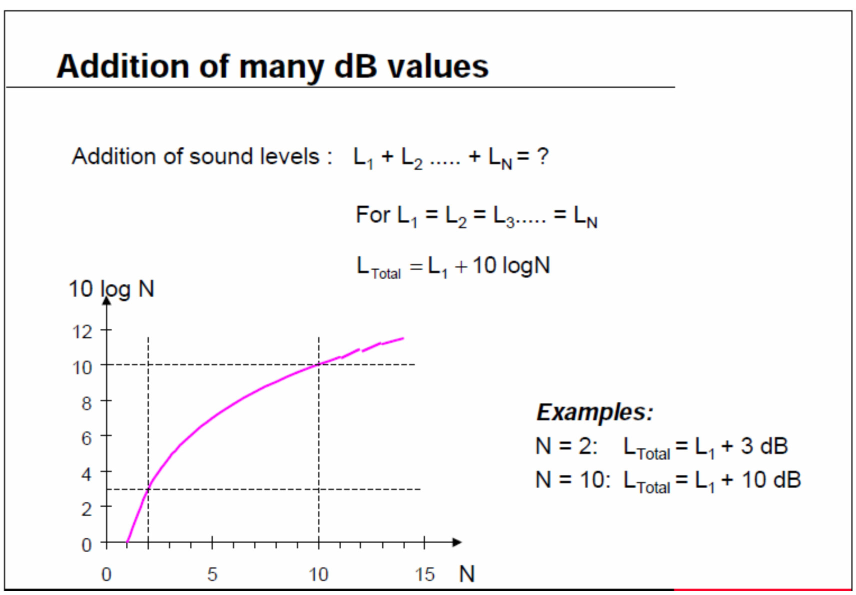


Fig. 2.4c: Addition of infinite sound pressure levels

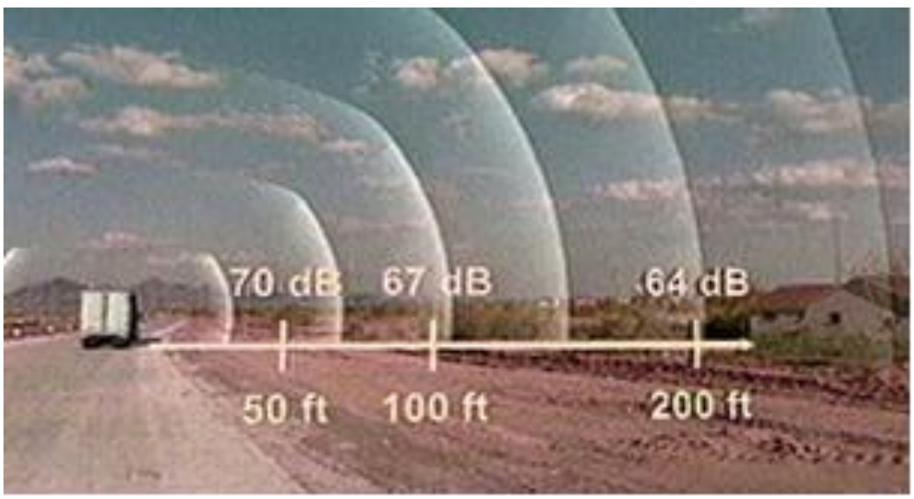
Addition of many dB values is done using the following equation:

$L_{Total} = 10 \log (10^{0.1 L1} + 10^{0.1 L2} + 10^{0.1L3} \ldots\ldots + 10^{0.1Ln})$

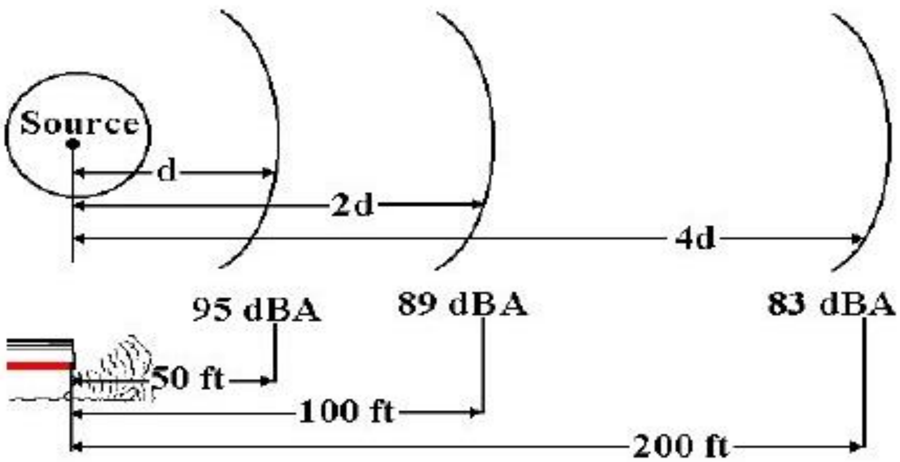
For equal levels the curve for adding values can be used.

2.4.2: Sound Transmission Loss

In case of Line Source:



In case of Point Source:



- When the two train will pass at same point than 3 dB(A) noise will increase. Near Siddhartha Extension, it's very rare that two trains will cross each other. Maximum time in peak, train will be started in morning from depot, and will enter in night. Non peak hour train will go to depot and peak hour it will be back from depot.

CHAPTER-3: DATA COLLECTION

NOISE AND VIBRATION DATA COLLECTION

Noise data have been collected along the corridor. The data collection is shown in Fig 3.1.to 3.10 The photo shows the noise sensors used during monitoring carried out at the site below proposed NCRTC corridor listed below. One noise sensor was used for noise measurement. Noise data has been collected below proposed corridor and shown below as listed:

At Indian railway track – Figure 3.1 to figure 3.8

At gate number-3 – Figure 3.9 to figure 3.10

Noise monitoring at Railway Track:

Photo 3.1 Gate No.3, Siddhartha Extension front of Building

Photo 3.2: Track Interchange in

Photo 3.3 Noise Monitoring at Railway Track

Photo 3.4 Noise Monitoring at Railway Track

Photo 3.5 Noise Monitoring at Railway Track

Photo 3.6 Noise Monitoring at Railway Track

Photo 3.7 Noise Monitoring at Railway Track

Photo 3.8 Noise Monitoring at Railway Track

Noise monitoring at Gate -3

Photo 3.9 Noise Monitoring at Gate No. 3

Photo 3.10 Noise Monitoring at Gate No. 3

Noise Data Collection:

SIDDHARTHA EXTENSION TRAIN 4 WITHOUT HONKING

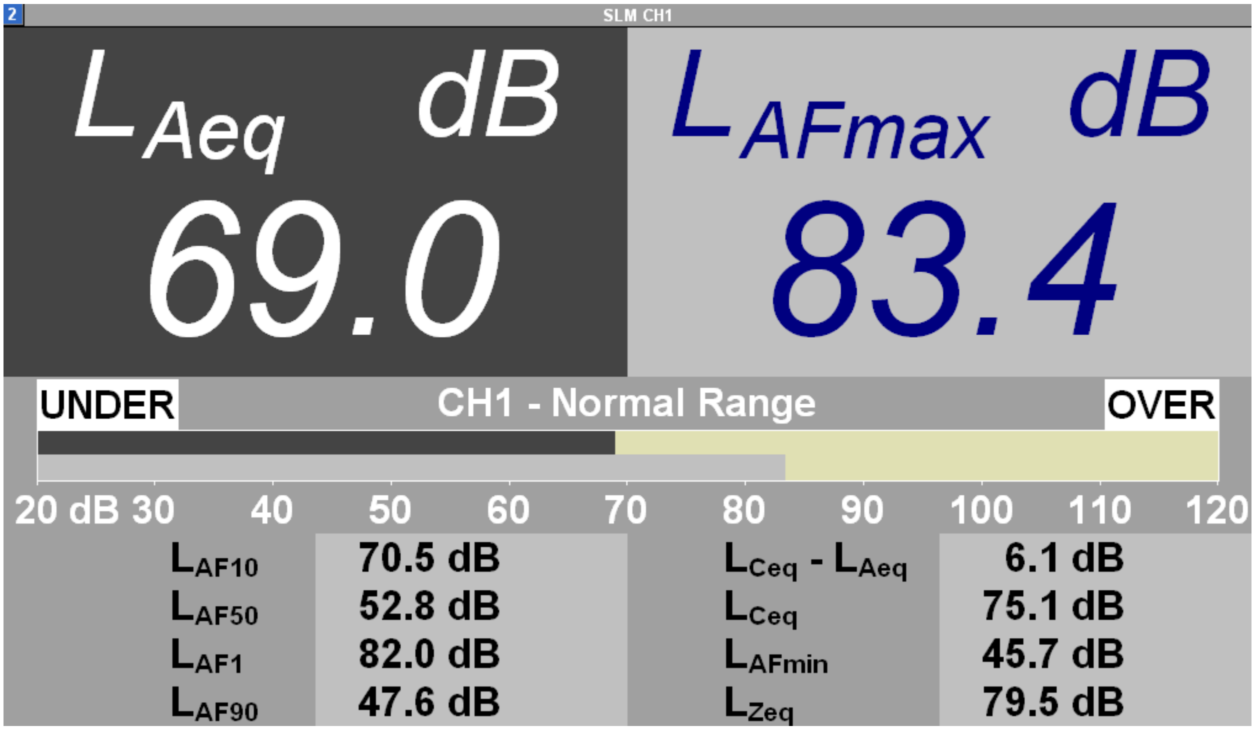


Fig No. 3.1: Various Parameter of Sound

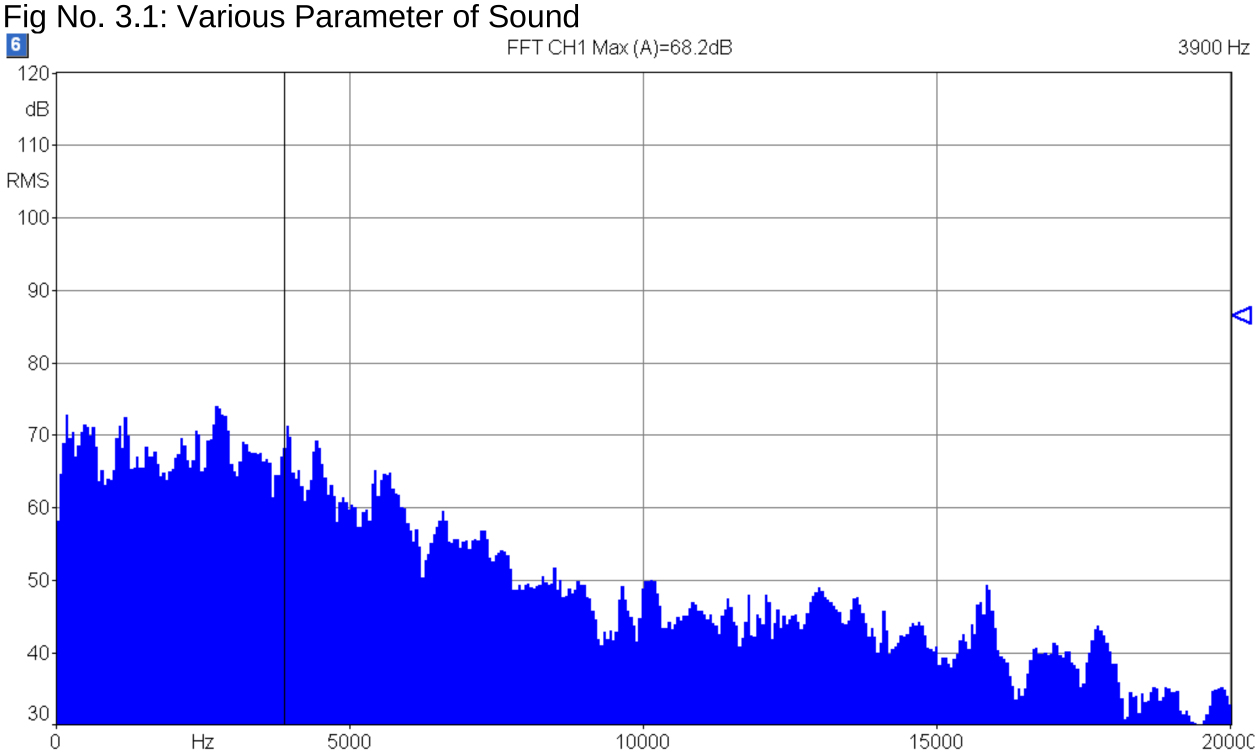


Fig No. 3.2: FFT Analysis

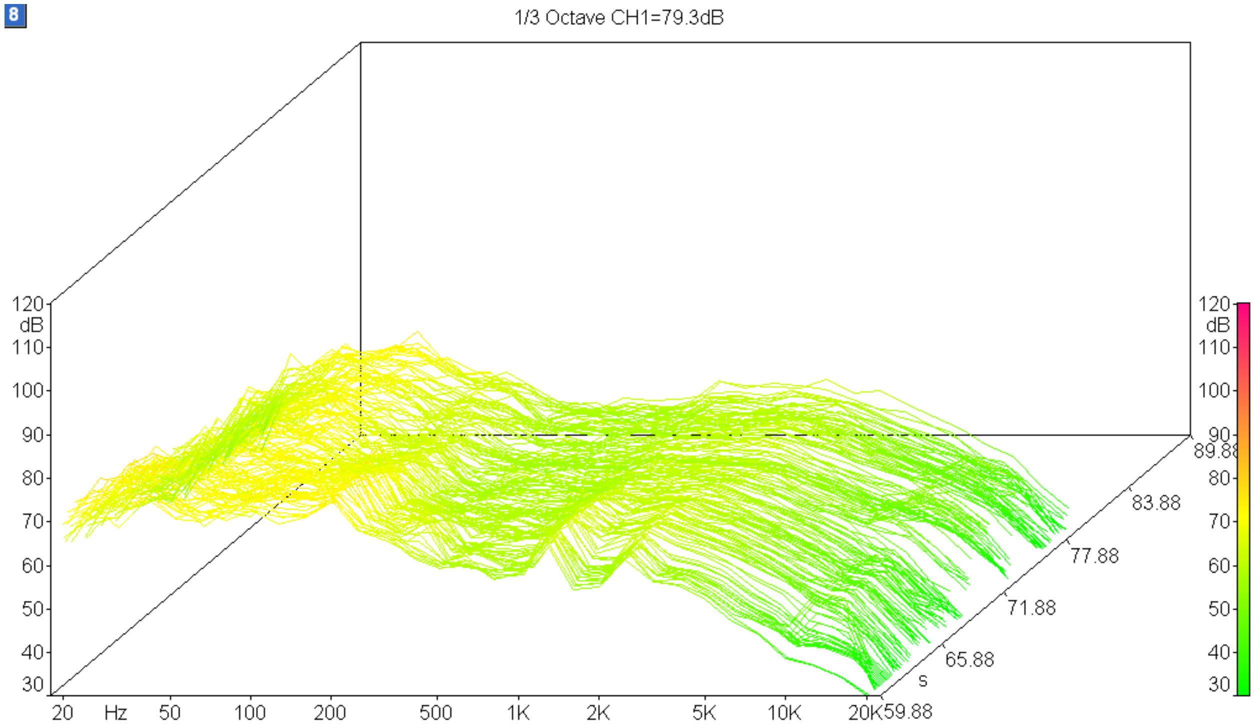


Fig No. 3.3: Water fall Analysis

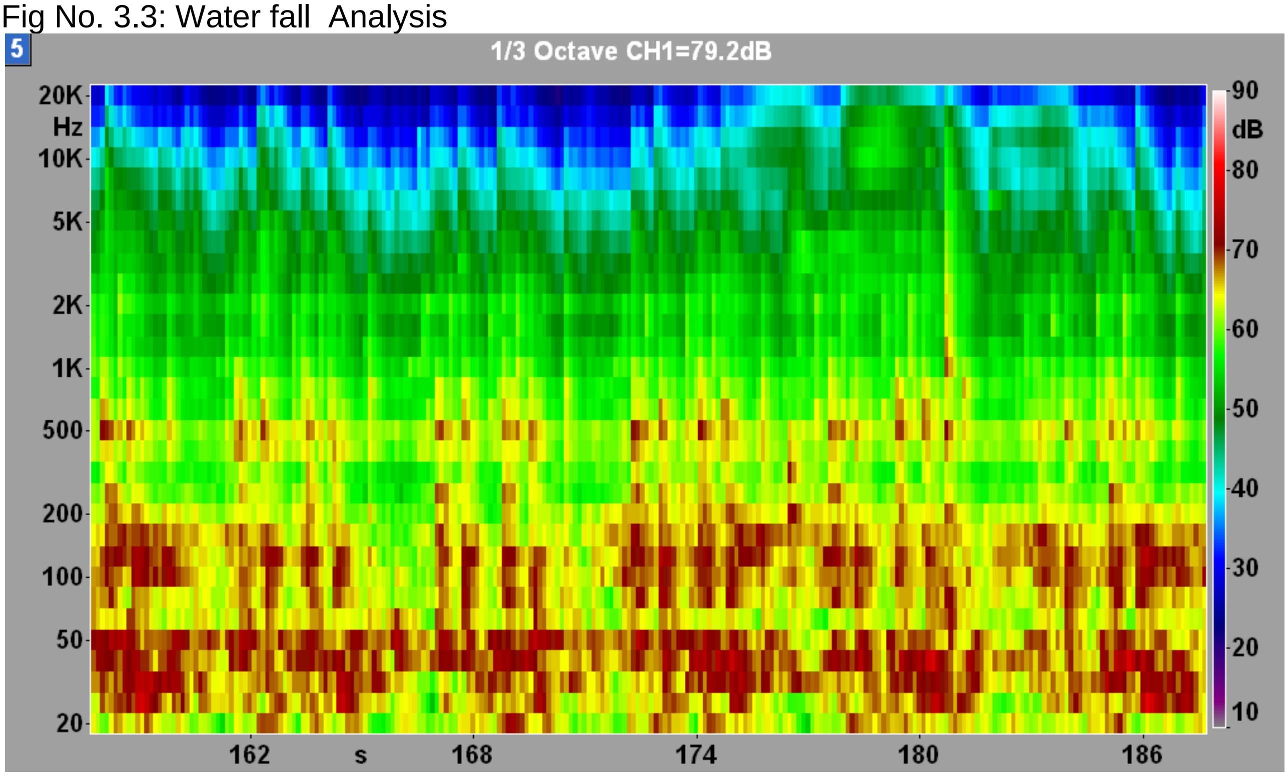


Fig No. 3. 4: Sonogramme Analysis

TRAIN HONKING

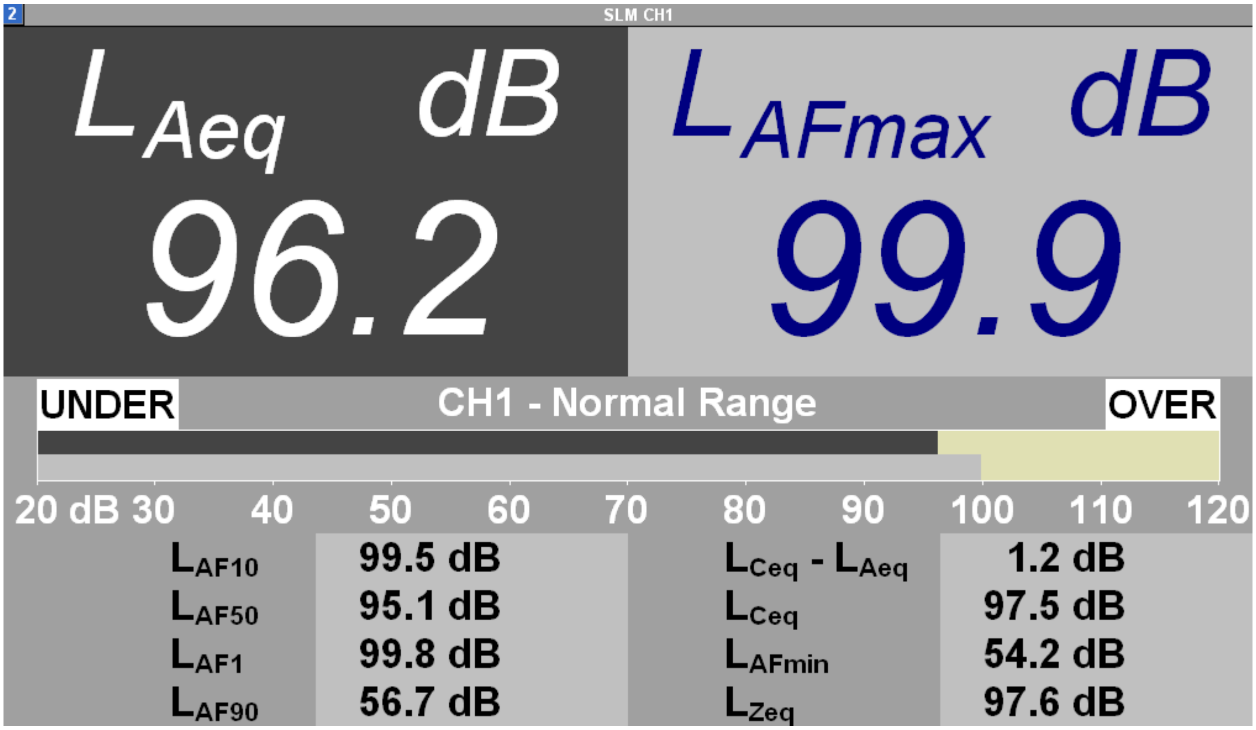


Fig No. 3.5: Various Parameter of Sound

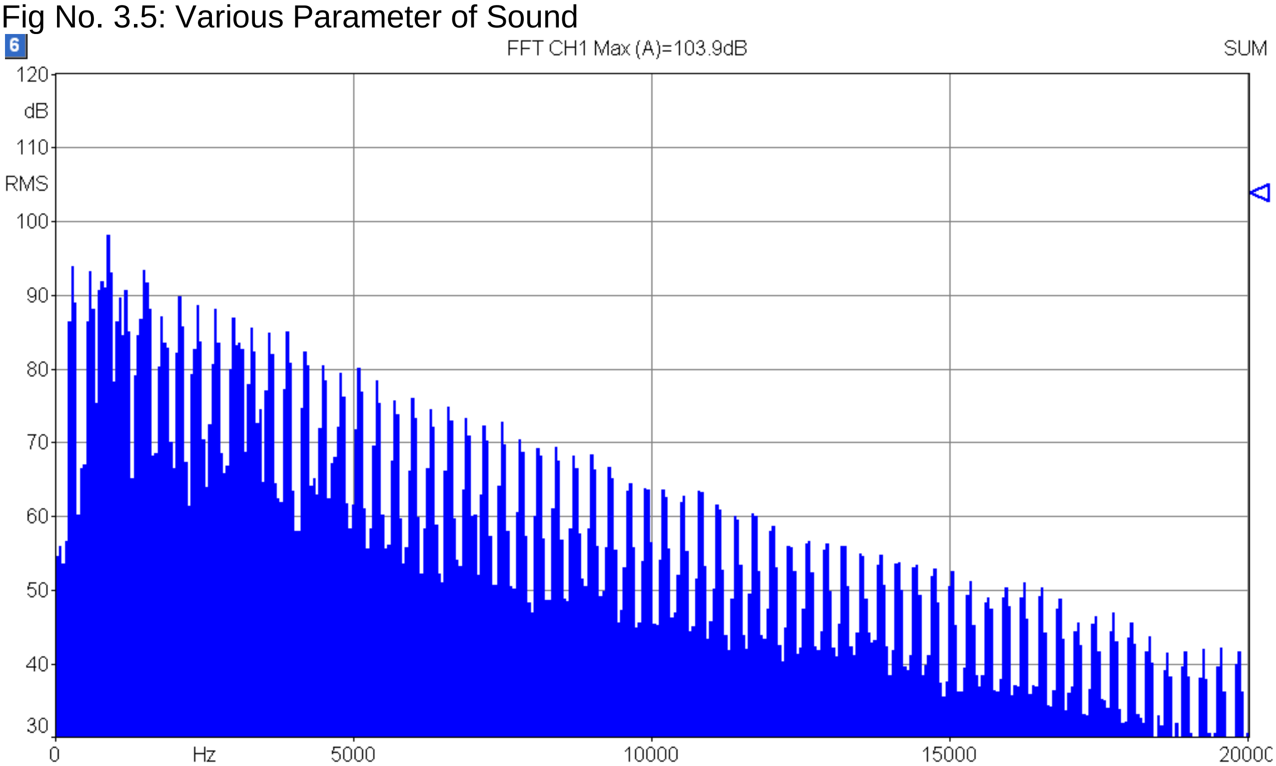


Fig No. 3. 6: FFT Analysis

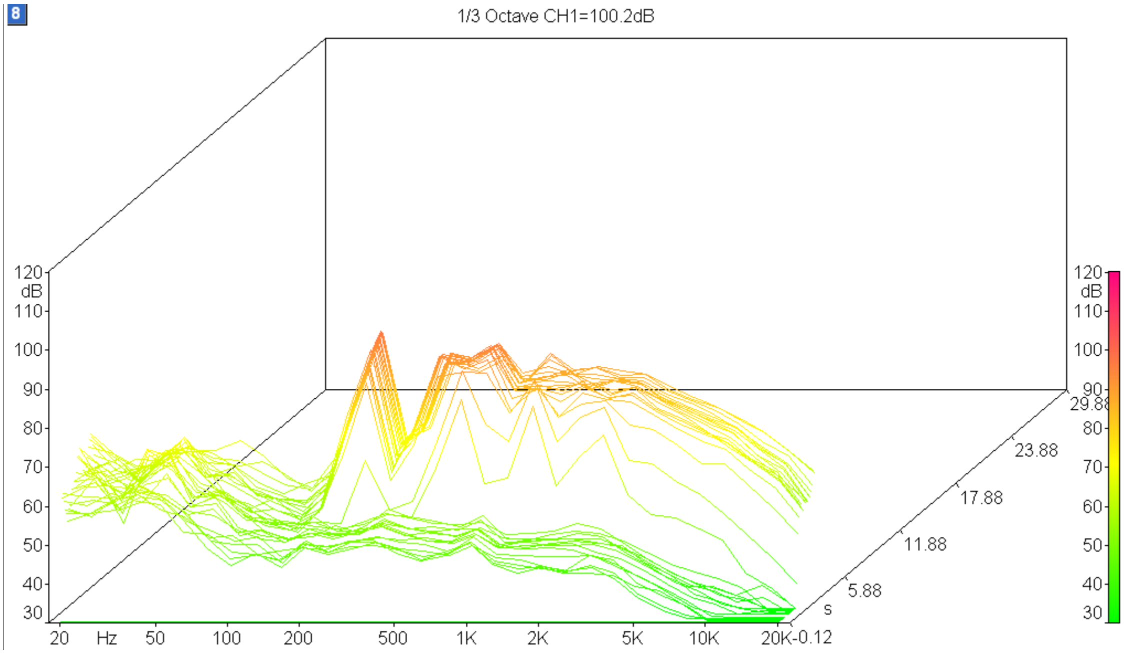


Fig No. 3. 7: Water fall Analysis

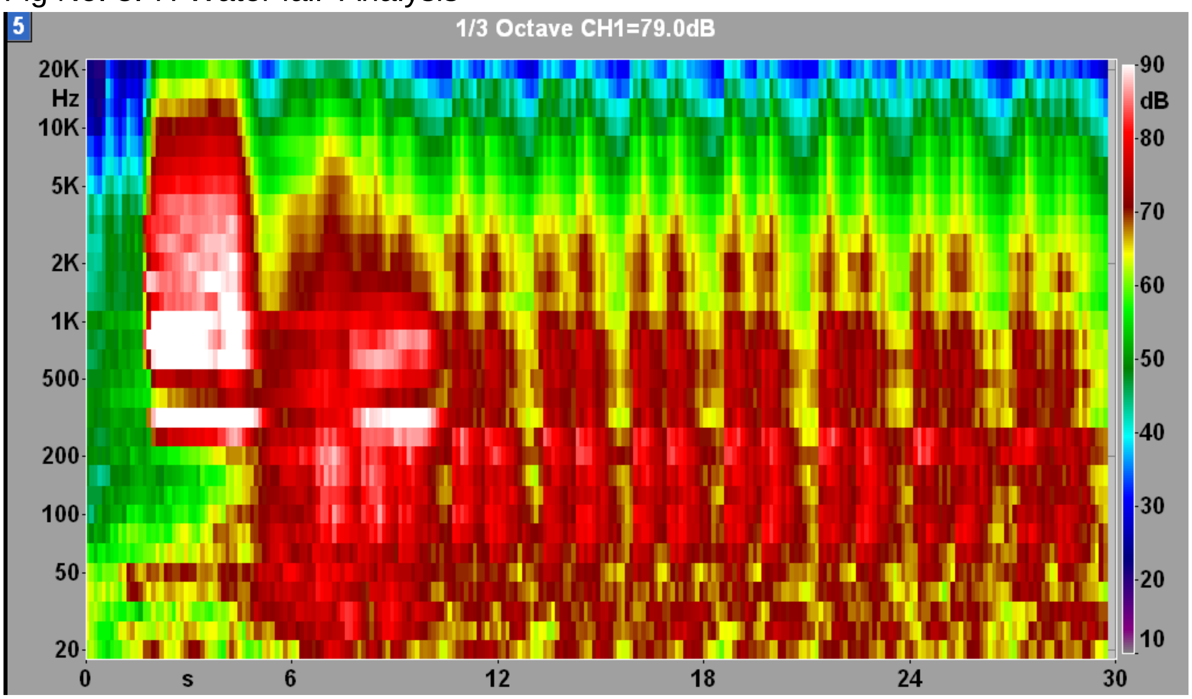


Fig No. 3.8: Sonogramme Analysis

TRAIN HONKING

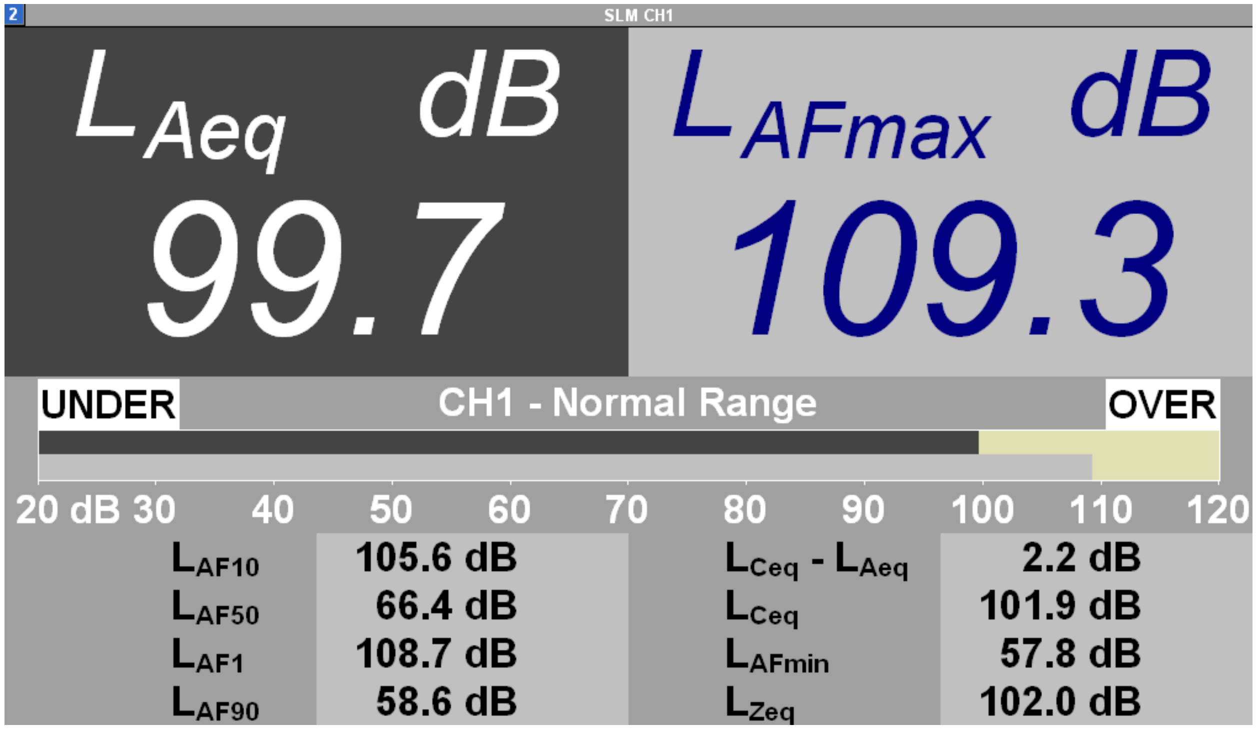


Fig No. 3.9: Various Parameter of Sound

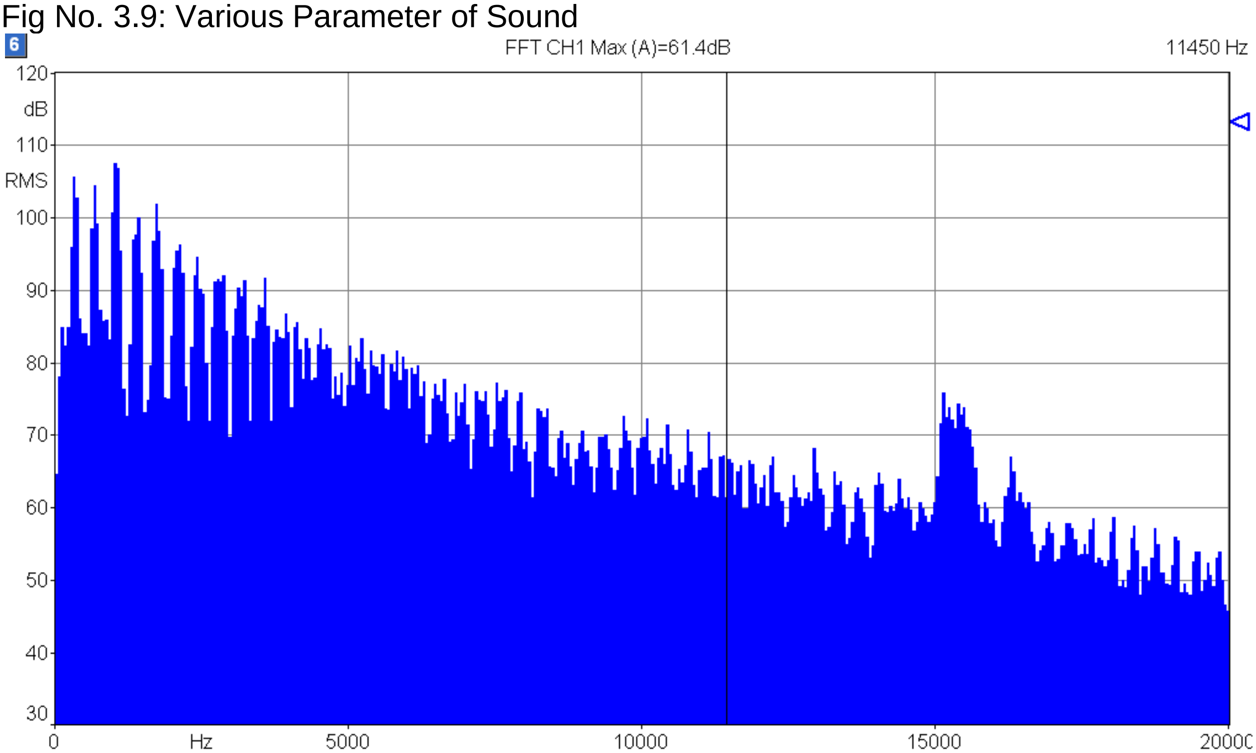


Fig No. 3.10: FFT Analysis

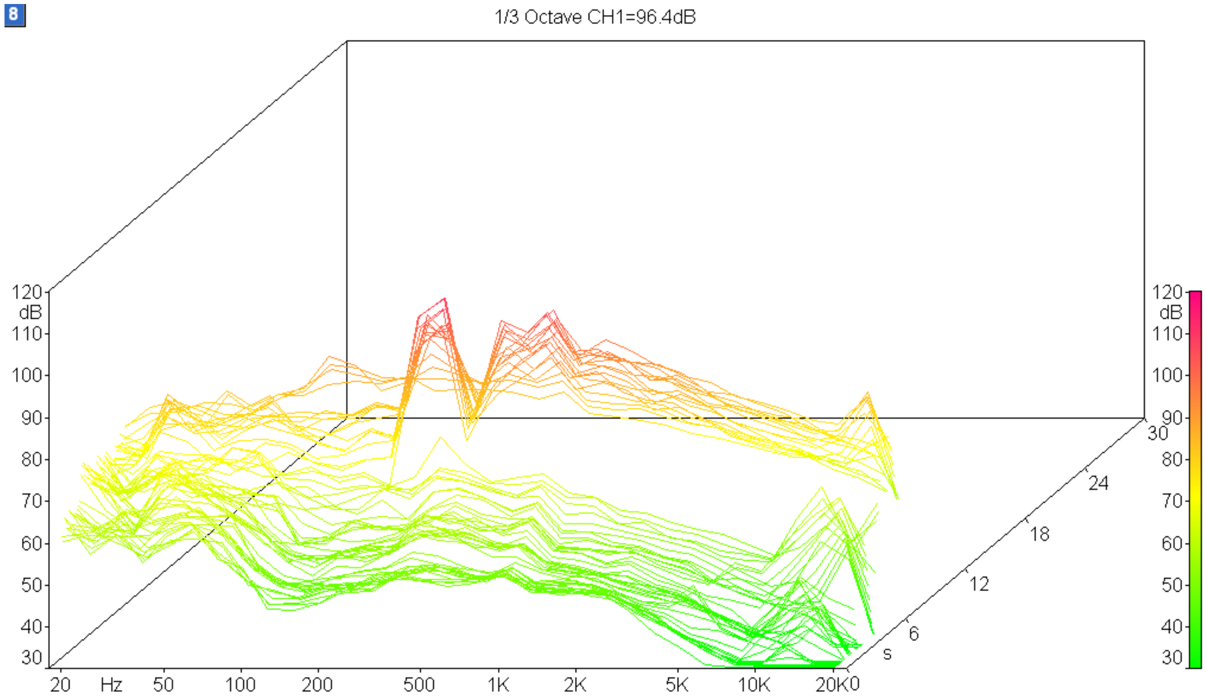


Fig No. 3.11: Water fall Analysis

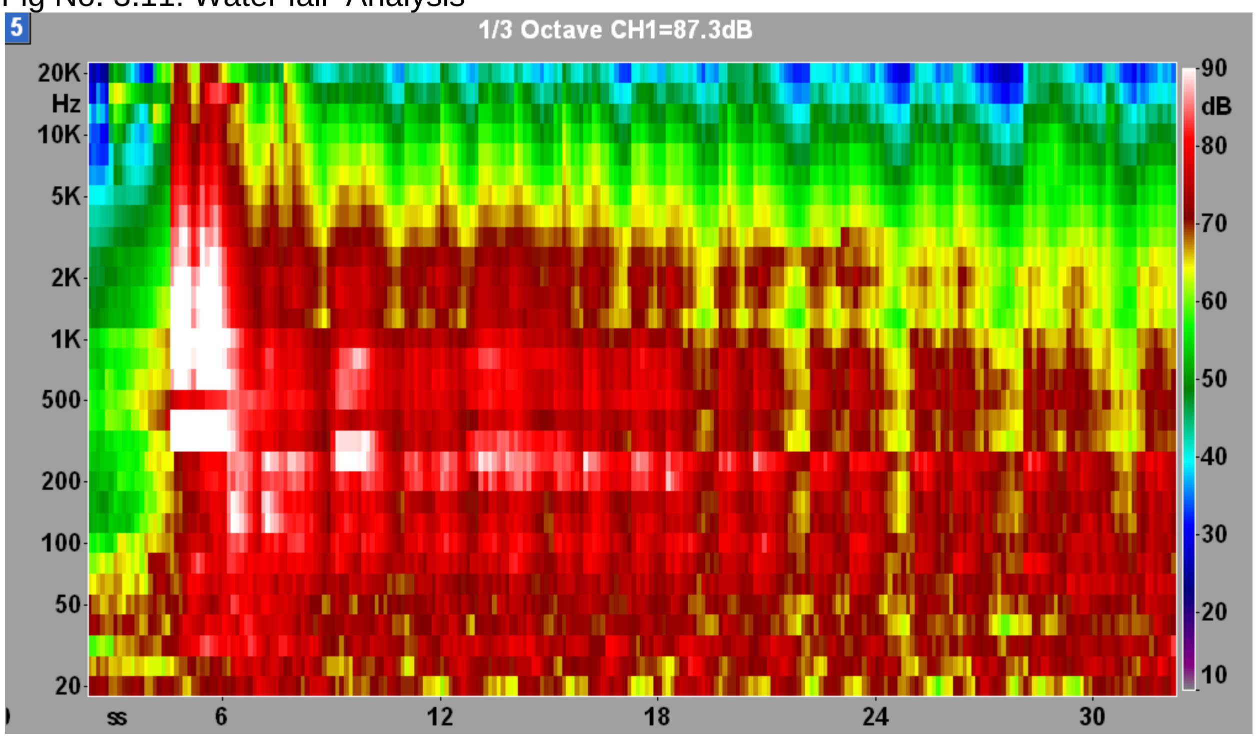


Fig No. 3.12: Sonogramme Analysis

SIDDHARTHA EXTENSION GATE 3

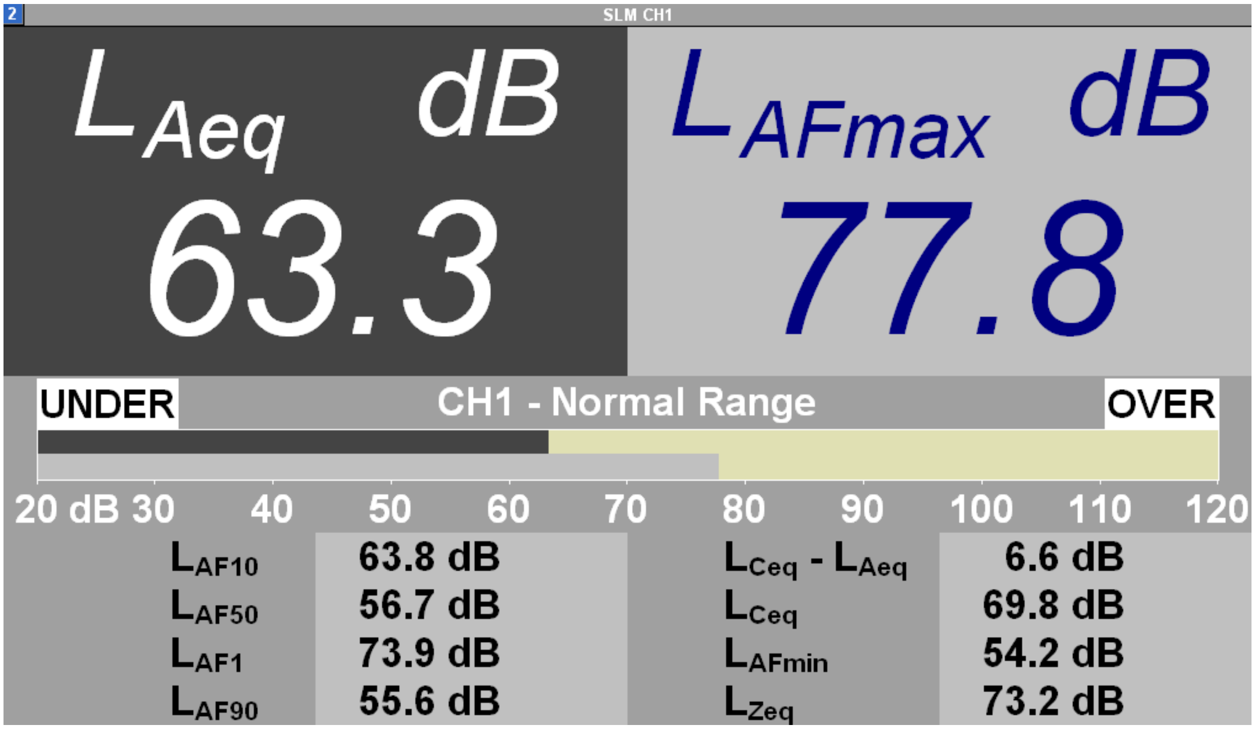


Fig No. 3.13: Various Parameter of Sound

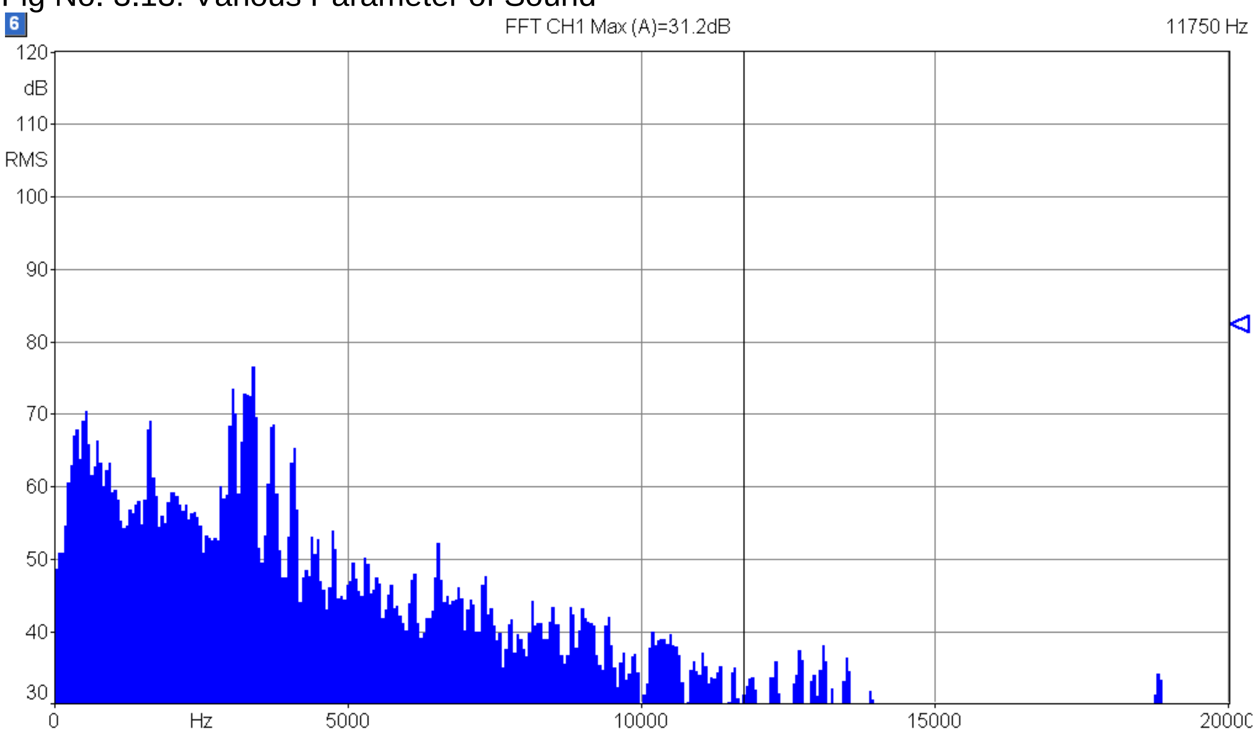


Fig No. 3.14: FFT Analysis

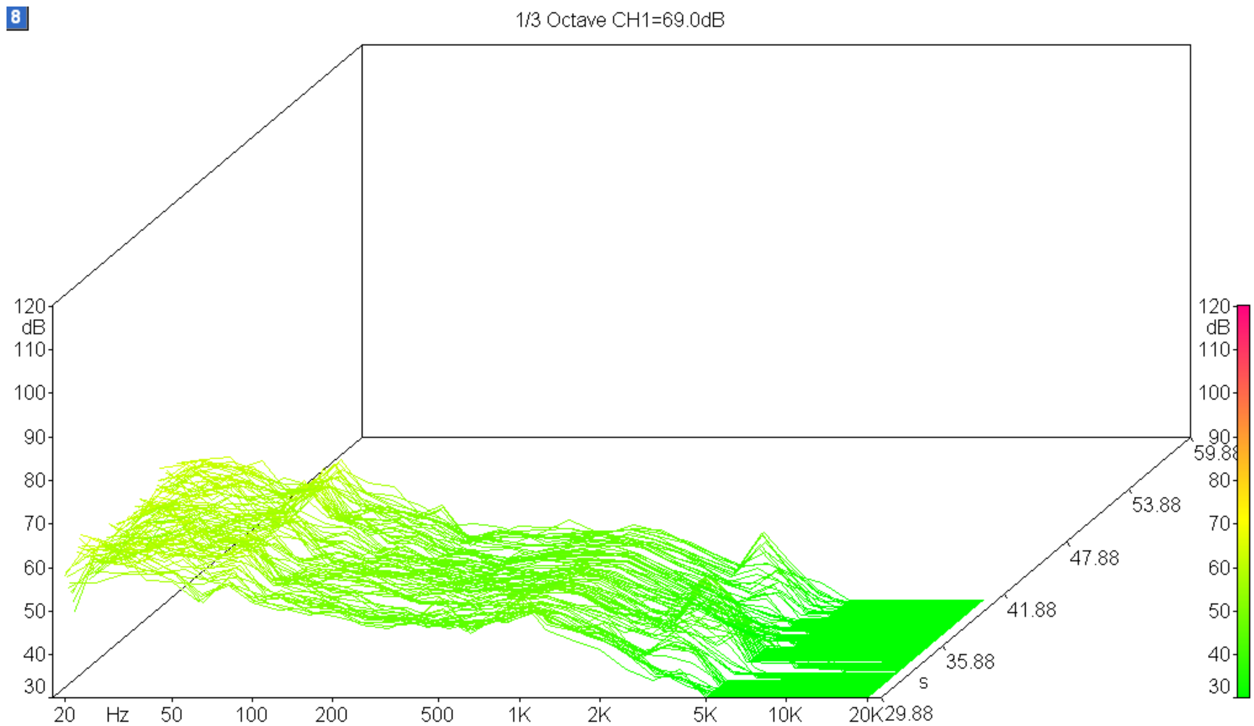


Fig No. 3. 15: Water fall Analysis

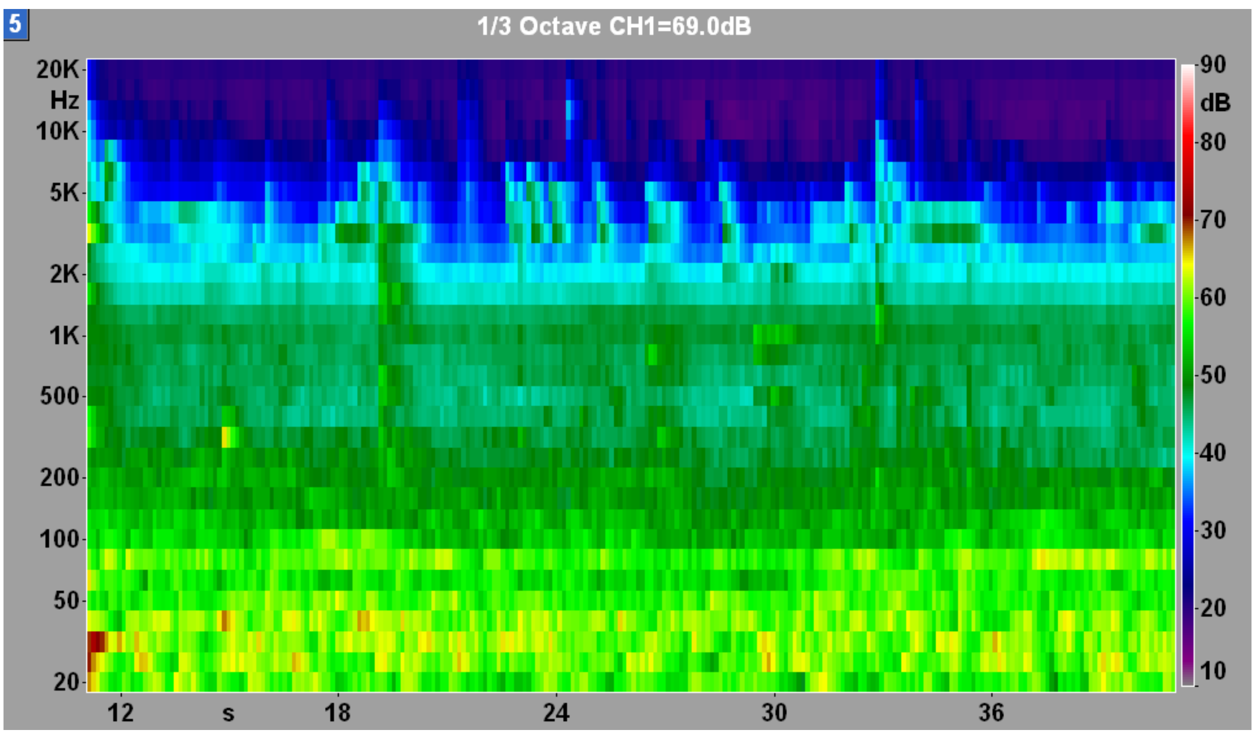
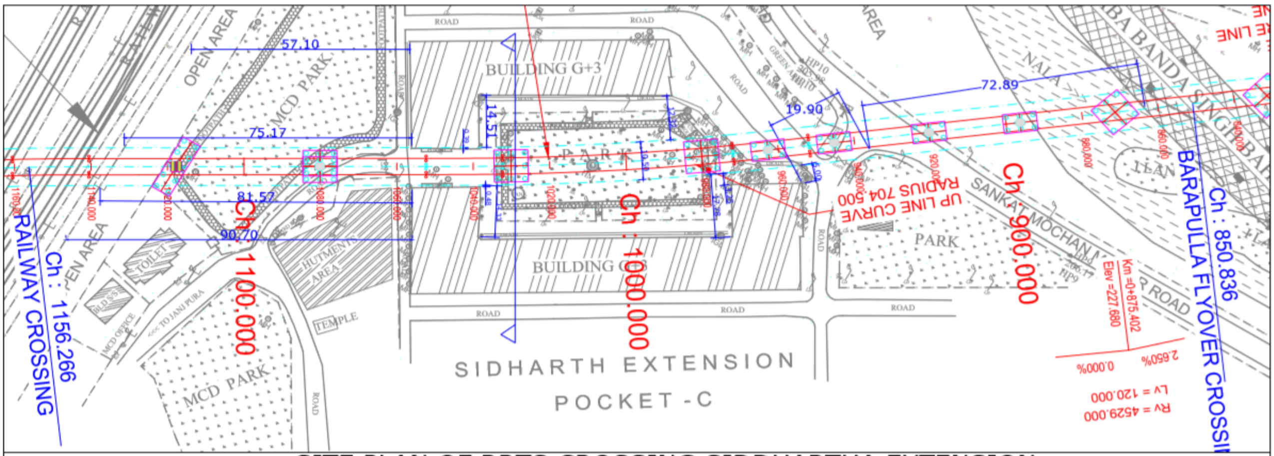
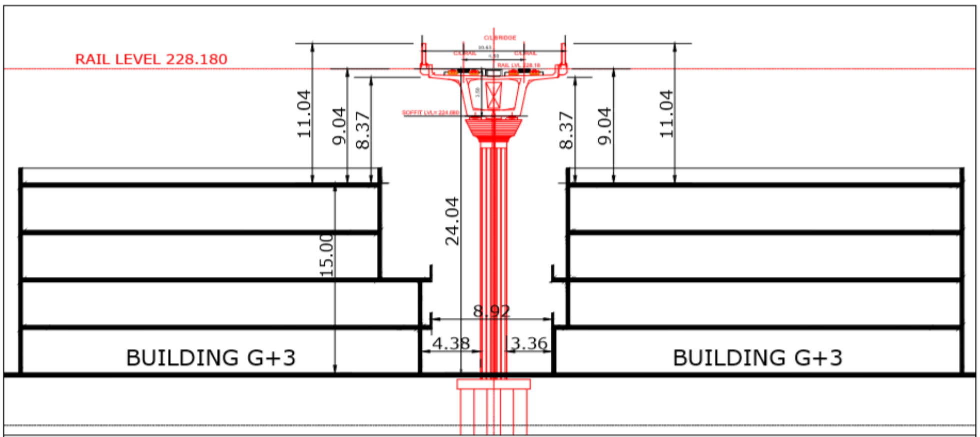


Fig No. 3.16: Sonogramme Analysis



SITE PLAN OF RRTS CROSSING SIDDHARTHA EXTENSION



CROSS-SECTION OF BUILDING AT SIDDHARTHA EXTENTION

CHAPTER 4: DESIGN OF NOISE BARRIER

4.0 Design of Noise Barrier

4.1 Noise Barrier

A noise barrier is an exterior structure designed to protect sensitive land uses from noise pollution. Noise barriers are the most effective method of mitigating roadway, railway, and industrial noise sources – other than cessation of the source activity or use of source controls. Noise barriers, often referred to as 'Sound abatement walls' are commonly constructed using steel, concrete, masonry, wood, plastics, poly carbonate, acrylic, insulating wool, or composites. Some noise barriers may consist of a masonry wall or earthwork, or a combination thereof (such as a wall atop an earth berm). Noise barriers fall in one of the two categories: absorptive and reflective. Absorptive barriers, as the name suggests, absorb sound energy emanating from the source of sound. A porous surface material and sound-dampening content material is said to be absorptive. This means little noise is reflected back towards the source or elsewhere. Barriers without any added absorptive treatment or design, such as block, concrete, polycarbonate sheet, glass, acrylic sheet, wood or metal, are considered reflective. This means, in the case of metro rail applications for example, that sound energy actually bounces from one side of the metro track to the other. Reflective barriers may either be on one side or on both sides of the track. Noise barriers can be extremely effective tools for noise pollution abatement. These can be given various shapes like parabolic, partial curve, inclined or even straight to meet desired aesthetic appeal or different land-use pattern. The top may be provided various shapes like ‘T’, inverted ‘L’ or ‘F’ depending on the noise abatement requirement. Because sound levels are measured using a logarithmic scale, a reduction of nine decibels is equivalent to elimination of about 80 percent of the unwanted sound. Cost and aesthetics play a role in the final choice of any noise barrier.

Critical locations vis-à-vis noise levels have been identified and related Google images have been digitized in MapInfo, GIS software. Thereafter design of noise barriers for affected location has been designed based on the present and future prediction of noise levels. While designing the noise barriers the privacy aspect has also been considered. The noise and privacy issues are addressed at the elevated corridor. Hence, 125m distance, noise barrier has been suggested along the viaduct.

4.1.1: Acoustic Treatment of Elevated corridors

The noise generated by elevated rail can undergo multiple reflections between the parapet side walls and the train surfaces and finally escape into the surrounding. To reduce this effect the side walls of the viaduct can be treated with Micro-perforated aluminum noise barrier with combination of polycarbonate sheet as shown in drawing. This is required in the selected length of portion of elevated corridor where noise barriers have been suggested as shown in Fig no. 1.3. from gate no.3 to existing railway track.

4.1.2: Erection of Sound Barriers

Noise barriers are used to control the sound propagated into the community by blocking the direct sound propagation path. In case of absorptive type, the barrier consists of a 100mm thick Al alloy backing sheet fixed on suitable frame work and 1mm micro-perforated aluminum sheet on the parapet of the viaduct. Outer side of the barrier shall have an Aluminum sheet of suitable color with coefficient of retro- reflection equal to zero candles/lux/sq.m.

The reflective type barrier will consist of at least 15mm thick polycarbonate sheet, which shall be fixed on a frame work on the parapet of the viaduct. It could be a panel of 2m x 2m depending upon the requirement of height. The frame should be sturdy enough to withstand design wind pressure. The poly carbonate sheet could be in light colored as per the requirements of visibility and privacy.

A modular construction technique can be adopted for both the above cases and prefabricated units can be fixed on the framework at sensitive locations.

4.3 Cost Analysis

POSTS

DESCRIPTION		*RATE*
BASIC COST OF STEEL-JSPL		*42000*
GST	*18%*	*7560*
FREIGHT UPTO FAB YARD		*4000*
LANDED COST AT FAB. LOCATION		*53560*
FABRICATION		*8000*
GALVANIZING		*16000*
TOTAL		*77560*
RATE/KG		77.56

POSTS

DESCRIPTION	*KG/M*	*LENGTH (m)*	*WEIGHT(kg)*	*RATE (Rs.)*	*TOTAL (Rs.)*
POSTS	*23*	*3.6*	*83*	*78*	*6422*
BASE PLATE	*63*	*0.6*	*38*	*78*	*2932*
CLEATS, GUSSETS, COVERS ETC			*35*	*78*	*2715*
PAINTING			*145*	*13*	*1885*

ANCHOR BOLTS			*8*	*250*	*2000*
GROUT			*52*	*6.5*	*2704*
SCREWS			*8*	*5.5*	*44*
SUB TOTAL					18701
GST				*18.00%*	
SUB TOTAL					18701
MISC					
FREIGHT TO SITE			*145*	*4*	*580*
SUB TOTAL					19281
OCTROI				*5.00%*	*0*
TOTAL					**19281**
COST/SQM					2142.37

POSTS					
DESCRIPTION	*KG/M*	*LENGTH*	*WEIGHT*	*RATE*	*TOTAL*
POSTS	*23*	*3.6*	*83*	*78*	*6422*
BASE PLATE	*63*	*0.6*	*38*	*78*	*2932*
CLEATS, GUSSETS, COVERS ETC			*35*	*78*	*2715*
PAINTING			*145*	*13*	*1885*
ANCHOR BOLTS			*8*	*250*	*2000*
GROUT			*52*	*6.5*	*2704*
SCREWS			*8*	*5.5*	*44*
SUB TOTAL					18701
GST				*18.00%*	3366
SUB TOTAL					22068
MISC					
FREIGHT TO SITE			*145*	*4*	*580*
SUB TOTAL					22648
OCTROI				*5.00%*	
TOTAL					**22648**
COST/SQM					2516.40

ALUMINIUM

DESCRIPTION	*UNIT*	*RATE (Rs.)*
BASIC COST OF ALUMINIUM	*M.Ton*	*210000*
GST	*18.00%*	*37800*
FREIGHT UPTO FAB YARD	*M.Ton*	*4000*
LANDED COST AT FAB. LOCATION	*M.Ton*	*251800*
FABRICATION	*M.Ton*	*15000*
OTHER		
TOTAL	*M.Ton*	*266800*
RATE/KG		**266.8**

MICRO PERFORATED SHEET

DESCRIPTION	UNIT	RATE (Rs.)
LANDED COST (CIF)OF MICRO PERFORATED ALUMINIUM SHEET	*SQM*	*1700*
IMPORT DUTIES, CLEARANCES ETC	*0.00%*	*0*
SUB TOTAL		*1700*
GST	*0.00%*	*0*
FREIGHT UPTO FAB YARD	*SQM*	*0*
LANDED COST AT FAB. LOCATION	*SQM*	*1700*
FABRICATION	*SQM*	*0*
OTHER		
TOTAL	*SQM*	*1700*
RATE/SQM		1700
RATE/KG		629.63

ABSORPTIVE PANEL (MICRO PERFORATED)

DESCRIPTION	UNIT	HEIGHT (m)	LENGTH (m)	WEIGHT (kg)	RATE	TOTAL (Rs.)
PANEL SHEET (FRONT)	*KG*	*0.5*	*3.0*	*4.66*	*630*	*2934*
PANEL SHEET (REAR)	*KG*	*0.5*	*3.0*	*7.39*	*267*	*1972*
CAPS	*KG*	*0.1*	*0.5*	*0.53*	*267*	*143*
PAINTING	*SQM*			*4.62*	*180*	*832*
ABSORBENT MATERIAL	*SQM*	*0.5*	*3.0*			*0*
GASKETS	*Mtr*			*2*	*100*	*200*
SCREWS	*No*			*22*	*5*	*110*
ASSEMBLY	*No*					100
SUB TOTAL						6290
GST					*18.00%*	
SUB TOTAL						6290
MISC						
FREIGHT TO SITE	*No*					*150*
SUB TOTAL						6440
OCTROI					*5.00%*	
SUB TOTAL						6440
CONTRACTOR OVERHEADS AND PROFIT					15%	965.99
TOTAL						**7405.95**
COST/SQM						4937.30

ABSORPTIVE PANEL (MICRO PERFORATED)

DESCRIPTION	UNIT	HEIGHT (m)	LENGTH (m)	WEIGHT (kg)	RATE	TOTAL (Rs.)
PANEL SHEET (FRONT)	KG	0.5	3.0	4.66	630	2934
PANEL SHEET (REAR)	KG	0.5	3.0	7.39	267	1972
CAPS	KG	0.1	0.5	0.53	267	143
PAINTING	SQM			4.62	180	832
ABSORBENT MATERIAL	SQM	0.5	3.0			0
GASKETS	Mtr			2	100	200
SCREWS	No			22	5	110
ASSEMBLY	No					100
SUB TOTAL						6290
GST					18.00%	1132
SUB TOTAL						7422
MISC						
FREIGHT TO SITE	No					150
SUB TOTAL						7572
OCTROI					5.00%	379
SUB TOTAL						7951
CONTRACTOR OVERHEADS AND PROFIT					15%	1192.61
TOTAL						**9143.37**
COST/SQM						6095.58

PC / PMMA (15mm thickness) WITH FRAME

DESCRIPTION	Unit	RATE
BASIC COST OF PMMA 15MM	SQM	4450
GST	18%	801
CESS ON EXCISE DUTY		0
SALES TAX AGAINST C FORM / VAT		0
FREIGHT UPTO FAB YARD		50
LANDED COST AT FAB. LOCATION		5301
RATE/SQM of PMMA 15mm		5301

DESCRIPTION	Unit	RATE
BASIC COST OF STEEL		42000
GST	18%	7560
FREIGHT UPTO FAB YARD		3500
LANDED COST AT FAB. LOCATION		53060
FABRICATION		8000
GALVANIZING		16000

TOTAL		*77060*
RATE/KG steel frame		77.06

TRANSPARENT PANEL

DESCRIPTION		*HEIGHT (m)*	*LENGTH (m)*	*WEIGHT (Kg)*	*RATE (Rs.)*	*TOTAL (Rs.)*
PC/PMMA SHEET		*0.5*	*3.0*		*5301*	*7952*
FRAME METAL		*0.5*	*3.0*	*34*	*77*	*2647*
FASTENERS				*16.0*	*10*	*160*
PAINTING				*5*	*250*	*1250*
GASKETS				*10*	*200*	*2000*
ASSEMBLY						100
SUB TOTAL						14108
GST					*18.00%*	2539
SUB TOTAL						16647
MISC						
FREIGHT TO SITE						*150*
SUB TOTAL						16797
OCTROI					*5.00%*	*0*
TOTAL						**16797**
COST/SQM						11198

TRANSPARENT PANEL

DESCRIPTION	*HEIGHT (m)*	*LENGTH (m)*	*WEIGHT (Kg)*	*RATE (Rs.)*	*TOTAL (Rs.)*
PC/PMMA SHEET	*0.5*	*3.0*		*5301*	*7952*
FRAME METAL	*0.5*	*3.0*	*34*	*77*	*2647*
FASTENERS			*16.0*	*10*	*160*
PAINTING			*4*	*250*	*875*
GASKETS			*10*	*200*	*2000*
ASSEMBLY					100
SUB TOTAL					13733
GST				*18.00%*	
SUB TOTAL					13733
MISC					
FREIGHT TO SITE					*150*
SUB TOTAL					13883
OCTROI				*5.00%*	*0*
TOTAL					**13883**
COST/SQM					9255

Noise Barrier BOQ					
Length - (m)	250				
Item Description	Unit	Rate/Item (in Rs.)	Qty (Nos)	Amount (Rs.)	Qty (SQM)
Post (UC 152x23 - (3000mm+600)	No	18701	126	2356326	756
Absorptive Panel (1.2mmx500mmx3000mm)	No	6290	500	3145000	750
Transparent Panel (15mmx500mmx3000mm)	No	14108	250	3527000	125
Flashings, packing etc	No	600	1000	600000	
Grout at alignment	No	300	150	45000	
Sub Total				9673326	
Contractor overheads and profit	%	12%		1160799	
Octroi	%	5%		0	
Sub Total				10834125	
GST	%	18%		1950142	
Installation / SQM	SQM	725		543750	
Total with GST				**13328017**	
Total without GST				**11377875**	

Rate per m^2 = Total Cost with GST / Quantity = 13328017/756= 17360/m^2
(For both types of noise Barrier mentioned below)

4.4 *Specifications*

Description	Unit	Rate/unit Rs.	Quantity	Total in Rs.
Micro perforated Mono-absorbent panels and Transparent panels must confirm to be certified panels. Structural steel for post, plates etc., should be hot dip galvanised with a coat of primer and two coats of epoxy finish paint of approved shade. 1. **From Gate no. 3 to railway track 125m length** **Total Length = 125m both sides at the height of 2.5m and semi circular shape half meter on top, hence total height consider 3m.** Height of Noise Barrier = 3m straight & 0.5m Loop = 3.5m	SQM	**17360**/-	250x3.0 = 750m^2	13020000/-
Total Rs.				13020000/-

- **Technical Specifications:**

Noise barrier shall compose of certified and tested panels by competent agencies.

2. Material Specifications:

- Posts are UC 152 or equivalent type welded to a 20mm thick base plate with all required gussets, cleats etc duly hot dig galvanized with a coat of primer and two coats of epoxy finish paint. Posts are fastened to the flyover with M 20 anchors and chemical grout.

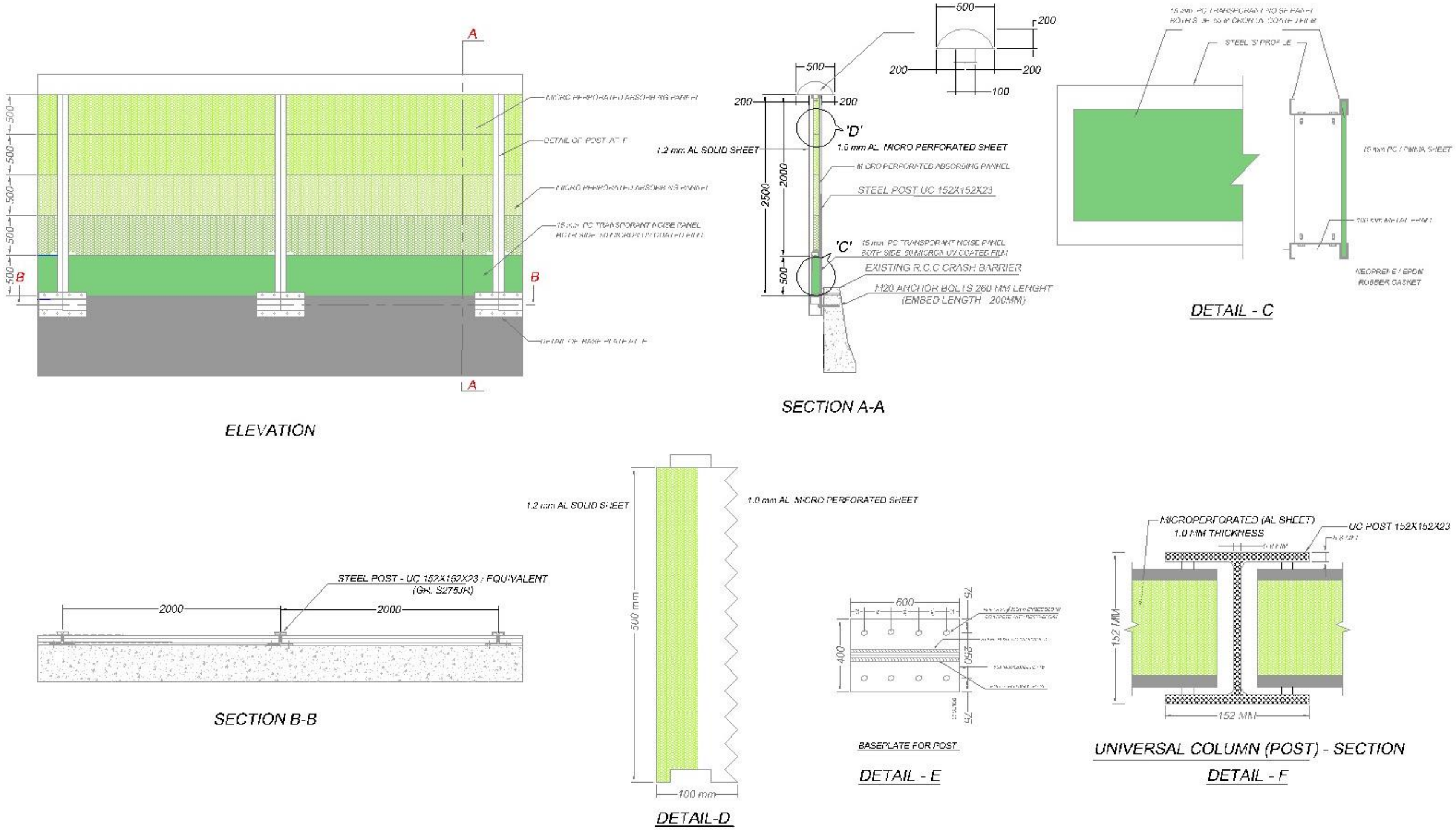
    - Mono – absorbent Micro-Perforated Aluminum panels 0.5m x3.0m of 1.0 mm thick front & 1.2mm thick back/top/bottom aluminum material duly assembled with self-drilling GI screws or riveted. Aluminum panels shall be powder coated.

- Sound proofing transparent panels shall be made of 15mm thick PC Sheet (of size 0.5 x 2.0m) duly encased in a bolted steel frame with EPDM rubber gasket. The steel frame is to be hot dip galvanized with a coat of primer and two coats of epoxy finish paint.

- Anchors bolts and connection bolts must be hot dip galvanized.

- Steel: S 235JR (EN 100025)/ IS 2062/IS5986 or equivalent.
  Aluminum: ALU 1050A/ALU 3004/ALU 3105 or equivalent.
  Galvanization: EN 1461/IS 4759 or equivalent.
  Anchors & connection Bolts: Conforming to IS1367 grade 8.8 or equivalent.
  Chemical grout: RE 500 make or equivalent.
- **Others :**

  Detailed drawings must be submitted by the bidder before fabrication of noise barriers for onward approval by CRRI.



ABSORPTIVE PANEL	
NRC VALUE	>=0.85
LIFE	>20 years
WEIGHT OF PANEL	<=10kg m2

REFLECTIVE PANEL (15 PMMA)	
TRANPARENCY	Till 30 YEARS
LIFE	30 years

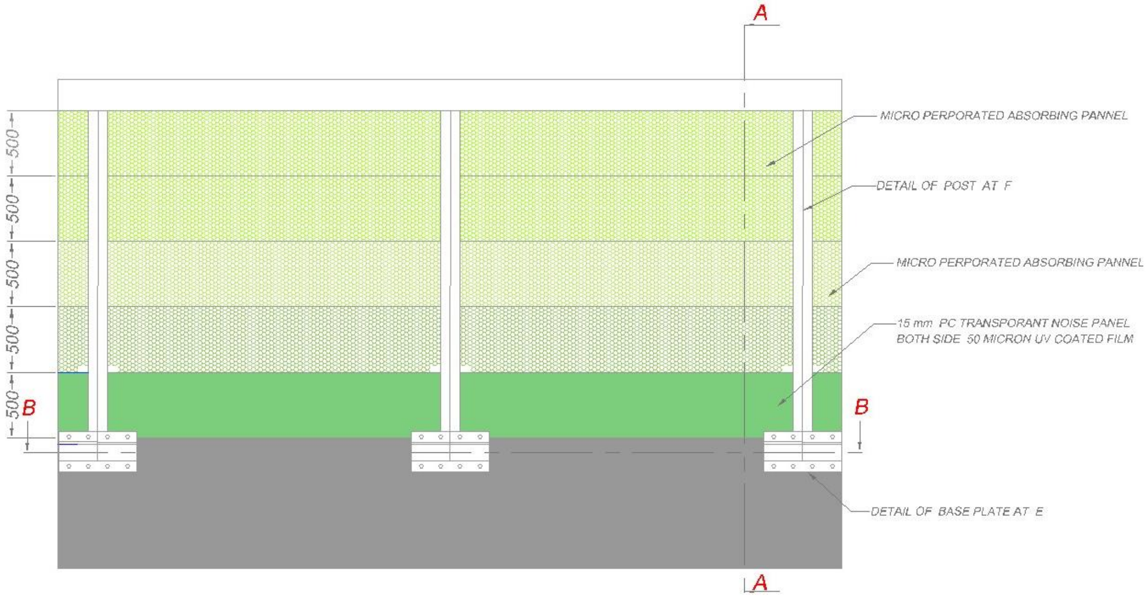
POST	
POST WEIGHT	<=23kg/m2
LIFE	30years
EFFECT OF WATER ACID /ALKALI	NO EFFECT TILL 20 YEARS

CSIR CRRI

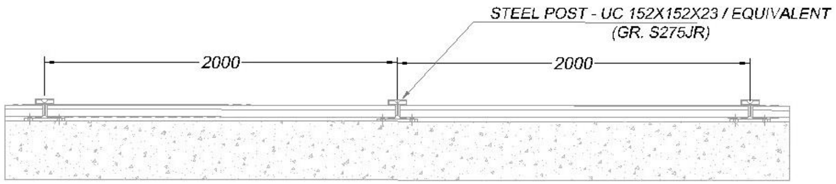
CSIR - CENTRAL ROAD RESEARCH INSTITUTE, NEW DELHI-110025

CUSTOMER:	NCRTC NEW DELHI
SITE:	SARAIKALE KHA TO ASHRAM
NAME OF WORK:	NOISE BARRIER DESIGN

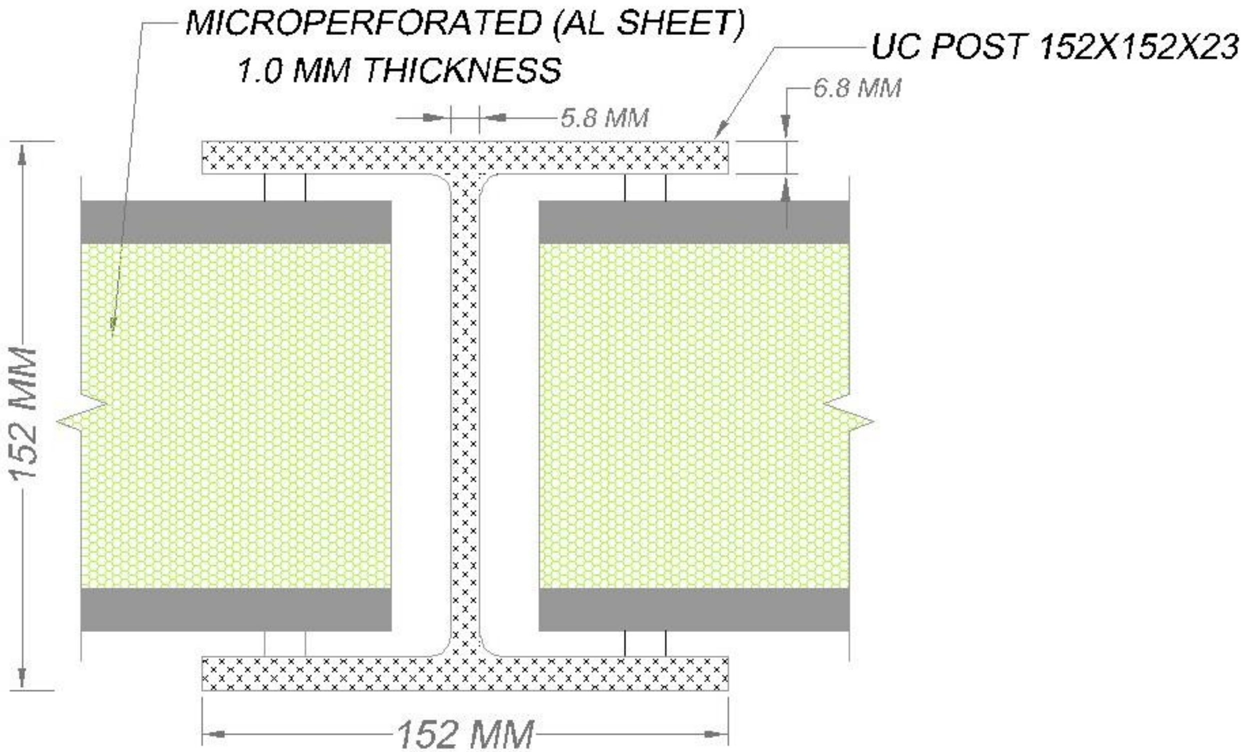
DRAWING NO.	CRRI-001	SHEET NO.	1	DATE	29-12-2020	GALVANIZING	IS 4759	REV. NO.	00



ELEVATION

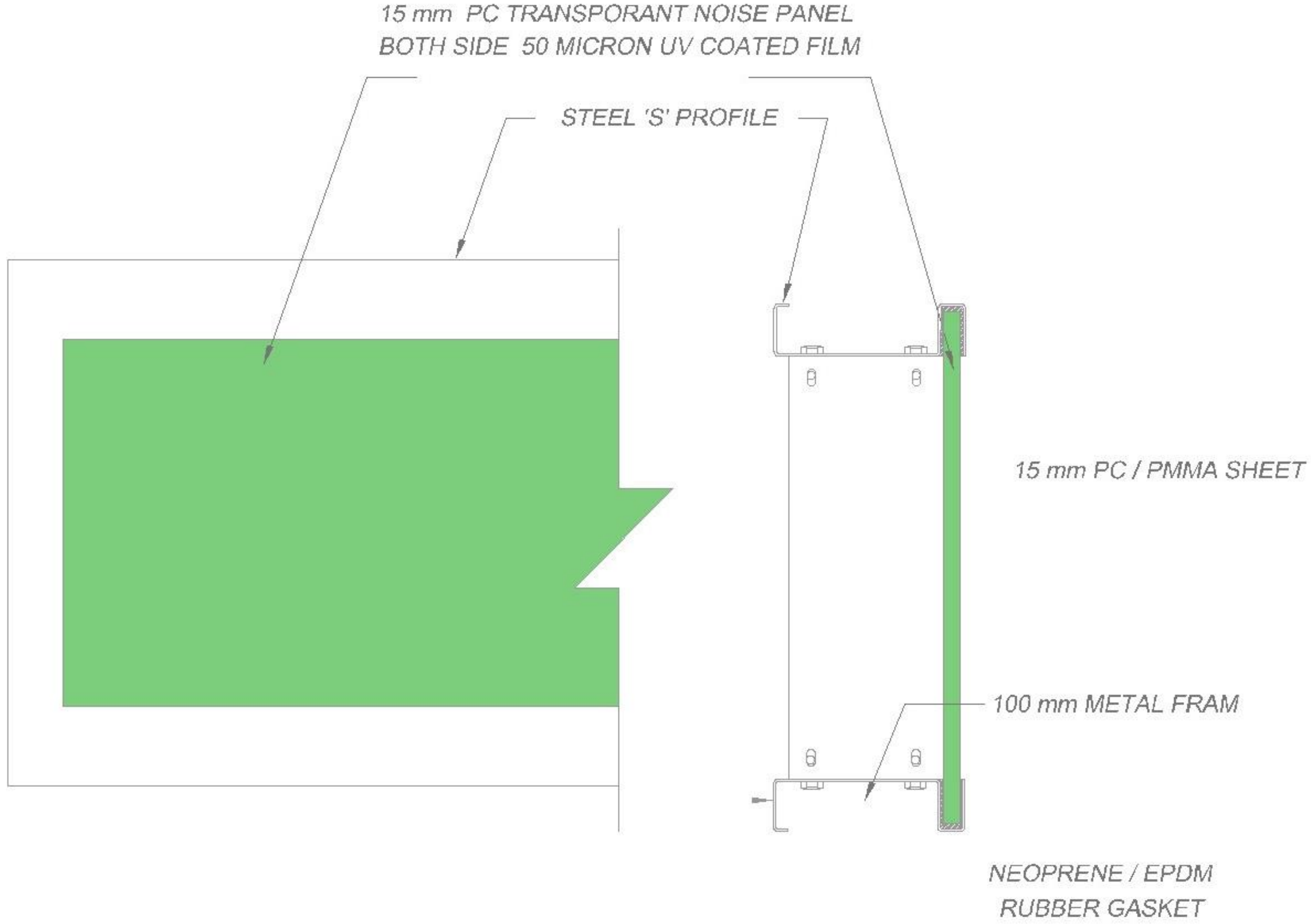


SECTION B-B

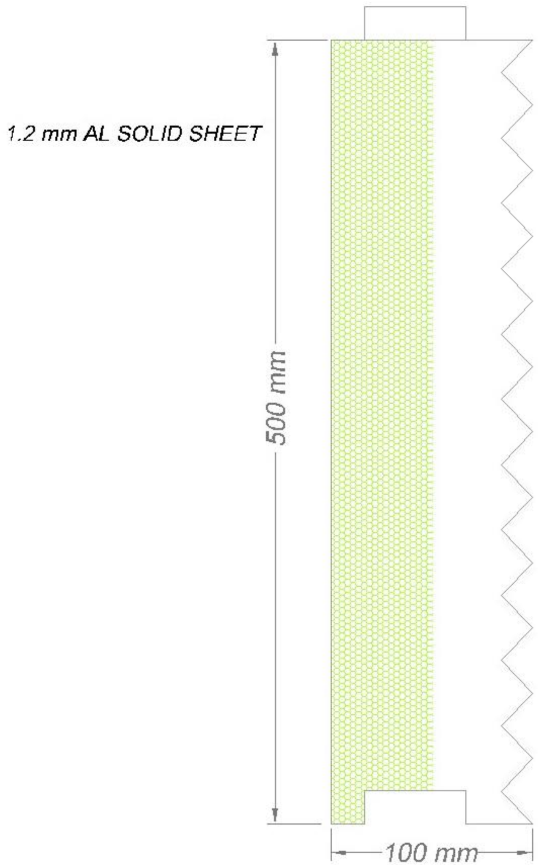


UNIVERSAL COLUMN (POST) - SECTION

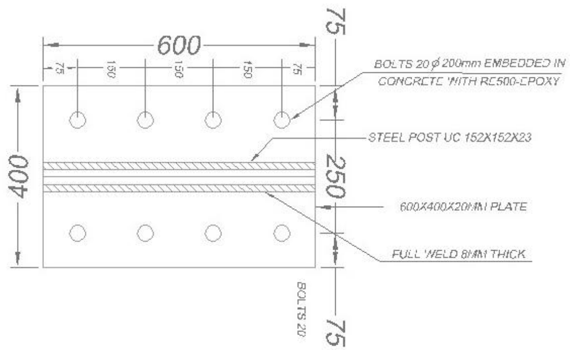
DETAIL - F


15 mm PC TRANSPORANT NOISE PANEL
BOTH SIDE 50 MICRON UV COATED FILM
STEEL 'S' PROFILE
15 mm PC / PMMA SHEET
100 mm METAL FRAM
NEOPRENE / EPDM
RUBBER GASKET

DETAIL - C

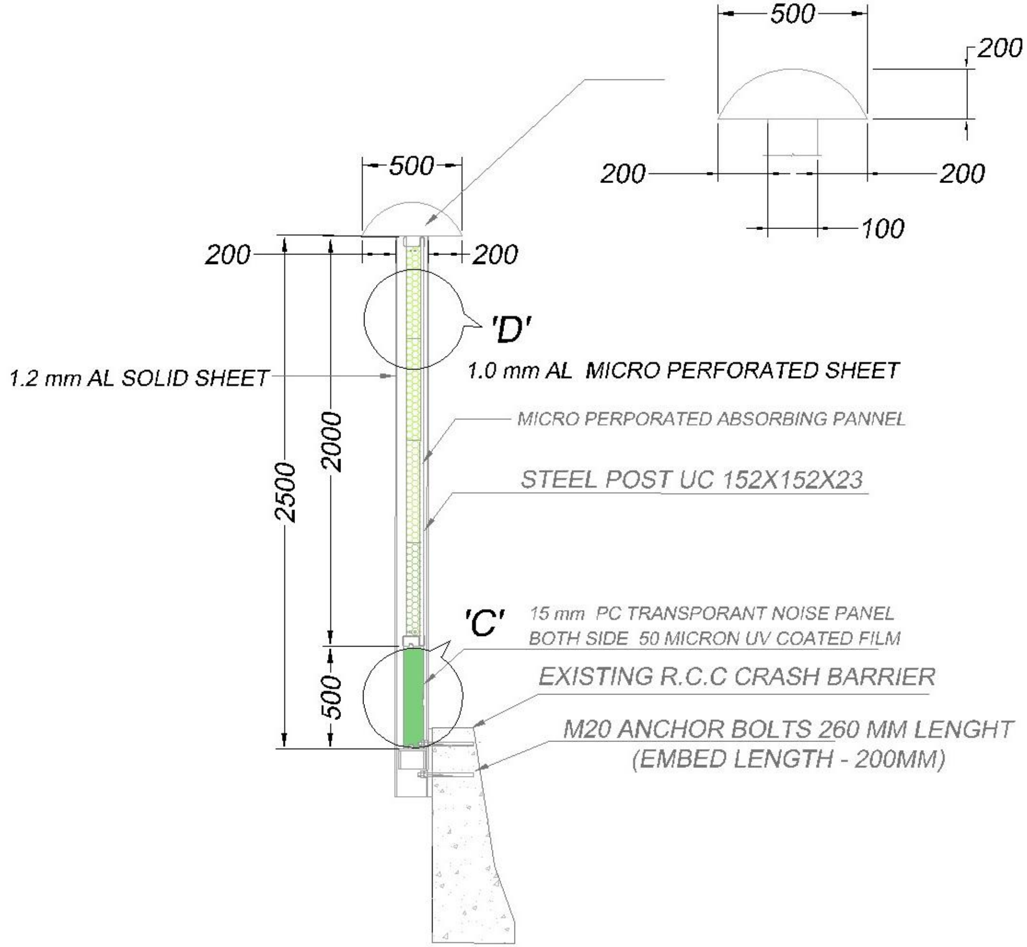


DETAIL-D

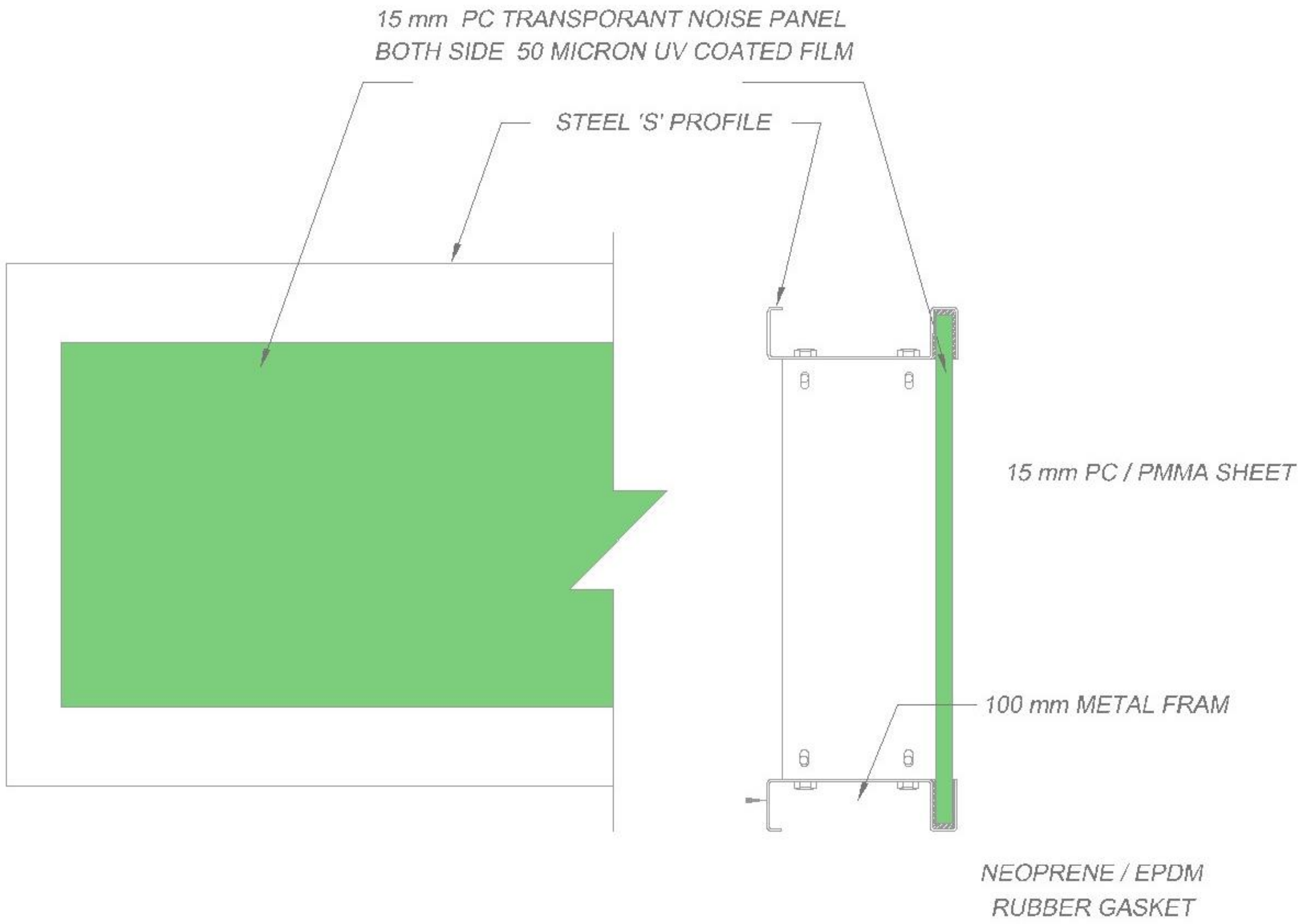


BASEPLATE FOR POST

DETAIL - E


500
200
200
200
100
500
200
200
'D'
1.2 mm AL SOLID SHEET
1.0 mm AL MICRO PERFORATED SHEET
MICRO PERPORATED ABSORBING PANNEL
STEEL POST UC 152X152X23
2500
2000
'C'
15 mm PC TRANSPORANT NOISE PANEL
BOTH SIDE 50 MICRON UV COATED FILM
EXISTING R.C.C CRASH BARRIER
500
M20 ANCHOR BOLTS 260 MM LENGHT
(EMBED LENGTH - 200MM)

SECTION A-A



15 mm PC TRANSPORANT NOISE PANEL
BOTH SIDE 50 MICRON UV COATED FILM
STEEL 'S' PROFILE
15 mm PC / PMMA SHEET
100 mm METAL FRAM
NEOPRENE / EPDM
RUBBER GASKET

DETAIL - C

CONCLUSIONS:

Surveys in tandem with noise monitoring were conducted various locations falling all along the elevated metro corridor to understand the prevailing traffic scenario and the noise and vibration generated. Besides these surveys inventory of the residential areas along the corridor has been conducted.

Total Height of rail = 24.04m
Top Floor roof to viaduct height = 8.37m
Building height = 15m
Roof to parapet wall height = 11.04m
Third floor door/ window to height of parapet wall = 11+3 = 14m
Distance of rail to parapet =2m
Total distance = 14+2 =16m
There will not be primary sound impact on roof of building; it will be affected by secondary sound.

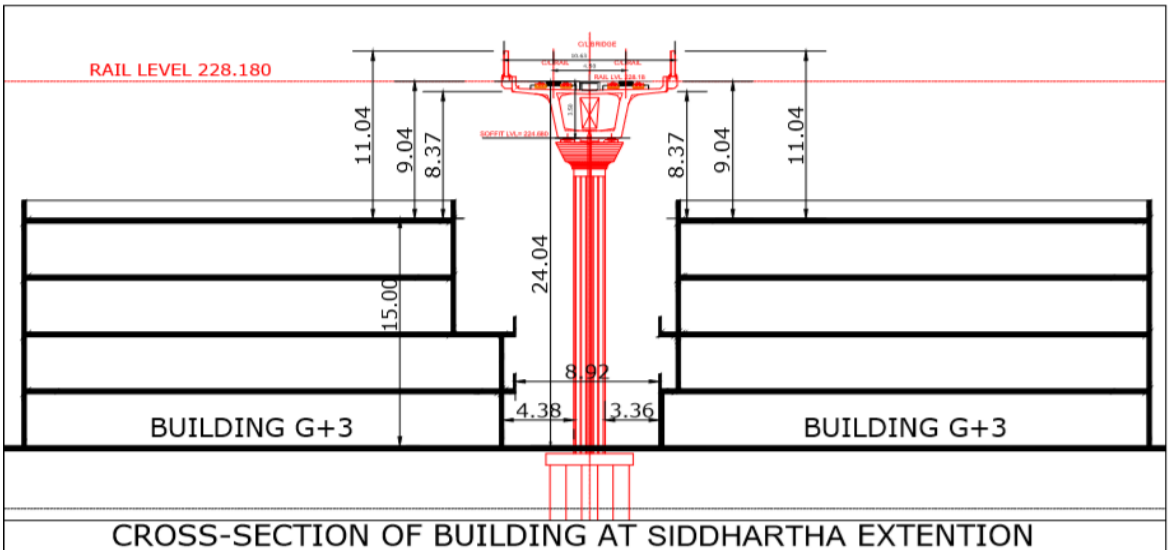


Fig No. 5.1: Cross-Section of Building

Secondary Noise transfers to building top have been classified with diagram.

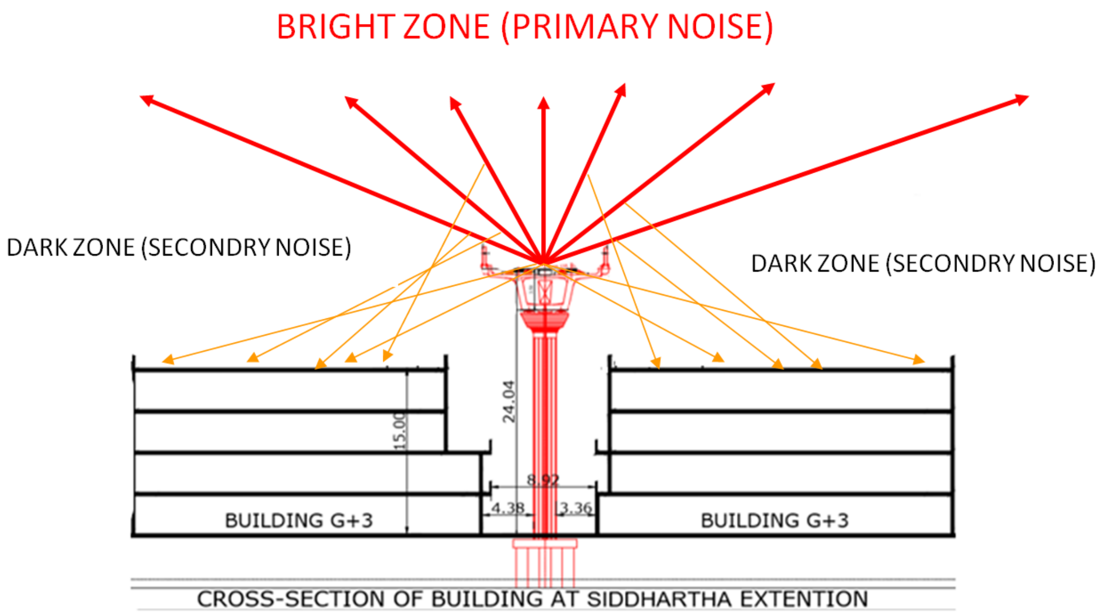


Fig No. 5.1a: Secondary Noise transfers to building

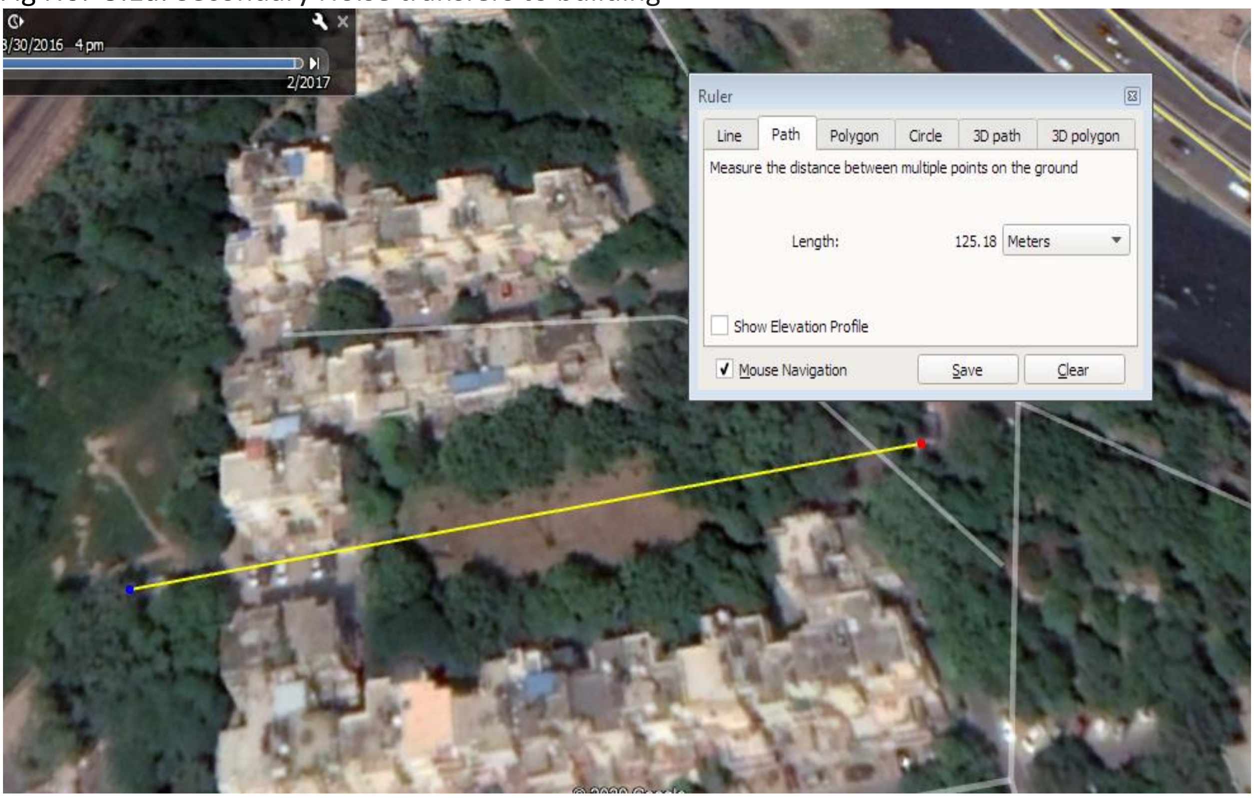
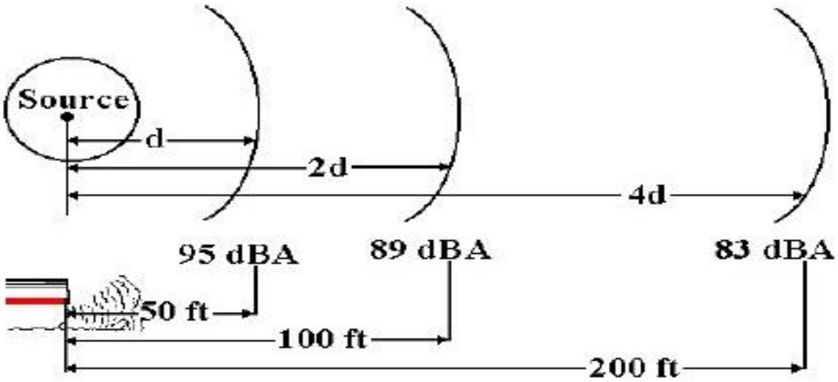


Fig No. 5.2: Siddhartha Extension portion

5.1: In case of Point Source:



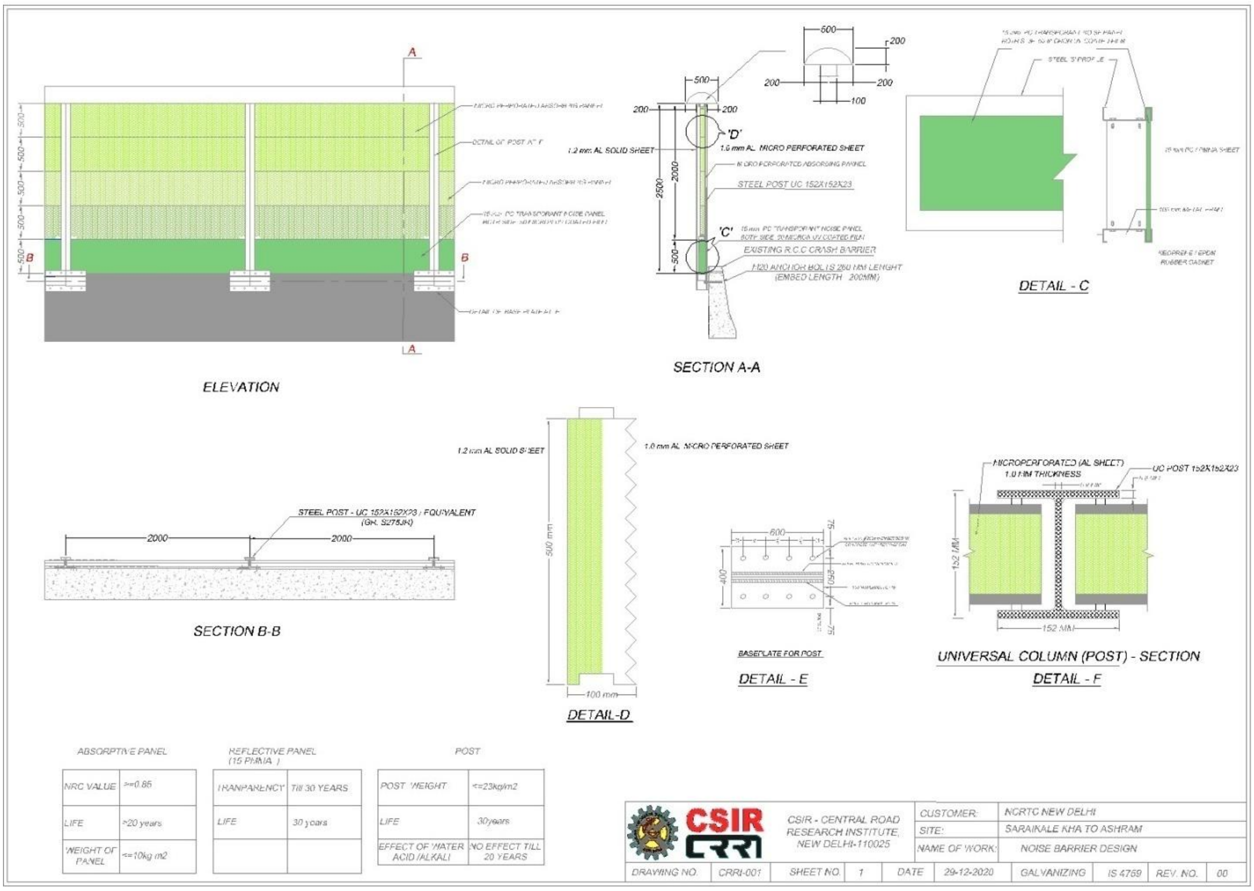
- Height of Rail Level is 24m from ground and 8.37m from roof level. Via duct is sufficient to stop the noise generated by rail and wheel.
- Maximum noise will go to upward direction in the form of primary noise, while secondary noise will reach to roof level.
- Total exposure of noise level will be less than 45 dB(A), because number of train has been taken 25 and duration of train is 10 second.
- Existing noise at rail due to honking is around 100 dB(A) at 5m distance. Hence its contribution to building is at 70m -80m will be 76 dB(A). (Shown in chapter 3)
- But if train is not honking then noise at 5m distance is 69 dB(A), and at building will be 45 dB(A)
- While at gate 3 there will not be any noise impact on building. (Shown in chapter 3)
- Noise absorption calculation are as follows

$$C = 1 - 10^{-\left(\frac{d}{20}\right)}$$

C is coefficient of Sound Reduction
D is decibel drop

Recommendation of Noise Barrier:

- 3m noise barrier has been recommended for the length of 125m up & down direction has been shown in chapter 4.



- Total noise absorption will be 20-22 dB(A) after installation of noise barrier.
- After installation of noise barrier, there will not be any noise or air born vibration problem to the resident of *Siddhartha* extension.

Annexure - I

Noise Exposure during Pass-by Train

L_{total} = 10 log [t x 10 $^{0.1 \times L}$/T]

Where t and L are the time and level for exposure and T is the total exposure for the calculation (24 hours)

Hence, in 24 hrs	= 25 trains
Duration of crossing the metro	approx. 10 sec
Hence, t_1	= 25 x 0.01 = 0.25

L_{total} = 10 log [0.25 x 10 $^{0.1 \times 78}$/24]

=52 dB (A) at source

At Receiver End:

Noise exposure at receiver end will be less than 40 dB(A). Hence, there will be any effect of noise on resident of Siddhartha Extension.

Annexure - II

National Ambiant Noise Quality Standard

Category of Area	Limit in dB(A) Leq	
	Day time	Night time
Industrial Area	75	70
Commercial Area	65	55
Residential Area	55	45
Silence Zone	50	40

- Day time is reckoned between 6 am to 10 pm
- Night time is reckoned between 10 pm to 6 am
- Silence zone is defined as areas upto 100 m around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by the competent authority

Annexure-III

Standards and Guidelines for Noise Limit

A. Noise Limit for Generator sets run with Petrol or Kerosene.

	Noise Limit from	
	September 1, 2002	**September 1, 2003**
Sound Power Level	90 dBA	86 dBA

B. Noise Limit for Generator Sets run with Diesel (upto 1000 KVA) manufactured on or after the 1st January 2005

The maximum permissible sound pressure level for new diesel generator shall be 75 dB (A) at 1 metre from the enclosed surface. The diesel generator sets should be provided with integral acoustic enclosure at the manufacturing stage itself.

B.1. Noise limit for DG sets not covered by paragraph 1.

1. Noise from DG set shall be controlled by providing an acoustic enclosure or by treating the room acoustically, at the users end.
2. The acoustic enclosure or acoustic treatment of the room

Noise Calculations

To determine the combined sound pressure level (L_e) resulting from the sound pressure levels of two or more noise sources (L_1, L_2, etc.) it iis necessary to calculate and add the mean square values of their individual sound pressures and then convert this back to a sound pressure level using the formula given below:

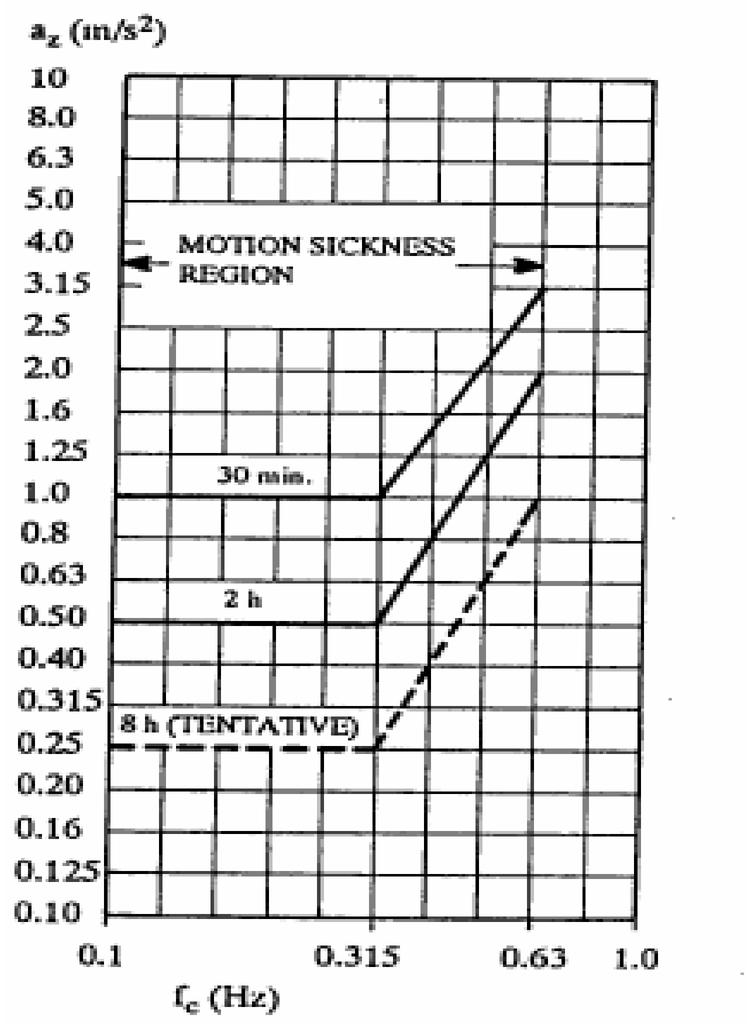
$$L_c = 10 \log_{10}(10^{L1/10} + 10^{L2/10})$$

Annexure-IV

Noise Standard for Continuous Exposure (CPCB)

Exposure Time	Sound Pressure Level (dB(A))
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	107
0.25 and less	115

Annexure-V



ISO 2631/3 Severe Discomfort Boundaries

Annexure-VI

International Guidelines

Standards for evaluating the potential for building damage

- DIN 4150 (1984), Deutsches Institut fuer Normung
- SN 640 312 (1978), Association of Swiss Highway Engineers
- BD 7385 (1993), British Standards Institution
- Report No. 8507 (1980), U.S. Bureau of Mines (blasting-induced vibration)
- Publication No. NPC-119 (1978), Ontario Ministry of the Environment (blasting-induced vibration)
- ISO 4866 (1990), International Organization for Standardization

Standards for evaluating human response to vibration levels

- ISO 2631/2 (1989), International Organization for Standardization
- ISO 8041 (1990), International Organization for Standardization
- BS 6472 (1984), British Standards Institution
- ANSI S3.29 (1983), American National Standards Institute

Scale of vibration discomfort from British standard 6841 (1987) and International standard 2631 (1997)

	Rms weighted acceleration (ms-2)	
Extremely uncomfortable	3.15	
	2.5	
	2.0	Very Uncomfortable
	1.6	
Uncomfortable	1.25	
	1.0	
	0.8	Fairly Uncomfortable
	0.63	
A little uncomfortable	0.5	Not uncomfortable
	0.4	
	0.315	
	0.25	

Annexure-VII

Vibration dose values at which various degrees of adverse comment may be expected in buildings (based on International Standard 2631 part 2(1989) and British standard 6472 (1942)

Place comment	Low probability	Adverse comment	Adverse
	Adverse comment	Possible	Possible
Critical working area	0.1	0.2	0.4
Residential	0.2-0.4	0.4-0.8	0.8-1.6
Office	0.4	0.8	1.6
Workshops	0.8	1.6	3.2

Annexure-VIII

Degree of Hearing Loss (**WHO classification**); WHO (1980) recommended the following classification on the basis of pure tone audiogram taking the average of the thresholds of hearing for frequencies of 500, 1000 and 2000 Hz with reference to ISO : R. 389-1970 (international calibration of audiometers).

Hearing loss and difficulty in hearing speech:

Hearing threshold in better ear (average of 500, 1000, 2000)	Degree of impairment (WHO classification)	Ability to understand speech
0-25	Not significant	No significant difficulty with faint speech
26-40	Mild	Difficulty with faint speech
41-55	Moderate	Frequent difficulty with normal speech
56-70	Moderately sever	Frequent difficulty even with loud speech
71-91	Severe	Can understand only shouted or amplified speech
above 91	Profound	Usually cannot understand even amplified speech

Appendix 5: Vibration Analysis

A. Vibration due to RRTS operation

1. Identification of Vibration-Sensitive Land Use

The criteria for acceptable ground-borne vibration are expressed in terms of RMS velocity levels in decibels. The criteria apply to train-generated ground-borne vibration and noise whether the trains run underground, at the surface, or on elevated guideway. The limits are specified for the three land-use categories defined below:

1.1. *Vibration Category 1 - High Sensitivity:* Included in Category 1 are buildings where vibration would interfere with operations within the building, including levels that may be well below those associated with human annoyance. Typical land uses covered by Category 1 are vibration-sensitive research and manufacturing, hospitals with vibration-sensitive equipment, and university research operations. The degree of sensitivity to vibration will depend on the specific equipment that will be affected by the vibration.

Note that this category does not include most computer installations or telephone switching equipment. Although the owners of this type of equipment often are very concerned about the potential of ground- borne vibration interrupting smooth operation of their equipment, it is rare for a computer or other electronic equipment to be particularly sensitive to vibration. Most such equipment is designed to operate in typical building environments where it may experience occasional shock from bumping and continuous background vibration caused by other equipment.

1.2. Vibration Category 2 – Residential: This category covers all residential land uses and any buildings where people sleep, such as hotels and hospitals. No differentiation is made between different types of residential areas. This is primarily because ground-borne vibration and noise are experienced indoors, and building occupants have practically no means to reduce their exposure. Even in a noisy urban area, the bedrooms often will be quiet in buildings that have effective noise insulation and tightly closed windows. Moreover, street traffic often abates at night when trains continue to operate. Hence, an occupant of a bedroom in a noisy urban area is likely to be just as exposed to ground-borne noise and vibration as someone in a quiet suburban area.

1.3. Vibration Category 3 – Institutional: Vibration Category 3 includes schools, places of worship (e.g., churches), other institutions, and quiet offices that do not have vibration-sensitive equipment, but still have the potential for activity interference. Although it is generally appropriate to include office buildings in this category, it is not appropriate to include all buildings that have any office space. For example, most industrial buildings have office space, but it is not intended that buildings primarily for industrial use be included in this category.

There are some buildings, such as concert halls, television and recording studios, and theaters that can be very sensitive to vibration and noise but do not fit into any of the three categories. Because of the sensitivity of these buildings, they usually warrant special attention during the environmental assessment of a high-speed rail project.

2. Categorization as per FTA:

According to FTA Ground-Borne Vibration Impact Criteria, all educational and religious institutions are catrgorized in “Vibration Category 3: Institutional” and all Hospitals are categorized in “Vibration Category 2: Residential”.

The proposed Delhi-Ghaziabad-Meerut RRTS will have a design speed of 180 kmph and operating speed of 160 kmph with a frequency of 15 trains per hour for the year 2024. As per the Vibration screening procedure, for residential land use, within 70 meter is identified as potentially affected location. For institutional land use, all institutes within 50 meters are identified as potentially affected locations.

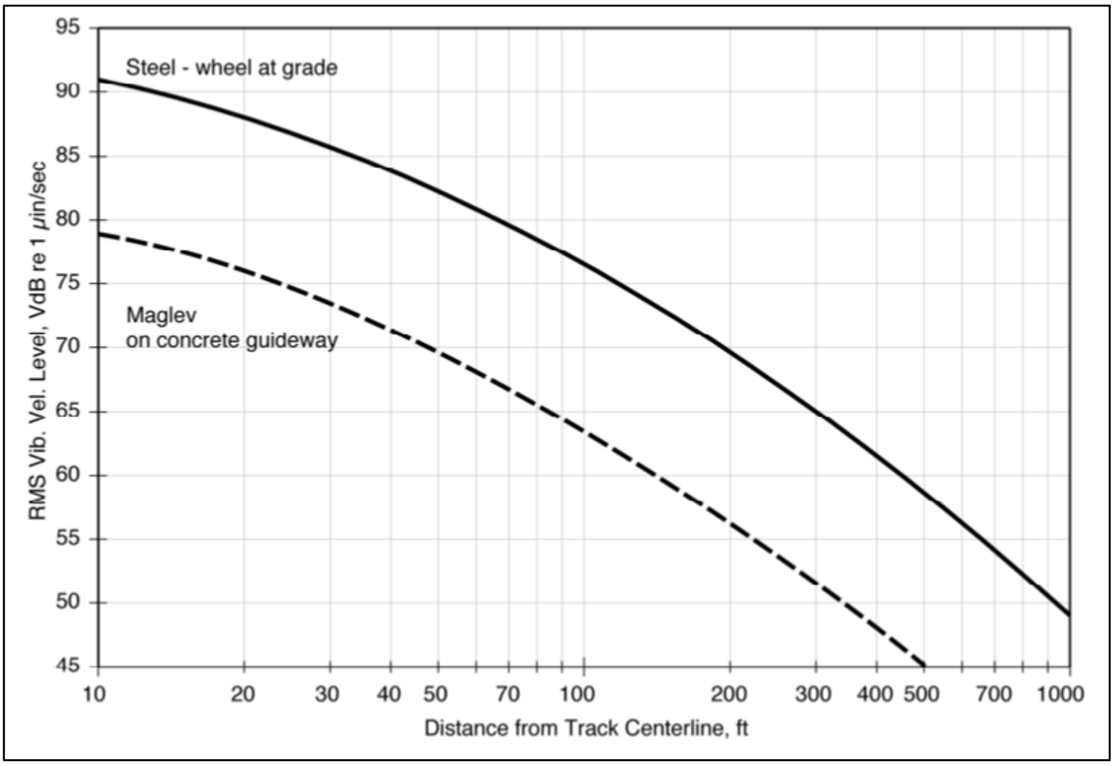
3. Base Curve

The generalized projection curves for high-speed trains are shown in below figure. The curves represent typical ground surface vibration levels assuming equipment in good condition and speeds of 150 mph. The levels must be adjusted to account for factors such as different speeds, equipment, and geologic conditions.

Speed Adjustment: -3.5 for speed of 160 kmph
Speed adjustment: -3.5 VdB for speed of 160 kmph
Wheel condition: Assume wheels in good condition. No adjustment is applied.

Track system: Assume rails are in good condition. No adjustment.
Track structure: -10 VdB for Viaduct and -3 for tunnel section
Propagation: 0, Normal propagation is considered, as the underlying soil is fine sand/ fine silt upto a depth of 40 meter from the ground surface throughout the alignment.
Foundation coupling: 1-2 Story Masonry: -7 VdB, 2-4 Story Masonry: -10 VdB.
Receiver location: 1-5 floors above grade: -2 dB/floor, 5-10 floor above grade: -1 dB/floor
Floor response: No adjustment.

Figure 2: Generalized Ground-Borne Vibration Curve



Predicted Vibration levels during operation of proposed Delhi-Ghaziabad-Meerut RRTS:

The procedure adopted for prediction of vibration levels is as per the FTA guideline. The vibration levels were obtained from the base curve shown in figure 1 and necessary corrections were undertaken wherever applicable. The predicted vibration levels were well below the threshold levels for different land uses set by FTA except at eight locations. The modeling results are also presented in below table 2:

Table 6: Predicted Vibration levels due to RRTS Operation

S.No.	Description	LHS/ RHS	Chainage in KM	Coordinates X (Latitude)	Y (Longitude)	Section Type	Distance in feet	Estimated Vibration Level, VdB	Ground Borne Vibration Threshold levels as per FTA, VdB	Vibration Level Exceedance, VdB	Reduction with mitigation measures	Residual vibraton level after mitigation VdB
1	ISBT	RHS	0+900	28°35'6.83"N	77°15'31.18"E	Elevated	165	68.5	72	-3.5	-15	53.5
2	Barapulla Flyover & Nalla Crossing	Crossing	1+350	28°34'56.10"N	77°15'25.82"E	Elevated	20	73.5	72	1.5	-15	58.5
3	Siddharth Apartments	LHS & RHS	1+480	28°34'53.88"N	77°15'22.43"E	Elevated	23.1	74.5	72	2.5	-15	59.5
4	Railway Crossing	Crossing	1+680	28°34'50.75"N	77°15'16.64"E	Elevated	20	73.5	72	1.5	-15	58.5
5	Highway Crossing	Crossing	1+810	28°34'46.35"N	77°15'10.93"E	Elevated	20	73.5	72	1.5	-15	58.5
6	Hindustan Prefab Limited	RHS	1+830	28°34'43.70"N	77°15'7.43"E	Elevated	165	68.5	72	-3.5	-15	53.5
7	Hindustan Prefab Limited	RHS	2+000	28°34'31.66"N	77°15'8.41"E	Elevated	20	73.5	72	1.5	-15	58.5

B. Construction Vibration Assessment

Construction activity can result in varying degrees of ground vibration, depending on the equipment and methods employed. Operation of construction equipment causes ground vibrations that spread through the ground and diminish in strength with distance. Buildings founded on the soil in the vicinity of the construction site respond to these vibrations with varying results, ranging from no perceptible effects at the lowest levels, low rumbling sounds and perceptible vibrations at moderate levels, and slight damage at the highest levels.

Ground vibrations from construction activities do not often reach the levels that can damage structures, but they can be within the audible and perceptible ranges in buildings very close to the site. A possible exception is the case of fragile buildings, many of them old, where special care must be taken to avoid damage. The construction vibration criteria should include special consideration for such buildings. The construction activities that typically generate the most severe vibrations are blasting and impact pile driving.

1. Vibration Source Levels from Construction Equipment

Ground-borne vibration related to human annoyance is generally related to RMS velocity levels expressed in vibration decibels. However, a major concern with regard to construction vibration is building damage. Various types of construction equipment have been measured under a wide variety of construction activities with an average of source levels reported in terms of velocity as shown in Table 3. The data provides a reasonable estimate for a wide range of soil conditions.

Table 7: Vibration Source Level for Construction Equipment [6]

Equipment		PPV at 25 ft (in/s)	Approximate Lv at 25 ft (RMS velocity in decibels (VdB) re 1 µin/s.)
Pile driver (impact)	Upper range	1.518	112
	Typical	0.644	104
Pile driver (vibratory)	Upper range	0.734	105
	Typical	0.17	93
Clam shovel drop (slurry wall)		0.202	94
Hydromill (slurry wall)	In soil	0.008	66
	In rock	0.017	75

[6] Hanson, C. E., Ross, J. C., Towers, D. A., & Harris, M. (2012). *High-speed ground transportation noise and vibration impact assessment* (No. DOT/FRA/ORD-12/15). United States. Federal Railroad Administration. Office of Railroad Policy and Development.

Vibratory roller	0.21	94
Hoe ram	0.089	87
Large bulldozer	0.089	87
Caisson drilling	0.089	87
Loaded trucks	0.076	86
Jackhammer	0.035	79
Small bulldozer	0.003	58

For evaluating potential annoyance or interference with vibration-sensitive activities as a result of construction vibration, the criteria for General Assessment can be applied. In most cases, however, the primary concern regarding construction vibration relates to potential damage effects. Guideline vibration damage criteria are given in below Table 4 for various structural categories. These limits should be viewed as criteria that should be used during the environmental impact assessment phase to identify problem locations that must be addressed during final design.

Table 8: Construction Vibration Damage Criteria as per FTA guidelines

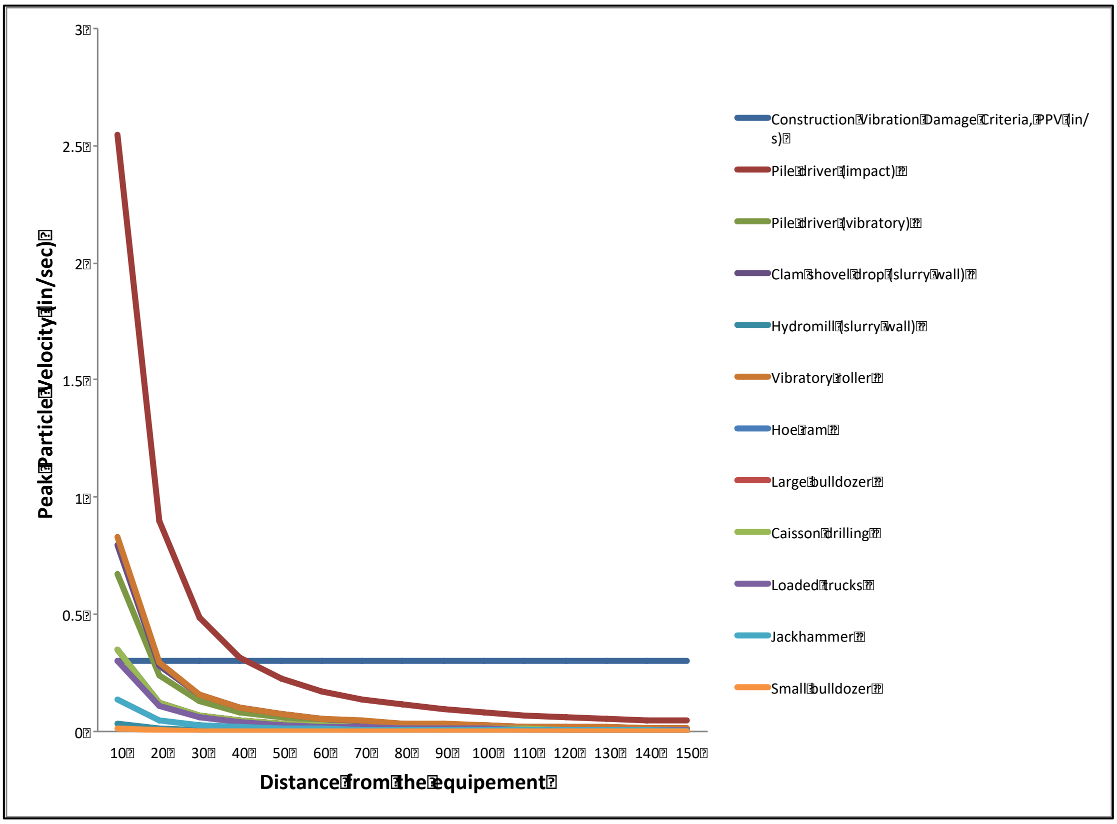
Building Category	**PPV (in/s)**	**Approximate Lv, RMS velocity in decibels (VdB) re 1 µin/s.**
I. Reinforced-concrete, steel or timber (no plaster)	0.5	102
II. Engineered concrete and masonry (no plaster)	0.3	98
III. Nonengineered timber and masonry buildings	0.2	94
IV. Buildings extremely susceptible to vibration damage	0.12	90

Construction vibration is assessed in cases where there is a significant potential for impact from construction activities. Such activities include blasting, pile driving, vibratory compaction, demolition, and drilling or excavation in close proximity to sensitive structures. Construction vibration assessment is carried out for all potential sensitive receptors as per the guidelines by FTA for high speed rail projects.

Predicted Vibration levels during RRTS Construction:

The procedure adopted for prediction of vibration levels during RRTS Construction is as per the FTA guideline. The reference vibration levels for each construction equipement is taken from table 3 to calculate the peak particle velocity (PPV) at sensitive receptor location. The PPV values are then compared with the Construction Vibration Damage Criteria set by FTA (Table 4) for different building category.

Figure 3: Ground Borne Vibrations due to various construction equipments



All the predicted levels were well below the threshold levels for different land uses set by FTA during construction stage. The anaylysis results are presented in below table 5:

Table 9: Ground Borne Vibration levels during RRTS Construction stage

S.No.	Description	Coordinate X (Latitude)	Coordinate Y (Longitude)	Section Type	Distance of equipment from the receiver (in feet)	Clam shovel drop (slurry wall)	Hydromill (slurry wall)	Vibratory roller	Hoe ram	Large bulldozer	Caisson drilling	Loaded trucks	Jackhammer	Small bulldozer	Construction Vibration Damage Criteria, PPV (in/s)
1	ISBT	28°35'6.83"N	77°15'31.18"E	Elevated	165	0.012	0.000	0.012	0.005	0.005	0.005	0.004	0.002	0.000	0.5
2	Barapulla Flyover & Nalla Crossing	28°34'56.10"N	77°15'25.82"E	Elevated	20	0.282	0.011	0.293	0.124	0.124	0.124	0.106	0.049	0.004	0.5
3	Siddharth Apartments	28°34'53.88"N	77°15'22.43"E	Elevated	23.1	0.227	0.009	0.236	0.100	0.100	0.100	0.086	0.039	0.003	0.5
4	Railway Crossing	28°34'50.75"N	77°15'16.64"E	Elevated	20	0.282	0.011	0.293	0.124	0.124	0.124	0.106	0.049	0.004	0.5
5	Highway Crossing	28°34'46.35"N	77°15'10.93"E	Elevated	20	0.282	0.011	0.293	0.124	0.124	0.124	0.106	0.049	0.004	0.5
6	Hindustan Prefab Limited	28°34'43.70"N	77°15'7.43"E	Elevated	165	0.012	0.000	0.012	0.005	0.005	0.005	0.004	0.002	0.000	0.5
7	Hindustan Prefab Limited	28°34'31.66"N	77°15'8.41"E	Elevated	20	0.282	0.011	0.293	0.124	0.124	0.124	0.106	0.049	0.004	0.5

Appendix 6: Details of affected Trees

HPL LINE TREE LIST (Chainage 950 to 1650)						
SL.NO.	TREE NO	GIRTH	TREE NAME	EASTING	NORTHING	REMARK
1	h1	0.2	Siras	720953.064	3163939.188	To be transplant
2	H8	1.3	SAFEDA	720863.885	3163874.333	To be Cut
3	H10	0.5	BER	720841.2327	3163841.17	To be Cut
4	H10A	0.37	BER	720841.2327	3163841.17	To be Cut
5	H11	0.27	BER	720840.0605	3163841.02	To be Cut
6	H12	0.52	KANJI	720817.6182	3163829.353	To be Cut
7	H12A	0.28	KANJI	720817.6182	3163829.353	To be Cut
8	H15	0.66	SIRAS	720706.0542	3163753.62	To be transplant
9	H16	0.6	PIPAL	720709.5008	3163743.425	To be transplant
10	H16A	0.62	PIPAL	720709.5008	3163743.425	To be transplant
11	H17	0.42	SIRAS	720716.9118	3163742.685	To be transplant
12	h18	0.41	Ber	720839.692	3163840.195	To be Cut
13	H18	0.4	SIRAS	720719.6267	3163746.237	To be transplant
14	h23	0.23	Papri	720818.144	3163829.632	To be Cut
15	H23	0.96	KANJI	720694.5596	3163741.204	To be Cut
16	h24	0.38	Papri	720817.466	3163829.614	To be Cut
17	H24	1	SHEESHAM	720695.7841	3163741.273	To be Cut
18	h25	0.2	Papri	720816.899	3163829.655	To be Cut
19	H25	0.43	KANJI	720701.9592	3163740.274	To be Cut
20	h26	0.32	Papri	720816.705	3163829.182	To be Cut
21	H26	0.9	KANJI	720710.0674	3163739.591	To be Cut
22	H31	0.87	NEEM	720693.5578	3163728.37	To be Cut
23	H33	0.37	KANER	720694.6768	3163728.334	To be transplant
24	H34	1.7	PIPAL	720690.6244	3163725.588	To be transplant
25	H37	0.8	SIRAS	720678.5145	3163721.777	To be transplant
26	H38	0.6	TULIP	720679.1678	3163725.535	TREE CUTTING
27	H39	0.27	SIRAS	720679.0578	3163727.673	To be transplant
28	H40	2.2	PIPAL	720668.488	3163714.353	To be transplant
29	H41	1.18	BAKAYAN	720665.6074	3163709.576	To be Cut
30	H42	0.28	ASHOK	720664.422	3163711.248	To be transplant
31	H43	0.2	SHAHTOOT	720661.8296	3163711.341	To be transplant
32	H44	0.96	PIPAL	720659.5011	3163712.09	To be transplant
33	H44A	0.86	PIPAL	720659.5011	3163712.09	To be transplant
34	H45	2.63	PIPAL	720655.9411	3163712.735	To be transplant
35	H47	2.6	ASHOK	720652.021	3163711.092	To be transplant
36	H48	0.24	ASHOK	720653.0565	3163710.804	To be transplant
37	H49	0.3	KANER	720658.9118	3163704.677	To be transplant
38	H50	1	NEEM	720650.5755	3163709.046	To be Cut
39	H51	1.2	NEEM	720653.8052	3163708.333	To be Cut
40	H52	0.55	AMALTASH	720654.7071	3163703.401	To be transplant
41	H53	0.73	SAGWAN	720658.5031	3163700.983	To be Cut
42	H54	0.46	CHAMPA	720607.4201	3163675.067	To be transplant
43	H55	0.9	AMALTASH	720613.9401	3163671.651	To be transplant
44	H56	0.27	SIRAS	720607.4499	3163673.945	To be transplant
45	H57	1	SATADU	720577.2179	3163651.694	TREE CUTTING
46	H58	0.8	KANJI	720577.7525	3163647.992	To be Cut
47	H59	1	PAKAD	720577.629	3163646.477	To be transplant
48	H60	1.2	SHEESHAM	720574.7521	3163644.89	To be Cut
49	H61	0.27	SHAHTOOT	720567.3032	3163649.258	To be transplant

50	H63	1.3	SAFEDA	720549.3636	3163643.505	To be transplant
51	H64	1.5	SAFEDA	720549.1219	3163639.069	To be transplant
52	H65	1	SEMAL	720546.8021	3163632.966	To be Cut
53	H66	2.1	SEMAL	720540.6045	3163631.73	To be Cut
54	H67	0.5	KANER	720540.1135	3163623.865	To be transplant
55	H68	0.8	KANER	720537.2991	3163624.357	To be transplant
56	H69	0.9	KANER	720535.673	3163625.056	To be transplant
57	H70	0.7	SHAHTOOT	720535.3675	3163629.615	To be transplant
58	H71	0.6	SHAHTOOT	720531.8024	3163627.513	To be transplant
59	H72	0.8	SHAHTOOT	720531.3834	3163627.518	To be transplant
60	H73	1	BABOOL	720534.0346	3163628.369	To be Cut

DELHI - GHAZIABAD - MEERUT RRTS CORRIDOR							
Tree list from HP-24 to HPL Employee Quarter (Stabling Line)							
SN.	TREE NO.	TREE NAME	GIRTH	EASTING	NORTHING	LOCATION	REMARKS
1	S1	JANGAL JALEBI	0.9	720484.499	3163596.464		To be transplant
2	S2	JANGAL JALEBI	2.3	720484.305	3163598.097		To be transplant
3	S3	JANGAL JALEBI	0.23	720484.533	3163601.234		To be transplant
4	S4	JANGAL JALEBI	0.75	720483.419	3163606.495		To be transplant
5	S5	JANGAL JALEBI	0.5	720483.551	3163605.629		To be transplant
6	S6	JANGAL JALEBI	0.23	720483.613	3163608.745		To be transplant
7	S7	JANGAL JALEBI	1	720483.589	3163610.902		To be transplant
8	S8	PEEPAL	0.9	720479.385	3163606.426		To be transplant
9	S9	PEEPAL	0.36	720478.243	3163607.845		To be transplant
10	S10	JANGAL JALEBI	0.9	720483.354	3163612.069		To be transplant
11	S11	JANGAL JALEBI	1	720483.703	3163612.539		To be transplant
12	S12	SHAHTOOT	0.62	720469.337	3163600.196		To be transplant
13	S13	SHIRASH	0.65	720468.566	3163596.963		To be cut
14	S14	SHIRASH	0.35	720467.609	3163596.357		To be cut
15	S15	SHIRASH	0.4	720466.972	3163596.028		To be cut
16	S16	SHIRASH	0.4	720466.594	3163595.34		To be cut
17	S17	SHIRASH	0.3	720466.546	3163596.23		To be cut
18	S18	SHIRASH	0.4	720464.766	3163597.072		To be cut
19	S19	SHIRASH	0.45	720464.477	3163598.533		To be cut
20	S20	SHIRASH	0.33	720466.403	3163600.311		To be cut
21	S21	SHIRASH	0.15	720464.464	3163605.243		To be cut
22	S22	AMALTASH	0.32	720460.921	3163603.184		To be transplant
23	S23	SHIRASH	0.19	720459.921	3163599.02		To be cut
24	S24	SHIRASH	0.7	720460.547	3163594.647		To be cut
25	S25	SHISHAM	0.36	720475.512	3163590.537		To be transplant
26	S26	JANGAL JALEBI	1.4	720485.193	3163589.262		To be transplant
27	S27	JANGAL JALEBI	0.8	720485.113	3163587.699		To be transplant
28	S28	JANGAL JALEBI	0.72	720485.741	3163586.202		To be transplant
29	S29	JANGAL JALEBI	0.31	720485.657	3163585.11		To be transplant
30	S30	JANGAL JALEBI	1.6	720485.422	3163584.344		To be transplant
31	S31	SAFEDA	2.1	720473.396	3163580.614		To be cut
32	S32	PAPRI	0.3	720475.838	3163588.044		To be transplant
33	S32A	PAPRI	0.26	720475.838	3163588.044		To be transplant
34	S32B	PAPRI	0.16	720475.838	3163588.044		To be transplant
35	S33	PEEPAL	0.27	720475.474	3163585.159		To be transplant
36	S34	JANGAL JALEBI	0.39	720474.001	3163586.939		To be transplant
37	S35	SHIRASH	0.18	720472.473	3163585.189		To be cut
38	S36	PAPRI	0.23	720470.583	3163587.21		To be transplant
39	S36A	PAPRI	0.15	720470.583	3163587.21		To be transplant
40	S37	SHAHTOOT	0.36	720467.401	3163587.077		To be transplant
41	S38	SHIRASH	0.3	720465.13	3163583.787		To be cut
42	S39	SHISHAM	1.2	720466.106	3163582.963		To be transplant
43	S40	SHIRASH	0.19	720465.971	3163579.096		To be cut
44	S41	SHAHTOOT	0.65	720463.257	3163576.327		To be transplant
45	S42	SHIRASH	1.1	720462.432	3163572.583		To be cut
46	S43	SAFEDA	1.07	720466.367	3163570.731		To be cut
47	S44	SHIRASH	1.14	720463.015	3163569.23		To be cut
48	S45	PAPRI	1.16	720459.585	3163568.073		To be transplant
49	S46	PAPRI	0.25	720456.151	3163569.463		To be transplant
50	S47	SHIRASH	0.23	720454.511	3163570.243		To be cut
51	S48	SHIRASH	1.4	720453.801	3163571.396		To be cut
52	S49	PAPRI	0.39	720455.903	3163574.468		To be transplant
53	S49A	PAPRI	0.23	720455.903	3163574.468		To be transplant
54	S50	PAPRI	0.38	720456.419	3163578.448		To be transplant
55	S51	SHIRASH	1.12	720455.516	3163580.725		To be cut
56	S52	AMALTASH	0.26	720453.31	3163583.512		To be transplant
57	S53	GULMOHAR	0.92	720452.165	3163586.746		To be transplant
58	S54	AMALTASH	0.15	720450.782	3163579.861		To be transplant
59	S55	ALSTRONIA	0.27	720449.498	3163579.586		To be transplant
60	S56	ALSTRONIA	0.37	720448.01	3163578.561		To be transplant
61	S57	PEEPAL	2.3	720447.291	3163575.69		To be transplant
62	S57A	SHIRASH	0.15	720447.291	3163575.69		To be cut
63	S58	SHIRASH	0.16	720450.158	3163576.262		To be cut
64	S59	KACHANAR	0.32	720451.725	3163572.843		To be transplant
65	S60	SHIRASH	0.54	720452.057	3163569.073		To be cut
66	S61	PAPRI	0.3	720456.723	3163564.088		To be transplant
67	S61A	PAPRI	0.18	720456.723	3163564.088		To be transplant
68	S61B	PAPRI	0.2	720456.723	3163564.088		To be transplant
69	S62	SHIRASH	0.22	720454.611	3163562.212		To be cut
70	S63	SHIRASH	0.37	720456.318	3163560.058		To be cut
71	S64	SHIRASH	0.6	720453.53	3163559.972		To be cut
72	S65	SHIRASH	0.27	720454.771	3163558.917		To be cut
73	S66	SHIRASH	0.27	720453.058	3163558.969		To be cut
74	S67	SHIRASH	0.26	720451.037	3163560.485		To be cut
75	S67A	SHIRASH	0.28	720451.037	3163560.485		To be cut

76	S68	PEEPAL	0.26	720451.86	3163562.06		To be transplant
77	S69	AMALTASH	0.58	720449.652	3163562.393	HP-24 to HP-28 (Near Mazar)	To be transplant
78	S70	SHIRASH	0.23	720451.872	3163564.67		To be cut
79	S71	SHIRASH	0.23	720451.3	3163566.65		To be cut
80	S72	AMALTASH	0.29	720449.902	3163569.996		To be transplant
81	S73	AMALTASH	0.72	720448.331	3163557.092		To be transplant
82	S74	SHIRASH	0.27	720452.428	3163556.979		To be cut
83	S75	SHIRASH	0.2	720452.537	3163556.332		To be cut
84	S76	SHIRASH	0.24	720452.392	3163555.325		To be cut
85	S77	KANEER	0.28	720446.511	3163550.121		To be transplant
86	S78	SHAHTOOT	1	720439.886	3163557.221		To be transplant
87	S79	SHIRASH	0.32	720439.701	3163551.018		To be cut
88	S80	SHIRASH	0.32	720437.978	3163551		To be cut
89	S81	BAKAYAN	0.3	720433.075	3163553.335		To be cut
90	S81A	BAKAYAN	0.26	720433.075	3163553.335		To be cut
91	S82	AMALTASH	0.9	720440.589	3163576.426		To be transplant
92	S83	AMALTASH	0.34	720430.664	3163565.743		To be transplant
93	S83A	AMALTASH	0.26	720430.664	3163565.743		To be transplant
94	S84	SHIRASH	0.3	720428.088	3163562.748		To be cut
95	S85	JANGAL JALEBI	0.2	720426.553	3163557.492		To be transplant
96	S86	SHIRASH	0.18	720424.693	3163554.068		To be cut
97	S87	KIKAR	0.56	720424.001	3163548.789		To be cut
98	S88	BAKAYAN	1.45	720425.941	3163547.434		To be cut
99	S89	SHIRASH	0.2	720430.282	3163549.661		To be cut
100	S89A	SHIRASH	0.15	720430.282	3163549.661		To be cut
101	S90	JANGAL JALEBI	0.3	720432.176	3163548.84		To be transplant
102	S91	SHIRASH	0.18	720436.736	3163548.077		To be cut
103	S92	SHAHTOOT	0.34	720441.733	3163547.995		To be transplant
104	S92A	SHAHTOOT	0.23	720441.733	3163547.995		To be transplant
105	S92B	SHAHTOOT	0.25	720441.733	3163547.995		To be transplant
106	S93	SHIRASH	0.82	720440.754	3163545.309		To be cut
107	S93A	SHIRASH	0.4	720440.754	3163545.309		To be cut
108	S93B	SHIRASH	0.4	720440.754	3163545.309		To be cut
109	S94	SHIRASH	1.11	720440.416	3163546.121		To be cut
110	S95	SHIRASH	0.23	720436.7	3163546.623		To be cut
111	S96	SHIRASH	0.23	720439.096	3163542.955		To be cut
112	S97	SHAHTOOT	0.85	720438.288	3163543.453		To be transplant
113	S98	SHIRASH	0.21	720435.947	3163542.954		To be cut
114	S99	SHIRASH	0.28	720435.676	3163541.124		To be cut
115	S100	SHIRASH	0.42	720437.184	3163539.108		To be cut
116	S100A	SHIRASH	0.46	720437.184	3163539.108		To be cut
117	S101	SHIRASH	0.35	720430.849	3163545.447		To be cut
118	S102	SHIRASH	0.34	720432.739	3163546.126		To be cut
119	S103	SHAHTOOT	0.36	720428.833	3163545.316		To be transplant
120	S104	BAKAYAN	1.1	720428.049	3163545.061		To be cut
121	S105	SHIRASH	0.4	720431.251	3163540.974		To be cut
122	S106	SHIRASH	0.2	720430.535	3163540.447		To be cut
123	S107	SHIRASH	0.5	720427.258	3163539.725		To be cut
124	S108	SHIRASH	0.3	720432.261	3163535.97		To be cut
125	S109	SHIRASH	0.36	720431.497	3163534.577		To be cut
126	S110	SHAHTOOT	0.2	720430.258	3163532.132		To be transplant
127	S111	KIKAR	1.1	720425.802	3163530.253		To be cut
128	S112	SHIRASH	0.3	720425.798	3163523.581		To be cut
129	S113	SHIRASH	0.33	720422.011	3163522.246		To be cut
130	S114	SHAHTOOT	0.37	720419.743	3163518.928		To be transplant
131	S115	BAKAYAN	0.95	720422.135	3163527.763		To be cut
132	S116	BAKAYAN	0.92	720422.239	3163532.634		To be cut
133	S117	BELPATTAR	0.75	720412.447	3163540.275		To be transplant
134	S118	BAKAYAN	0.83	720412.082	3163532.953		To be cut
135	S119	BAKAYAN	1.27	720415.684	3163530.251		To be cut
136	S120	SHAHTOOT	1.15	720409.552	3163529.237		To be transplant
137	S121	KIKAR	1.3	720415.031	3163522.169		To be cut
138	S122	KIKAR	1.16	720414.837	3163515.382		To be cut
139	S123	SHIRASH	0.2	720414.742	3163515.689		To be cut
140	S124	SHIRASH	0.28	720412.904	3163514.024		To be cut
141	S124A	SHIRASH	0.26	720412.904	3163514.024		To be cut
142	S125	SHAHTOOT	0.85	720411.171	3163514.798		To be transplant
143	S125A	SHAHTOOT	0.86	720411.171	3163514.798		To be transplant
144	S125B	SHAHTOOT	0.72	720411.171	3163514.798		To be transplant
145	S125C	SHAHTOOT	0.65	720411.171	3163514.798		To be transplant
146	S126	SHIRASH	0.26	720412.689	3163515.759		To be cut
147	S127	NEEM	0.3	720410.531	3163518.189		To be cut
148	S128	PILKHAN	0.36	720406.802	3163508.573		To be transplant
149	S129	SHIRASH	0.15	720402.293	3163507.98		To be cut
150	S130	SHISHAM	0.18	720400.208	3163518.79		To be transplant

151	S131	BAKAYAN	0.86	720406.448	3163527.527		To be cut
152	S132	PEEPAL	0.9	720454.026	3163589.919		To be transplant
153	S132A	PEEPAL	1	720454.026	3163589.919		To be transplant
154	S132B	PEEPAL	1.33	720454.026	3163589.919		To be transplant
155	S133	BAKAYAN	0.93	720420.231	3163527.159		To be cut
156	S134	SHIRASH	0.27	720382.608	3163489.043	**HP-29 (Mathura Road Towards SSK)**	To be cut
157	S135	SHIRASH	0.29	720381.495	3163489.718		To be cut
158	S136	SHIRASH	0.25	720382.726	3163489.771		To be cut
159	S137	SHIRASH	0.29	720382.706	3163492.122		To be cut
160	S138	SHIRASH	0.4	720381.938	3163492.818		To be cut
161	S139	SHIRASH	0.38	720381.427	3163492.47		To be cut
162	S139A	SHIRASH	0.29	720381.427	3163492.47		To be cut
163	S140	SHIRASH	0.5	720380.27	3163490.215		To be cut
164	S141	SHIRASH	0.5	720373.244	3163488.782		To be cut
165	S141A	SHIRASH	0.55	720373.244	3163488.782		To be cut
166	S142	SHIRASH	0.3	720374.542	3163490.027		To be cut
167	S143	KIKAR	1.104	720372.428	3163497.598		To be cut
168	S144	SHIRASH	0.38	720374.791	3163499.957		To be cut
169	S145	BER	0.39	720367.411	3163481.503		To be cut
170	S146	BER	0.4	720367.082	3163481.29		To be cut
171	S147	BER	0.28	720366.253	3163481.21		To be cut
172	S147A	BER	0.26	720366.253	3163481.21		To be cut
173	S148	KIKAR	0.3	720338.264	3163452.369		To be cut
174	S149	SHIRASH	0.15	720344.086	3163458.674		To be cut
175	S150	SHIRASH	0.23	720338.921	3163450.511		To be cut
176	S151	SHIRASH	0.15	720337.441	3163449.028		To be cut
177	S152	KIKAR	0.22	720331.19	3163449.442		To be cut
178	S153	SHIRASH	0.4	720349.159	3163455.89		To be cut
179	S154	SHIRASH	0.26	720348.373	3163455.893		To be cut
180	S155	KIKAR	0.3	720339.655	3163454.956		To be cut
181	S156	KIKAR	0.2	720338.91	3163454.174		To be cut
182	S157	KIKAR	0.21	720339.897	3163453.581		To be cut
183	S158	KIKAR	0.15	720329.569	3163450.946		To be cut
184	S159	KIKAR	0.15	720330.77	3163448.373		To be cut
185	S160	SHIRASH	0.17	720330.753	3163447.811		To be cut
186	S161	KIKAR	0.38	720331.017	3163447.483		To be cut
187	S162	KIKAR	0.4	720329.031	3163446.601		To be cut
188	S163	KIKAR	0.16	720329.559	3163445.568		To be cut
189	S164	SHIRASH	0.16	720327.246	3163435.558		To be cut
190	S165	SHIRASH	0.33	720324.843	3163436.112		To be cut
191	S165A	SHIRASH	0.26	720324.843	3163436.112		To be cut
192	S165B	SHIRASH	0.27	720324.843	3163436.112		To be cut
193	S166	SHIRASH	0.36	720323.234	3163436.437		To be cut
194	S166A	SHIRASH	0.29	720323.234	3163436.437		To be cut
195	S167	SHIRASH	0.37	720321.829	3163436.717		To be cut
196	S167A	SHIRASH	0.2	720321.829	3163436.717		To be cut
197	S167B	SHIRASH	0.22	720321.829	3163436.717		To be cut
198	S167C	SHIRASH	0.15	720321.829	3163436.717		To be cut
199	S168	SHIRASH	0.21	720320.758	3163436.915		To be cut
200	S168A	SHIRASH	0.23	720320.758	3163436.915		To be cut
201	S168B	SHIRASH	0.2	720320.758	3163436.915		To be cut
202	S168C	SHIRASH	0.23	720320.758	3163436.915		To be cut
203	S168D	SHIRASH	0.29	720320.758	3163436.915		To be cut
204	S169	KIKAR	0.4	720317.338	3163437.844		To be cut
205	S170	KIKAR	0.26	720316.598	3163438.533		To be cut
206	S171	SHIRASH	0.3	720312.229	3163435.618		To be cut
207	S171A	SHIRASH	0.2	720312.229	3163435.618		To be cut
208	S171B	SHIRASH	0.21	720312.229	3163435.618		To be cut
209	S172	SHIRASH	0.19	720305.098	3163424.014		To be cut
210	S172A	SHIRASH	0.18	720305.098	3163424.014		To be cut
211	S172B	SHIRASH	0.15	720305.098	3163424.014		To be cut
212	S173	SHIRASH	0.31	720301.273	3163427.476		To be cut
213	S174	SHIRASH	0.34	720299.52	3163428.222		To be cut
214	S175	SHIRASH	0.25	720298.527	3163427.523		To be cut
215	S176	SHIRASH	0.37	720299.815	3163425.942		To be cut
216	S177	SHIRASH	0.25	720299.589	3163424.852		To be cut
217	S178	SHIRASH	0.18	720296.976	3163424.807		To be cut
218	S179	SHIRASH	0.26	720296.541	3163424.172		To be cut
219	S179A	SHIRASH	0.24	720296.541	3163424.172		To be cut
220	S180	SHIRASH	0.18	720330.473	3163441.777		To be cut
221	S181	SHIRASH	0.34	720303.542	3163433.528		To be cut
222	S182	SHAHTOOT	0.2	720302.15	3163432.551		To be transplant
223	S183	SHIRASH	0.34	720295.541	3163422.69		To be cut
224	S184	SHIRASH	0.18	720294.805	3163421.442		To be cut
225	S184A	SHIRASH	0.3	720294.805	3163421.442		To be cut
226	S184B	SHIRASH	0.38	720294.805	3163421.442		To be cut
227	S185	SHIRASH	0.37	720293.102	3163418.28		To be cut
228	S185A	SHIRASH	0.26	720293.102	3163418.28		To be cut
229	S185B	SHIRASH	0.15	720293.102	3163418.28		To be cut
230	S186	SHIRASH	0.4	720291.389	3163415.754		To be cut
231	S186A	SHIRASH	0.27	720291.389	3163415.754		To be cut
232	S187	SHIRASH	0.16	720290.49	3163414.697		To be cut
233	S187A	SHIRASH	0.15	720290.49	3163414.697		To be cut
234	S188	SHIRASH	0.22	720290.281	3163413.913		To be cut
235	S189	SHIRASH	0.38	720289.62	3163412.548		To be cut

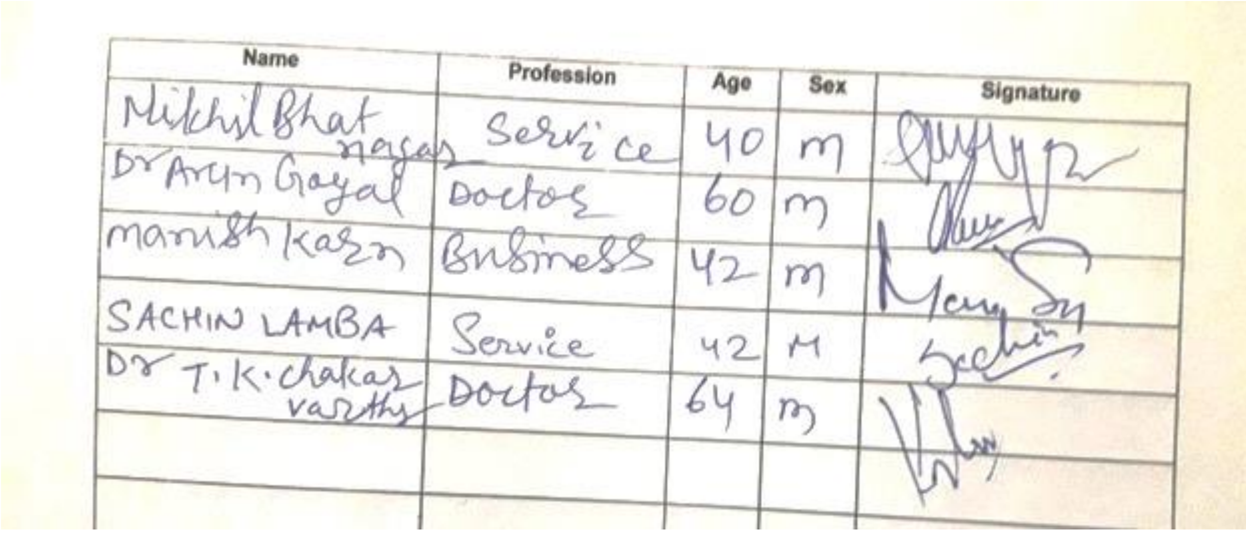
236	S189A	SHIRASH	0.2	720289.62	3163412.548		To be cut
237	S190	SHIRASH	0.29	720288.873	3163411.13		To be cut
238	S191	ASHOKA	0.15	720288.641	3163408.047		To be transplant
239	S192	ASHOKA	0.2	720284.112	3163404.626		To be transplant
240	S193	ASHOKA	0.15	720285.618	3163407.681		To be transplant
241	S194	ASHOKA	0.18	720287.124	3163411.249		To be transplant
242	S195	ASHOKA	0.19	720288.275	3163413.844		To be transplant
243	S196	ASHOKA	0.18	720291.458	3163419.332		To be transplant
244	S197	ASHOKA	0.16	720293.355	3163422.141		To be transplant
245	S198	ASHOKA	0.16	720295.427	3163425.279		To be transplant
246	S199	ASHOKA	0.16	720297.074	3163427.227		To be transplant
247	S200	ASHOKA	0.15	720298.501	3163430.046		To be transplant
248	S201	ASHOKA	0.19	720300.371	3163432.093		To be transplant
249	S202	ASHOKA	0.19	720302.377	3163435.01		To be transplant
250	S203	ASHOKA	0.2	720304.423	3163438.53		To be transplant
251	S204	ASHOKA	0.2	720305.8	3163440.36		To be transplant
252	S205	KIKAR	1.47	720335.059	3163462.487		To be cut
253	S206	KIKAR	0.6	720337.312	3163463.915		To be cut
254	S207	ASHOKA	0.15	720293.625	3163437.344		To be transplant
255	S208	ASHOKA	0.15	720292	3163435.322		To be transplant
256	S209	ASHOKA	0.15	720289.813	3163432.732		To be transplant
257	S210	ASHOKA	0.18	720284.733	3163427.546		To be transplant
258	S211	PEEPAL	1.2	720271.446	3163423.118		To be transplant
259	S212	ASHOKA	0.16	720280.98	3163419.376		To be transplant
260	S213	PEEPAL	1.9	720278.258	3163419.482		To be transplant
261	S214	SHISHAM	1.27	720277.337	3163420.162		To be transplant
262	S215	ASHOKA	0.22	720279.029	3163414.266		To be transplant
263	S216	ASHOKA	0.25	720278.1	3163411.601		To be transplant
264	S217	NEEBU	0.2	720274.786	3163411.926		To be transplant
265	S218	NEEM	0.15	720274.297	3163411.599		To be cut
266	S219	ASHOKA	0.2	720274.765	3163403.397		To be transplant
267	S220	ASHOKA	0.26	720273.744	3163400.47		To be transplant
268	S221	SHISHAM	0.16	720272.678	3163397.528		To be transplant
269	S222	ASHOKA	0.24	720271.435	3163394.366		To be transplant
270	S223	BER	3.15	720272.63	3163407.046		To be cut
271	S224	SHAHTOOT	0.9	720268.999	3163410.025		To be transplant
272	S225	PILKHAN	0.47	720262.954	3163407.908		To be transplant
273	S226	SHAHTOOT	1.15	720269.91	3163402.837		To be transplant
274	S227	ASHOKA	0.26	720263.899	3163411.201		To be transplant
275	S228	NEEM	0.73	720262.891	3163412.293		To be cut
276	S229	PEEPAL	0.45	720262.414	3163413.071		To be transplant
277	S230	SHAHTOOT	0.5	720259.634	3163414.842		To be transplant
278	S231	JAMUN	1.26	720260.752	3163403.314		To be transplant
279	S232	BARGAD	1.5	720259.946	3163398.507		To be transplant
280	S233	BOTAL BRUSH	0.8	720258.835	3163393.611		To be transplant
281	S234	SHIRASH	0.28	720258.633	3163394.277		To be cut
282	S235	SHAHTOOT	1	720244.781	3163406.828		To be transplant
283	S236	SHAHTOOT	1	720242.976	3163403.234		To be transplant
284	S237	AAM	1.23	720234.947	3163384.117		To be transplant
285	S238	NEEM	0.26	720233.329	3163386.423		To be cut
286	S239	ASHOKA	0.22	720253.535	3163380.904		To be transplant
287	S240	ASHOKA	0.23	720255.622	3163382.966		To be transplant
288	S241	PEEPAL	0.2	720256.183	3163385.531		To be transplant
289	S242	SHAHTOOT	0.81	720260.508	3163382.25		To be transplant
290	S243	ASHOKA	0.23	720232.052	3163370.085		To be transplant
291	S244	ASHOKA	0.26	720228.682	3163370.199		To be transplant
292	S245	SHAHTOOT	0.23	720225.074	3163363.722		To be transplant
293	S245A	SHAHTOOT	0.26	720225.074	3163363.722	**HP-30 upto HPL Employee Courter**	To be transplant
294	S245B	SHAHTOOT	0.24	720225.074	3163363.722		To be transplant
295	S245C	SHAHTOOT	0.23	720225.074	3163363.722		To be transplant
296	S246	PAPRI	0.31	720223.835	3163361.573		To be transplant
297	S246A	PAPRI	0.22	720223.835	3163361.573		To be transplant
298	S246B	PAPRI	0.2	720223.835	3163361.573		To be transplant
299	S247	SHIRASH	0.2	720221.733	3163362.416		To be cut
300	S247A	SHIRASH	0.21	720221.733	3163362.416		To be cut

301	S248	SHIRASH	0.38	720218.944	3163360.061	To be cut
302	S249	KIKAR	0.18	720217.949	3163358.519	To be cut
303	S250	SHAHTOOT	0.23	720218.249	3163357.453	To be transplant
304	S251	SHIRASH	0.3	720220.696	3163357.639	To be cut
305	S252	SHIRASH	0.18	720221.805	3163355.84	To be cut
306	S253	SHIRASH	0.22	720221.011	3163353.358	To be cut
307	S254	NEEM	0.76	720217.86	3163353.847	To be cut
308	S254A	NEEM	0.77	720217.86	3163353.847	To be cut
309	S255	NEEM	0.31	720216.791	3163354.901	To be cut
310	S256	NEEM	0.16	720217.196	3163356.742	To be cut
311	S257	SHIRASH	0.34	720223.272	3163350.313	To be cut
312	S258	SHEMAL	0.37	720224.363	3163352.131	To be transplant
313	S258A	SHEMAL	0.27	720224.363	3163352.131	To be transplant
314	S259	SHIRASH	0.23	720223.083	3163348.968	To be cut
315	S260	SHIRASH	0.27	720221.689	3163350.368	To be cut
316	S261	SHIRASH	0.56	720220.835	3163344.605	To be cut
317	S262	JANGAL JALEBI	0.45	720215.172	3163346.277	To be transplant
318	S263	NEEM	0.28	720216.49	3163350.282	To be cut
319	S264	SHIRASH	0.19	720214.901	3163345.632	To be cut
320	S265	SHIRASH	0.43	720221.179	3163343.175	To be cut
321	S266	NEEM	0.8	720219.827	3163340.953	To be cut
322	S266A	NEEM	0.76	720219.827	3163340.953	To be cut
323	S266B	NEEM	0.7	720219.827	3163340.953	To be cut
324	S267	NEEM	0.84	720218.003	3163340.654	To be cut
325	S268	SHIRASH	0.2	720219.25	3163340.002	To be cut
326	S269	SHIRASH	0.71	720216.308	3163337.624	To be cut
327	S270	SHIRASH	0.38	720216.133	3163334.528	To be cut
328	S271	SHIRASH	0.93	720216.209	3163331.963	To be cut
329	S271A	SHIRASH	0.23	720216.209	3163331.963	To be cut
330	S272	SHIRASH	0.27	720214.652	3163330.999	To be cut
331	S273	SHIRASH	0.21	720215.674	3163330.262	To be cut
332	S274	NEEM	0.26	720212.803	3163332.604	To be cut
333	S275	NEEM	0.52	720212.493	3163329.6	To be cut
334	S276	NEEM	0.27	720212.341	3163330.958	To be cut
335	S277	SHIRASH	0.49	720214.562	3163328.486	To be cut
336	S278	SHIRASH	0.26	720214.272	3163326.854	To be cut
337	S279	ASHOKA	1.1	720221.742	3163375.401	To be transplant
338	S280	AMRUD	0.27	720224.107	3163383.964	To be transplant
339	S280A	AMRUD	0.2	720224.107	3163383.964	To be transplant
340	S280B	AMRUD	0.16	720224.107	3163383.964	To be transplant
341	S280C	AMRUD	0.2	720224.107	3163383.964	To be transplant
342	S280D	AMRUD	0.2	720224.107	3163383.964	To be transplant
343	S281	JAMUN	0.6	720225.22	3163388.573	To be transplant
344	S281A	JAMUN	0.26	720225.22	3163388.573	To be transplant
345	S282	PAM	0.66	720223.09	3163391.603	To be transplant
346	S283	PEEPAL	3.5	720207.603	3163371.429	To be transplant
347	S284	AAM	2	720201.807	3163376.794	To be transplant
348	S285	NEEM	1.38	720191.71	3163369.095	To be cut
349	S286	PEEPAL	2.77	720193.618	3163360.886	To be transplant
350	S287	AMRUD	0.34	720198.004	3163357.302	To be transplant
351	S287A	AMRUD	0.32	720198.004	3163357.302	To be transplant
352	S288	JAMUN	0.71	720200.401	3163362.277	To be transplant
353	S289	NEEBU	0.3	720204.535	3163362.551	To be transplant
354	S290	PEEPAL	3.56	720208.984	3163361.904	To be transplant
355	S291	BER	0.32	720216.928	3163360.87	To be cut
356	S292	JAMUN	0.6	720208.76	3163357.216	To be transplant

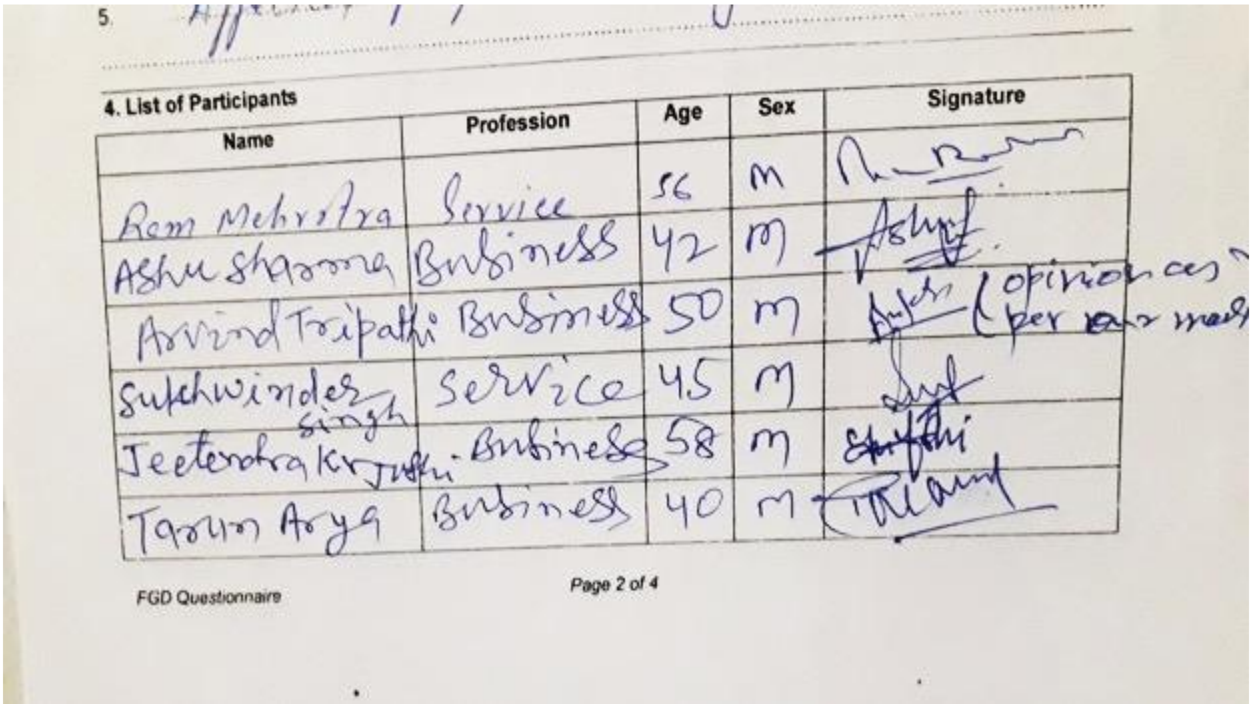
357	S293	JAMUN	0.39	720208.591	3163354.408		To be transplant
358	S294	JAMUN	0.2	720209.063	3163350.078		To be transplant
359	S295	NEEM	0.75	720206.422	3163345.546		To be cut
360	S296	MAHUA	2.14	720206.098	3163342.743		To be transplant
361	S297	JANGAL JALEBI	1.04	720199.068	3163344.813		To be transplant
362	S298	PEEPAL	0.3	720200.253	3163340.518		To be transplant
363	S299	PEEPAL	1.8	720196.898	3163342.102		To be transplant
364	S300	JANGAL JALEBI	0.53	720196.374	3163340.145		To be transplant
365	S301	IMLI	0.17	720177.011	3163329.521		To be transplant
366	S302	PAM	0.5	720174.124	3163328.084		To be transplant
367	S303	IMLI	0.16	720176.834	3163329.709		To be transplant
368	S304	NEEBU	0.16	720177.377	3163329.479		To be transplant
369	S305	AMRUD	0.31	720177.33	3163329.585		To be transplant
370	S305A	AMRUD	0.2	720177.33	3163329.585		To be transplant
371	S305B	AMRUD	0.23	720177.33	3163329.585		To be transplant
372	S306	AMRUD	0.23	720182.494	3163331.461		To be transplant
373	S306A	AMRUD	0.21	720182.494	3163331.461		To be transplant
374	S307	FICUS	0.28	720198.482	3163334.826		To be transplant
375	S308	FICUS	0.47	720201.05	3163335.016		To be transplant
376	S309	FICUS	0.6	720199.922	3163334.449		To be transplant
377	S310	AMRUD	0.31	720197.745	3163333.728		To be transplant
378	S311	NEEBU	0.41	720192.273	3163332.332		To be transplant
379	S312	SHARIFA	0.31	720190.792	3163332.107		To be transplant
380	S313	NEEM	0.93	720190.044	3163332.45		To be cut
381	S314	MAHUA	1.8	720201.56	3163316.291		To be transplant
382	S315	AMRUD	0.66	720198.946	3163312.384		To be transplant
383	S316	SANTRA	0.23	720201.023	3163308.498		To be transplant
384	S317	JAMUN	1.5	720195.238	3163296.057		To be transplant
385	S318	NEEM	1.51	720179.218	3163291.634		To be cut
386	S319	GULAR	0.5	720175.35	3163283.627		To be transplant
387	S320	AMRUD	0.64	720178.091	3163284.229		To be transplant
388	S321	NEEBU	0.5	720179.761	3163284.71		To be transplant
389	S322	KADIPATTA	0.22	720174.821	3163291.27		To be transplant
390	S323	SHAHTOOT	0.53	720174.119	3163295.815		To be transplant
391	S324	SHAHTOOT	0.7	720180.711	3163303.062		To be transplant
392	S325	JAMUN	1.6	720172.84	3163300.541		To be transplant
393	S326	NEEBU	0.3	720173.939	3163304.824		To be transplant
394	S327	PEEPAL	2.3	720200.066	3163279.88		To be transplant
395	S328	PEEPAL	1.18	720198.284	3163277.824		To be transplant
396	S329	SHAHTOOT	0.3	720187.111	3163275.937		To be transplant
397	S330	KANEER	0.17	720185.08	3163275.291		To be transplant
398	S330A	KANEER	0.16	720185.08	3163275.291		To be transplant
399	S331	JAMUN	1.36	720180.049	3163275.44		To be transplant
400	S332	PAKAD	0.9	720184.3	3163263.608		To be transplant
401	S333	SHAHTOOT	0.63	720184.679	3163260.054		To be transplant
402	S333A	SHAHTOOT	0.27	720184.679	3163260.054		To be transplant
403	S333B	SHAHTOOT	0.3	720184.679	3163260.054		To be transplant
404	S333C	SHAHTOOT	0.22	720184.679	3163260.054		To be transplant
405	S333D	SHAHTOOT	0.35	720184.679	3163260.054		To be transplant
406	S334	NEEBU	0.28	720198.85	3163262.299		To be transplant
407	S334A	NEEBU	0.2	720198.85	3163262.299		To be transplant
408	S334B	NEEBU	0.23	720198.85	3163262.299		To be transplant
409	S335	PEEPAL	3.4	720196.831	3163254.368		To be transplant
410	S336	PEEPAL	0.6	720186.992	3163248.76		To be transplant
411	S337	JAMUN	1.3	720188.736	3163240.055		To be transplant
412	S338	NEEM	1.35	720174.964	3163231.076		To be cut
413	S339	JAMUN	1.9	720170.064	3163250.876		To be transplant
414	S340	AAM	0.28	720163.115	3163267.149		To be transplant
415	S341	NEEM	1.4	720168.882	3163267.409		To be cut
416	S342	PEEPAL	0.55	720305.829	3163436.209		To be transplant

APPENDIX 7: Details of Public Consultation along the RRTS Corridor

Date : 04-12-20
Locality: Siddhartha Ext,Pkt-C
Ward: Bhogal
District: South East Delhi



Name	Profession	Age	Sex	Signature
Nikhil Bhatnagar	Service	40	m	
Dr Arun Goyal	Doctor	60	m	
manish karn	Business	42	m	
SACHIN LAMBA	Service	42	M	Sachin
Dr T.K. chakarvarthy	Doctor	64	m	



5. [illegible]

4. List of Participants				
Name	Profession	Age	Sex	Signature
Ram Mehrotra	Service	56	M	
Ashu Sharma	Business	42	m	Ashu
Arvind Tripathi	Business	50	m	(opinion as per [illegible]
Sukhwinder singh	Service	45	m	
Jeetendra kr Tripathi	Business	58	m	
Tarun Arya	Business	40	m	

FGD Questionnaire

Page 2 of 4

APPENDIX 8: Copy of Letter for tree cutting submitted to Dy. Conservator of Forest

www.ncrtc.in

राष्ट्रीय राजधानी क्षेत्र परिवहन निगम

(भारत सरकार एवं प्रतिभागी राज्य सरकारों का एक संयुक्त उपक्रम)

National Capital Region Transport Corporation

(A Joint venture of Government of India and participating State Governments)

No. NCRTC/CPM/D/Forest/Delhi-South/2020/08/1110 17/08/2020

To,

The Dy. Conservator of Forest,
South Forest Division
Near Dr. Karni Singh Shooting Range,
Tughlakabad, Mehrauli Badarpur Road,
New Delhi-110044

Sub: Implementation of Delhi-Ghaziabad-Meerut Regional Rapid Transit System (RRTS) Corridor- **Regarding Permission for Tree cutting/felling in Delhi-Meerut RRTS Stabling Yard alignment from Sarai Kale Khan at chainage 950 to chainage 1650 near Siddharth extension and Sarai Kale Khan Station Yard at chainage 0 to 200.**

Ref: NCRTC's letter no. NCRTC/CPM/D/Forest Deptt/2018/08/72 dated 16.11.2018

Dear Sir,

Vide above referred letter, the case was put up regarding permission for tree cutting/felling under the jurisdiction of DCF/South for implementation of Delhi-Meerut RRTS alignment.

Delhi-Meerut RRTS alignment starts from Sarai Kale Khan and terminates beyond Meerut in Modipuram. For the efficient operations of RRTS a Stabling Yard has been planned within Delhi area which will be connected by Viaduct from Sarai Kale Khan to Jangpura along with a Station Yard at Sarai Kale Khan.

In order to establish the above facilities, permission is required for cutting/felling of 113 nos. of trees. A list of trees falling in Stabling Yard alignment from Chainage 950 to 1650 and Station Yard from Chainage 0 to 200 with necessary details of the trees is

17/8/20

enclosed herewith at Annex A. Other necessary details like Form B, drawing showing tree location, affidavit are attached in the annexes.

In view of the above, it is humbly requested to accord permission for felling/cutting of the trees as per list attached at Annex A for smooth implementation of this public funded project.

An early approval will be highly appreciated.

Thanking You,

Yours faithfully,

13/8/20

(Subodh Kumar)
Chief Project Manager/Delhi
Email:subodh.kumar@ncrtc.in

Encl:

i) Form B
ii) List of trees
iii) Drawing showing tree location
iv) Affidavit

APPENDIX 9: Copy of Letters dated 05.07.2021 and 17.08.2021 from NCRTC to Sr. Citizen Welfare Forum (Sidhath Extension)

स्वच्छ भारत
एक कदम स्वच्छता की ओर

ncrtc
गति से प्रगति

Appendix-9

www.ncrtc.in

राष्ट्रीय राजधानी क्षेत्र परिवहन निगम
(भारत सरकार एवं प्रतिभागी राज्य सरकारों का एक संयुक्त उपक्रम)
National Capital Region Transport Corporation
(A Joint venture of Government of India and participating State Governments)

No. NCRTC/CPM/D/SIDDHARTH EXTN./2019/97/2067 Date: 17.08.2021

To,

The Sidhartha Extension Sr. Citizens' Welfare Forum (Regd.),
Porta Cabin Near Gate No. 3,
Pocket 'C', Sidhartha Extension,
New Delhi-110014.

(Kind Atten.: Sh. M.M. Gupta)

Sub: Implementation of Delhi-Ghaziabad-Meerut Regional Rapid Transit System (RRTS) Corridor – Properties/Flats falling in Sidhartha Extension on stabling line alignment of NCRTC

Ref: (i) NCRTC's office letter no. NCRTC/Genl./1/Vol.III dated 05.07.2021
(ii) Letter No. SSWF/SID.EXTN./2019/20/137 Dt. 14.11.2020
(iii) Letter No. SSWF/SID.EXTN./2019/20/136 Dt. 05.11.2020
(iv) NCRTC's office letter no. NCRTC/CPM/D/MISC/2019/69/351 dated 05.08.2019

Kindly refer to your above referred letters through which you have raised concerns on health, safety and social related issues due to passing of RRTS Stabling Yard alignment through Sidhartha Extn. Pocket-C. Brief on Stabling alignment was communicated vide this office letter dated 05.07.2021 (reference-(i)). However, for your better understanding and appreciation regarding RRTS project, following information is shared:-

A. (i) NCR in India, being the largest in country and one of the largest urban agglomerations in the world, is currently facing issues of severe congestion and unprecedented pollution levels, which is caused by uncontrolled urban sprawl followed by high transport demand. In order to address these concerns and empower citizens through improved efficient mobility and promote sustainable socio-economic growth of National Capital Region, Functional Plan on Transport for NCR-2032 has recommended development of Regional Rapid Transit System (RRTS) across the NCR.

(ii) RRTS is a high-speed (Design speed of 180 kmph and average speed close to 100 kmph), high capacity rail-based commuter transit system serving traffic nodes at about 5-10 km. It will significantly reduce the travel time between various towns of NCR served by it. Such transport solution will support the goal of sustainable economic and social development of the region, with protection of decaying environment.

(iii) RRTS is a large-scale strategic infrastructure project and has been included in the National Infrastructure Pipeline (NIP), recently finalized by the Task Force headed by Secretary, DEA and unveiled by Hon'ble Finance Minister. Furthermore, the Project is included as a medium-term measure in 'Comprehensive Action Plan' (CAP) for Air Pollution Control in Delhi & NCR' and forms an integral part of recommendation of 'High Powered Committee on Decongesting Traffic in Delhi'.

(iv) RRTS will significantly reduce traffic congestion on the roads due to modal shift in favour of public transport through a high-speed, high-throughput, environmentally friendly, safe, secure, rail-based public transport. Further, there will be a significant reduction in CO2 emissions (about 1000 Tonnes/Day) as a result of shift of commuters from road-based transport to RRTS. Pollution reduction will also accrue additional economic benefits such as savings due to improved health of citizens, reduced expenditure on treatment of diseases/medicines, etc.

B. Considering importance of RRTS project for achieving socio-economic-environmental benefits, the RRTS projects have been viewed favourably by various constitutional and statuary authorities:

1. In the matter of M.C. Mehta v/s Union of India and others (Writ Petition (C) No. 13029 of 1985, On January 18, 2019, Hon'ble Supreme Court of India observed that this project is "absolutely necessary and there should be no delay on the part of concerned authorities". In the same case, the Hon'ble Supreme Court on 06.03.2019 observed that "the corridor (Delhi-Meerut) is absolutely necessary for Rapid Transport to ease the out growing congestion and for reducing the pollution."

2. In November 2019, due to alarming increase in air pollution in NCR, Hon'ble Supreme Court had banned the construction activities in Delhi-NCR. However, Hon'ble Supreme Court passed an order on 16.12.2019 stating "Considering the importance of the project in question for reducing the pollution in Delhi, we permit the construction activity relating to project even during nighttime."

3. NCRTC has also been permitted project alignment through Yamuna river flood plain by the National Green Tribunal (NGT) and Yamuna Standing Committee.

4. Hon'ble Supreme Court, in one of the cases, had banned all construction in sanitary land fill sites. However, in case of RRTS project, considering its importance, Hon'ble Supreme Court vide order dated August 7, 2020 has allowed construction of elevated viaduct over Millennium Park, which is a sanitary land fill site.

C. Issues/difficulties raised vide above referred letters has been deliberated below along with NCRTC's comments:-

1. FEW SUGGESTIONS

SN	SUGGESTIONS	NCRTC COMMENTS
1.	There is lack of awareness of the project among residents w.r.t. exact route and its cutting through the colony, location of pillars commencing from outer ring road till end. - As it concerns movement of heavy traffic e.g., school buses/ lorries, ambulance, etc. covering of Barapullah Nallah for road expansion to ease traffic has to be examined.	• NCRTC has shared the details of alignment passing through Sidhartha Extension. Required drawings were shared vide letter under reference (iv) dated 05.08.2019. • NCRTC has already clarified the location of Piers in the colony to all the three groups individually during the visits and it was clarified that due to permanent structures of RRTS, traffic in Sidhartha Extension will not get affected. • NCRTC will make proper workable and good arrangement of traffic movement during temporary phase of construction also.
2.	Exploring other options of parking yards: - To explore other options to make the parking yard e.g., in Millennium Park, adjoining to Nizamuddin station parking yards.	• Various alternate alignment options for the Viaduct and Yard were explored to avoid the above residential colony but no other techno-commercial option was found technically feasible. • Viaduct is crossing the colony as elevated structure at a height of about 24 m from ground level.

2. SOME UPDATES

SN	UPDATES	NCRTC COMMENTS
1.	The area is water logged since	• The ground conditions can only be

	2010, and is on records. Foundations of all types of construction are deemed to be submerged in water and in process of degeneration. When the area was rehabilitated, it was all dry land and foundations laid as per normal DDA standards, without any consideration of such circumstances arising in future. Over a period of time say, after few decades, and degeneration process getting quite active, shall it with stand to the vibrations generated by new metro trains besides risks of natural phenomena of earthquake tremors etc. In addition, there exists Indian Railway traffic, having multiplied manifolds, over a period of time which also transmits vibrations, as is being experienced by many residents. Proposed Rapid Metro traffic is bound to add to our vows.	ascertained by Geo-Technical investigation for which permission from RWA was requested. However, Permission is still awaited. • NCRTC will take all reasonable precautions at the appropriate time once NOC is granted for geotechnical investigations in the complex. • NCRTC is a professional organization and mandated by GoI to construct a state of the art high speed rail-based system at an estimated cost of Rs. 30,274 cr. All precautions and measures towards structural stability of NCRTC structures and also for adjoining structures shall be considered while designing the structure. • It is assured that NCRTC is fully equipped to undertake the design of heavy structures in all type of soils including for underground structures.
2.	Flat nos., falling between 195 to 220 are likely to be affected the most out of which some are already identified by NCRTC, while in the left out, some others having common walks – 2 parallel rows on both sides are not included. Besides quite a few other blocks can be considered. We are in total dark about the criterion adopted in identifying some as affected flats, in isolation.	• NCRTC has already carried out the social impact assessment of this connecting line and will incorporate the same as an addendum to the approved SIA report. • NCRTC will follow the recommendations of SIA report which is under scrutiny by ADB. SIA will be shared once approved by ADB.
3.	Lots of input costs, energy is added to raw flats by residents	• The issue will be addressed with eligible flat owners if applicable.

	to satisfy their own needs/ requirements.	
4.	This area is ideally located on outer Ring Road and Yamuna banks and well connected to Railway stations, Bus terminals, Hospitals, children's schools, etc.; all within 10 kms radius and Airport about 25 kms.	• This RRTS project will further enhance connectivity in Delhi NCR area and will improve connectivity significantly.

3. INFORMATION REQUIRED FROM NCRTC

SN	UPDATES	NCRTC COMMENTS
1.	What all clearance/NOC's, NCRTC has already obtained from agencies like DDA, SDMC, Environments, pollution board, noise pollution and what are defined limits WITH CURRENT VALUES. How much green area is likely to be used, which trees are to be felled etc., with copy of documents/clearances.	• NCRTC has obtained all required clearances from concerned Authorities before starting the construction work. • For tree cutting permission, survey will be conducted after NOC is issued by RWA. No green area is likely to be used on permanent basis other than required for three piers.
2.	What are required parameters national/international and being followed, when you cut through an existing urbanized residential complex allotted by DDA with over 32 years of physical habitation? - Noise levels - Vibrations limit to withstand sagging structures. Soil testing from IIT etc.	• No such parameters are defined for specific case. • Study has already been conducted for Noise and vibrations in Pocket-C, Sidhartha Extension for RRTS Corridor. • NCRTC confirms that noise level will not increase more than the existing noise levels due to movement of RRTS trains on the subject viaduct. • Soil testing will be carried out after it is permitted by RWA inside the complex.
3.	We admit we have shallow knowledge on the subject and the residents, within their natural right, deserve to be	No comments

	apprised.	
4.	All communication by individuals etc., when replied by NCRTC, need to be marked with a copy to RWA/Senior Citizens Forum.	• Communication remains a confidential matter between NCRTC and individual flat owners.
5.	Were some other locations examined/eliminated, before zeroing on the present site/plan?	• Replied against item no. 2 of "Few Suggestions" as mentioned above.
6.	What are NCRTC's plans for impacted flats.	• NCRTC will follow Resettlement Plan, which is under final scrutiny with ADB. • The copy of the same shall be made available shortly after the approval of competent authority.
7.	NCRTC's assurance on safety/security concerns while work remains in progress.	• NCRTC is a professional organization and executing project work with high level of safety norms. • Delhi-Meerut Corridor construction work is in progress on the median of the road having heavy traffic movements. All safety measures are being taken in professional manner. • NCRTC shall meet requisite safety/security requirements during construction period and even afterwards as required.
8.	Assurance to examine unidentified concerns which are likely to arise in future and during implementation stage and later on	• NCRTC is committed to deal all the issues related to this project right from start to completion and thereafter.
9.	Restoration of parks, roads and other children's installed recreations facilities etc.	• NCRTC is committed to do all restorations works if disturbed due to RRTS project. • This has already been briefed/ communicated /assured to all the three-groups representing one Sidhartha Extension. • NCRTC is committed to maintain existing facilities like Park, Roads and other children recreation

		installations if disturbed in Pocket-C area of Sidhartha Extension.

4. INFORMATION REQUIRED FROM NCRTC

SN	UPDATES	NCRTC COMMENTS
1.	**Structural Safety**: It is obvious that, at first hand, there is going to be adverse effect on the adjoining structures, on both sides of the track, taking into account its vicinity. The layout plan and study conducted need to be shared with the residents.	• There will not be any adverse effect on adjoining structures. In fact, piling will improve ground condition. • The method for Piling will be boring of pile instead of driving of pile by impact method. • NCRTC proposes to undertake structural survey of flats in complex adjoining to alignment before, during and after completion of project activities in the complex subject to issue of NOC.
2.	**Environmental Pollution**: It is obvious that the flats, as mentioned above, will face issues of environmental pollution due to noise, vibration, blockage of sunlight and air and depletion of the green area. The resident needs to be educated whether any study has been conducted in this respect.	• NCRTC is committed not to increase the present levels of environmental pollution after and during construction of RRTS project. • NCRTC has already carried out Noise and Vibration study by CRRI. • NCRTC confirms that noise level will not increase more than the existing noise levels due to movement of RRTS trains on the subject viaduct. • Sunlight study is in progress. It will be shared after completion.
3	**Health and well being of Senior Citizens and Children**: Whether any study has been conducted to evaluate short term and long term affects, in this serious matter, during construction and after putting it in operation? Is there any long term health plan on the anvil?	• NCRTC is committed not to increase the existing environmental conditions and pollution levels during construction and after construction. • NCRTC is constructing a professionally designed viaduct which will have no adverse health impact on the health of residents. If

		there is any apprehension, it may be spelt out.
4	**<u>Risk factors</u>**: There are apprehensions that being a giant construction whether or not there will be any risk during earthquakes or other natural calamities/disaster.	• NCRTC is a professional organization and is utilizing the services of international and national experts to undertake the design of heavy structures in all conditions including earthquake. • NCRTC has specialized experts such as General Consultant, Detailed Design Consultant, Team of Project Executing Contractors, who work as per laid down standards and good industry policies. • Construction activities are being taken up based on approved design & drawings and design takes care of earthquake forces.
5	**<u>Dangerous Ground Water Table</u>**: It is a matter of record in a litigation by one of the residents that the ground water table in the area is very precarious, merely 1.5 to 2.5 meters and there have been incidents of ground sinking at different places, number of times. DJB had also undertaken a corrective action, on the direction of the Court involving Crores of rupees. However, there is no study or details about its efficacy or impact. It is hoped NCRTC must also have taken into accounts this aspect and any report or document on this need to be shared.	• We are thankful for keeping NCRTC updated regarding ground water table in the area. We assure that NCRTC design team will take into account this information during design of viaduct. • NCRTC has not been provided NOC to assess and know technically the facts available regarding.
6	**<u>Clearances from concerned authorities</u>**: It is hope that necessary NOC or clearances must have been	NCRTC has obtained all required clearances from concerned Authorities before starting the construction work.

	obtained from the agencies like DDA, MCD, Central Pollution Control Board, etc. If so details to be divulged to the extent feasible.	
7	**Effects of the DMRC UG Metro Line passing through a part of the colony**: It is a matter of record that a section of the Pink Line of DMRC has been laid UG, diagonally from Sankat Mochan Mandir Marg to flats in blocks 50-ABCD to 55-ABCD. There has been considerable damage to the flats and some rehabilitation measures had also reportedly been taken. However, as per version of the residents they still feel lot of continuous vibration from the passing trains which tantamount to various apprehensions disturbing their peace of mind.	• The subject matter does not pertain to NCRTC. • NCRTC is not constructing underground tunnel through Sidhartha Extension.
8	**Totally ignoring the representations from RWA & Sr. Citizens Forum**: It was pointed that there have been various representations from Sr. Citizens' Welfare Forum & RWA, who have been writing from the initial stages of the Project. How can NCRTC proceed without a formal NOC from the above duly registered bodies? A clarification needs to be given in the matter. If at all there are some, the same may please be placed on record.	• NCRTC is maintaining contact with all the three organizations of Sidhartha Extn. • NCRTC will approach the concern at appropriate time for NOC if required.

5. **Some of the Concerns /Issues raised by residents** during meetings and replied are under:

SN	Residents Concern	NCRTC Comments
1	Vibration and Noise pollution due to trains passing at mere 9 meters above the residences.	• NCRTC has conducted study through an independent body CRRI for mitigating Noise & Vibrations Pollution. • NCRTC has already agreed to provide noise barrier if noise generated due to RRTS trains will be higher than existing ambient noise. • All necessary measures shall be adopted to keep the noise and vibration within permissible limits during construction as well as during train operations. • NCRTC committed not to increase in level of vibration and noise from the existing ambient noise levels.
2	Weakening of Structures due to Deep Pile Foundations	• Concerns of residents not correct. NCRTC should be allowed to access and know technical details of existing conditions. • Pile will strengthen the soil conditions of the area. • Deep foundations by boring of pile are commonly adopted practice for viaducts. There are several examples of similar kind of works executed in the vicinity of residential/commercial flats without weakening the existing structures. • NCRTC still confirm that an independent agency will be appointed to carry out structural survey before and after the construction of viaduct.
3	Damage to utility lines like Piped Natural Gas, electricity, phone, water pipes etc.	• NCRTC being a professional organization shall undertake all Utility diversions in planned manner at appropriate time. • NCRTC will deploy the specialized agencies for shifting of services like Gas pipeline etc. • If any utility system is damaged, it will be made good by NCRTC.
4	Blocking of Sunlight as the proposed width of	• Sunlight study is in progress. It will be shared after completion.

	the viaduct (10.63 m) is greater than the distance between the buildings (8.92 m).	
5	Loss of rainwater harvesting system and a park with green cover that consists of larger and old trees.	• Viaduct piers have been placed at the edge of the park, thus green cover in the park area will not get reduced. • Felling of trees would be kept to bare minimum with provision of transplantation of trees as per statutory norms. However, NCRTC will plant additional trees as part of its plantation campaign. • NCRTC will construct rainwater harvesting system which will cater the viaduct. • NCRTC can take up plantation even before execution of project in the Sidhartha Extension, if suggested by residents.
6	Safety of residents, excessive noise pollution and structural safety of buildings during construction.	• Construction of RRTS is large public infrastructure project being executed by experienced professional technical experts with deployment of modern technologies. • NCRTC is doing construction of Delhi-Meerut Corridor where high level of safety standards are being followed. • NCRTC has a well-developed multi-layer safety mechanism having teams from General Consultant, Detailed Design Consultant, Safety Team of Project Executing Contractors and that of NCRTC to take care of safety aspects. • Standard Safety, Health and Environment (SHE) guidelines shall be observed during project implementation. • Structural safety of the adjoining buildings can be observed through building survey carried out before and after the construction.
7	Hinderance to internet and mobile networks due to interference by electric traction	• Mobile and internet networks of residents in the society won't be affected due to OHE traction of RRTS. • It can be appreciated that commuters travelling in DMRC/Railway network are

	line.	able to access internet from inside the train, being in the closer proximity to the OHE.
8.	Risk Factors – Risk during construction due to earthquake and natural calamities/disasters.	• RRTS is a high speed, high-capacity rail-based commuter system being developed by experienced professional and engineers. • Dedicated teams such of General Consultant, Detailed Design Consultant, Team of Project Executing Contractors, their designers and NCRTC team are involved in the design and construction for the designed performance and safety of proposed structures. • Design takes care of all the forces as per codal provisions.
9.	Ignoring the representation from RWA & SCF	• NCRTC is maintaining communication with all the organizations of Sidhartha Extn.
10.	Depletion of green area	• It will be ensured that available green area remains same and there is no depletion of green area. • NCRTC can take up plantation even before execution of project in the Sidhartha Extension, if suggested by residents.
11.	Issue of Health Hazard for more than 100 Senior Citizens and children living in the affected flats	• RRTS will significantly reduce traffic congestion on road due to model shift in favor of public transport through a high-speed environment friendly, safe, secured, rail-based public transport system. • NCRTC will assure that all required health parameters remain within the existing limits and continuous monitoring mechanism will be developed during construction.

With Best Wishes,

17/08/21

(Subodh Kumar)
Chief Project Manager/Delhi
Email: cpm.delhi@ncrtc.in

No. NCRTC/Genl./1/Vol.III **dated : 05-07-2021**

To,

The Siddharth Extension Sr. Citizens' Welfare Forum,
Porta Cabin Near Gate No.3,
Pocket 'C' Siddharth Extension,
New Delhi-110014

(Kind attention : Shri M.M. Gupta)

1. Refer to your email dated 17th June 2021 addressed to MD, NCRTC inter-alia others. Your concern on health and social related issues specially on residents of Siddhartha extension due to implementation of RRTS projects are well appreciated. A brief on RRTS and Jangpura Stabling yard is given below for better appreciation.

   (i) Regional Rapid Transit System (RRTS) is a rail based high speed, high frequency regional transit system connecting regional urban nodes as public transit backbone.

   (ii) As the name suggests, the system is defined by regional character and high speed creating a network of networks, wherein the RRTS is integrated with National Network of Indian Railways and Airport on one hand and with intra-city networks such as city-buses, Metro, IPT etc on the other.

   (iii) Sarai Kale Khan is planned to develop as major station to integrate three RRTS Cooridor namely Delhi – Meerut Corridor, Delhi – Alwar Cooridor and Delhi – Sonipat Cooridor and ISBT.

   (iv) Development of terminal station, stabling yard, office complex and residential complex for RRTS employees at Jangpura are also part of RRTS and connectivity from Sarai Kale Khan station to the Stabling Yard is planned through elevated viaduct which is more than 21 meter height from ground level.

2. The Connectivity to Jangpura from Sarai Kale Khan is also deliberated in length by NCRTC involving expats from engineering point of view, cost optimization and minimum displacement of personals. Development of such projects always attracts social issues and its endeavor of implementing agencies to optimize these in the interest of public for the public.

Contd.......2/-

3. The route through urban area is selected by NCRTC with minimum 5 meter offset from the outer edge of viaduct and structures region considered in infringement zone for acquisition. Initially displacement of residents of 24 (twenty four) flats of Siddhartha extension were envisaged and design is being refined to reduce it further to least possible.

4. Studies on sound eco, noise, air pollutions including vibration effects for such projects are mandatory requirements to maintain the baseline values (i.e. the relevant values on the date before physical commencement of work) during construction and operation. These values are mandatory to be monitored on defined interval. NCRTC is monitoring their issues on monthly basis.

5. In addition to studies, the design of RRTS system is also improvised by NCRTC to reduce such effects. NCRTC is constructing ballastless track, which is creating least eco, noise, vibration pollution in the world and even coaches are designed accordingly.

6. In addition to regular SIA consultant, CRRI has also been engaged by NCRTC to study the issue of noise and vibration pollution. The report is also under finalization and shall be available in the public domain shortly along with EIA report. All the baseline values of various pollution parameters are specified in the EIA report for future references. CRRI has recommended provisions of noise barriers in Siddhartha extension which shall also be complied with in the interest of people.

7. I hope all the queries have been answered regarding first such project of India. NCRTC is at your service and always open to attend further queries in future also.

We are thankful for your kind support to NCRTC in larger interest of public as well as national interest.

(Yogesh Chandra Shrivastava)
Chief Engineer/General

APPENDIX 10: Alternate Alignment Option Study Connecting Line from Sarai Kale Khan RRTS station to Stabling Yard at Jungpura

Table 1: Comparison of Alignment options for connecting line (viaduct) from Sarai Kale Khan Station to Jangpura Stabling Yard

Main Feature	Merits	Demerits	Final Decision	Reason for acceptance/ Rejection
Alignment Option-I				
By passing Siddhartha Extension Colony	Siddharth extension colony is not getting affected.	This Alignment will have following disadvantages/technical issues: 50 m span over Barapulla flyover is having sharp horizontal curve of 145 m. As per SoD the minimum radius of horizontal curve for the depot/stabling yard should not be less than 300m. Therefore, the alignment is technically not feasible. Further, the alignment will have a 122 m span viaduct with 65-degree skew angle at railway crossing. Out of 122 m span, 50 m length is on curve of 150m radius and 72 m length is straight. Due to space constraint, launching and movement of construction machinery and materials, 122 m single span viaduct is not possible. The feasibility of construction of an intermediate pier in the space available between the running tracks is also explored and found not feasible due to (i) OHE traction lines of 25 KV for Delhi Agra main line is a hinderance in mobilization of construction machinery in the intermediate space (ii) Construction will require block periods and shutdowns which will not permitted by railway. This alignment will be costlier due to additional requirement of 101 m span of viaduct on this alignment which can be avoided by choosing option II alignment.	Not recommended	The alignment is costlier, difficult to construct and technically not feasible. Therefore, cannot be selected.

		Parapet of RRTS viaduct is at a close proximity of 3m from G+4 building (near Barapulla Flyover).		
Alignment Option-II				
Inside Siddharth Extension colony affecting 24 no Flats	Geometry of alignment is made smooth.	24 no Flats inside Siddharth extension colony is getting affected. Alignment inside Siddharth extension colony is having horizontal curve of radius 702.25 m. The chances of wear and tear increase with reduction of radius.	Earlier recommended. It has been further improvised for option-III.	The radius of curve is 702.5 m which is more than compared to minimum technical requirement of 300m. 24 Numbers of flats would be affected inside Siddharth Extension which will have higher cost of compensation as well as higher number of displacements. Hence not selected.
Alignment Option-III				
Inside Siddharth Extension colony affecting 8 numbers of Flats	Number of affected flats are reduced to 8 number from 24 numbers. Thus, 16 number affected flats are being saved inside Siddharth Extension. Geometry of alignment is improvised to make it further smooth.	8 numbers of Flats inside Siddharth extension colony is getting affected	**Recommended**	The radius of curve is 1500m which will ease out the vibration and noise. At the same time, it will affect only 8 no. of flats inside Siddharth Extension which will have lower cost of compensation, lesser pollution and lower number of displacements. Hence found most suitable and selected for construction.

Figure 1: Plan Showing Alignment of Siddharth Extension-New Alignment Proposed

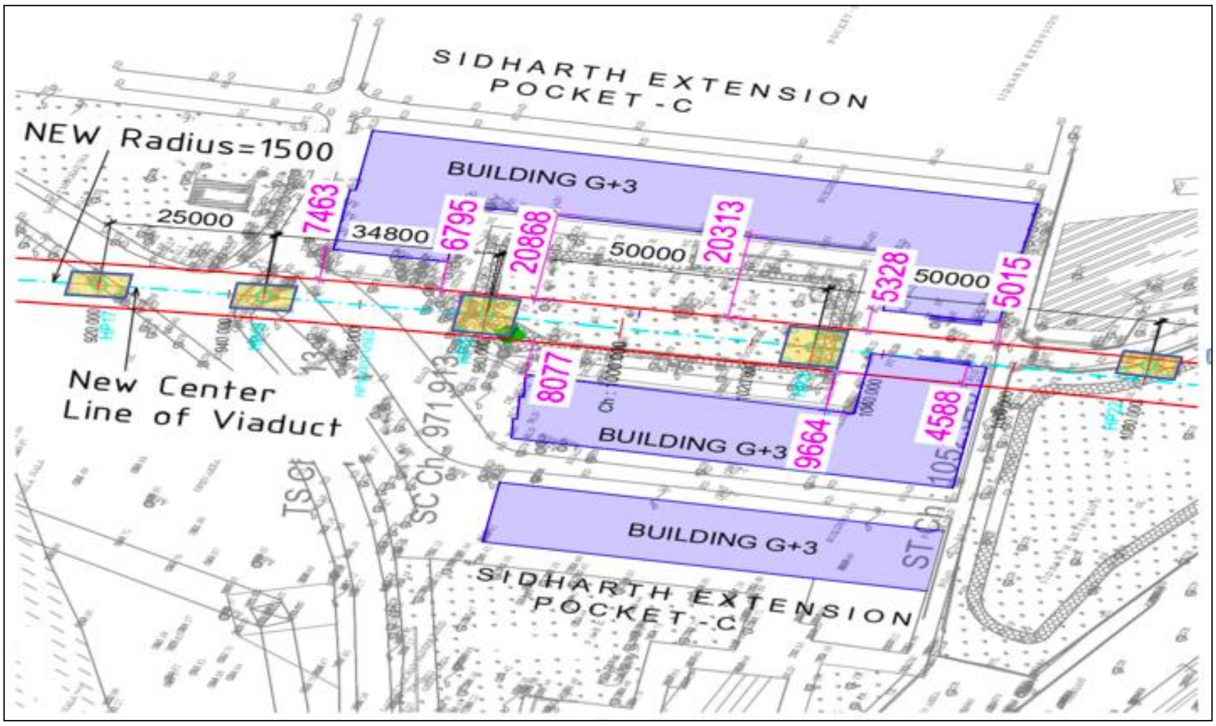


Figure 2: Plan Showing Alignment of Siddharth Extension-Old Alignment

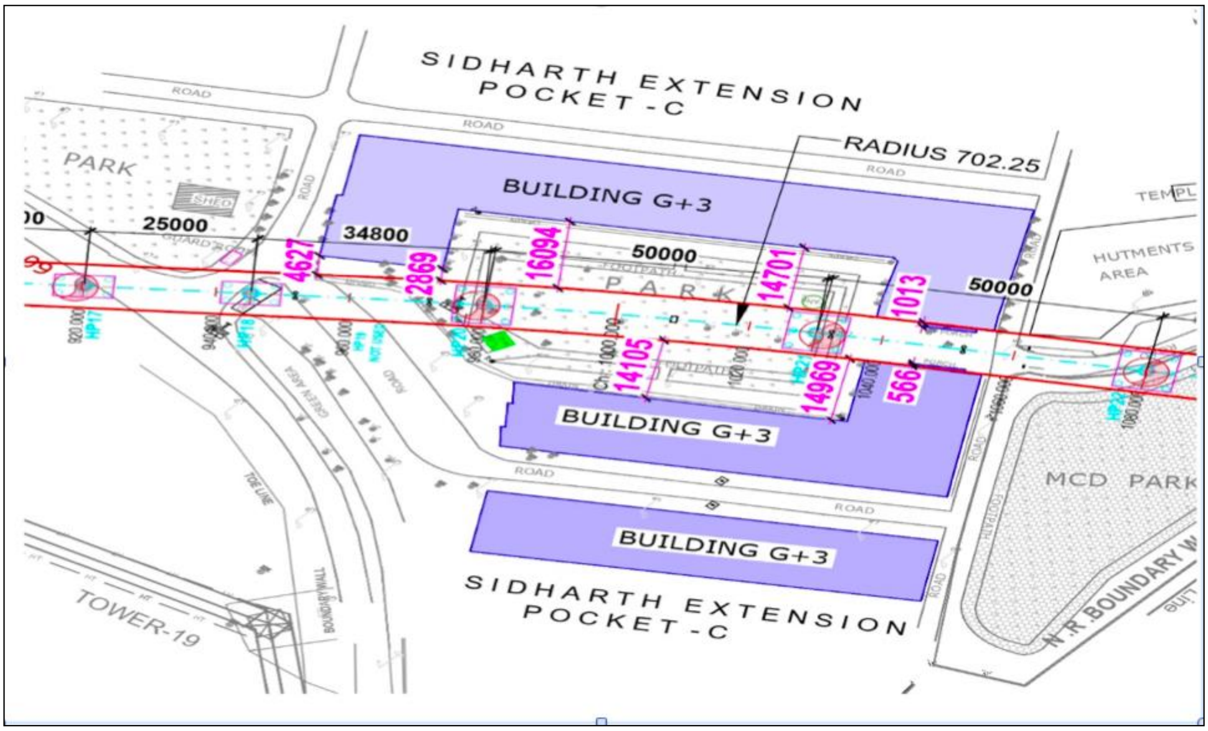
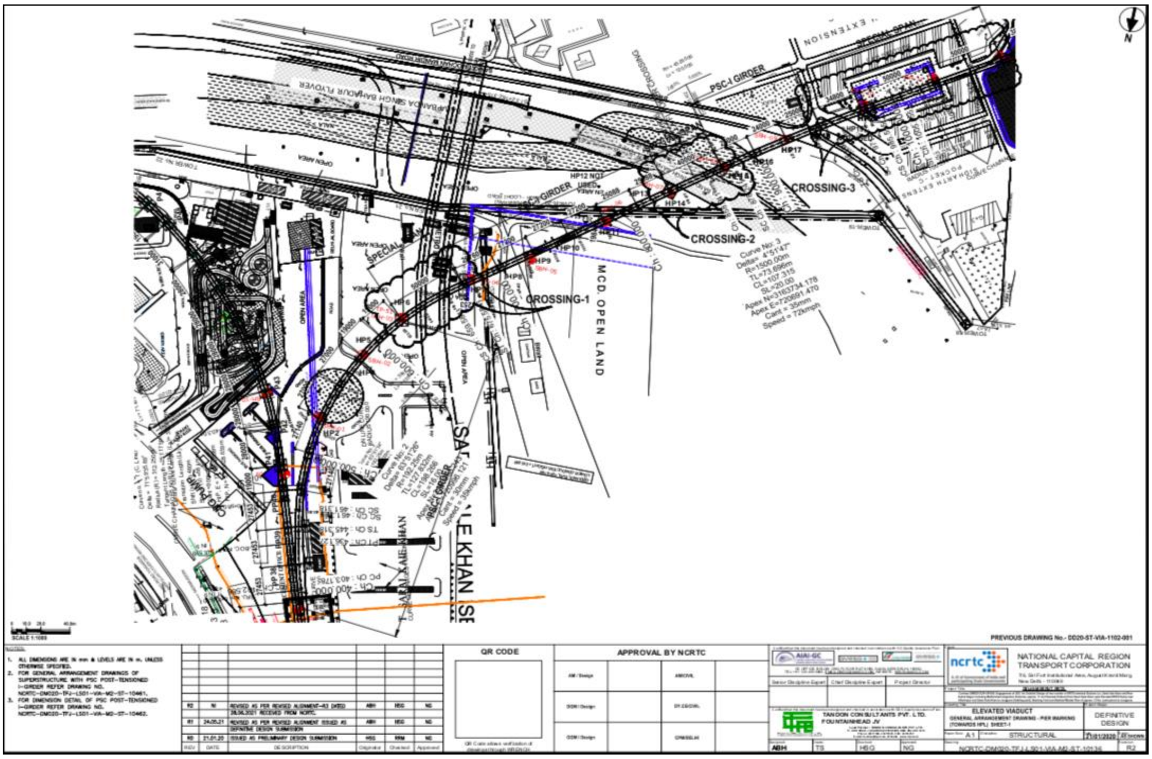
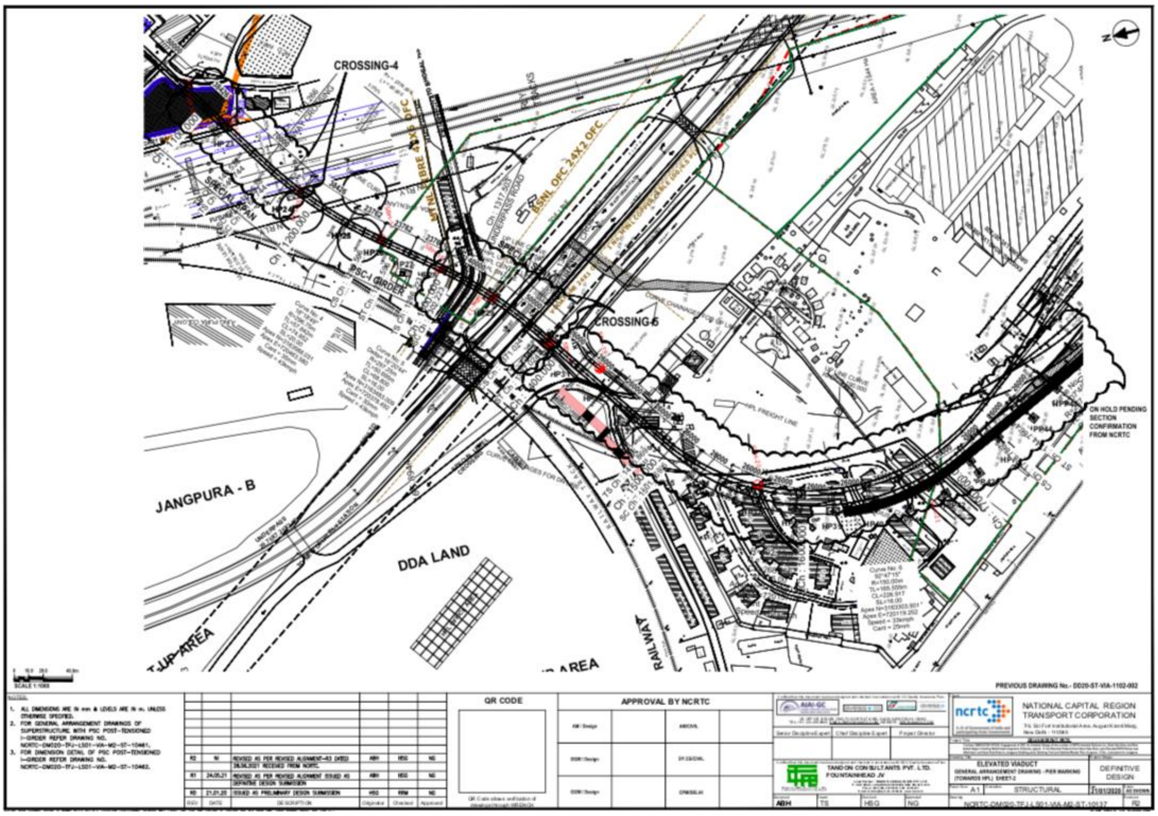


Figure 3: New Alignment Option-III





Minutes of Meeting held on January 6th, 2022 with with ADB, NCRTC, and Siddhartha Extension Senior Citizen's Welfare Forum (SESCWF)

Type of Meeting- Representative of Siddhartha Extension Senior Citizen Forum (SESCWF) Mr. Manmohan Gupta and Mohan Lal Ahuja requested ADB to set a meeting to explain their viewpoints and grievances with relation to the construction of stabling line passing through Siddhartha Extension. Accordingly, a virtual meeting with SESCWF representatives and NCRTC was held on 06 January 2022 to hear the grievances and suggestions for improvement of the local surroundings of the proposed stabling line at Jangpura.

Points Discussed:

SN.	Discussion Points
1.	Mr. Mohan Lal Ahuja appreciated NCRTC and ADB's initiative towards organizing the virtual meeting.
2.	Mr. Ahuja mentioned that NCRTC had not placed any hoarding about the project information in their area. Mr Ahuja also mentioned that no project reports and studies were shared with them. Mr. Ahuja is a senior citizen and has been a resident for 35 years. NCRTC contacted 25 residents, not all. Hoardings were not put at site. SESCWF wasn't aware of this. They were not informed. Mr. Ahuja mentioned that they checked a previous report on ADB website and realized that there are such reports prepared and available for disclosure. He referred their earlier communication with NCRTC and informed that there is a lack of awareness about the project among the residents about the exact route of stabling yard connecting line passing through Siddhartha Extension. In addition, he sought clarification on deciding project-affected persons (PAP) by NCRTC.
3.	Mr. Yogesh Srivastava (NCRTC) mentioned that they had shared respective correspondences on project developments and status in timely manner with the committee. He also mentioned that the latest correspondence was shared on 4th January 2022. He added that NCRTC is conducting studies on a shadow analysis and real estate projection as requested by the Welfare Association on pollution and environment. He informed that the required flats for construction of the Jangpura Stabling Line connection are being purchased through the direct purchase policy of NCRTC. He informed that all these information are already available in written correspondences available with RWA as well as SESCWF and PPT were shown to the all interested persons of the colony. He also agreed to discuss the matter with the competent authority of NCRTC to place hoarding to inform the Siddhartha Extension citizen about the project details and the list of the properties affected due to the construction. He assured that adverse impacts will be mitigated.
4.	Mr. Man Mohan Gupta mentioned that it was all because of the recent correspondence that they realized there were so many studies conducted for the project site, but those were not shared with the committee. Mr. Man Mohan Gupta mentioned that NCRTC hasn't taken the senior residents into consideration. Hoardings have not been put about exactly how many flats are directly affected. He also asked the reason as to why the project should traverse through the society. No survey report had been shared with the complainants, especially. Resettlement Plan dated March 2020 -has not been shared with them. Main concern is transparency and lack of communication with NCRTC. Mr Gupta raised a question as to why a second SIA was conducted?
5.	Mr. Ahuja and MR Gupta both mentioned no reports were proactively shared with them.The contractor of NCRTC, gave a presentation with 4 slides. Senior citizens houses have been marked as red. What was the rationale behind defining 5 meters as the distance for identifying affected households? Mr. Gupta said that due to changes in the connecting line alignment, they do not know which households will be affected, and which ones will not be affected. Mr. Man Mohan Gupta suggested that properties that fall outside the distance of 5m. from the viaduct should also be considered as affected properties
6.	Mr Gupta mentioned that there will be noise pollution for 2-3 years during construction stage. Property prices will gradually increase after 20 years. Senior citizens are already too old to wait for 20 years. Is there any International Standard for defining the 5 meters distance? Is there a guideline? This has not been shared by NCRTC.
7.	Mr. Gupta mentioned that the committee wants to know how NCRTC will compensate the senior citizens. He said under the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act 2013, they are considered affected persons and should therefore be compensated as per the Act.
8.	ADB informed SESCWF that the design of the Jangpura Stabling line was finalized after the publication of the approved Resettlement Plan (RP). NCRTC has taken up the preparation of supplementary SIA and RP to fulfil the ADB requirement to alleviate concerns of the community affecting directly and indirectly from the construction of the Jangpura Stabling line connection.
9.	The ADB team explained that it has stringent requirements on consultation and information disclosure, and that it is working with NCRTC to meet these requirements. It also informed that the ADB Safeguard Policy Statement, which applies to the project, requires NCRTC to assess, mitigate, and or compensate adverse impacts so that affected persons are not worse off due to the project. It updated that the Resettlement Plan for the stabling yard and connecting line was submitted by NCRTC on 28 December 2021, and is under compliance review.
10.	Mr. Yogesh informed that they have addressed their all concerns through various correspondences and in case, RWA feels that some of their issues need more clarification, they may nominate their representative to discuss the same. It is again and again being reiterated by NCRTC to address all their concerns related to sound, vibration etc except financial aid. NCRTC has also written to Resident Welfare Association of Siddhartha Extension to nominate an authorized representative to represent the colony to discuss rehabilitation plan for the colony after the construction and other issues for successful implementation of the project. It was agreed that a representative/ committee shall be nominated by the RWA to discuss the issues with NCRTC and outcome shall be shared with ADB .

11.	ADB Project Officer informed SESCWF representatives that their issues would be taken up for discussion with NCRTC management.

Appendix I List of Participants

Names of Participants	Organization
Mr. Yogesh Srivastava	Chief Engineer (General), NCRTC
Mr. Mohan Lal Ahuja	SESCWF member
Mr. Man Mohan Gupta	President, SESCWF
Mr. Sharad Saxena	Principal Transport Specialist-ADB
Mr. Kaushal. K Sahu	Senior Project Officer-ADB
Ms. Maria Laureen Estil. Laurito	Social Development Specialist-ADB
Ms. Suvalaxmi Sen	Environment Specialist-ADB

4037

581

Delhi Metro Rail Corporation Ltd.

No. DMRC/Land/15/Policy/NOC/04/533 14.09.2015

Subject : Guidelines for issue of N.O.C. for the properties lying along/adjoining the Delhi MRTS corridors – Phase III/IV

Guidelines for issue of NOC for the properties falling on or lying adjoining Delhi MRTS corridors of Phase III were issued vide this office note of even no.62 dated 12.05.2011 and even no.224 dated 7th June, 2012. Ministry of Urban Development, Govt. of India has desired that NOC cases should be disposed by DMRC within 7 days of receipt of proposal from local bodies.

CE/G is the nodal officer for dealing NOC cases. He will seek comments from the respective field units.

To streamline the procedure following guidelines shall be followed:-

1.1 **Elevated & Surface corridor**

1.1.1 No NOC be issued for construction activities within the land boundaries of proposed boundaries of elevated or surface corridor, stations, depots, other service buildings, ancillary structures, parking areas.

1.1.2 To provide flexibility at the time of construction, no NOC be issued for new construction up to 20 m on both sides of alignment or all sides of metro stations, depots or other structures, till the detailed alignment drawings are finalised and there is no scope for change in the alignment or plan of station, depots or other structures.

1.1.3 If any property falls partly inside and partly outside the aforesaid limit (20 metres beyond the proposed metro structures), such properties can be cleared only for the portion falling outside the limit of 20 m of proposed metro structures.

1.1.4 Once the alignment is finalised and there is no scope of change in alignment, NOC be issued in case proposed construction is away by 5 m or more from the edge of the metro alignment/structure for safety reasons.

1.2 **Underground Metro corridor**

1.2.1 No NOC for construction activity be issued within the land boundaries of proposed underground stations unless such provision has been made in design.

1.2.2 To provide flexibility at the time of construction, no NOC be issued for new construction within 20 m from the edge of the tunnel on both sides or land boundaries of the Metro station or other structures on all sides till the construction activity of Metro corridor/station is completed.

1.2.3 Once the construction of tunnel or underground structure is completed, NOC be issued if proposed construction is away by 5 m or more from the edge of the tunnel or land boundaries of structures.

...2

1.2.4 For issuing NOC to the building plan for additional floors due to increased FAR within 5 metre of the outer edge of tunnel, in principle approval shall be conveyed as per following guidelines:-

Sl. No.	Tunnel depth (in m) [Soil fill above tunnel crown]	No. of storeies/basements allowed (Over and above existing construction or vacant plot)
1	7 m	Additional 1 storey may be allowed. No basement is allowed.
2	13 m	Additional 2 stories may be allowed. Only one basement of 3.5 m may be allowed.
3	18 m	Additional 4 stories may be allowed. Total two basements of 3.5 m each may be allowed.

However, the final approval shall be given after scrutiny of detailed design by ED/Tech. on case to case basis.

1.3 Intranet Link

An Intranet Link has been developed for uploading the case by CE/G unit. Mail and SMS alert will be sent to concerned field unit (HOD). Comments of field unit are to be uploaded on the same link within 3 working days including comments of design wing wherever considered necessary.

These guidelines are issued with the approval of MD and in supersession of previous guidelines.

PM/6A
16/9/15

DMRC LTD.
Dy. No. 275
Dt. 15.9.15

14/9/15

(Atul Gadgil)
Chief Engineer/Gen.

4/6

All CPMs (CPMs/1 to 10), ED/Tech.

ED/Civil, CGM/Civil, GM/Consultancy & CE/Plg.

CC

DP, DW, DO & DBD for information please

OSD to MD for kind information of MD

PM/6A, 6B, 6C

PA - File in NOC file
- To circulate to all XGM/AEN for compliance of NOC cases

No. NCRTC/DM/ALLIGN-NOTIFI/80 New Delhi, dated 04-09-2020

Sub:- Revised Guidelines for issue of N.O.C. for the properties lying along/adjoining Delhi – Ghaziabad – Meerut RRTS corridor.

In supersession of the Guidelines issued earlier on 28-01-2020, for issue of NOC for the properties falling on or lying adjoining Delhi–Ghaziabad–Meerut RRTS corridor, following revised guidelines are issued to deal with NOC proposal on its receipt from local bodies.

CE/G is the nodal officer for dealing NOC cases.

To streamline the procedure following guidelines shall be followed : -

1.1 <u>Elevated & Surface Corridor</u>

1.1.1 In terms of the provision laid down in Section 21 under Metro Railways (Constructions of Works) Act 1978, the regulation for the construction of building or any development above the RRTS alignment or on any land within 20 meter of either side of RRTS alignment for facilitating construction of RRTS Corridor/ensuring safety of RRTS Corridor, is required to be implemented.

1.1.2 No NOC be issued for construction activities within and above the land boundaries of proposed boundaries of elevated or surface corridor, stations, depots, other service buildings, ancillary structures, parking areas.

1.1.3 To provide flexibility at the time of construction, no NOC be issued for new construction up to 20 meter on both sides of alignment or all sides of RRTS stations, depots or other structures, till the detailed alignment drawing are finalized and there is no scope for change in the alignment or plan of station, depots or other structures.

1.1.4 If any property falls partly inside and partly outside the aforesaid limit (20 meters beyond the proposed RRTS structures), such properties can be cleared only for the portion falling outside the limit of 20 meter of proposed RRTS structures.

4/9/2020

Contd.....2/-

1.1.5 Once the alignment is finalized and there is no scope of change in alignment, NOC be issued in case proposed construction is away by 5 meter or more from the edge of the RRTS alignment/structure for safety reasons.

1.2 Underground RRTS Corridor

1.2.1 No NOC for construction activity be issued within the land boundaries of proposed underground stations unless such provisions has been made in design.

1.2.2 To provide flexibility at the time of construction, no NOC be issued for New construction within 20 meter from the edge of the tunnel on both sides or land boundaries of the RRTS station or other structures on all sides till the construction activity of RRTS corridor/station is completed.

1.2.3 Once the construction of tunnel or underground structure is completed, NOC be issued if proposed construction is away by 5 meter or more from the edge of the tunnel or land boundaries of structures.

1.2.4 Separate guidelines will be issued for construction within 5 meter on either side of tunnel.

1.3 Other

1.3.1 (i) As per approved DCR rules for RRTS Corridor, no compound wall/fencing shall be permitted on boundary of plot fronting the road and 50% of marginal distance subject to minimum 3 meter (shall be kept accessible) and shall be used as footpath for pedestrian. However, it shall be permissible for the applicant to construct/ erect fencing on the boundary after leaving space for pedestrians.

(ii) No projection/construction shall be allowed within 6 mtr. from road (Right of Way) in setback except steps at ground level.

1.3.2 The applicant seeking NOC shall have to submit structural safety certificate from the Structural Engineer.

1.3.3 The NOC issued shall be valid for a period of three years from the date of issue and shall need to be renewed/ revalidated till the completion of construction of RRTS project or till the occupancy certificate of the building is issued whichever is earlier.

1.3.4 The NOC issued shall be deemed cancelled, if actual construction at the site is in variation to the plan approved by NCRTC.

1.3.5 If the application wants to use tower crane for the proposed development on the plot, then the working arm of the crane should not come within 5 meter from RRTS Via-duct and also the working arm of the crane should not come over the RRTS station.

1.3.6 This NOC shall be deemed to be cancelled immediately if the documents submitted by the Architect/Applicant are found to be false.

4/9/2020

Contd……3/-

1.4 **Competent Authority to approve NOC in NCRTC**

1.4.1 ED/Design is the final competent authority in respect of issuing NOC to the building plan for additional floors due to increased FAR within 5 meters of the outer edge of tunnel.

1.4.2 CE/G will be competent authority to approve all other cases except those indicated in para 1.4.1 above.

These guidelines are issued with the approval of MD.

4/9/2020

(Jayesh Kumar)
Chief Engineer (General)

To

Chief Project Managers (CPMs)/Delhi, GZB, MDNR & Meerut

Copy to ;

1. DP, DF, DRS & DS /NCRTC for kind information please
2. All the HoDs and Dy.HoDs, NCRTC, for kind information and necessary action please
3. GGM/IT for uploading on website of NCRTC and intranet.
4. OSD to MD for kind information of MD.

Delhi-Meerut RRTS – Stabling Yard Alignment at Pocket – C Siddharth Extension

Shadow & Wind Analysis Report

Prepared by: GreenTree Global

Date: 15th January 2022

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

Intent

This report covers the shadow and wind analysis of the Delhi-Meerut RRTS – Stabling Yard Alignment at Pocket – C Siddharth Extension with respect to the received information from the NCRTC team.

Acknowledgement

GreenTree Building Energy Pvt Ltd express it's gratitude to NCRTC for giving us this opportunity to do the Shadow Analysis for the RRTS viaduct (Delhi to Meerut) Stabling Yard Alignment at Pocket – C Siddharth Extension. GreenTree appreciates the active support from the NCRTC team.

GreenTree would also take this opportunity to thank the NCRTC staff for their cooperation in helping, understand and gather information of various inputs.

- Mr. Anurag Bajpai (Green Buildings Expert)
- Mr. Dhruv Jain (Process Expert)
- Mr. Jeyaraj Kalirajan (Energy Associate)
- Mr. Devanand. K. (Energy Analyst)

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

Executive Summary

The shadow and wind analysis has been evaluated for NCRTC (Delhi-Meerut RRTS – Stabling Yard Alignment at Pocket – C Siddharth Extension) located in New Delhi. The project team has gone through the drawings, orientation and has prepared the Shadow and wind analysis report.

Project Name	Delhi-Meerut RRTS – Stabling Yard Alignment at Pocket – C Siddharth Extension
Project Type	Elevated RRTS Station
Location	New Delhi
Latitude Longitude	28°34'52.3"N 77°15'19.3"E
Climate	Composite

GreenTree Building Energy Pvt. Ltd. DELHI NCR

Content

Table

GreenTree Building Energy Pvt. Ltd. DELHI NCR

Figures

GreenTree Building Energy Pvt. Ltd. DELHI NCR

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

GreenTree Building Energy Pvt. Ltd.
DELHI
NCR

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

1.0 OBJECTIVE

The prime intent of the report is to provide the effect of shadow & wind caused by the Stabling Yard alignment of Delhi Meerut RRTS Viaduct in the surrounding buildings near Siddharth Extension Pocket – C (Between Sarai Kale Khan Station and Stabling Yard).

The study has been carried out by comparing the base case and design case. The base case involves the analyzing the shadow of Buildings without RRTS Viaduct. The design case involves the Building with the proposed RRTS Viaduct and analyzing the shadow caused by the RRTS Viaduct in the surrounding buildings.

The below mentioned table represents the objectives and analysis performed:

Sr. No.	Description
1	Shadow analysis in the present scenario (Without RRTS Viaduct passing) Shadow analysis in the future scenario (With RRTS Viaduct passing)
2	Review the project drawings and design basis report and evaluate the sun path throughout the year
3	Calculation of Effective shadow range in the surrounding areas of RRTS Viaduct passing through pocket – C, Siddharth Extension for the entire period of Sunrays in a day at six months at a time interval of 15 minutes
4	Analyzing the shadow depth and orientation for six months including Summer Solstice, Winter Solstice, Autumn, Spring Equinox positions, January and February.
5	Wind analysis in the present scenario (Without RRTS Viaduct passing) Wind analysis in the future scenario (With RRTS Viaduct passing)

The first step is to create the Building 3D model in the Ecotect software in reference to the received drawings like plans & sections and by the site visit done.

The next step is to create the RRTS Viaduct in reference to the received drawings.

In reference to the drawings and Google Earth software, the direction of North has been provided in the model.

On the 3D model, the sun-path analysis has been done to understand the effect of shadow in respect to the orientation.

The shadow range has been analyzed for six months as mentioned below:

GreenTree Building Energy Pvt. Ltd. DELHI NCR

TABLE 1: ANALYSIS MONTHS

Seasons	Date & Month
Spring Equinox	21st March
Summer Solstice	21st June
Autumn Equinox	21st September
Winter Solstice	21st December.
January	21st January.
February	21st February.

Please find the Google Image location of the site:

FIGURE 1: GOOGLE EARTH IMAGE SHOWING THE LOCATION OF SITE

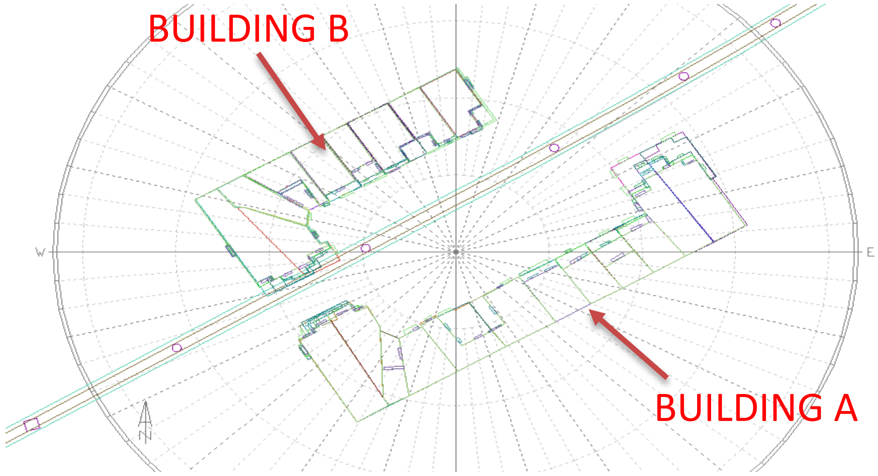


FIGURE 2: PLAN VIEW OF THE BUILDINGS & VIADUCT

2.0 Shadow analysis

2.1 Methodology

The shadow analysis is done by computerized software. The analysis is done by creating a 3D model in “Ecotect” by considering the buildings & viaduct along with the columns in reference to the received plans & sections. The shadows at different time & date were analysed in respect to the proposed viaduct and buildings.

Autodesk Ecotect Analysis is an environmental analysis tool that allows designer to simulate building performance from the earliest stages of conceptual design. It combines analysis functions with an interactive display that presents analytical results directly within the context of the building model.

ECOTECT is a complete building design and environmental analysis tool that covers the full range of simulation and analysis functions required to truly understand how a building design will operate and perform. It finally allows designers to work easily in 3D and apply all the tools necessary for an energy efficient and sustainable future. The following are some of the analysis performed using Ecotect Software:

- Solar Analysis
- Sun and Shadow Analysis
- Daylighting and Lighting
- Thermal performance
- Insolation Analysis
- Acoustic Analysis
- Weather data visualization

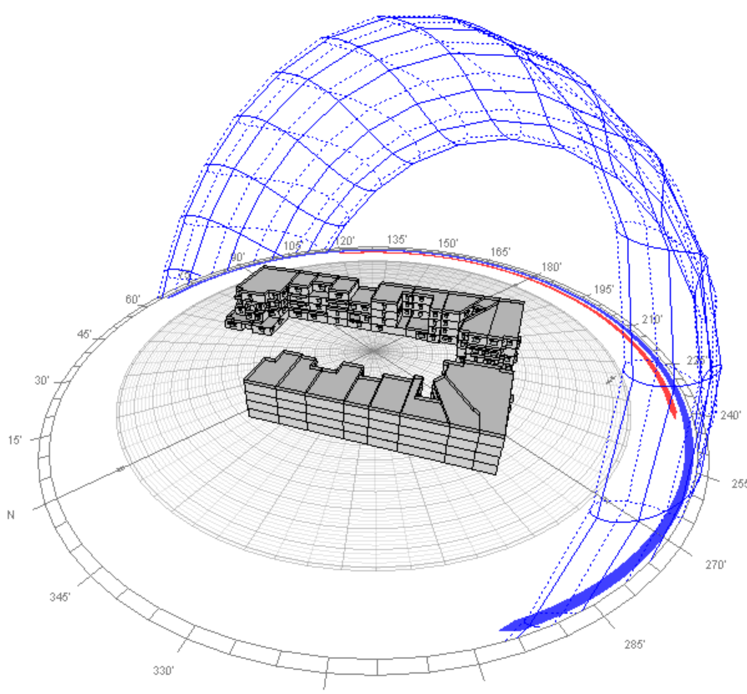


Figure 3: Annual Sun-path

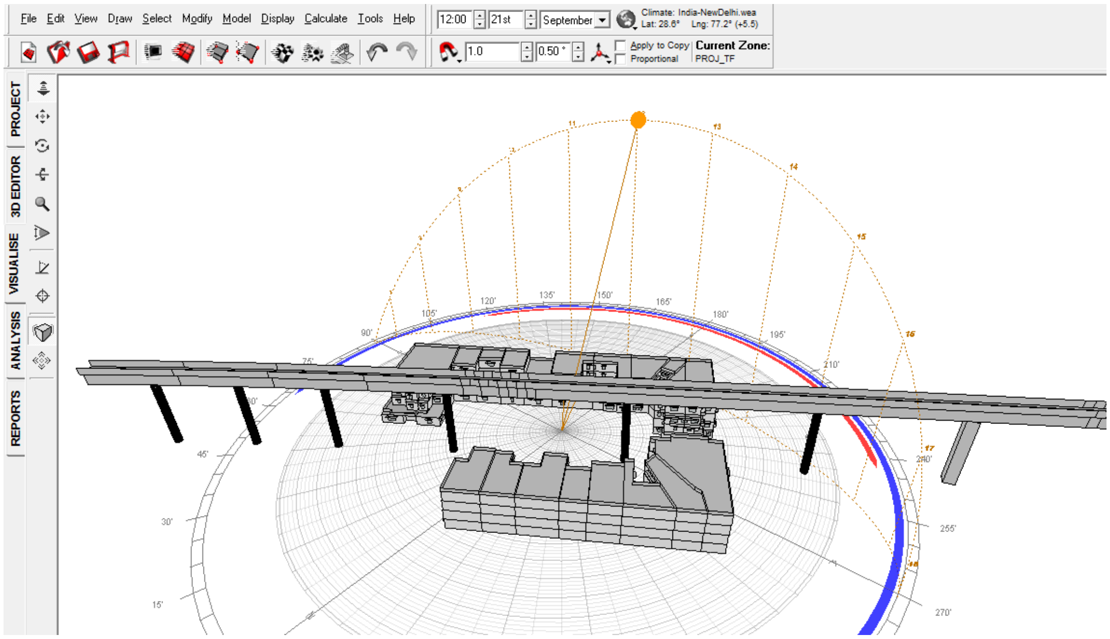


FIGURE 4: DAILY SUN-PATH

The above image indicates the daily sun path analysis of the proposed site. The interface shows the buildings & viaduct modeled in the Ecotect for the analysis. The above image also provides the details of the time, date & month considered during the analysis.

The yellow dotted line indicates the daily sun path for the mentioned date and the arrow indicates the position of sun at the given time and date.

Further we have used the New Delhi weather file for the analysis as the proposed location is in Siddharth Extension Pocket – C, New Delhi.

Equinox is defined as the days when the Sun is exactly above the Equator, which makes day and night of equal length and it happens twice in a year as Spring and Autumn Equinox.

Solstice is defined as the days where the Sun's path in the sky is the farthest north or south from the Equator. In Summer Solstice, the day is longer than the night and vice versa in Winter Solstice.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

2.2 3D Views – Base Case & Design Case

Below 3D models are the general representation of the building for the purpose of Shadow analysis due to the viaduct inclusion/ construction.

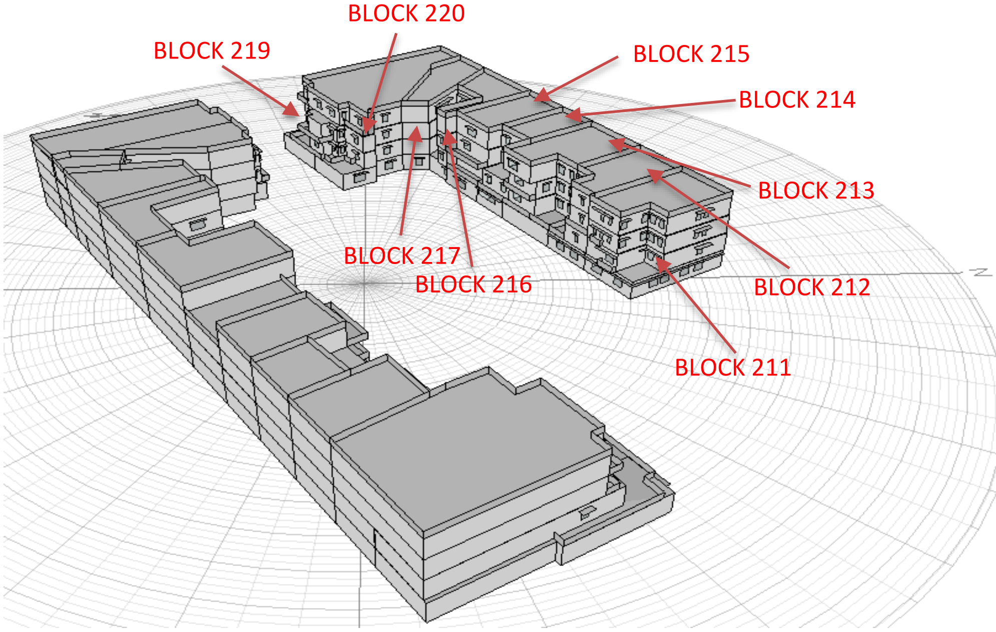


Figure 5: 3D View – Base Case

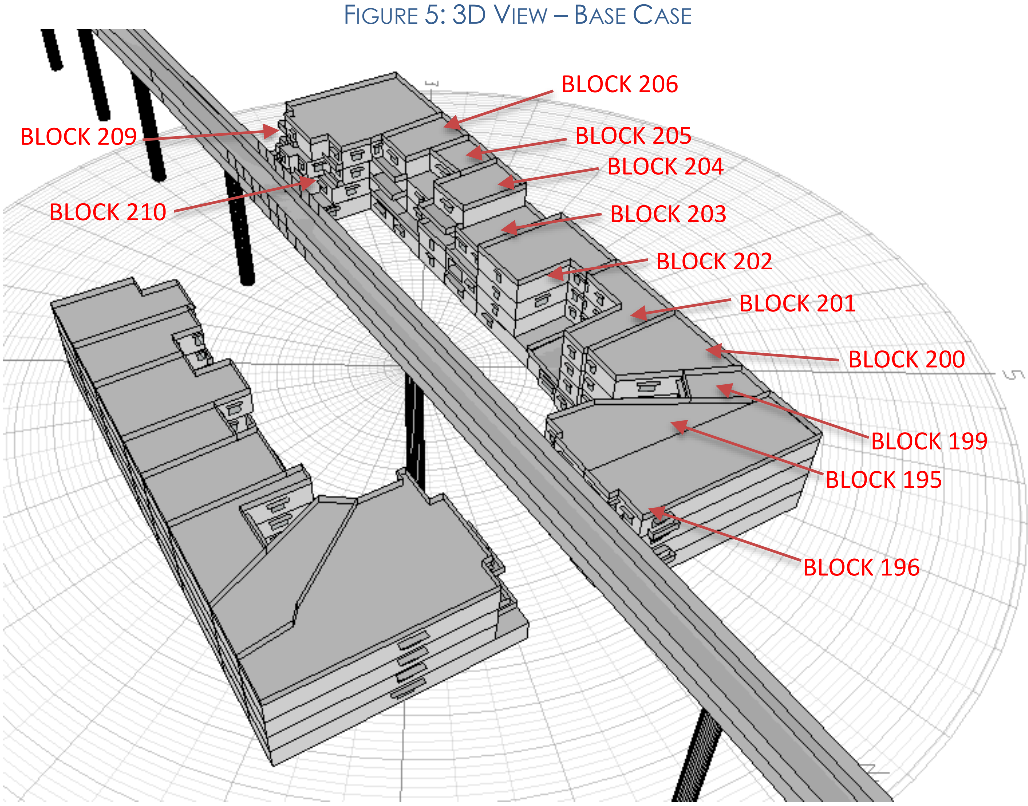


Figure 6: 3D View – Design Case

GreenTree Building Energy Pvt. Ltd. DELHI NCR

2.3 Shadow Analysis 1 – Winter Morning Time (8AM – 10AM)

During Morning hours of winter season, the occupant feels comfort to have maximum sunlight as possible. But as per the analysis it is observed that “building B” is shaded most of the time by “building A” itself, which is the nearby existing building. Therefore by analyzing the shadow impact of viaduct in the Winter Months (i.e. November to February), the proposed viaduct is not casting any additional shadow to the façade of the surrounding buildings. Thereby no obstruction to the morning sun during winter season and thus does not affect the health and well-being to the surrounding buildings.

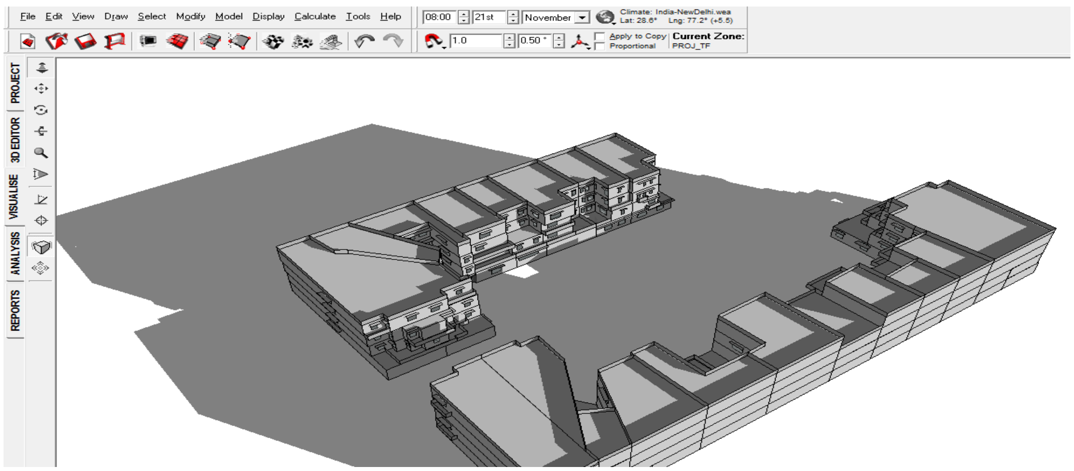


Figure 7: Shadow Range on 21st November 8 AM without viaduct

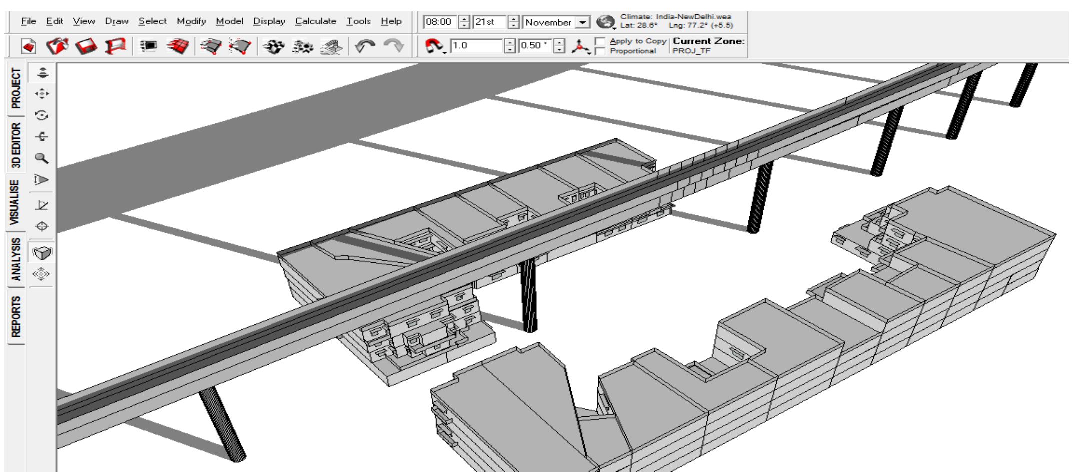


Figure 8: Shadow Range on 21st November 8 AM with viaduct

Figure 7 represents shadow caused by the Buildings. On the basis of the above image, the building A is casting shadow on the ground floors of the Building B. Figure 8 represents the shadow caused to the building by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is not casting any shadow on the façade, thereby not obstructing the morning sunlight falling on the façade of the buildings at 21st November 8 AM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

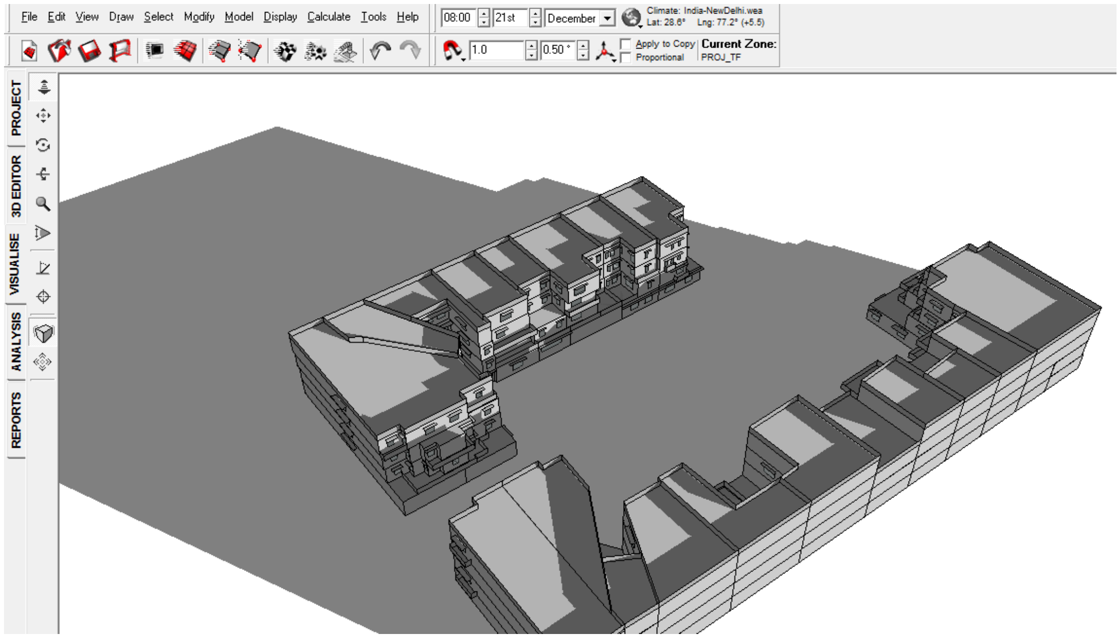


FIGURE 9: SHADOW RANGE ON 21ST DECEMBER 8 AM WITHOUT VIADUCT

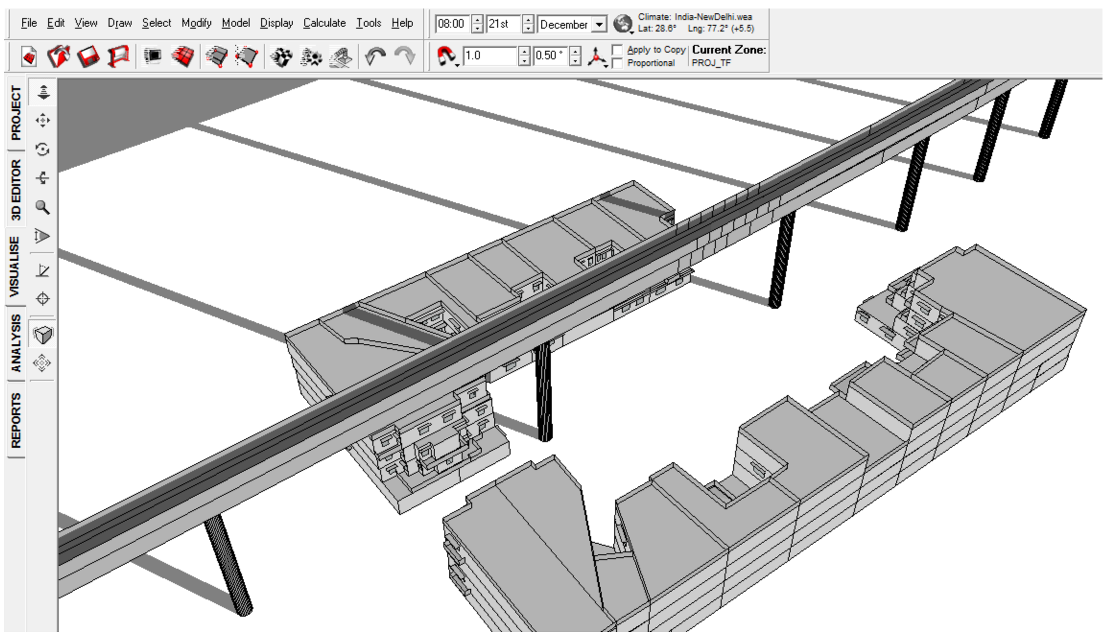


FIGURE 10: SHADOW RANGE ON 21ST DECEMBER 8 AM WITH VIADUCT

FIGURE 9 represents shadow caused by the Buildings. On the basis of the above image, the building A is casting shadow on the ground & first floors of the Building B. FIGURE 10 represents the shadow caused to the building by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is not casting any shadow on the façade, thereby not obstructing the morning sunlight falling on the façade of the buildings at 21st December 8 AM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

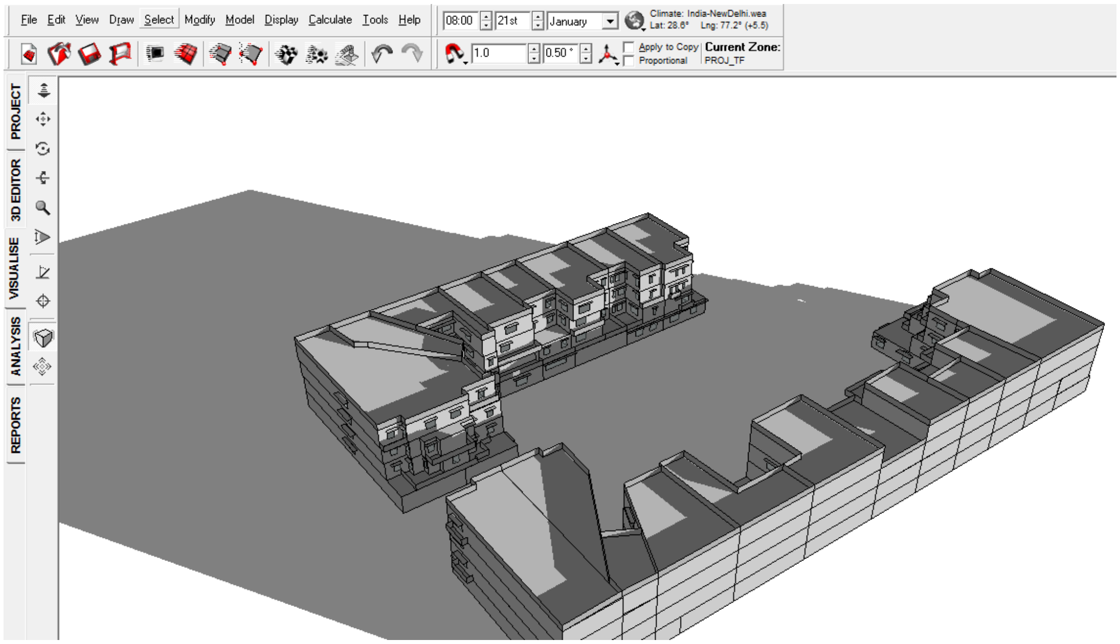


FIGURE 11: SHADOW RANGE ON 21ST JANUARY 8 AM WITHOUT VIADUCT

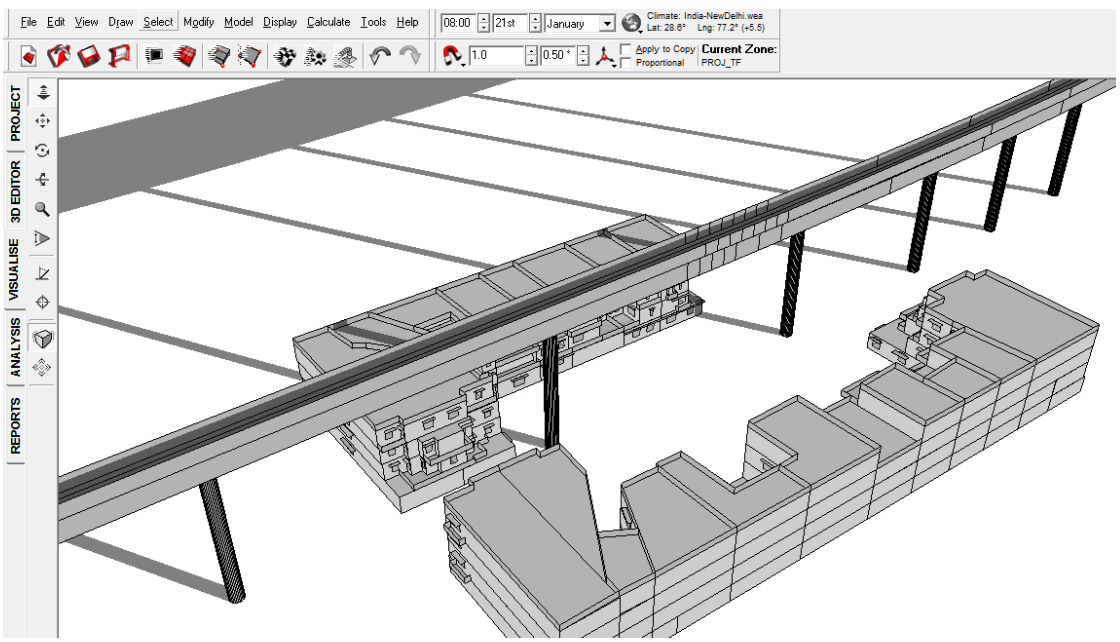


FIGURE 12: SHADOW RANGE ON 21ST JANUARY 8 AM WITH VIADUCT

FIGURE 11 represents shadow caused by the Buildings. On the basis of the above image, the building A is casting shadow on the ground & first floors of the Building B. FIGURE 12 represents the shadow caused to the building by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is not casting any shadow on the façade, thereby not obstructing the morning sunlight falling on the façade of the buildings at 21st January 8 AM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

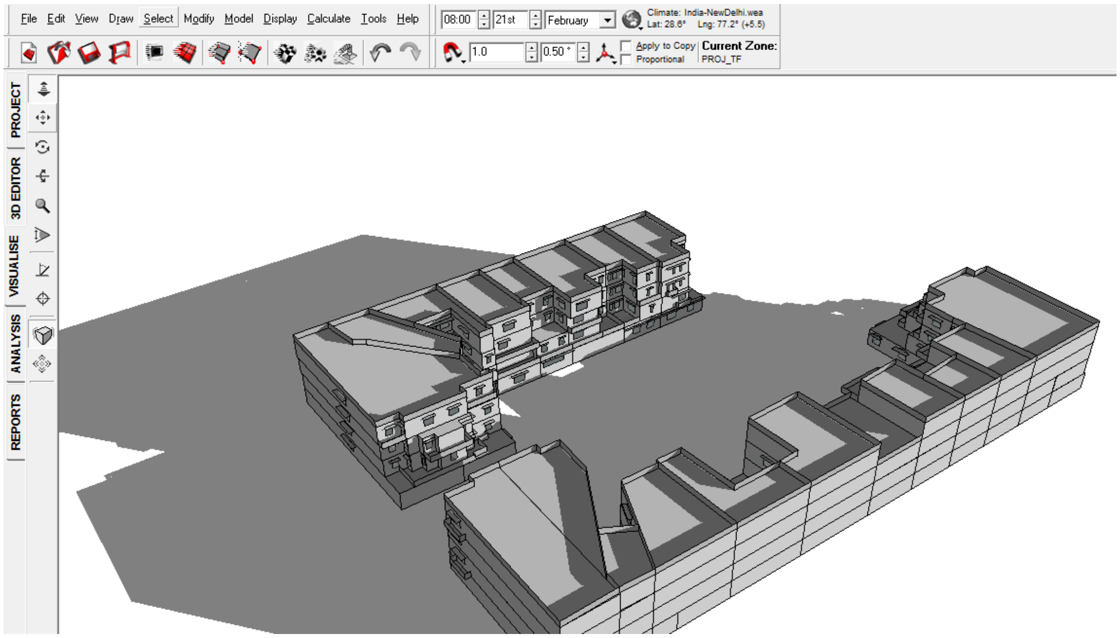


FIGURE 13: SHADOW RANGE ON 21ST FEBRUARY 8 AM WITHOUT VIADUCT

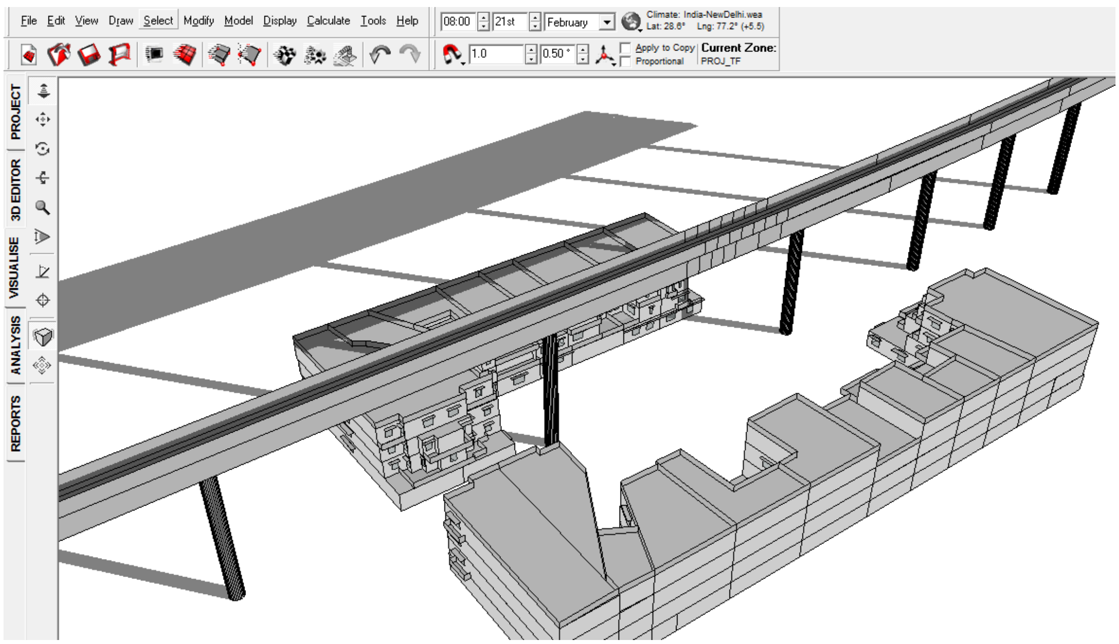


FIGURE 14: SHADOW RANGE ON 21ST FEBRUARY 8 AM WITH VIADUCT

FIGURE 13 represents shadow caused by the Buildings. On the basis of the above images, the building A is casting shadow on the ground floors of the Building B. FIGURE 14 represents the shadow caused to the building by the proposed RRTS Viaduct. On the basis of the above images, the Viaduct is not casting any shadow on the façade, thereby not obstructing the morning sunlight falling on the façade of the buildings at 21st February 8 AM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

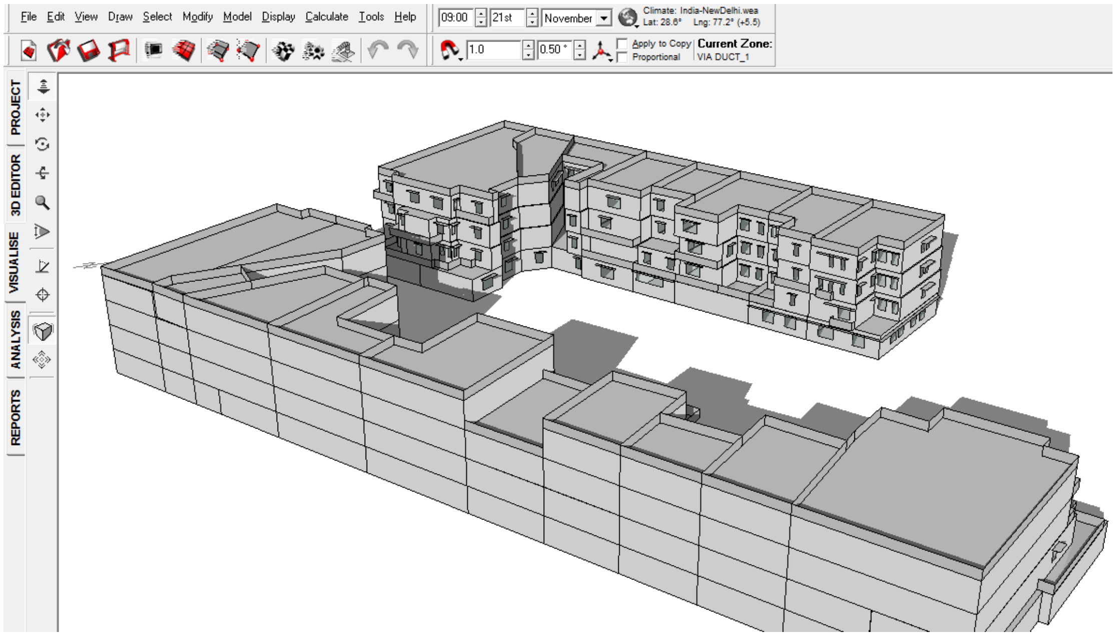


FIGURE 15: SHADOW RANGE ON 21ST NOVEMBER 9 AM WITHOUT VIADUCT

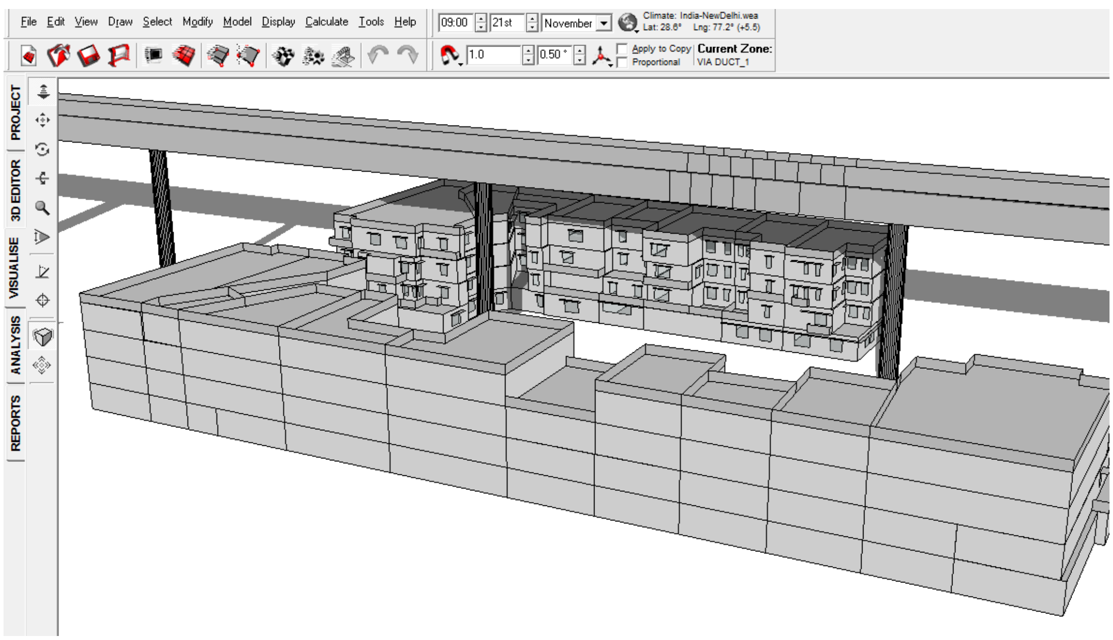


FIGURE 16: SHADOW RANGE ON 21ST NOVEMBER 9 AM WITH VIADUCT

FIGURE 15 represents shadow caused by the Buildings. On the basis of the above image, the building A is casting shadow on the ground & first floors of the Blocks – 219 & 220. FIGURE 16 represents the shadow caused to the building by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the Terrace of the Building – B, thereby not obstructing the morning sunlight falling on the façade of the buildings at 21st November 9 AM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

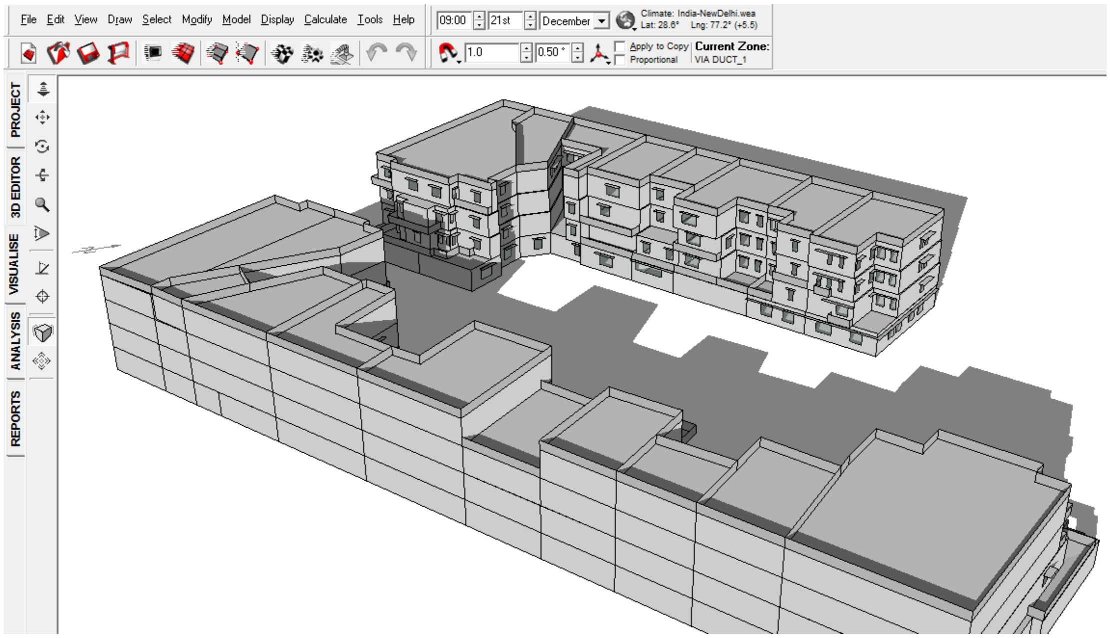


FIGURE 17: SHADOW RANGE ON 21ST DECEMBER 9 AM WITHOUT VIADUCT

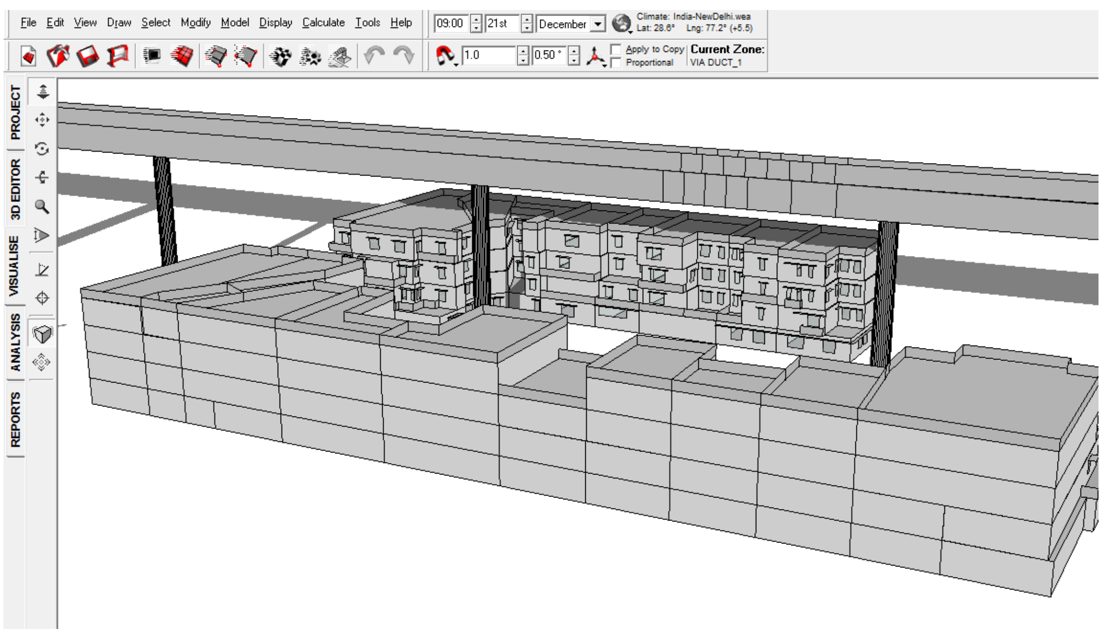


FIGURE 18: SHADOW RANGE ON 21ST DECEMBER 9 AM WITH VIADUCT

FIGURE 17 represents shadow caused by the Buildings. On the basis of the above image, the building A is casting shadow on the ground & first floors of the Blocks – 219 & 220. FIGURE 18 represents the shadow caused to the building by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the Terrace of the Buildings – B, thereby not obstructing to the morning sunlight falling on the façade of the buildings at 21st December 9 AM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

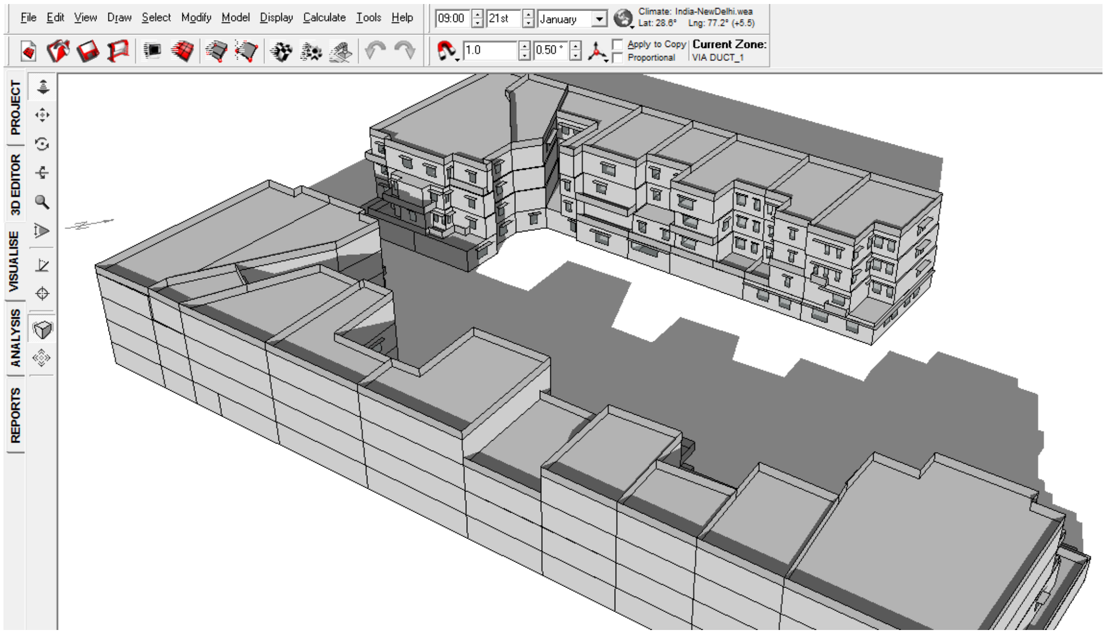


FIGURE 19: SHADOW RANGE ON 21ST JANUARY 9 AM WITHOUT VIADUCT

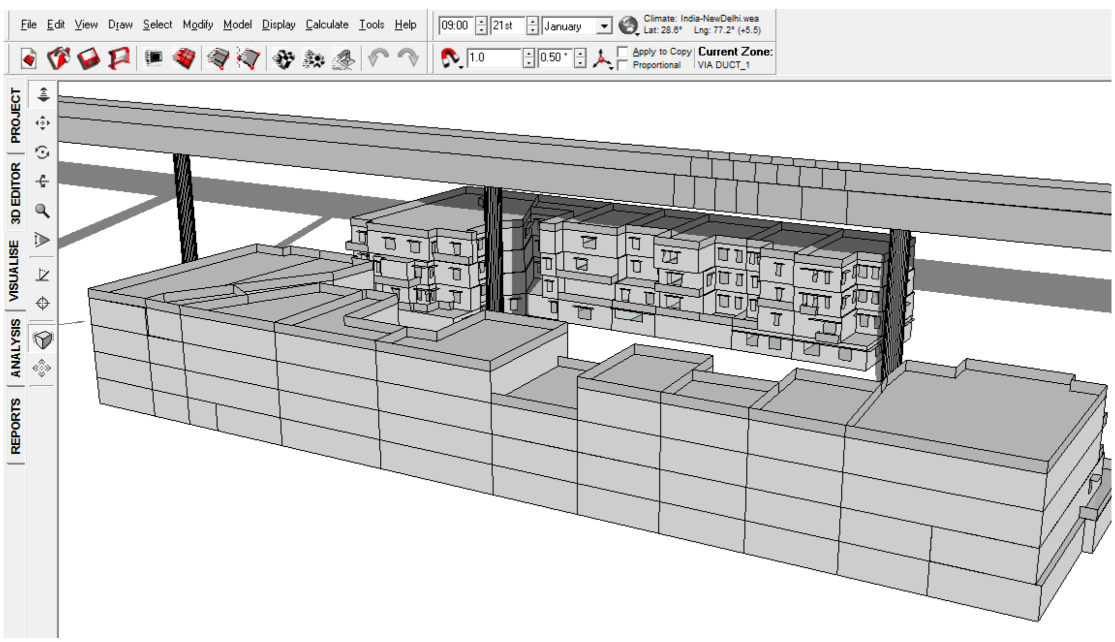


FIGURE 20: SHADOW RANGE ON 21ST JANUARY 9 AM WITH VIADUCT

FIGURE 19 represents shadow caused by the Buildings. On the basis of the above image, the building A is casting shadow on the ground & first floors of the Blocks – 219 & 220. FIGURE 20 represents the shadow caused to the building by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the Terrace of the Buildings – B, thereby not obstructing the morning sunlight falling on the façade of the buildings at 21st January 9 AM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

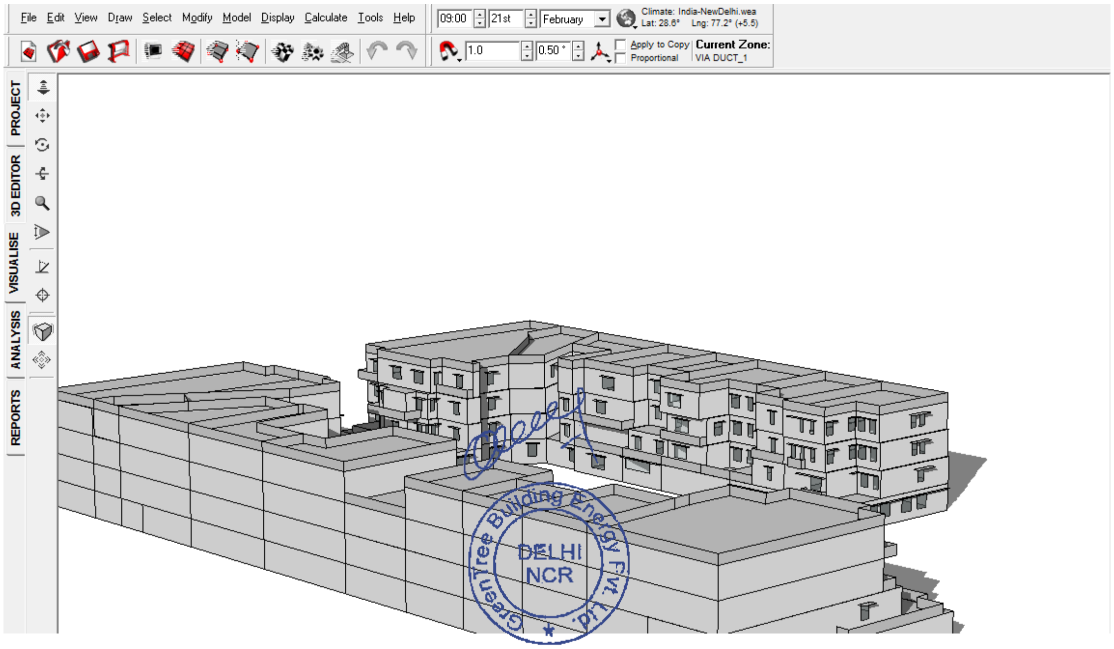


FIGURE 21: SHADOW RANGE ON 21ST FEBRUARY 9 AM WITHOUT VIADUCT

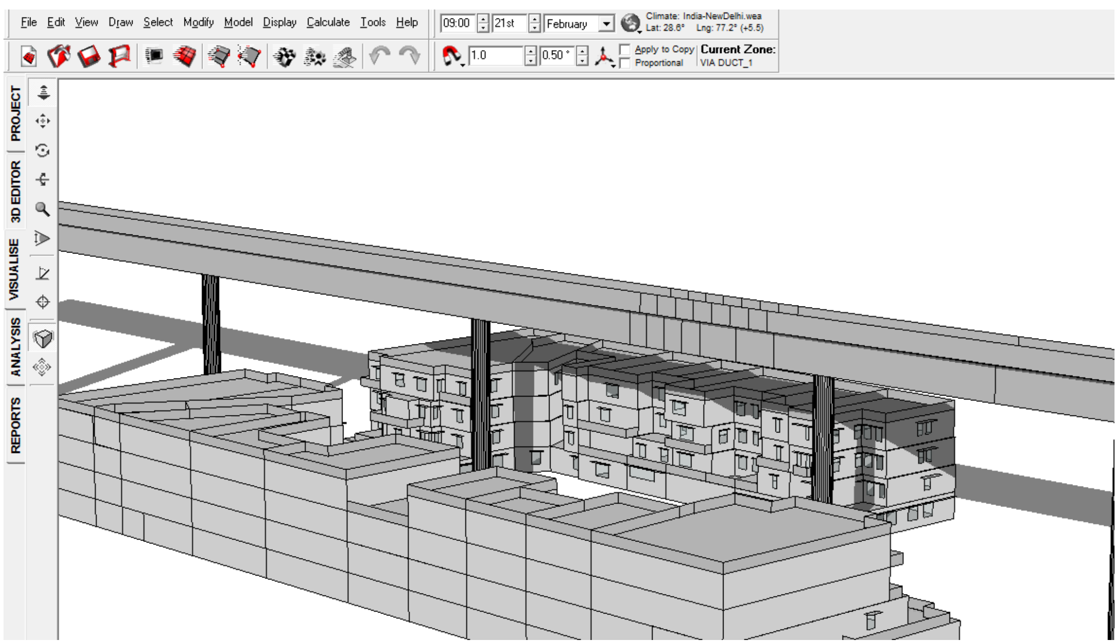


FIGURE 22: SHADOW RANGE ON 21ST FEBRUARY 9 AM WITH VIADUCT

FIGURE 21 represents shadow caused by the Buildings. On the basis of the above image, the building A is casting shadow on the ground floors of the Blocks – 219 & 220. FIGURE 22 represents the shadow caused to the building by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the Terrace of the Building – B, thereby not obstructing the morning sunlight falling on the façade of the buildings at 21st February 9 AM.

GreenTree Building Energy Pvt. Ltd.
DELHI
NCR

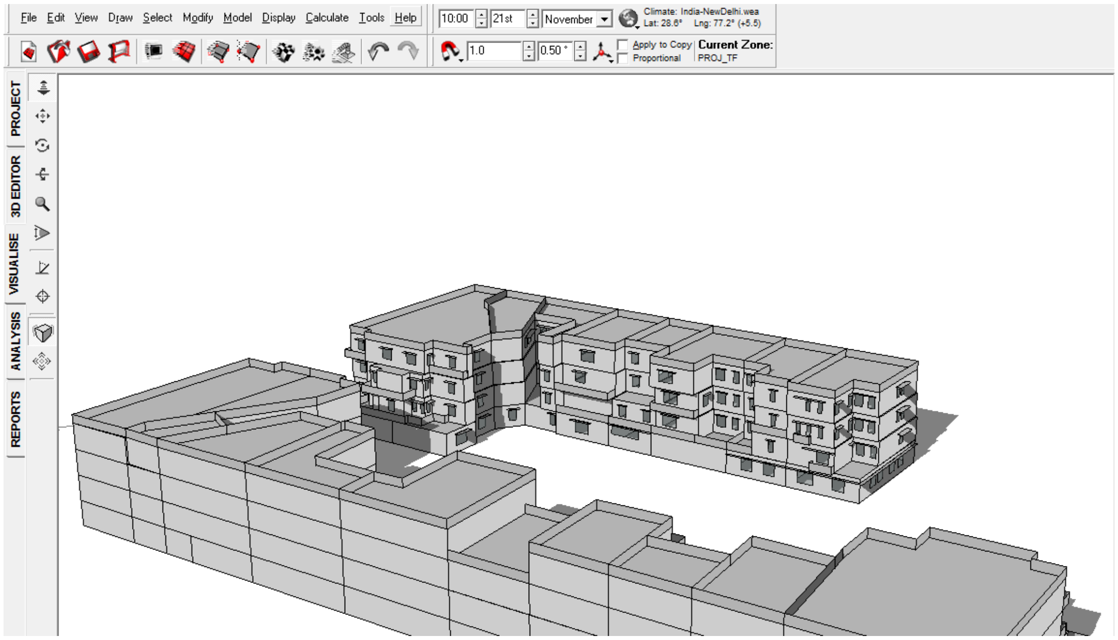


FIGURE 23: SHADOW RANGE ON 21ST NOVEMBER 10 AM WITHOUT VIADUCT

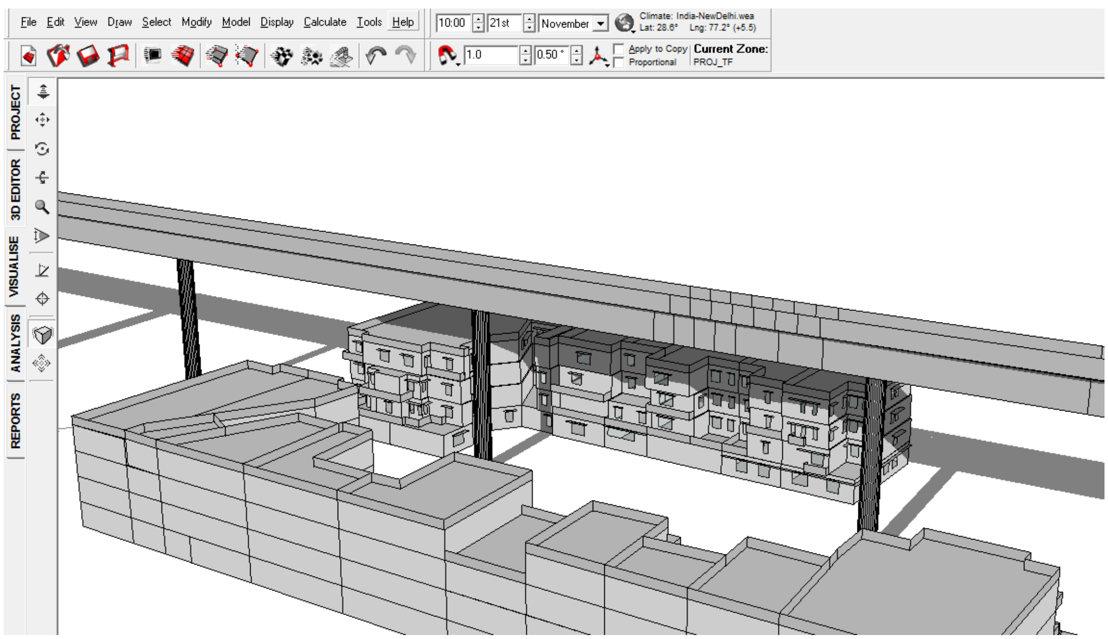


FIGURE 24: SHADOW RANGE ON 21ST NOVEMBER 10 AM WITH VIADUCT

FIGURE 23 represents shadow caused by the Buildings. On the basis of the above image, the building A is casting shadow on the ground floors of the Blocks – 219 & 220. FIGURE 24 represents the shadow caused to the building by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third floor of the Blocks – 211, 212, 213, 214 & 215 and ground, first, second & third floor of Block – 216, thereby not obstructing the morning sunlight falling on the back side of the buildings at 21st November 10 AM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

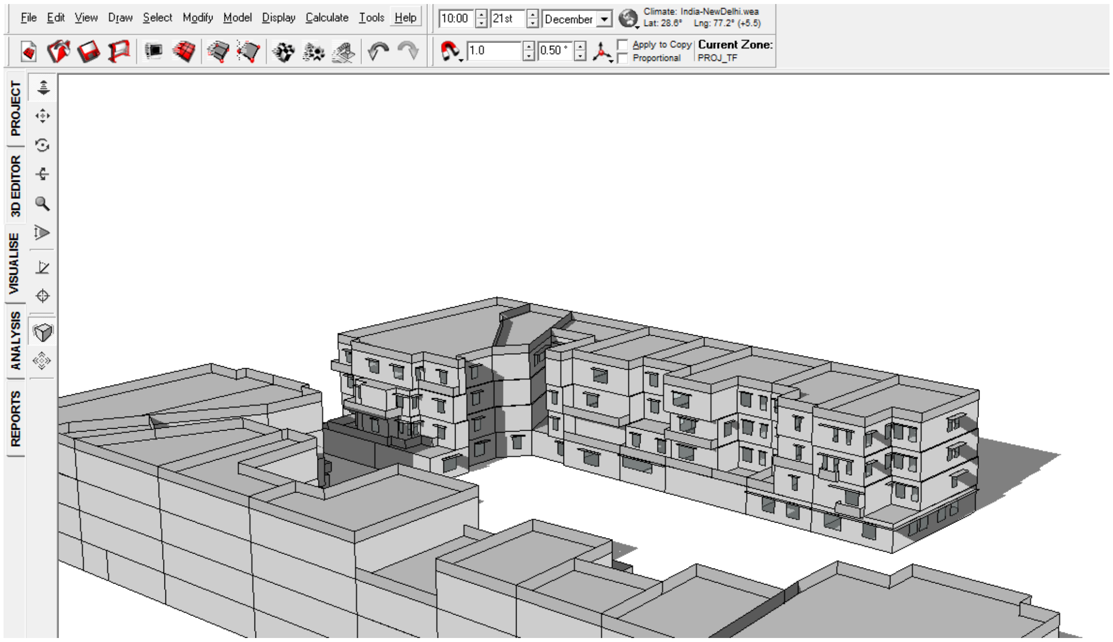


FIGURE 25: SHADOW RANGE ON 21ST DECEMBER 10 AM WITHOUT VIADUCT

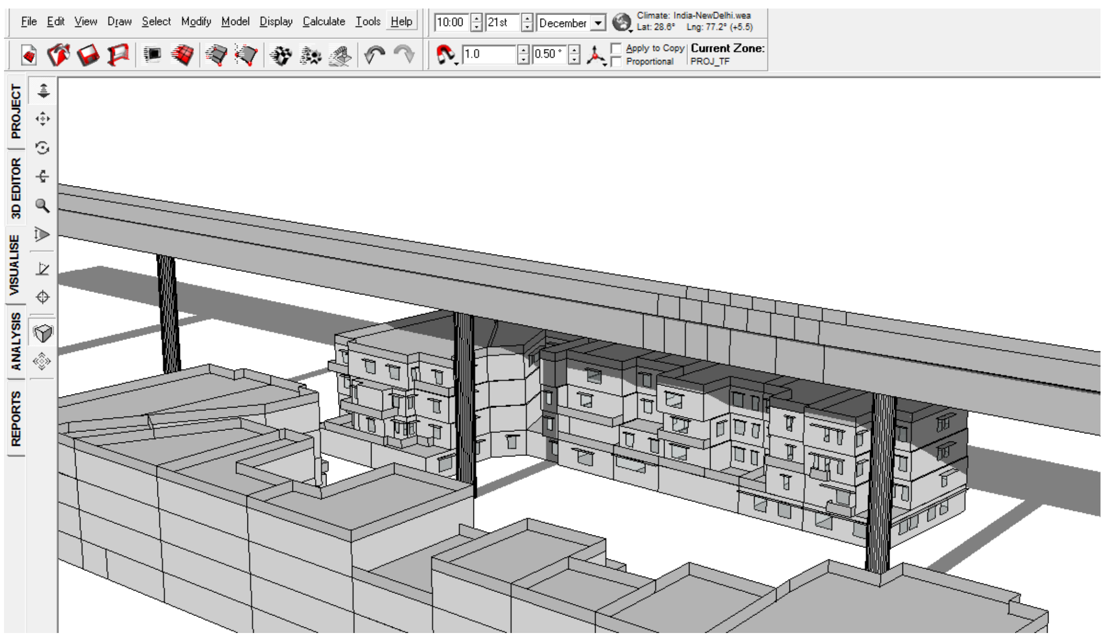


FIGURE 26: SHADOW RANGE ON 21ST DECEMBER 10 AM WITH VIADUCT

FIGURE 25 represents shadow caused by the Buildings. On the basis of the above image, the building A is casting shadow on the ground & first floors of the Blocks – 219 & 220. FIGURE 26 represents the shadow caused to the building by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third floor of the Blocks – 211, 212, 213, 214, & 215 and ground, first, second & third floor of Block – 216, thereby not obstructing the morning sunlight falling on the back side of the buildings at 21st December 10 AM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

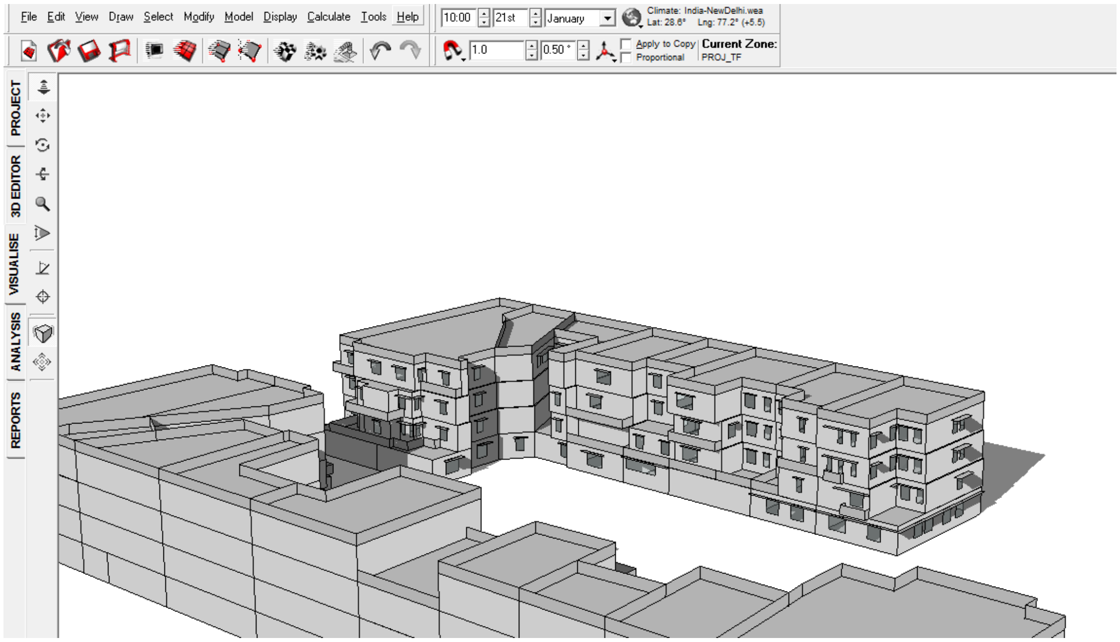


FIGURE 27: SHADOW RANGE ON 21ST JANUARY 10 AM WITHOUT VIADUCT

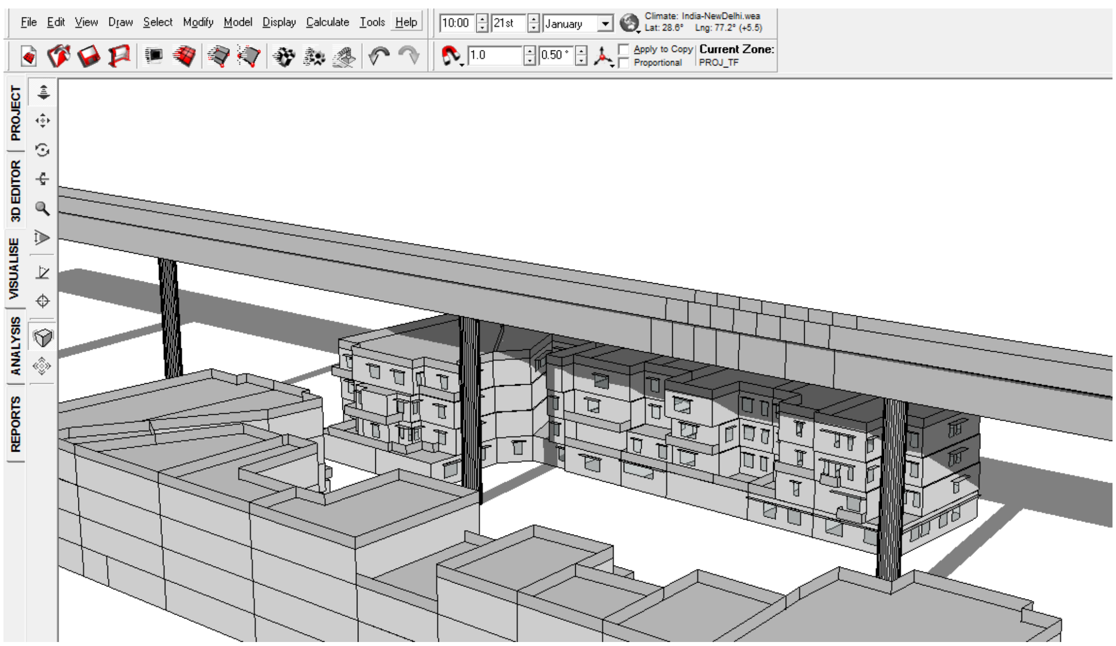


FIGURE 28: SHADOW RANGE ON 21ST JANUARY 10 AM WITH VIADUCT

FIGURE 27 represents shadow caused by the Buildings. On the basis of the above image, the building A is casting shadow on the ground & first floors of the Blocks – 219 & 220. FIGURE 28 represents the shadow caused to the building by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third floor of the Blocks – 211, 212, 213, 214, & 215 and ground, first, second & third floor of Block – 216, thereby not obstructing the morning sunlight falling on the back side of the buildings at 21st January 10 AM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

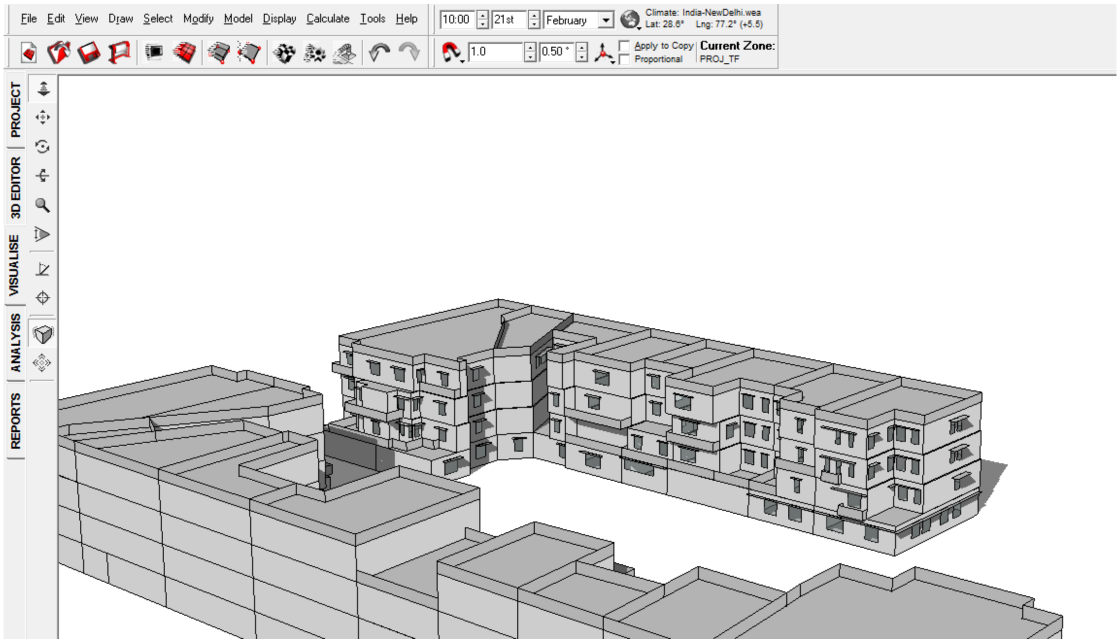


FIGURE 29: SHADOW RANGE ON 21ST FEBRUARY 10 AM WITHOUT VIADUCT

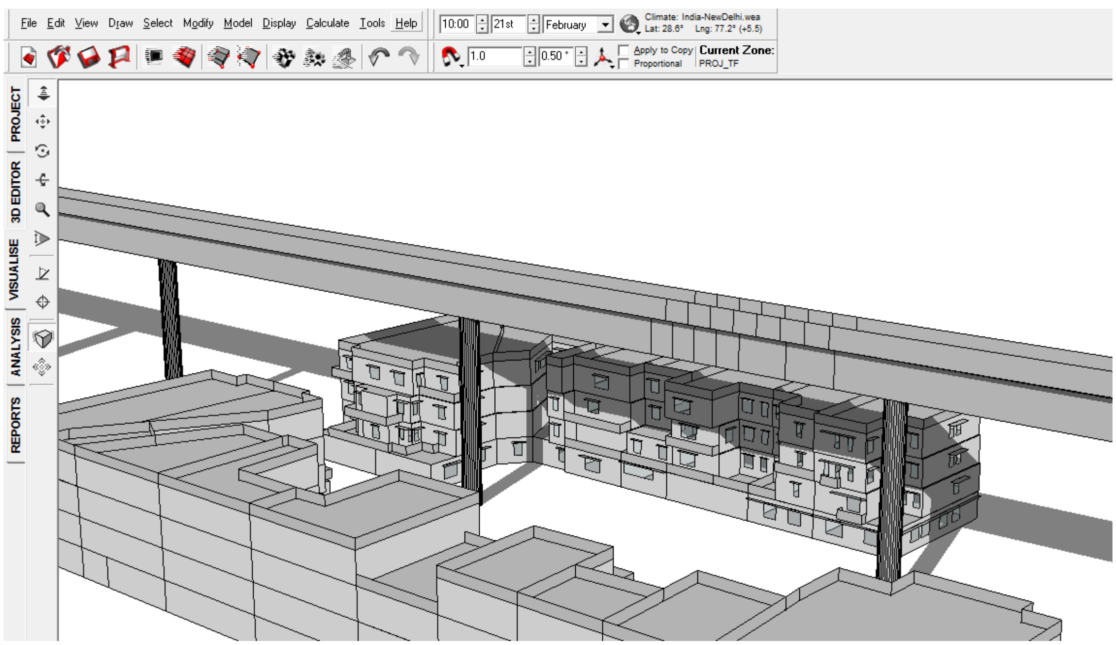


FIGURE 30: SHADOW RANGE ON 21ST FEBRUARY 10 AM WITH VIADUCT

FIGURE 29 represents shadow caused by the Buildings. On the basis of the above image, the building A is casting shadow on the ground floors of the Blocks – 219 & 220. FIGURE 30 represents the shadow caused to the building by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third & second floor of the Blocks – 211, 212, 213, 214, & 215 and ground, first, second & third floor of Block – 216, thereby not obstructing the morning sunlight falling on the back side of the buildings at 21st February 10 AM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

2.4 Shadow Analysis 2 – Annual Noon Time (11AM to 3PM)

During noon hours, the occupant feels comfort to have the shadow. Thus in our analysis during the noon time (i.e. from 11.00 AM to 3.00 PM), most of the time the viaduct is casting the shadow on both of the “building A” & “building B”. Thus the shadow provided by the viaduct does not affect the health and well-being of the occupants.

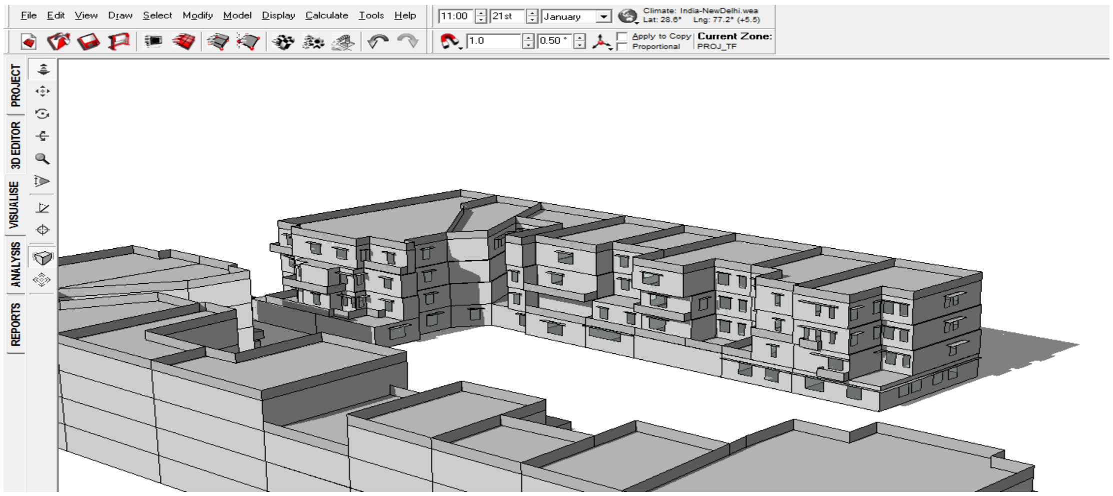


Figure 31: Shadow Range on 21st January 11 AM without viaduct

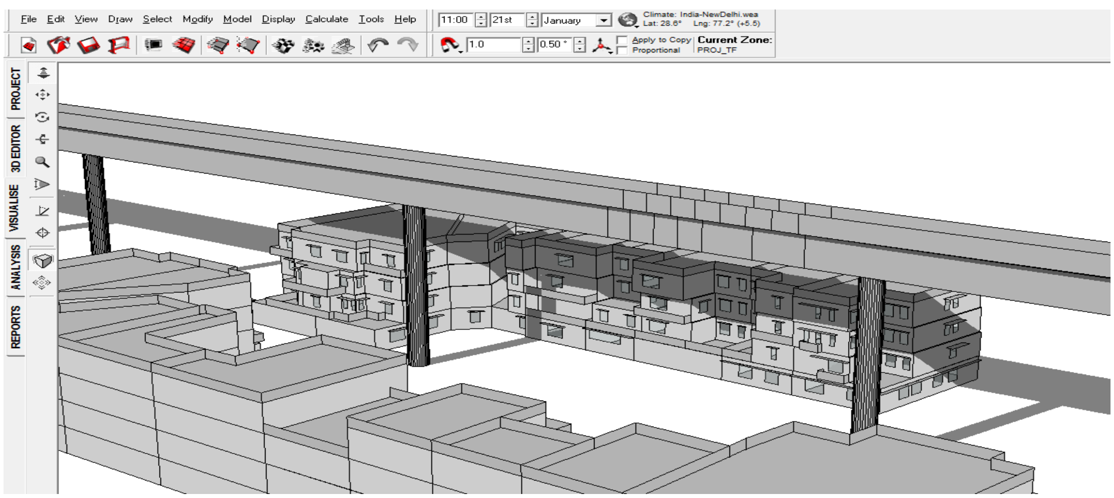


Figure 32: Shadow Range on 21st January 11 AM with viaduct

Figure 32 represents the shadow caused to the buildings. On the basis of the above image, the building A is casting shadow on the ground floors of the Blocks – 219 & 220. Figure 33 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third & second floor of the Blocks – 211, 212, 213, 214 & 216 and third, second, first & ground floor of Block – 215, thereby obstructing the direct sunlight falling on the back side of the buildings, which itself is acting as a shade for the back side of the façade on 21st January 11 AM.

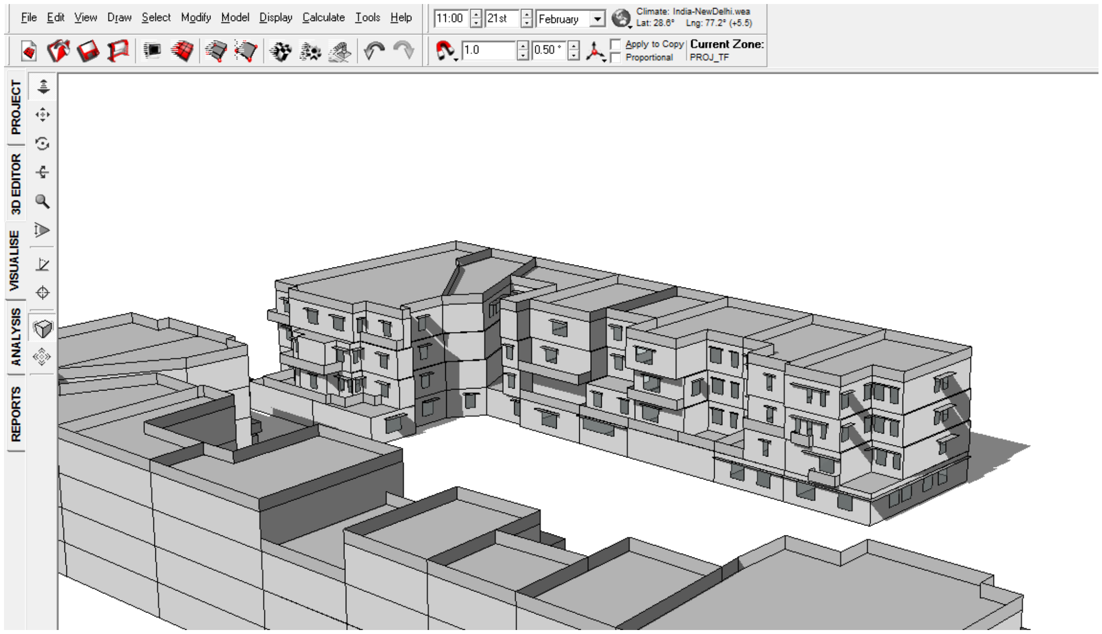


FIGURE 33: SHADOW RANGE ON 21ST FEBRUARY 11 AM WITHOUT VIADUCT

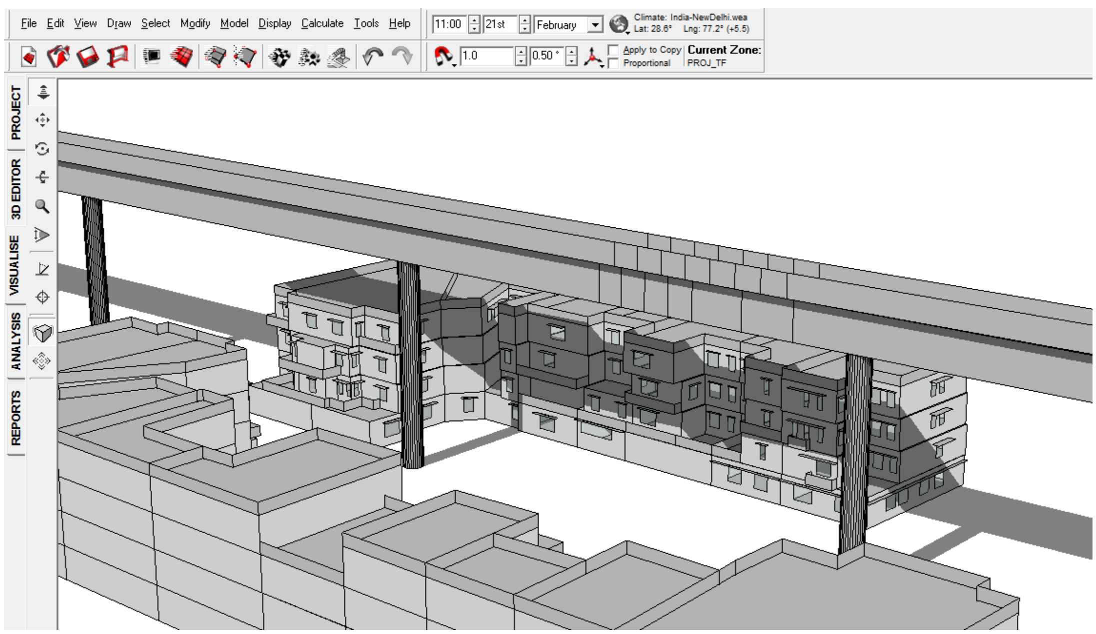


FIGURE 34: SHADOW RANGE ON 21ST FEBRUARY 11 AM WITH VIADUCT

FIGURE 33 represents the shadow caused to the buildings. On the basis of the above image, the buildings is not casting any shadow to the nearby buildings. FIGURE 34 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second & first floor of the Blocks – 211, 212, 213, 214 & 215 and third, second, first & ground floor of Block – 216, thereby obstructing the direct sunlight falling on the back side of the buildings, which itself is acting as a shade for the back side of the façade on 21st February 11 AM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

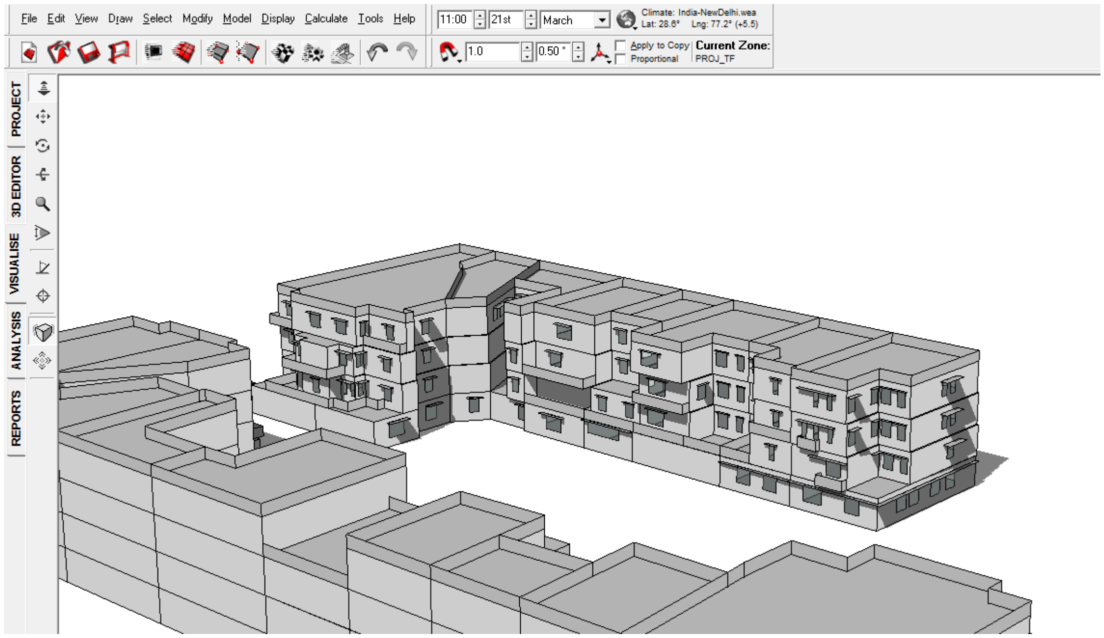


FIGURE 35: SHADOW RANGE ON 21ST MARCH 11 AM WITHOUT VIADUCT

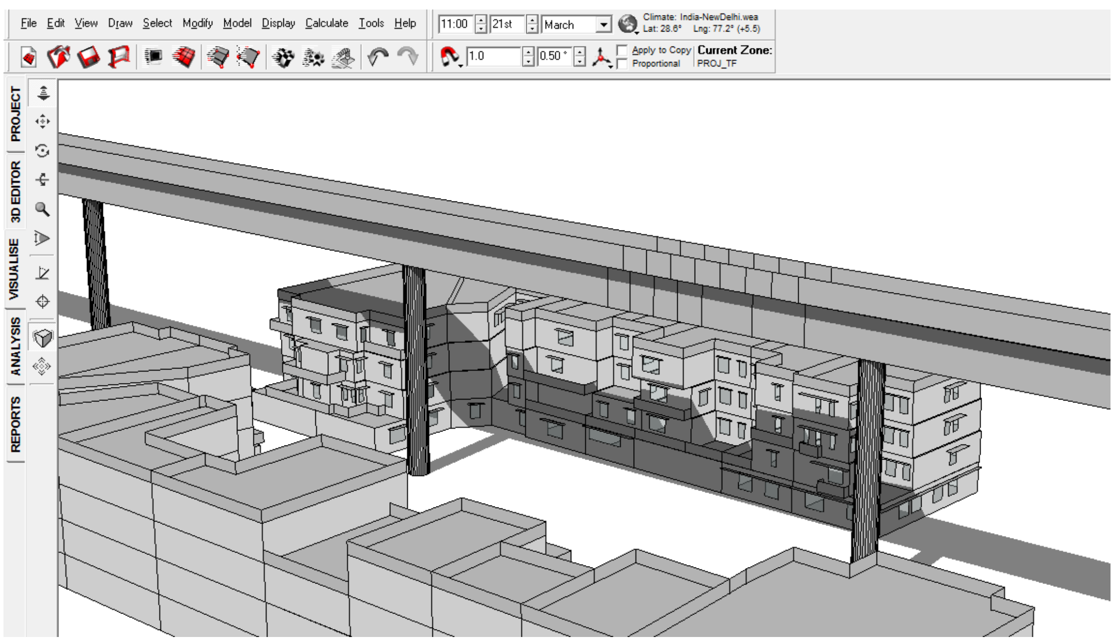


FIGURE 36: SHADOW RANGE ON 21ST MARCH 11 AM WITH VIADUCT

FIGURE 35 represents the shadow caused to the buildings. On the basis of the above image, the buildings is not casting any shadow to the nearby buildings. FIGURE 36 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the second, first & ground floor of the Blocks – 211, 212, 214 & 216, first & second floor of the Blocks – 213, 214 & 215 and third, second, first & ground floor of Block – 217, thereby obstructing the direct sunlight falling on the back side of the buildings, which itself is acting as a shade for the back side of the façade on 21st March 11 AM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

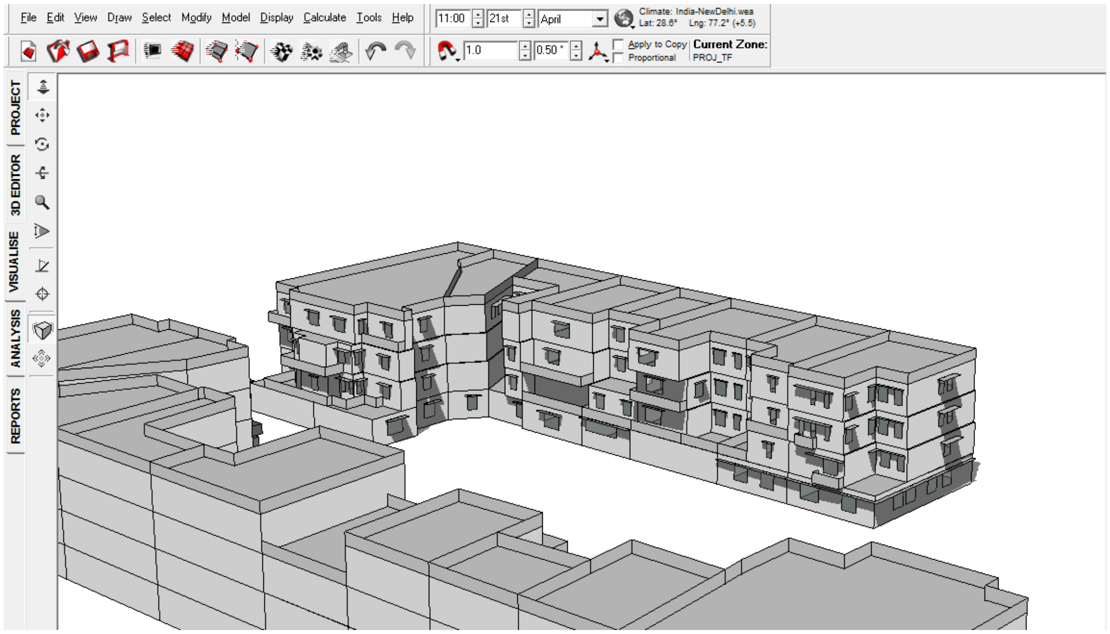


FIGURE 37: SHADOW RANGE ON 21ST APRIL 11 AM WITHOUT VIADUCT

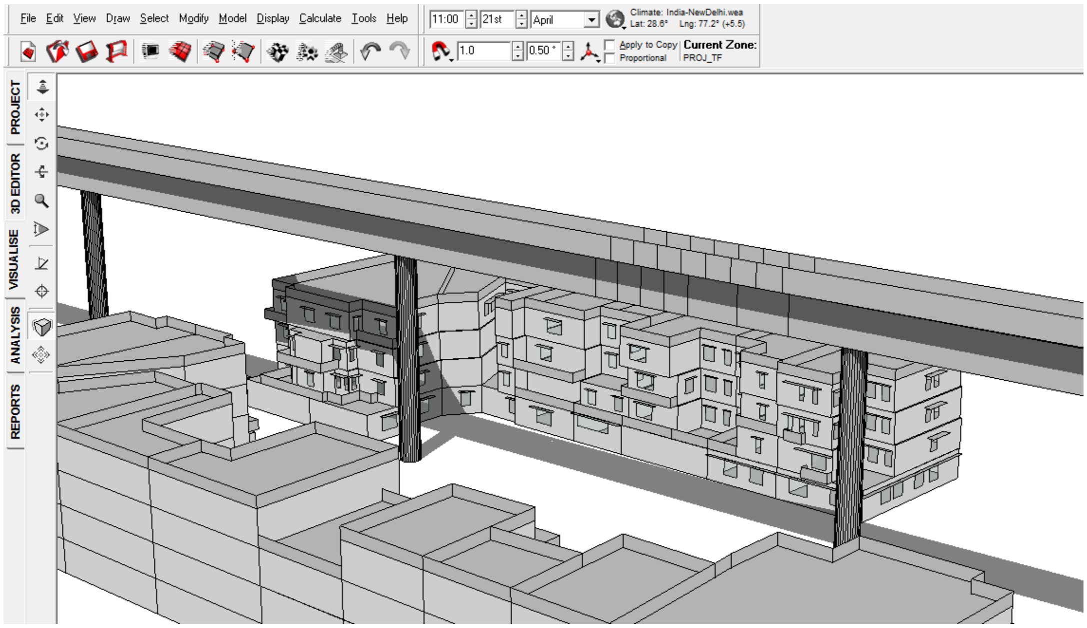


FIGURE 38: SHADOW RANGE ON 21ST APRIL 11 AM WITH VIADUCT

FIGURE 38 represents the shadow caused to the buildings. On the basis of the above image, the buildings is not casting any shadow to the nearby buildings. FIGURE 39 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third floor of Blocks – 219 & 220, thereby obstructing the direct sunlight falling on the façade of the buildings, which itself is acting as a shade for the façade on 21st April 11 AM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

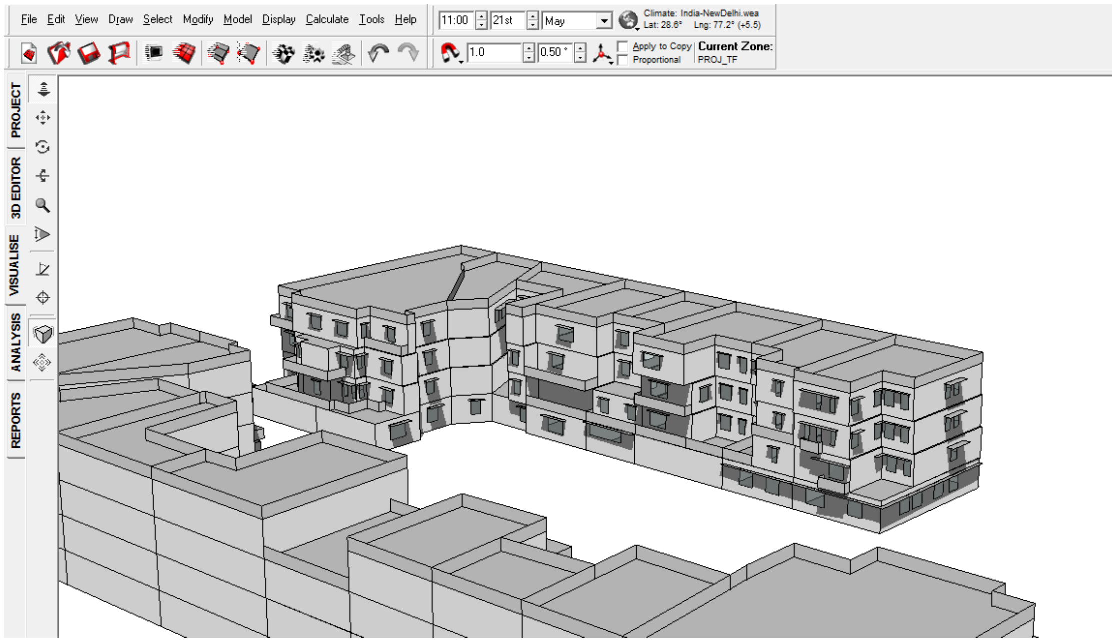


FIGURE 39: SHADOW RANGE ON 21ST MAY 11 AM WITHOUT VIADUCT

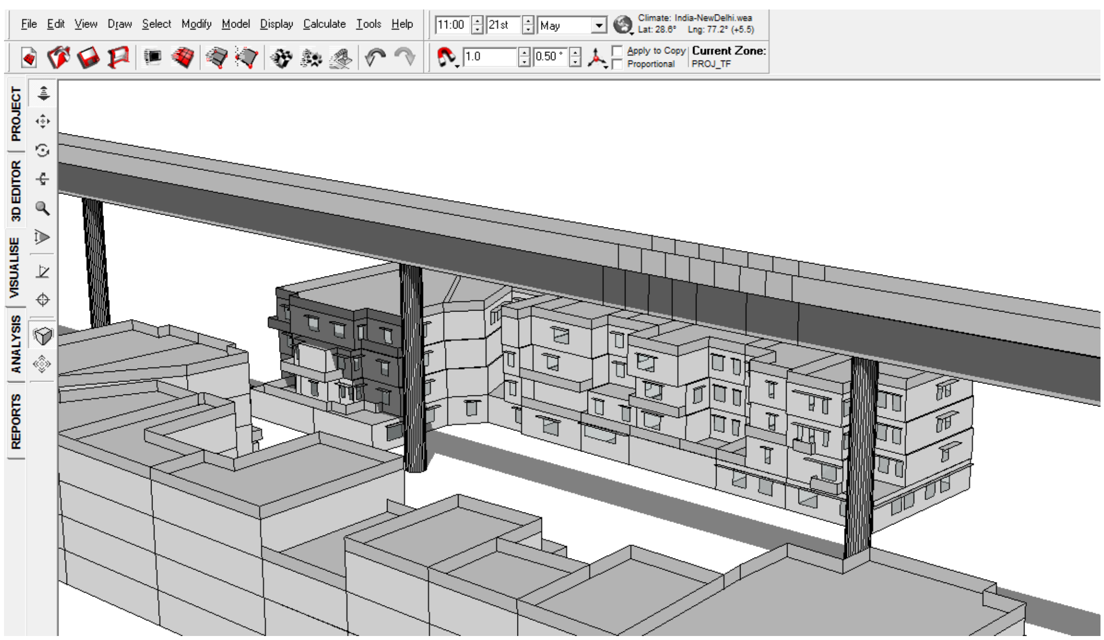


FIGURE 40: SHADOW RANGE ON 21ST MAY 11 AM WITH VIADUCT

FIGURE 39 represents the shadow caused to the buildings. On the basis of the above image, the buildings is not casting any shadow to the nearby buildings but all the windows are shaded by the overhang. FIGURE 40 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second & first floor of Blocks – 219 & 220, thereby obstructing the direct sunlight falling on the façade of the buildings, which itself is acting as a shade for the façade on 21st May 11 AM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

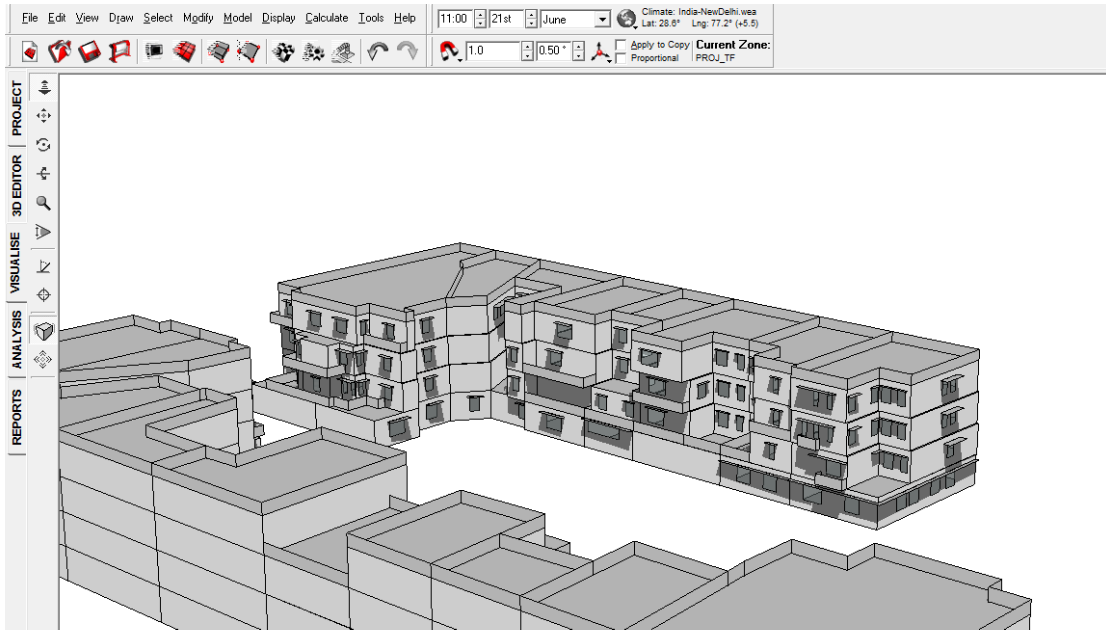


FIGURE 41: SHADOW RANGE ON 21ST JUNE 11 AM WITHOUT VIADUCT

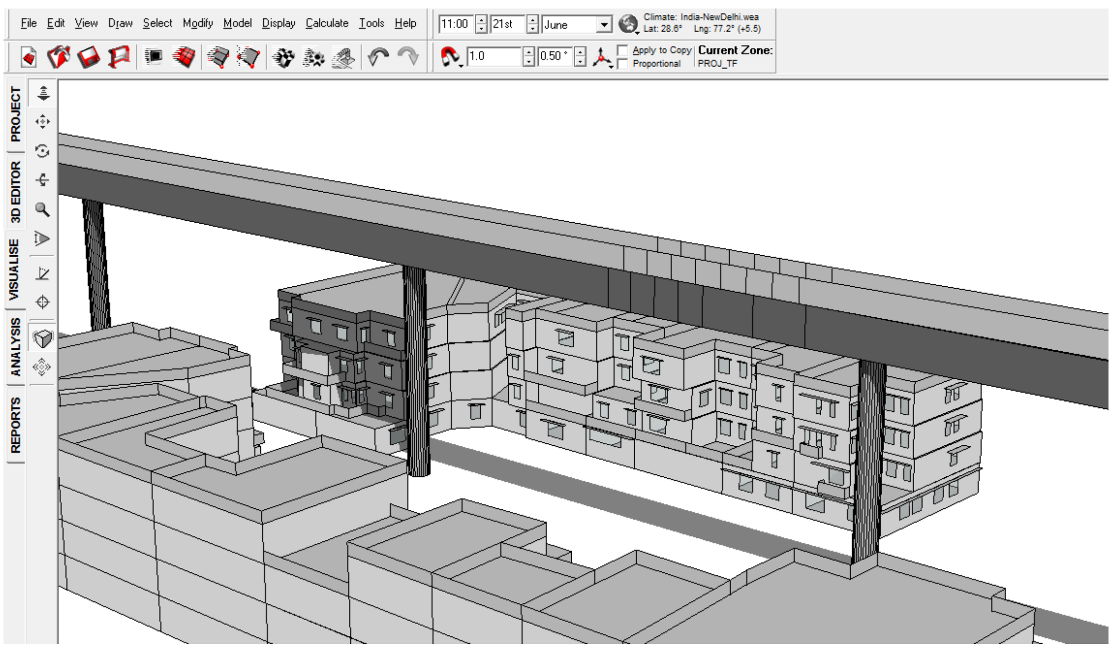


FIGURE 42: SHADOW RANGE ON 21ST JUNE 11 AM WITH VIADUCT

FIGURE 41 represents the shadow caused to the buildings. On the basis of the above image, the buildings is not casting any shadow to the nearby buildings but all the windows are shaded by the overhang. FIGURE 42 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second, first & ground floor of Blocks – 219 & 220, thereby obstructing the direct sunlight falling on the façade of the buildings, which itself is acting as a shade for the façade on 21st June 11 AM.

GreenTree Building Energy Pvt. Ltd. DELHI NCR

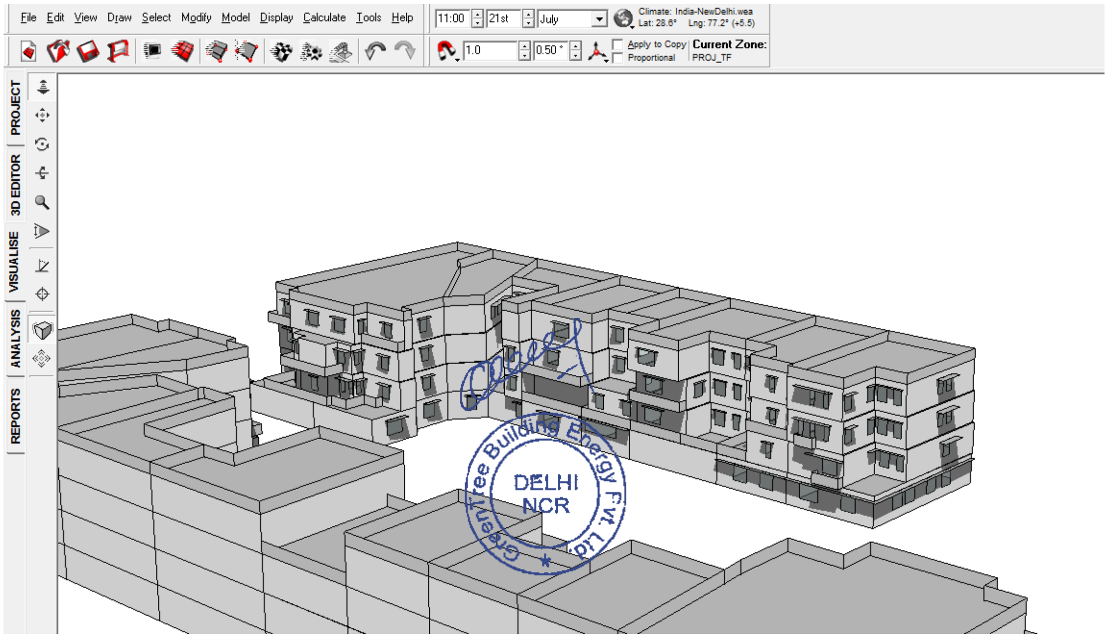


FIGURE 43: SHADOW RANGE ON 21ST JULY 11 AM WITHOUT VIADUCT

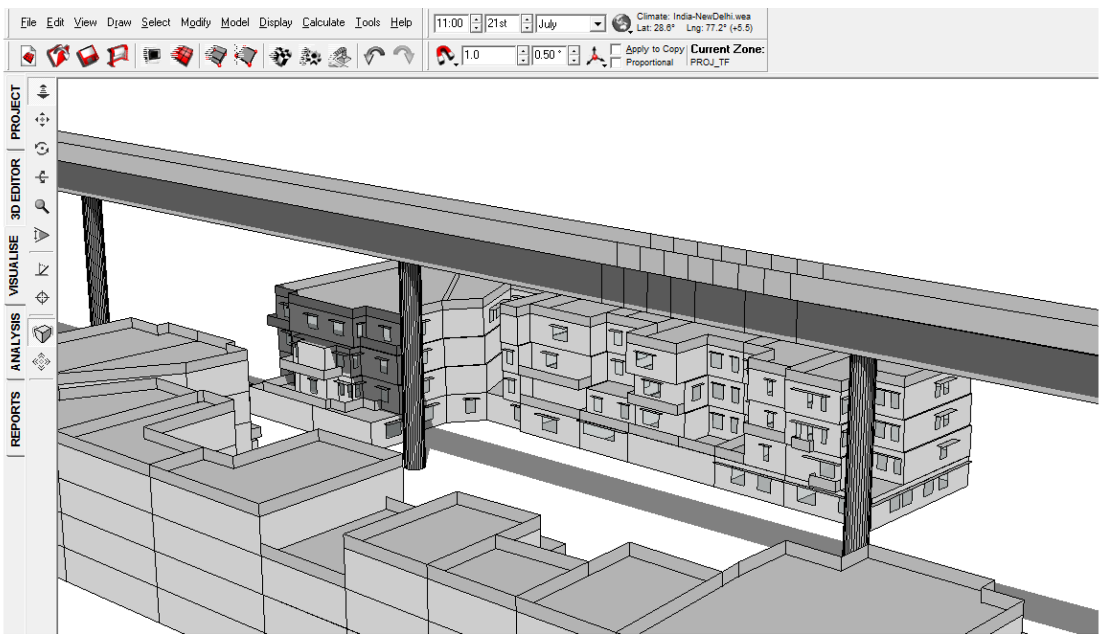


FIGURE 44: SHADOW RANGE ON 21ST JULY 11 AM WITH VIADUCT

FIGURE 43 represents the shadow caused to the buildings. On the basis of the above image, the buildings is not casting any shadow to the nearby buildings but all the windows are shaded by the overhang. FIGURE 44 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second, first & ground floor of Blocks – 219 & 220, thereby obstructing the direct sunlight falling on the façade of the buildings, which itself is acting as a shade for the façade on 21st 11 AM.

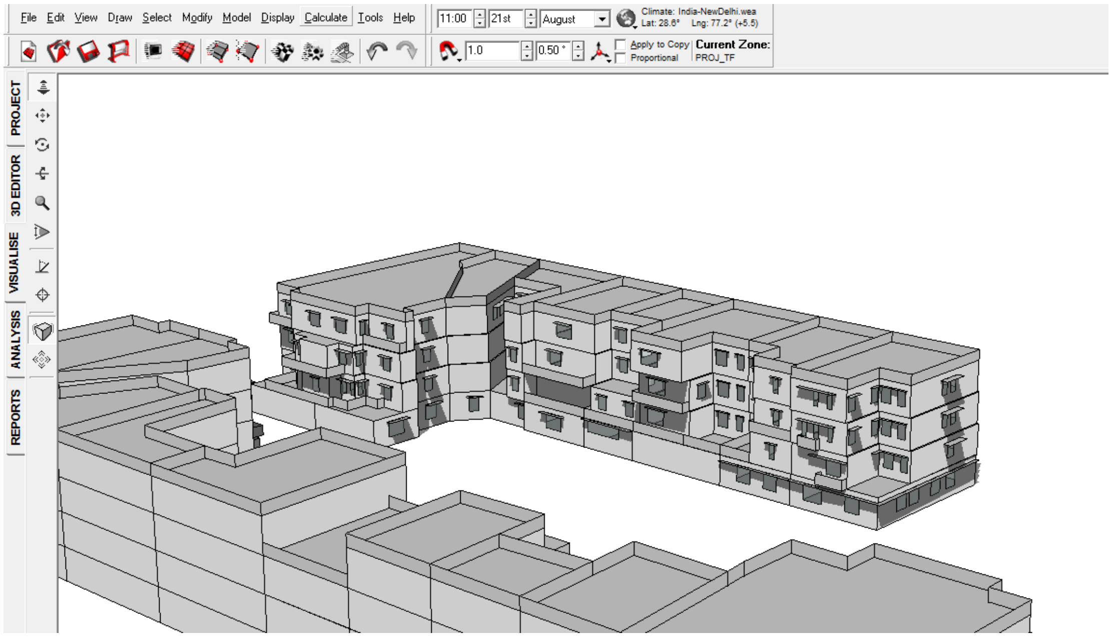


FIGURE 45: SHADOW RANGE ON 21ST AUGUST 11AM WITHOUT VIADUCT

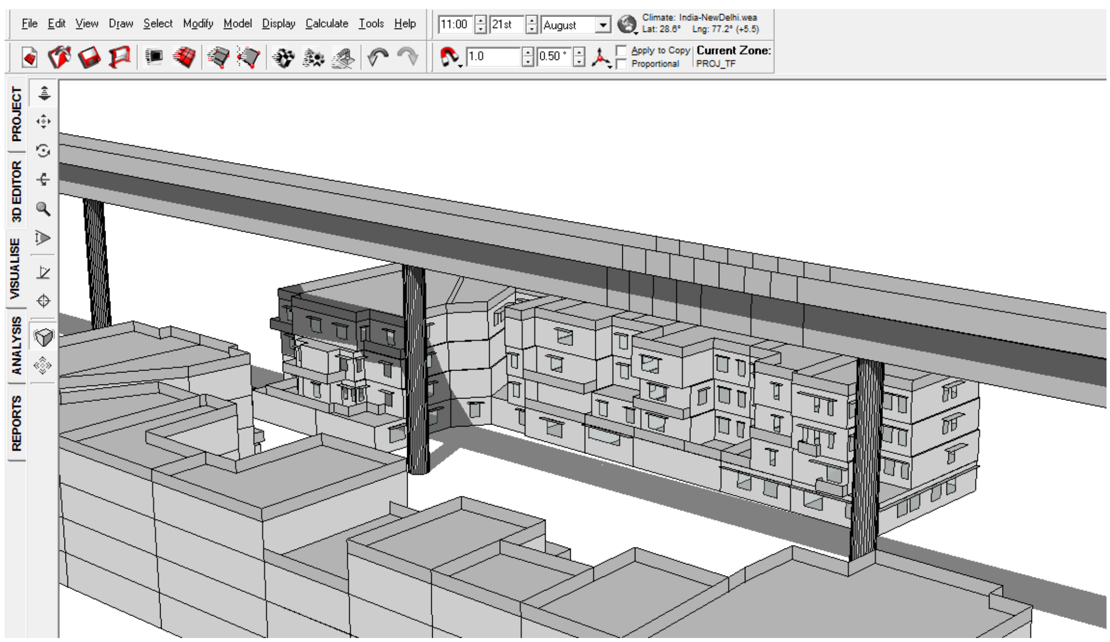


FIGURE 46: SHADOW RANGE ON 21ST AUGUST 11 AM WITH VIADUCT

FIGURE 45 represents the shadow caused to the buildings. On the basis of the above image, the buildings is not casting any shadow to the nearby buildings but all the windows are shaded by the overhang. FIGURE 46 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second, first & ground floor of Blocks – 219 & 220, thereby obstructing the direct sunlight falling on the façade of the buildings, which itself is acting as a shade for the façade on 21st August 11 AM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

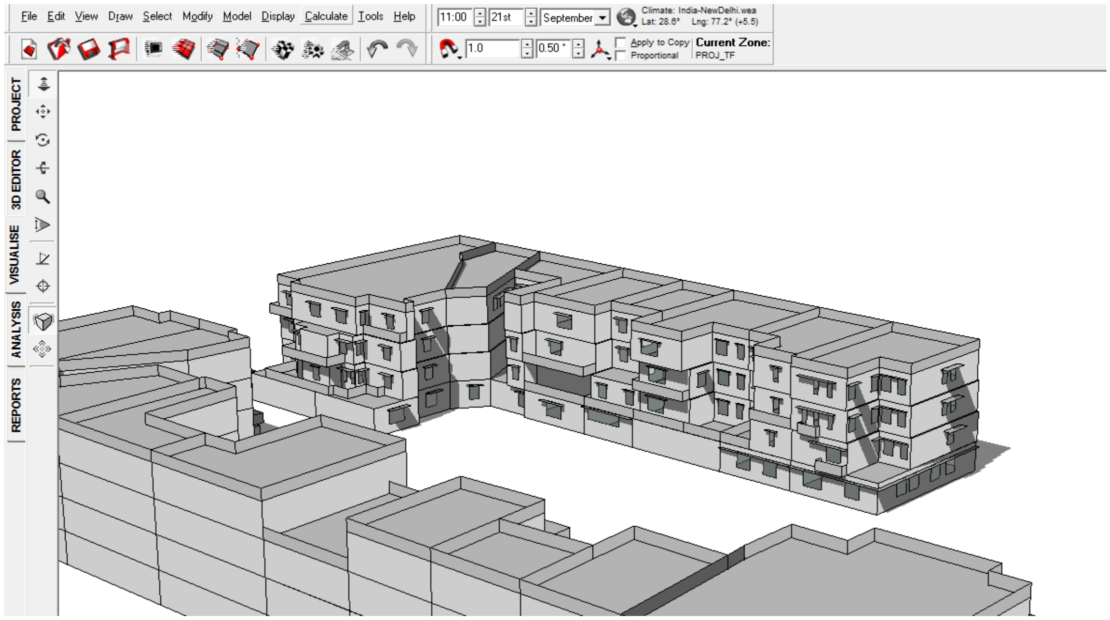


FIGURE 47: SHADOW RANGE ON 21ST SEPTEMBER 11 AM WITHOUT VIADUCT

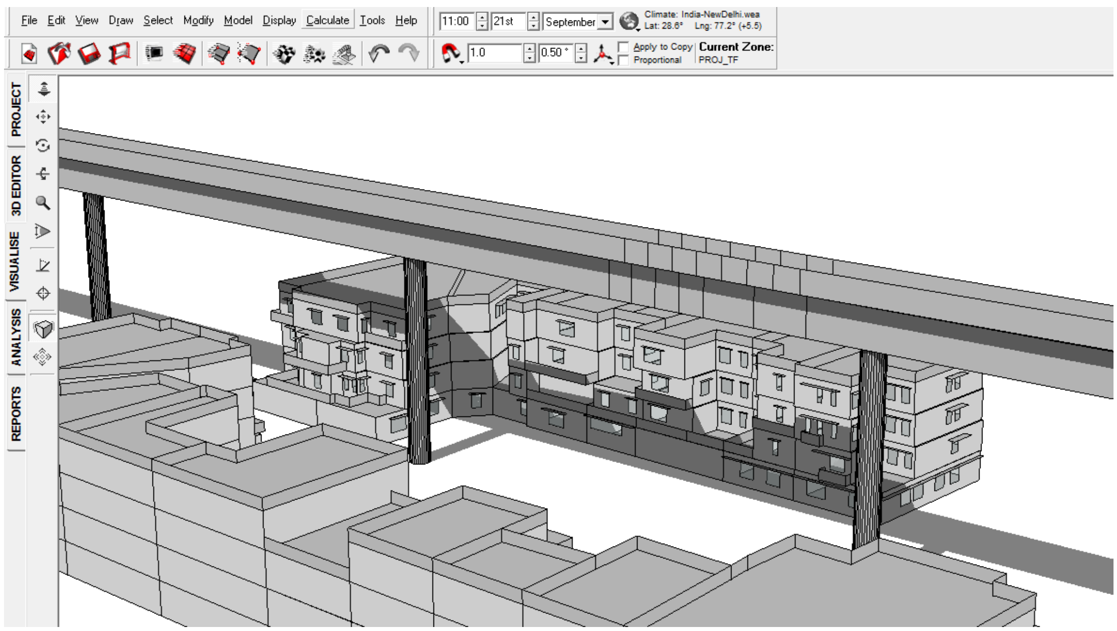


FIGURE 48: SHADOW RANGE ON 21ST SEPTEMBER 11 AM WITH VIADUCT

FIGURE 47 represents the shadow caused to the buildings. On the basis of the above image, the buildings is not casting any shadow to the nearby buildings. FIGURE 48 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second & first floor of Block – 211, second, first & ground floor of Blocks – 212, 213, 214, 215, 216 & 217, third & second floor of Blocks – 219 and third floor of the block – 220 thereby obstructing the direct sunlight falling on the back side of the buildings, which itself is acting as a shade for the back side of the façade on 21st September 11 AM.

GreenTree Building Energy Pvt. Ltd. DELHI NCR

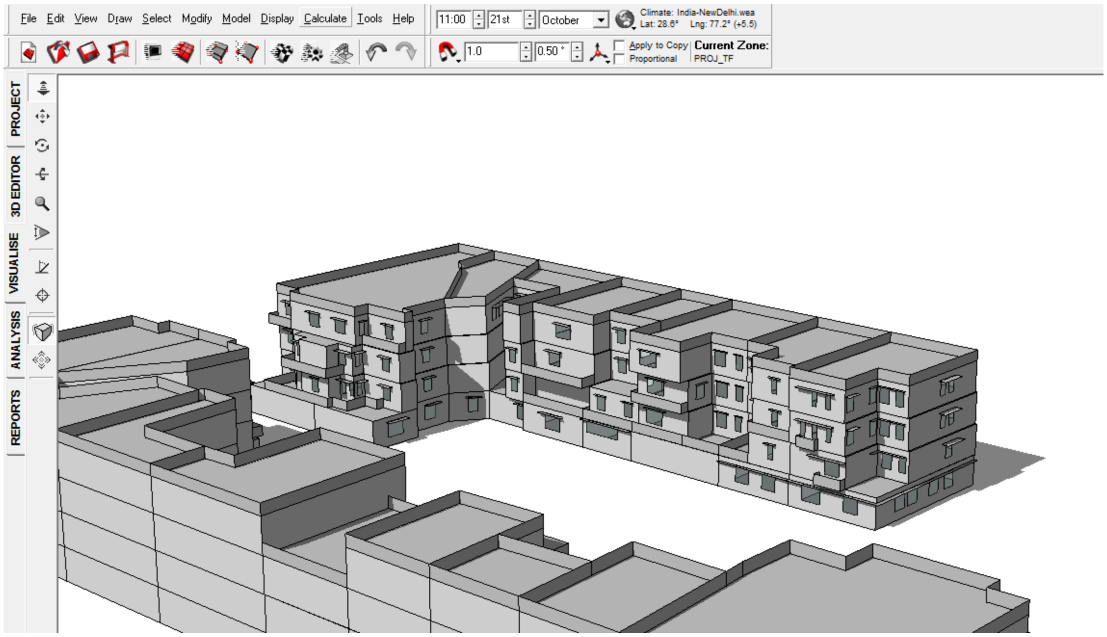


FIGURE 49: SHADOW RANGE ON 21ST OCTOBER 11 AM WITHOUT VIADUCT

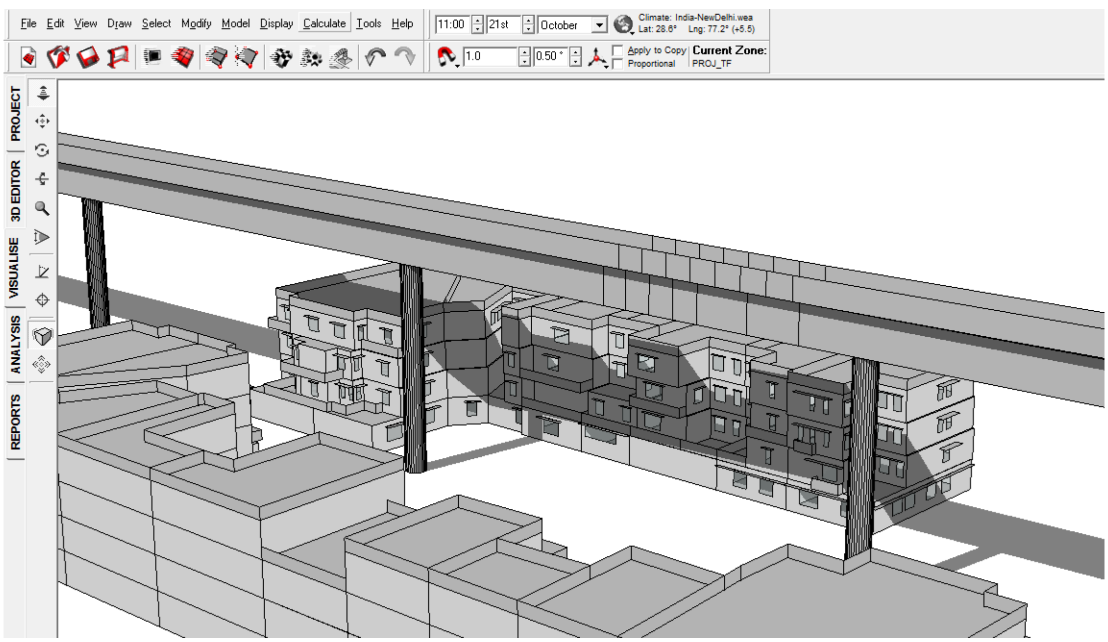


FIGURE 50: SHADOW RANGE ON 21ST OCTOBER 11 AM WITH VIADUCT

FIGURE 49 represents the shadow caused to the buildings. On the basis of the above images, the buildings is not casting any shadow to the nearby buildings. FIGURE 50 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above images, the Viaduct is casting shadow on the third, second & first floor of Blocks – 216 & 217, third, second & first floor of Blocks – 211, 212, 213, 214 & 216 and third, second, first & ground floor of Blocks – 216 thereby obstructing the direct sunlight falling on the back side of the buildings, which itself is acting as a shade for the back side of the façade on 21st October 11 AM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

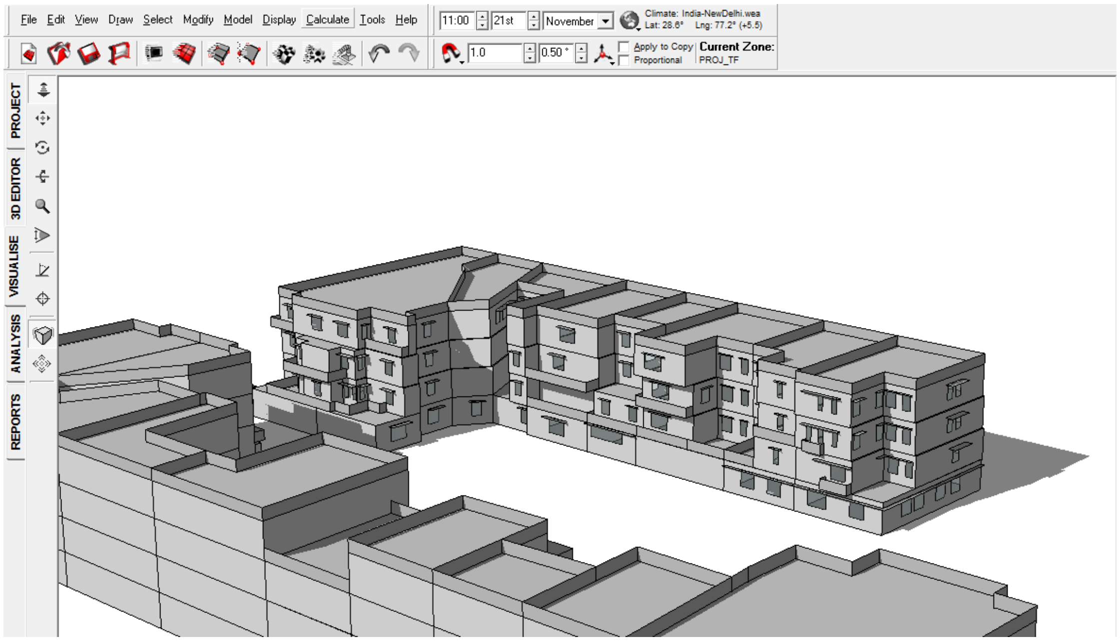


FIGURE 51: SHADOW RANGE ON 21ST NOVEMBER 11 AM WITHOUT VIADUCT

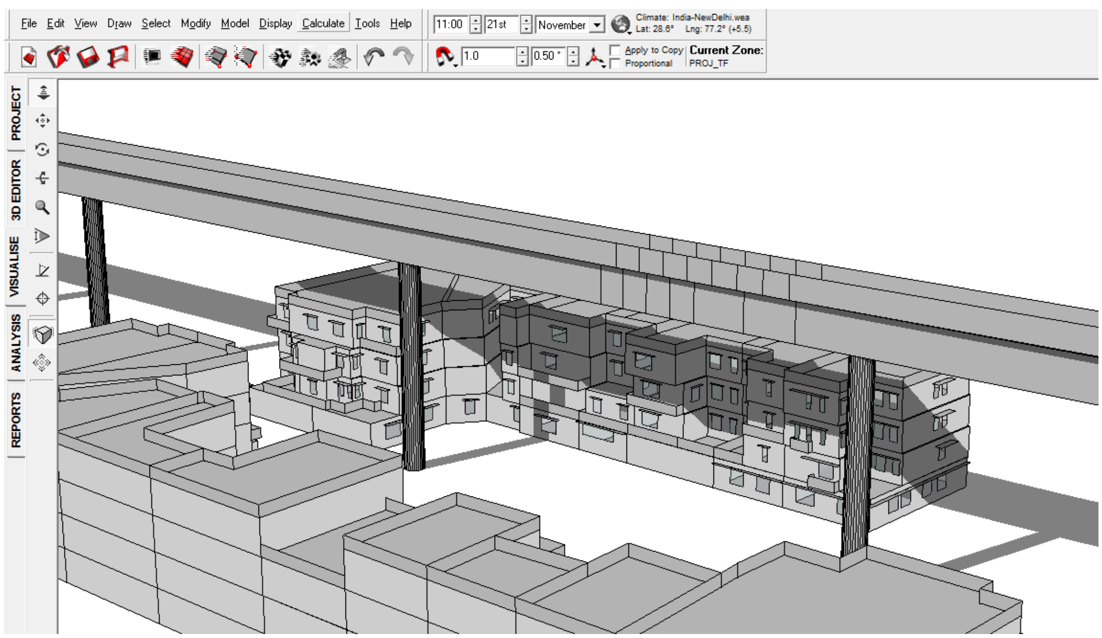


FIGURE 52: SHADOW RANGE ON 21ST NOVEMBER 11 AM WITH VIADUCT

FIGURE 51 represents the shadow caused to the buildings. On the basis of the above image, the building B is casting shadow on the ground floor of the Blocks – 219 & 220. FIGURE 52 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second & first floor of Blocks – 211, 212, 213 & 217, third & second floor of Blocks – 215 and third, second, first & ground floor of Blocks – 215 thereby obstructing the direct sunlight falling on the back side of the buildings, which itself is acting as a shade for the back side of the façade on 21st November 11 AM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

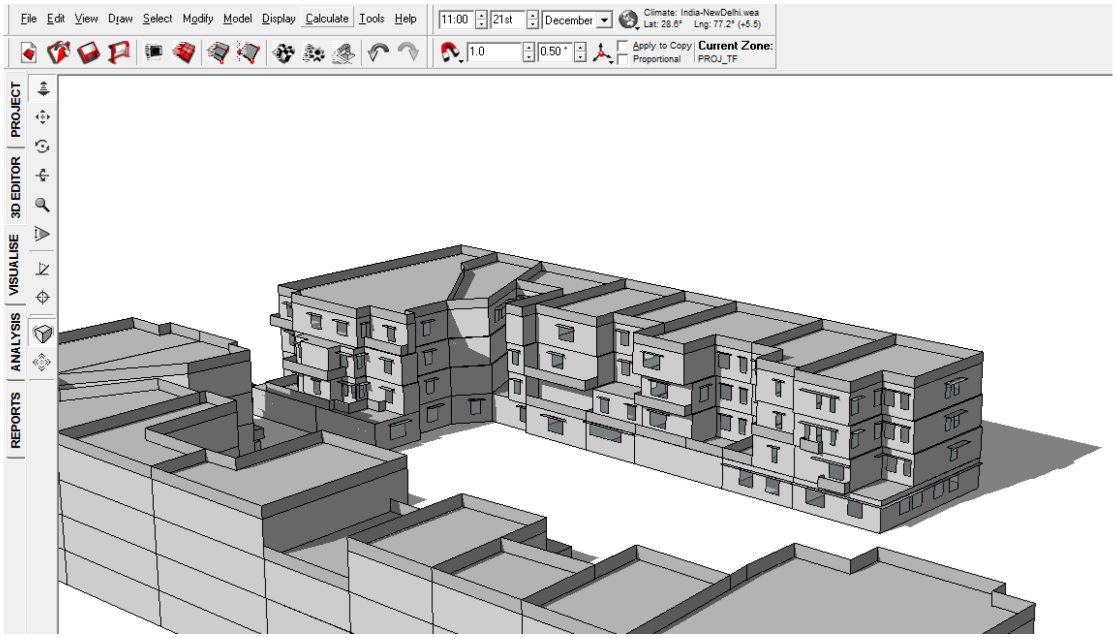


FIGURE 53: SHADOW RANGE ON 21ST DECEMBER 11 AM WITHOUT VIADUCT

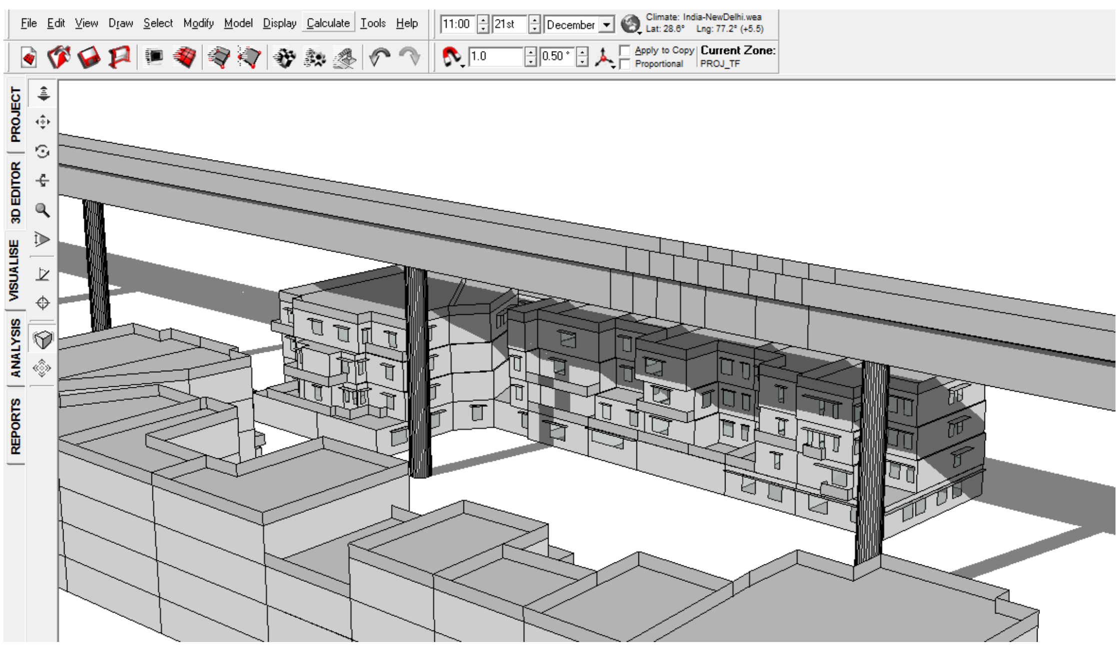


FIGURE 54: SHADOW RANGE ON 21ST DECEMBER 11 AM WITH VIADUCT

FIGURE 54 represents the shadow caused to the buildings. On the basis of the above image, the building B is casting shadow on the Blocks – 219 & 220. FIGURE 55 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third & second floor of Blocks – 211, 212, 213, 214 & 217 and third, second, first & ground floor of Blocks – 215 thereby obstructing the direct sunlight falling on the back side of the buildings, which itself is acting as a shade for the back side of the façade on 21st December 11 AM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

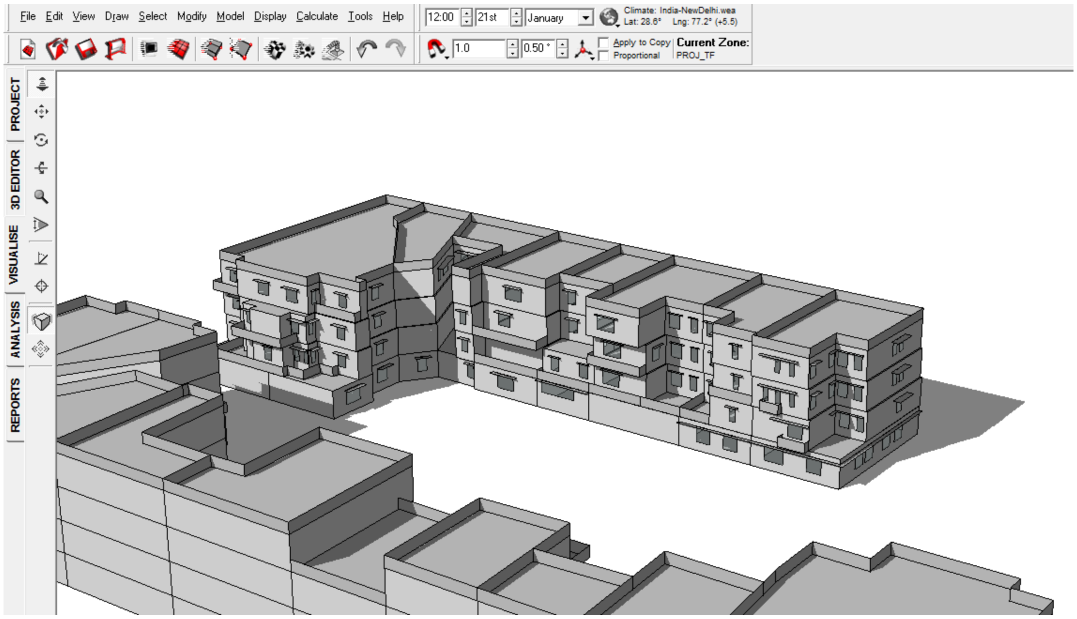


FIGURE 55: SHADOW RANGE ON 21ST JANUARY 12 PM WITHOUT VIADUCT

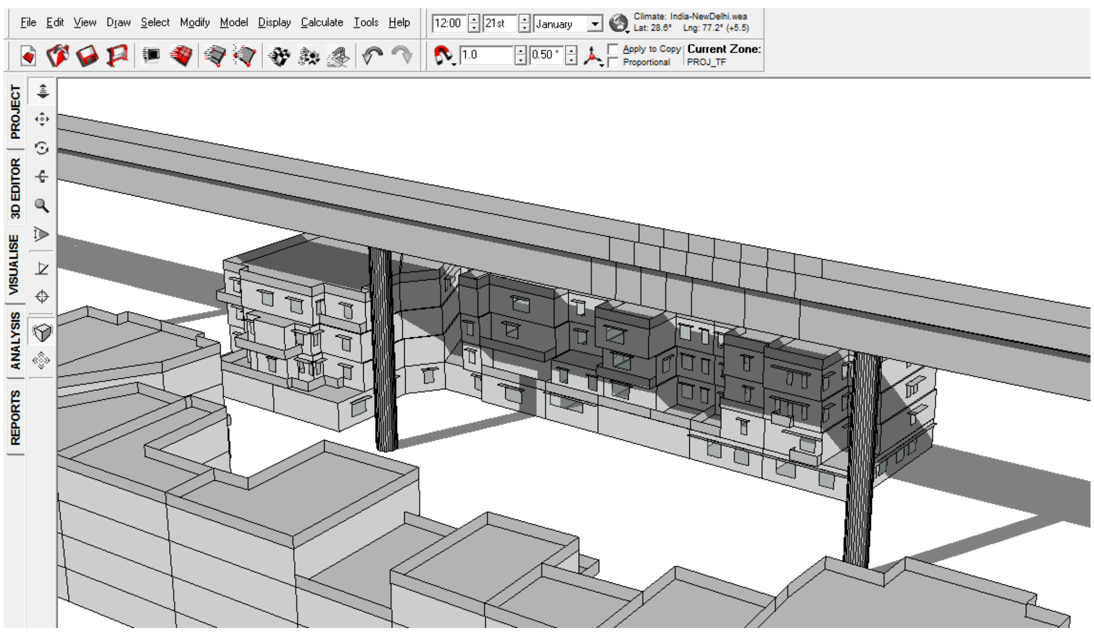


FIGURE 56: SHADOW RANGE ON 21ST JANUARY 12 PM WITH VIADUCT

FIGURE 55 represents the shadow caused to the buildings. On the basis of the above image, the building B is casting shadow on the Block – 220. FIGURE 56 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second & first floor of Blocks – 211, 212, 213, 214 & 217 and third, second, first & ground floor of Blocks – 215 thereby obstructing the direct sunlight falling on the back side of the buildings, which itself is acting as a shade for the back side of the façade on 21st January 12 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

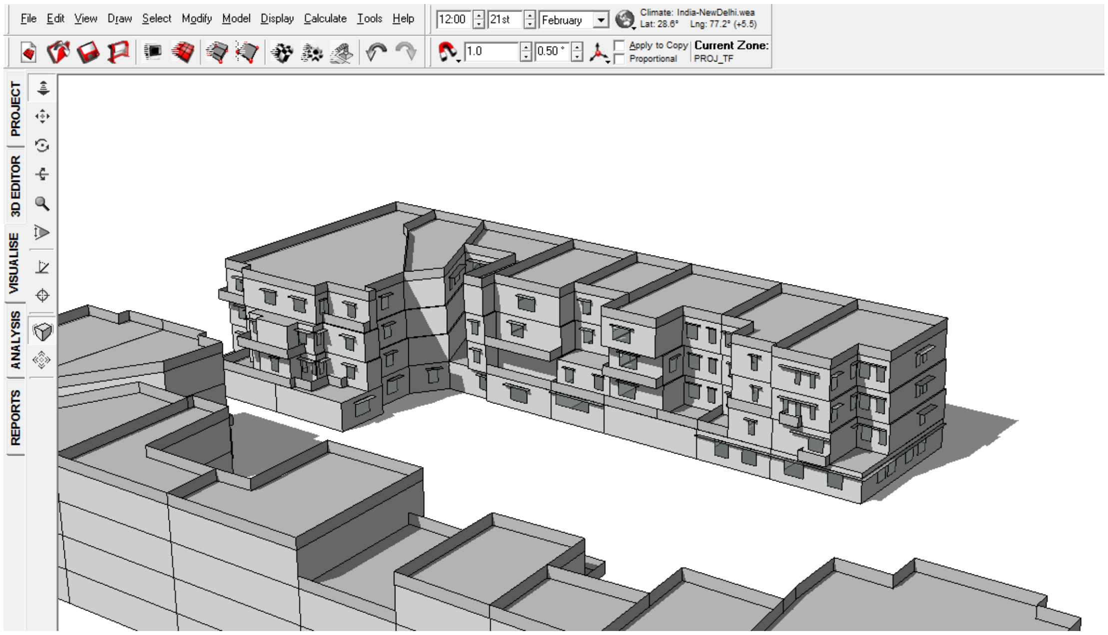


FIGURE 57: SHADOW RANGE ON 21ST FEBRUARY 12 PM WITHOUT VIADUCT

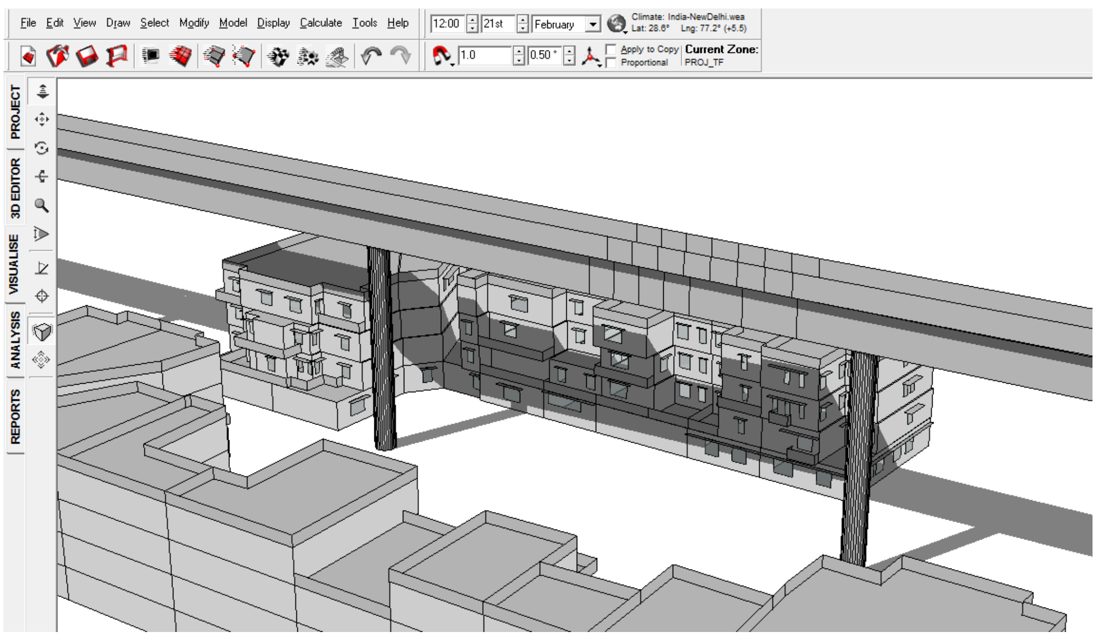


FIGURE 58: SHADOW RANGE ON 21ST FEBRUARY 12 PM WITH VIADUCT

FIGURE 57 represents the shadow caused to the buildings. On the basis of the above image, the Block – 220 is casting shadow on the Block – 217. FIGURE 58 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second, first & ground floor of Blocks – 211, 212, 213, 216 & 217, second, first & ground floor of Block – 215 and first & ground floor of Block – 214 thereby obstructing the direct sunlight falling on the back side of the buildings, which itself is acting as a shade for the back side of the façade on February 21st at 12 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

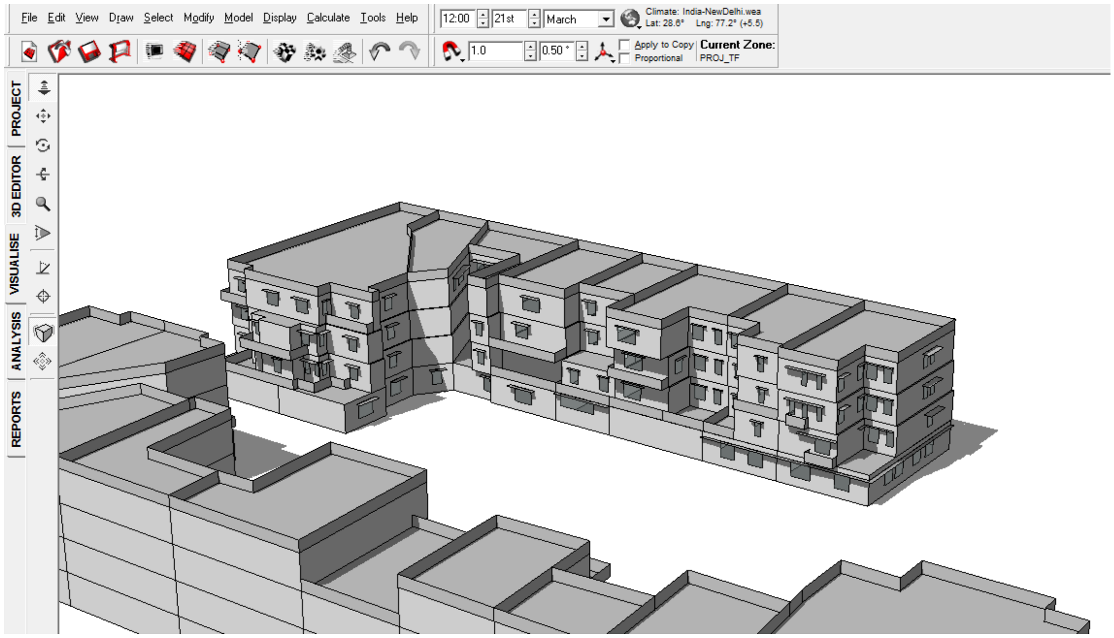


FIGURE 59: SHADOW RANGE ON 21ST MARCH 12 PM WITHOUT VIADUCT

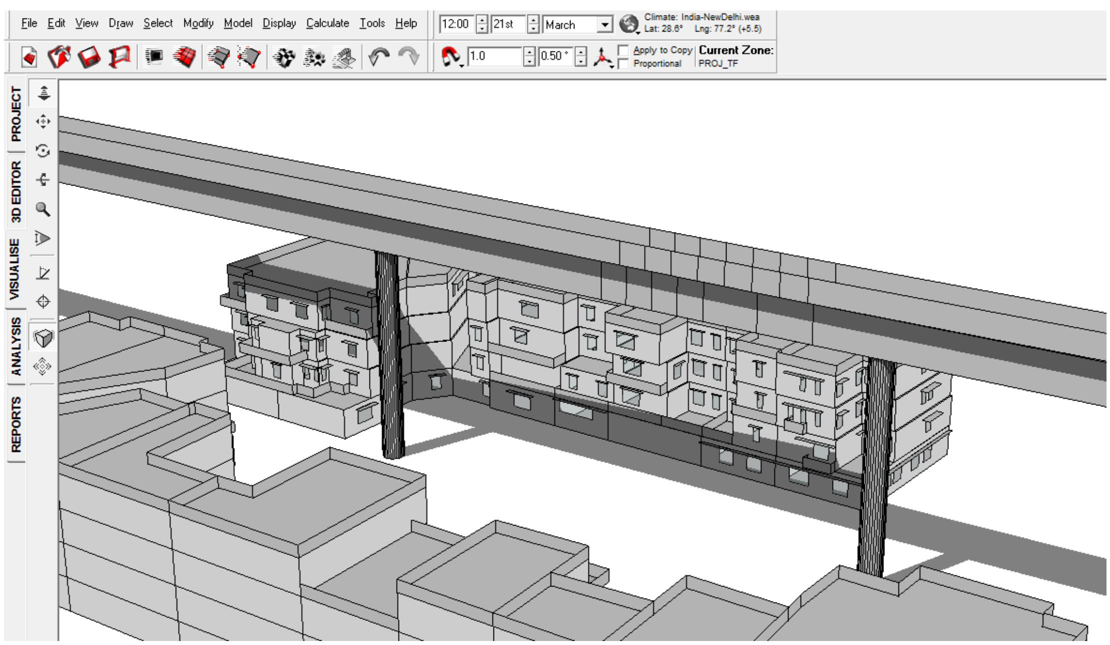


FIGURE 60: SHADOW RANGE ON 21ST MARCH 12 PM WITH VIADUCT

FIGURE 59 represents the shadow caused to the buildings. On the basis of the above image, the Block – 220 is casting shadow on the Block – 217. FIGURE 60 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the first & ground floor of Blocks – 211, 212 & 217, ground floor of Blocks – 213, 214, 215 & 216 and third floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the back side of the buildings, which itself is acting as a shade for the façade on 21st March 12 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

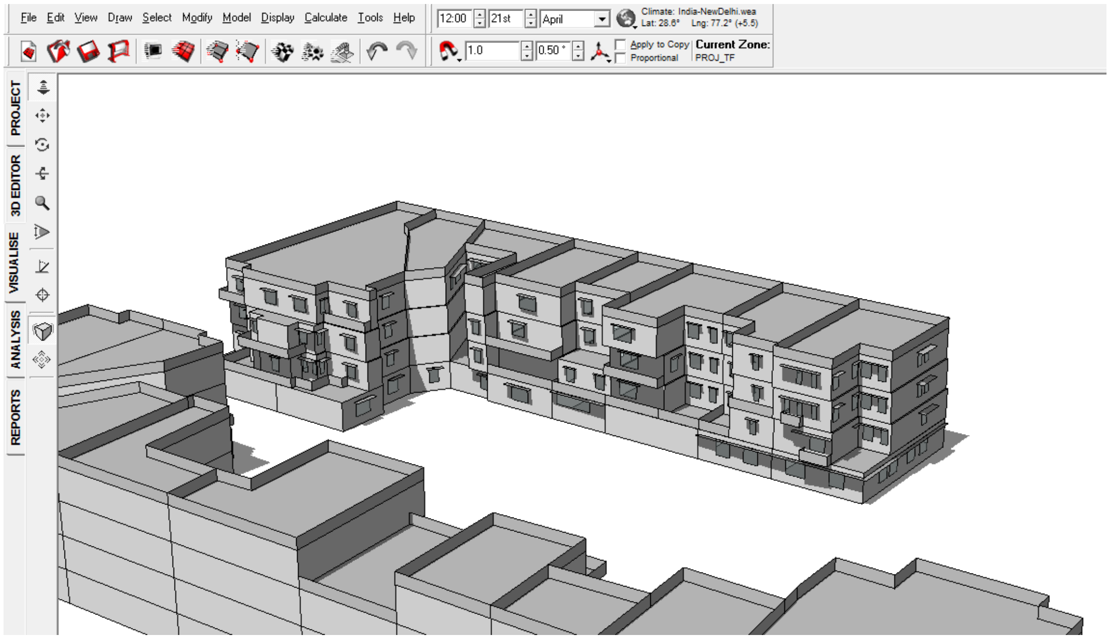


FIGURE 61: SHADOW RANGE ON 21ST APRIL 12 PM WITHOUT VIADUCT

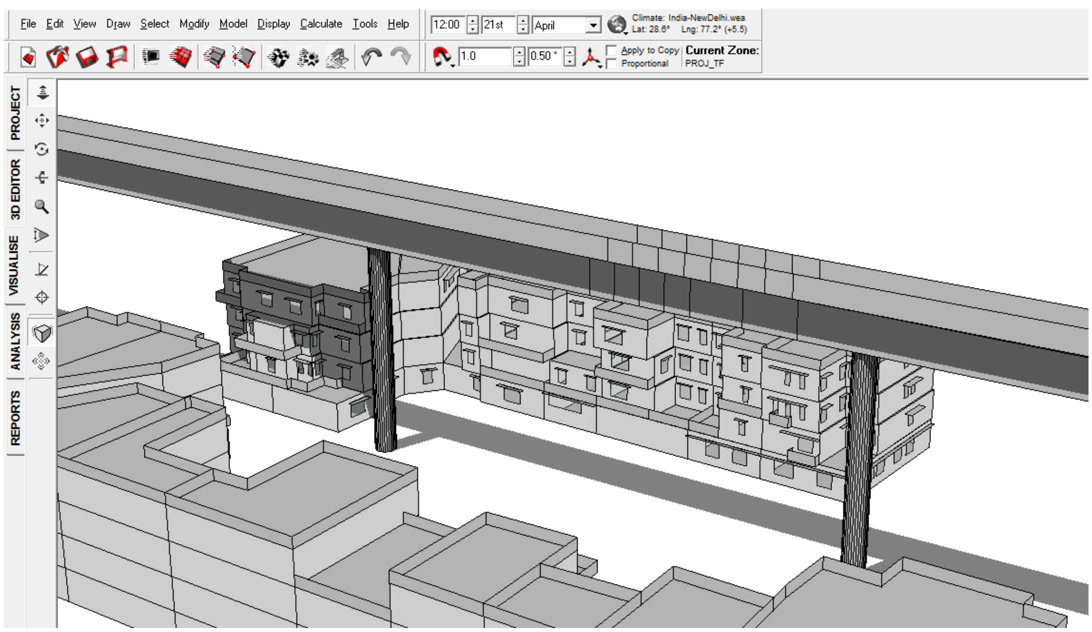


FIGURE 62: SHADOW RANGE ON 21ST APRIL 12 PM WITH VIADUCT

FIGURE 61 represents the shadow caused to the buildings. On the basis of the above image, the buildings are not casting any shadow on the nearby building but most of the windows is shaded by overhang. FIGURE 62 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second & first floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the façade of the buildings, which itself is acting as a shade for the façade on 21st April 12 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

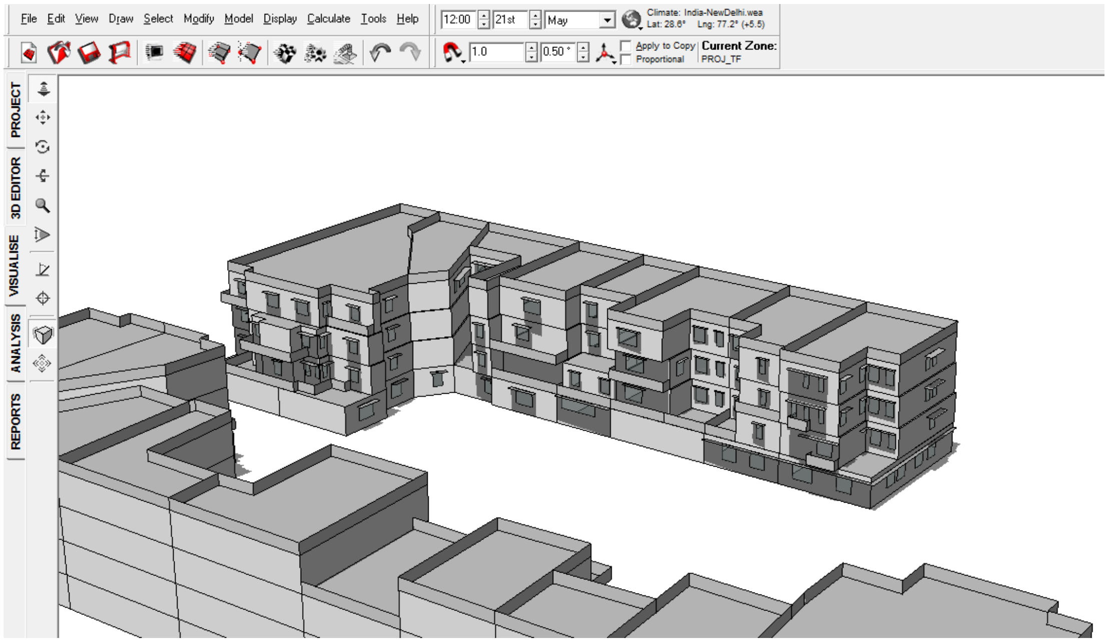


FIGURE 63: SHADOW RANGE ON 21ST MAY 12 PM WITHOUT VIADUCT

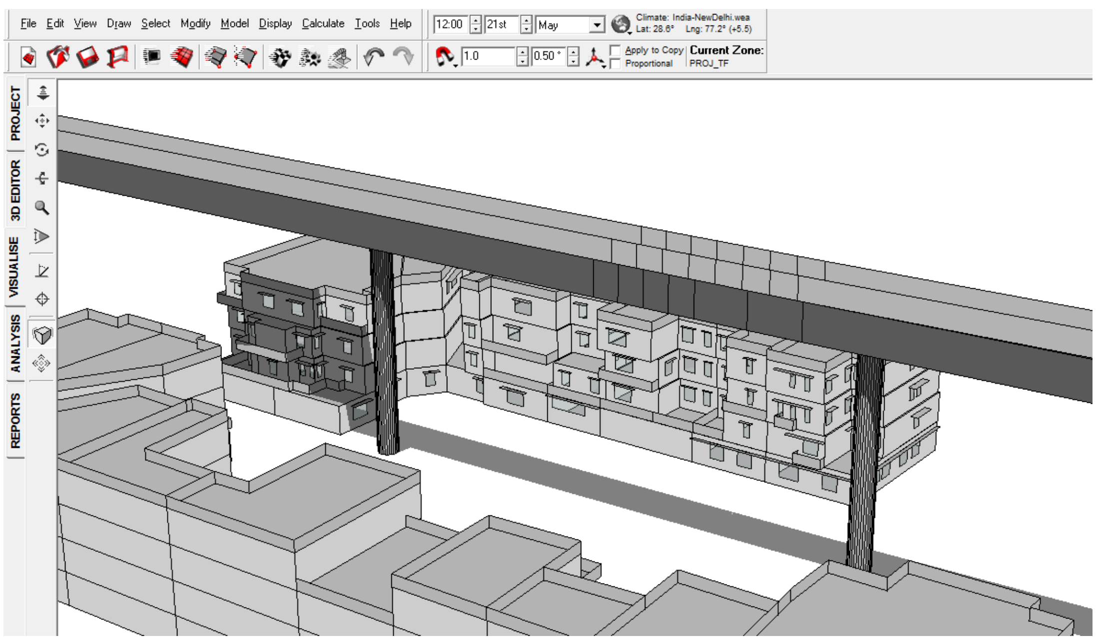


FIGURE 64: SHADOW RANGE ON 21ST MAY 12 PM WITH VIADUCT

FIGURE 63 represents the shadow caused to the buildings. On the basis of the above image, the buildings are not casting any shadow on the nearby building but most of the windows is shaded by overhang. FIGURE 64 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second, first & ground floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the façade of the buildings, which itself is acting as a shade for the façade on 21st May 12 PM.

GreenTree Building Energy Pvt. Ltd. DELHI NCR

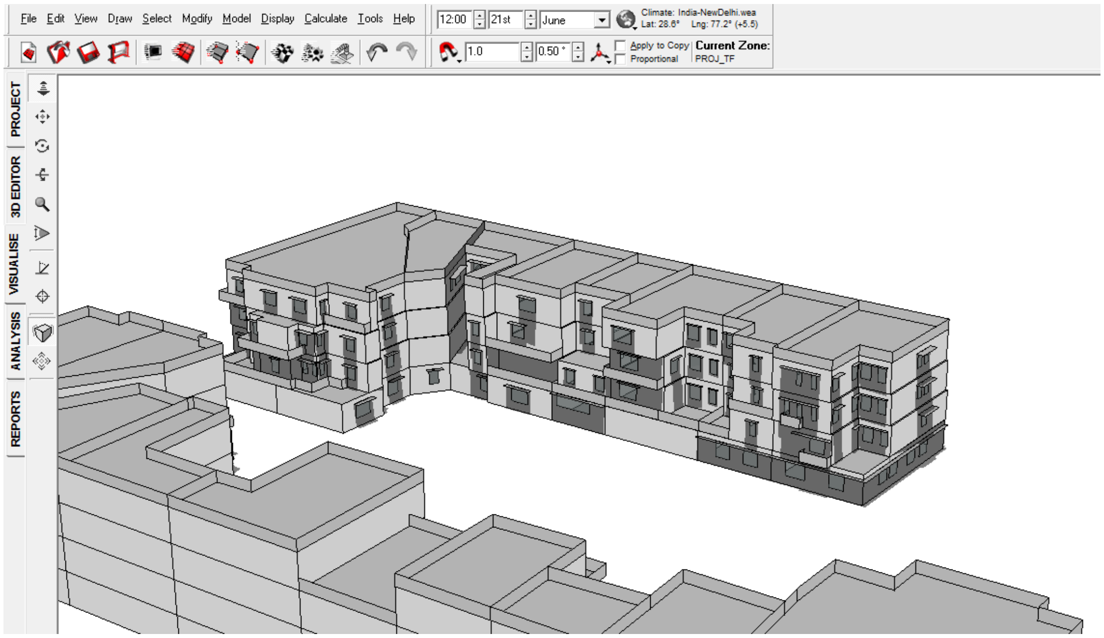


FIGURE 65: SHADOW RANGE ON 21ST JUNE 12 PM WITHOUT VIADUCT

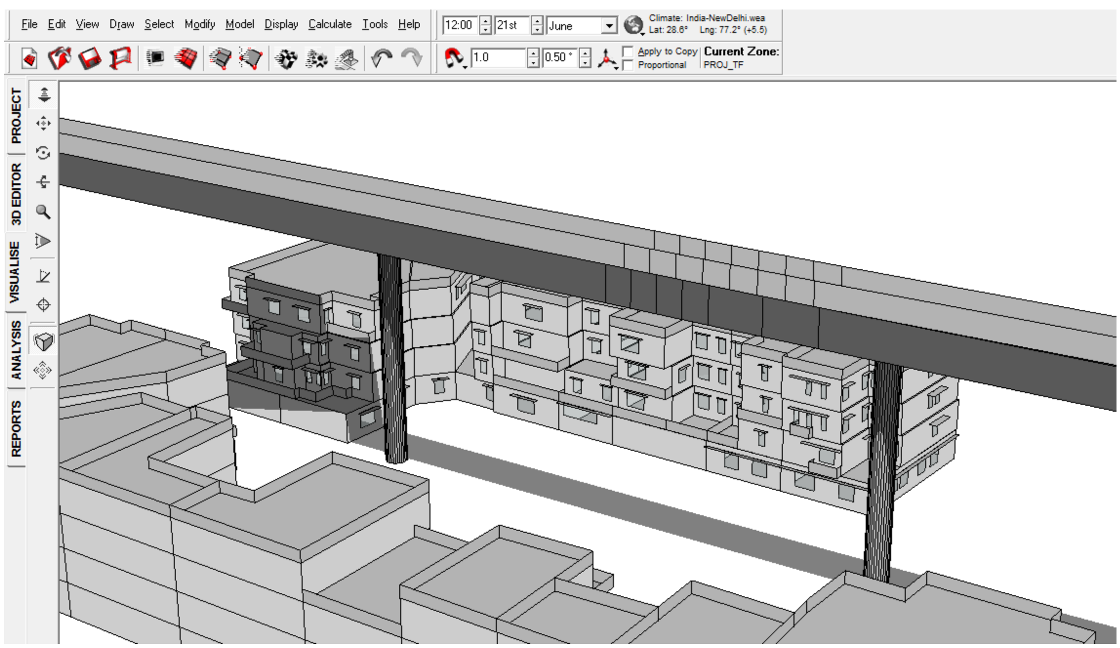


FIGURE 66: SHADOW RANGE ON 21ST JUNE 12 PM WITH VIADUCT

FIGURE 65 represents the shadow caused to the buildings. On the basis of the above image, the buildings are not casting any shadow on the nearby building but most of the windows is shaded by overhang. FIGURE 66 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second, first & ground floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the façade of the buildings, which itself is acting as a shade for the façade on 21st June 12 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

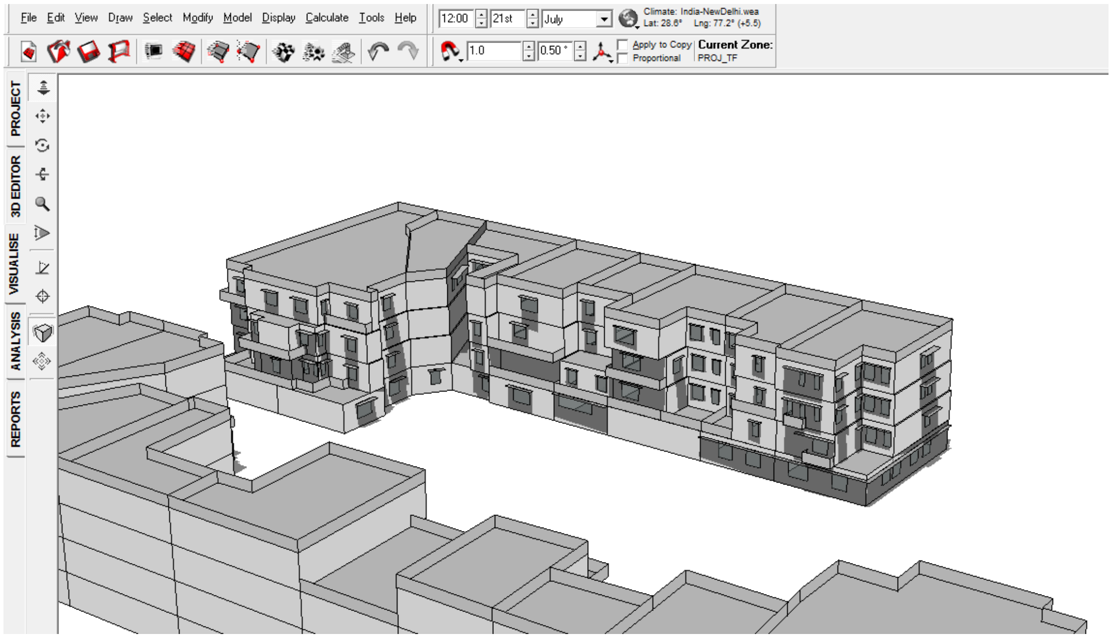


FIGURE 67: SHADOW RANGE ON 21ST JULY 12 PM WITHOUT VIADUCT

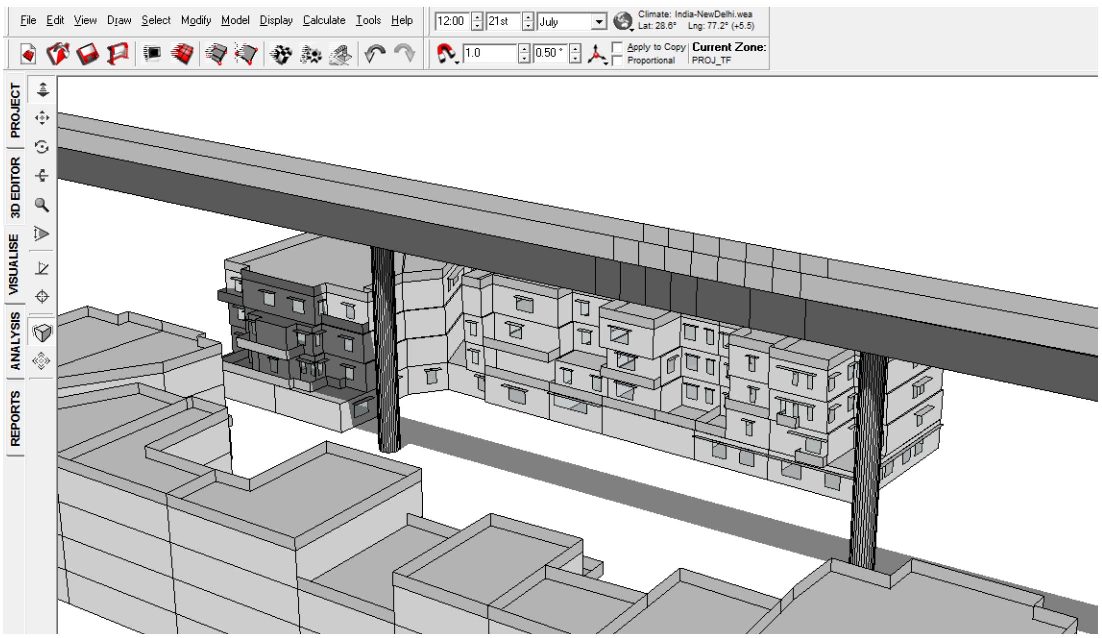


FIGURE 68: SHADOW RANGE ON 21ST JULY 12 PM WITH VIADUCT

FIGURE 67 represents the shadow caused to the buildings. On the basis of the above image, the buildings are not casting any shadow on the nearby building but most of the windows is shaded by overhang. FIGURE 68 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second, first & ground floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the façade of the buildings, which itself is acting as a shade for the façade on 21st July 12 PM.

GreenTree Building Energy Pvt. Ltd. DELHI NCR

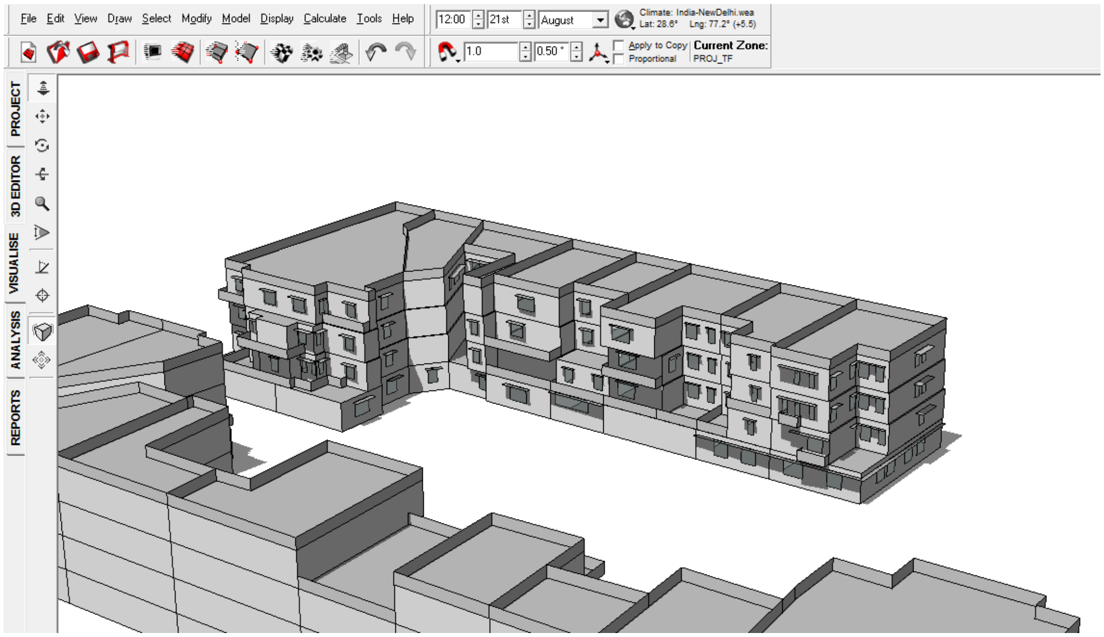


FIGURE 69: SHADOW RANGE ON 21ST AUGUST 12 PM WITHOUT VIADUCT

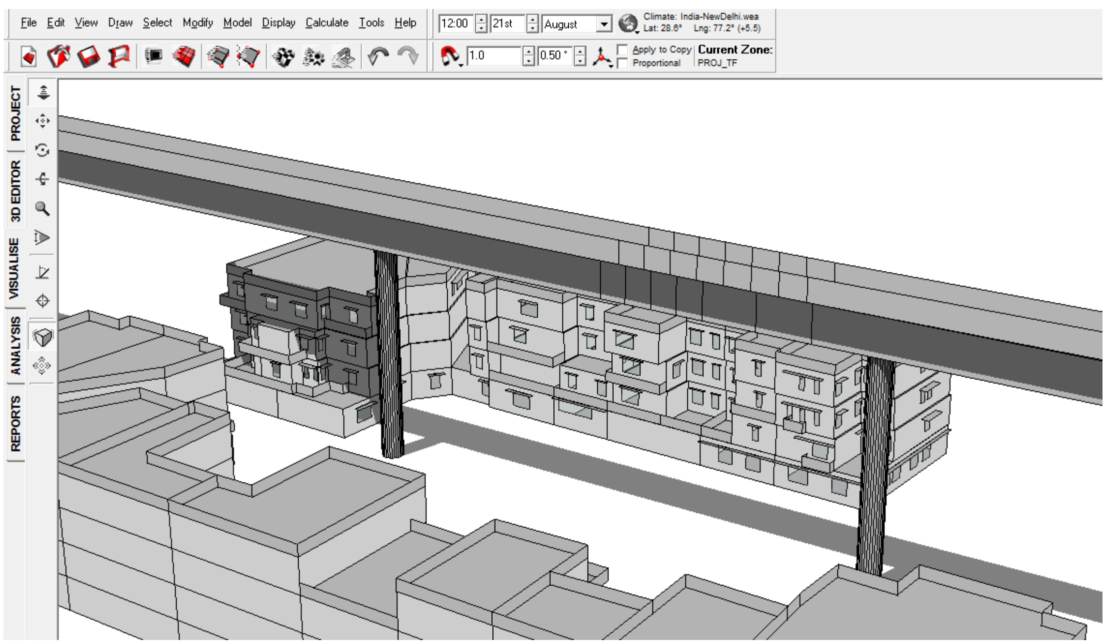


FIGURE 70: SHADOW RANGE ON 21ST AUGUST 12 PM WITH VIADUCT

FIGURE 69 represents the shadow caused to the buildings. On the basis of the above image, the buildings are not casting any shadow on the nearby building but most of the windows is shaded by overhang. FIGURE 70 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second, first & ground floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the façade of the buildings, which itself is acting as a shade for the façade on 21st August 12 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

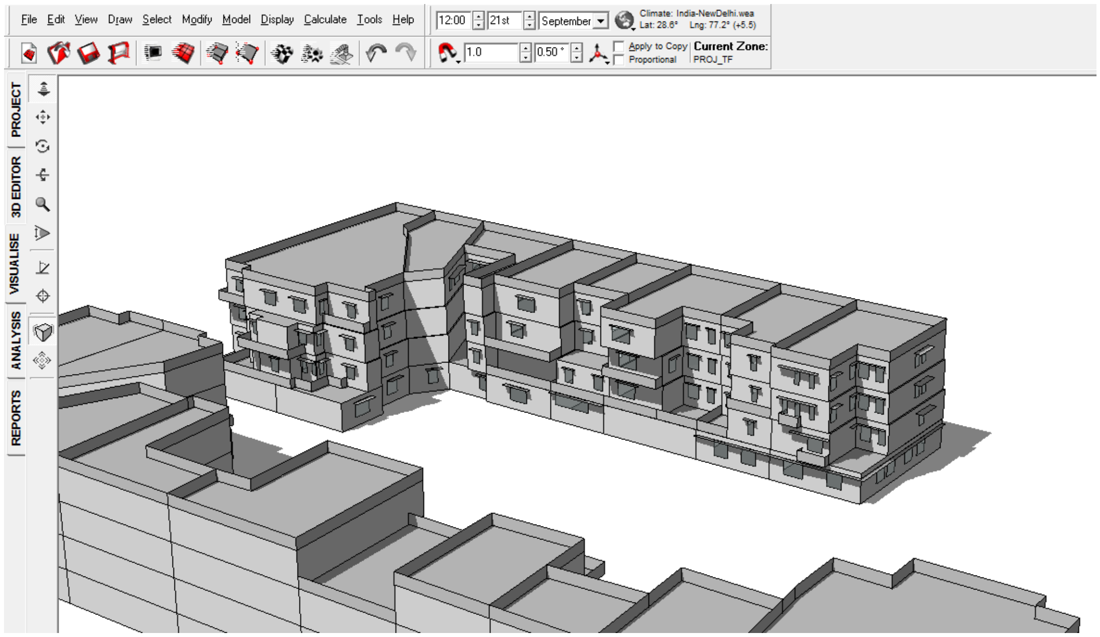


FIGURE 71: SHADOW RANGE ON 21ST SEPTEMBER 12 PM WITHOUT VIADUCT

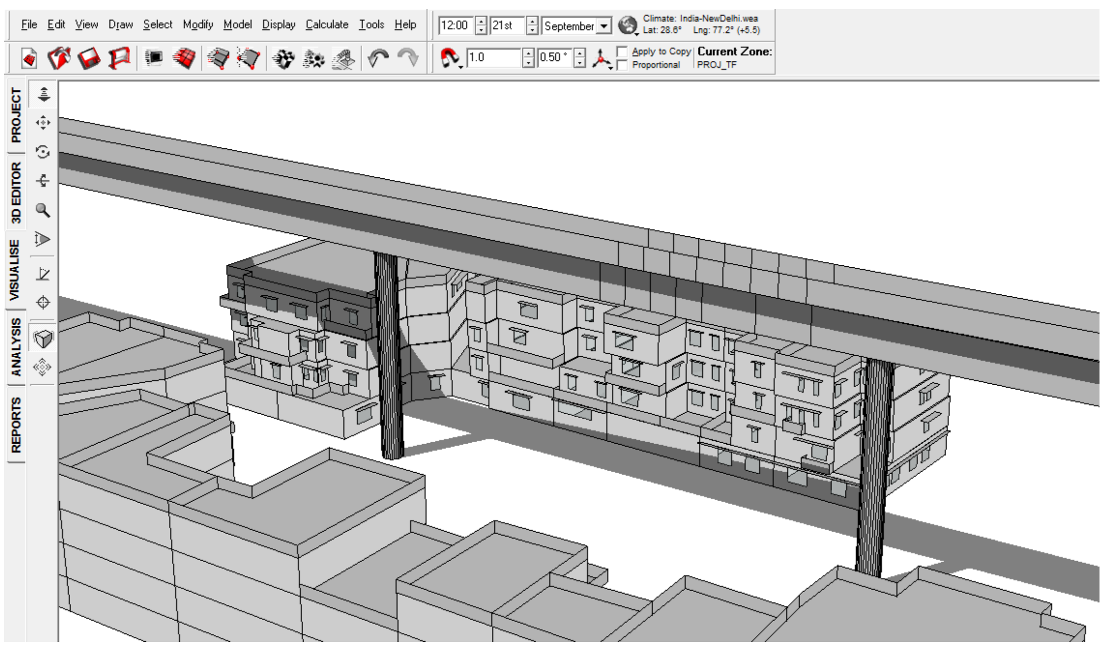


FIGURE 72: SHADOW RANGE ON 21ST SEPTEMBER 12 PM WITH VIADUCT

FIGURE 71 represents the shadow caused to the buildings. On the basis of the above image, the buildings are not casting any shadow on the nearby building but most of the windows is shaded by overhang. FIGURE 72 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second, first & ground floor of Block – 219, third floor of Block – 220 and ground floor of the block – 211, 212, 213, 214 & 217 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st September 12 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

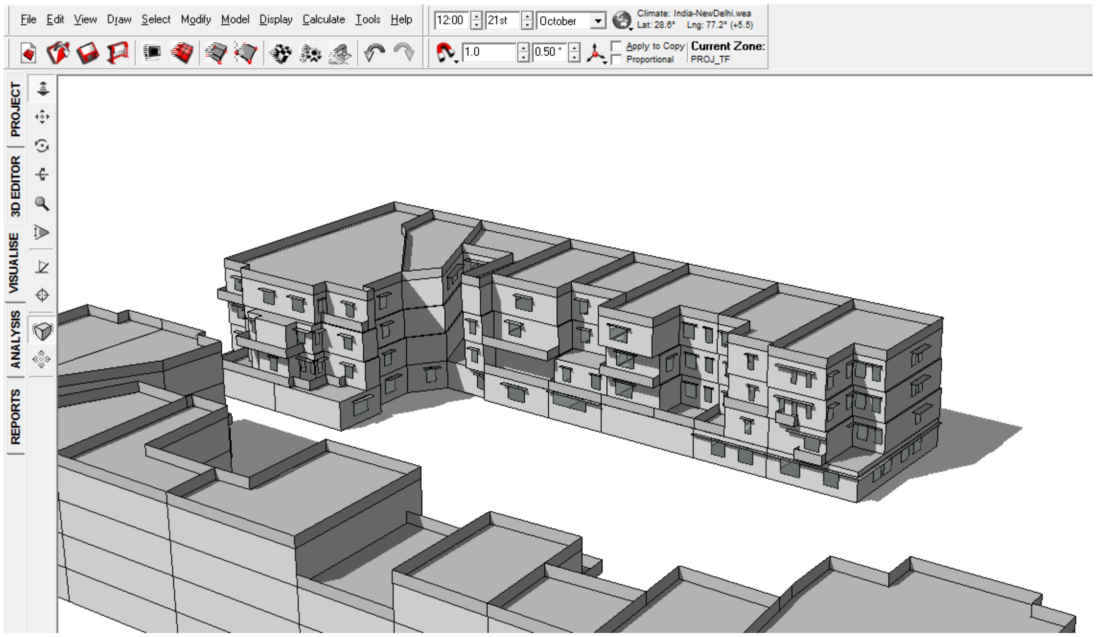


FIGURE 73: SHADOW RANGE ON 21ST OCTOBER 12 PM WITHOUT VIADUCT

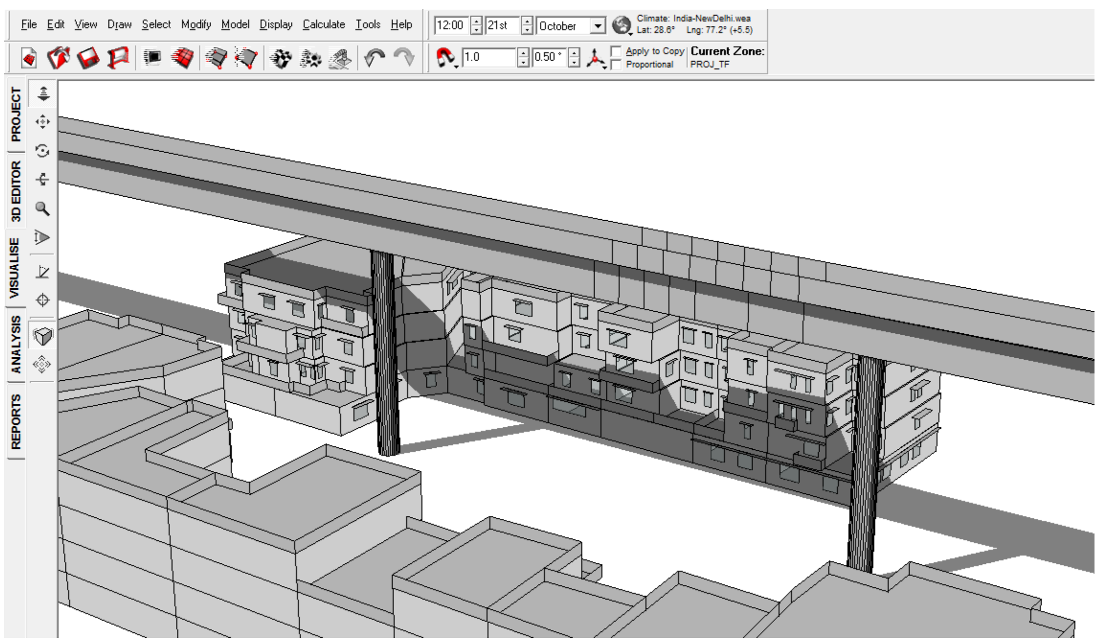


FIGURE 74: SHADOW RANGE ON 21ST OCTOBER 12 PM WITH VIADUCT

FIGURE 73 represents the shadow caused to the buildings. On the basis of the above image, the Block – 219 is casting shadow on the Block – 217. FIGURE 74 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the second, first & ground floor of Blocks – 211, 212, 213, 216 & 217, first & ground floor of Blocks –214 & 215 and third floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the back side of the building, which itself is acting as a shade for the back side of the buildings on 21st October 12 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

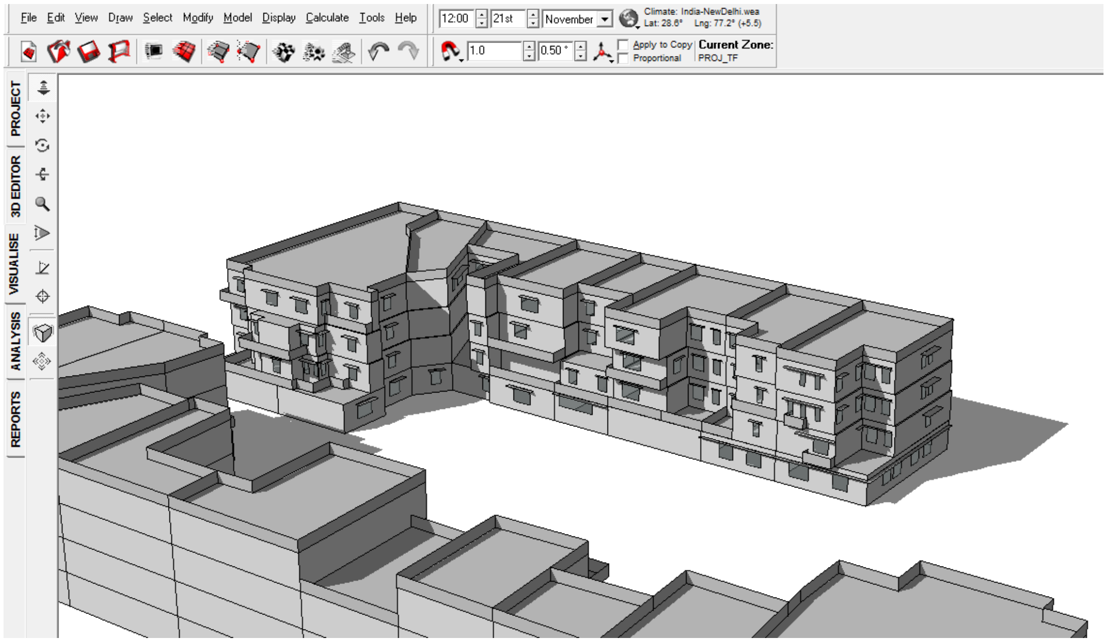


FIGURE 75: SHADOW RANGE ON 21ST NOVEMBER 12 PM WITHOUT VIADUCT

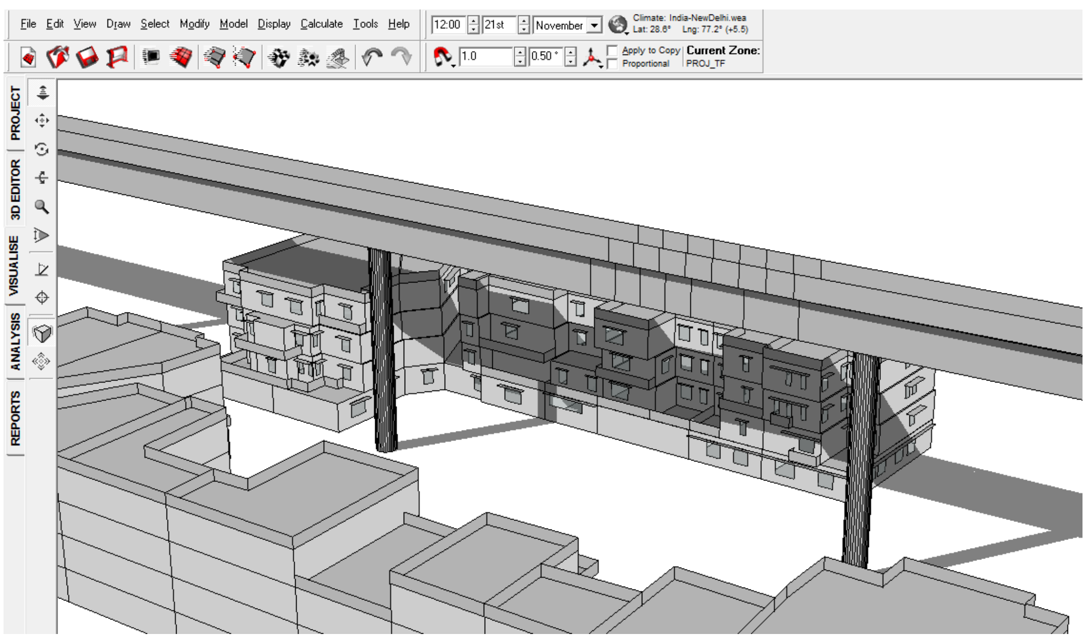


FIGURE 76: SHADOW RANGE ON 21ST NOVEMBER 12 PM WITH VIADUCT

FIGURE 75 represents the shadow caused to the buildings. On the basis of the above image, the Block – 219 is casting shadow on the Blocks – 217 & 216. FIGURE 76 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second & first floor of Blocks – 211, 212, 213, 215, 216 & 217 and second, first & ground floor of Block – 214 thereby obstructing the direct sunlight falling on the back side of the building, which itself is acting as a shade for the back side of the buildings on 21st November 12 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

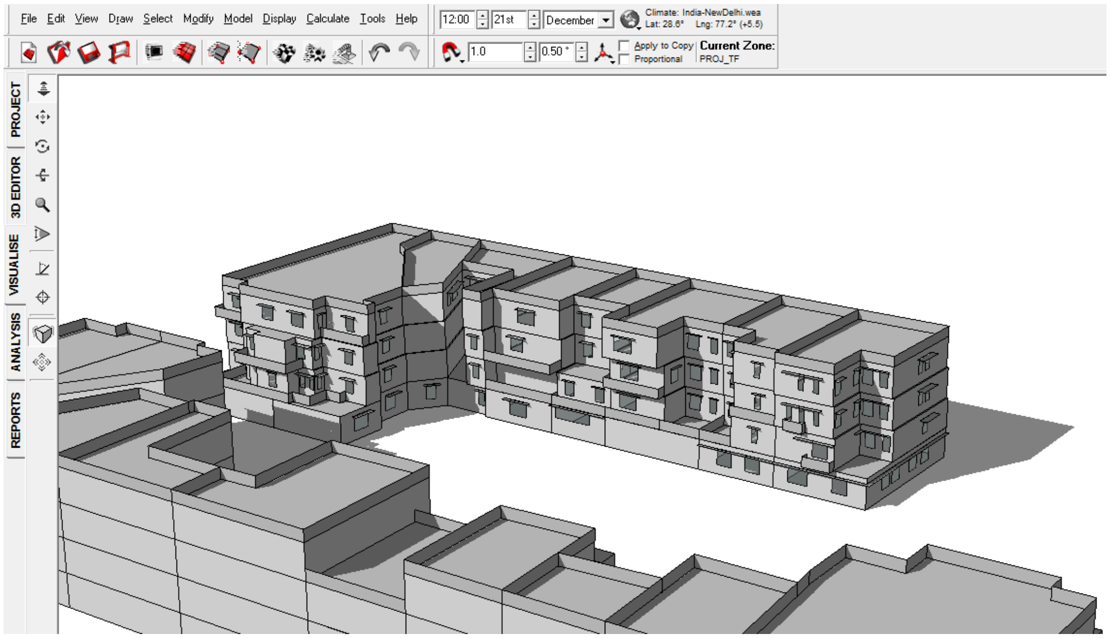


FIGURE 77: SHADOW RANGE ON 21ST DECEMBER 12 PM WITHOUT VIADUCT

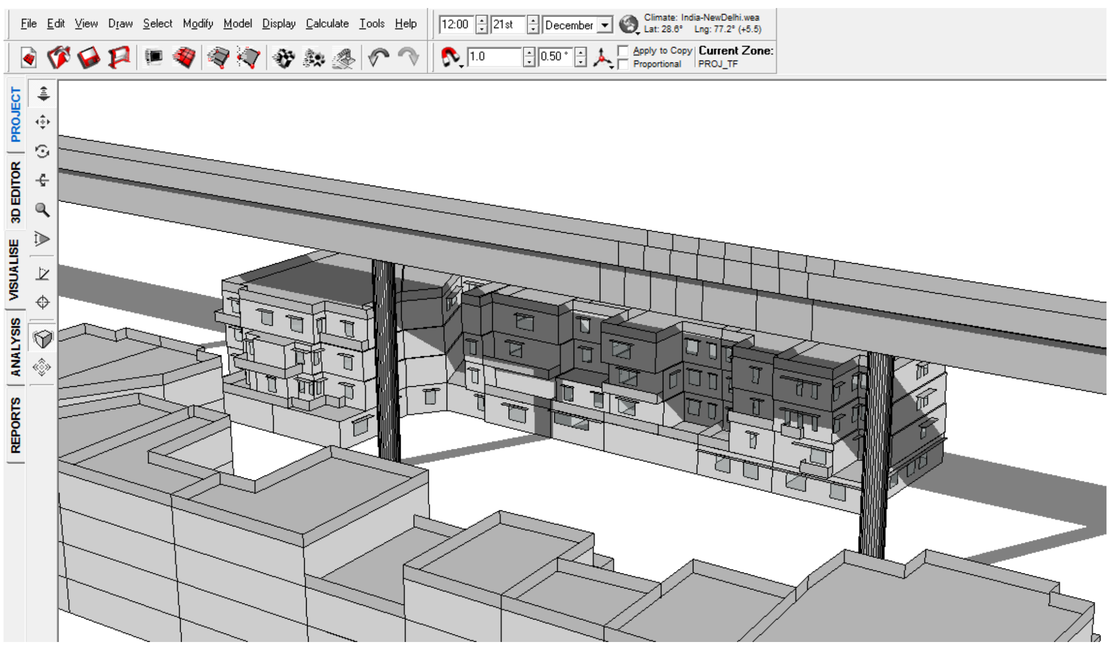


FIGURE 78: SHADOW RANGE ON 21ST DECEMBER 12 PM WITH VIADUCT

FIGURE 77 represents the shadow caused to the buildings. On the basis of the above image, the Block – 219 is casting shadow on the Blocks – 217 & 216. FIGURE 78 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second & first floor of Blocks – 211, 212, 213, 216 & 217, third & second floor of Block – 214 and third, second, first & ground floor of Block – 211 thereby obstructing the direct sunlight falling on the back side of the buildings, which itself is acting as a shade for the back side of the buildings on 21st December 12 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

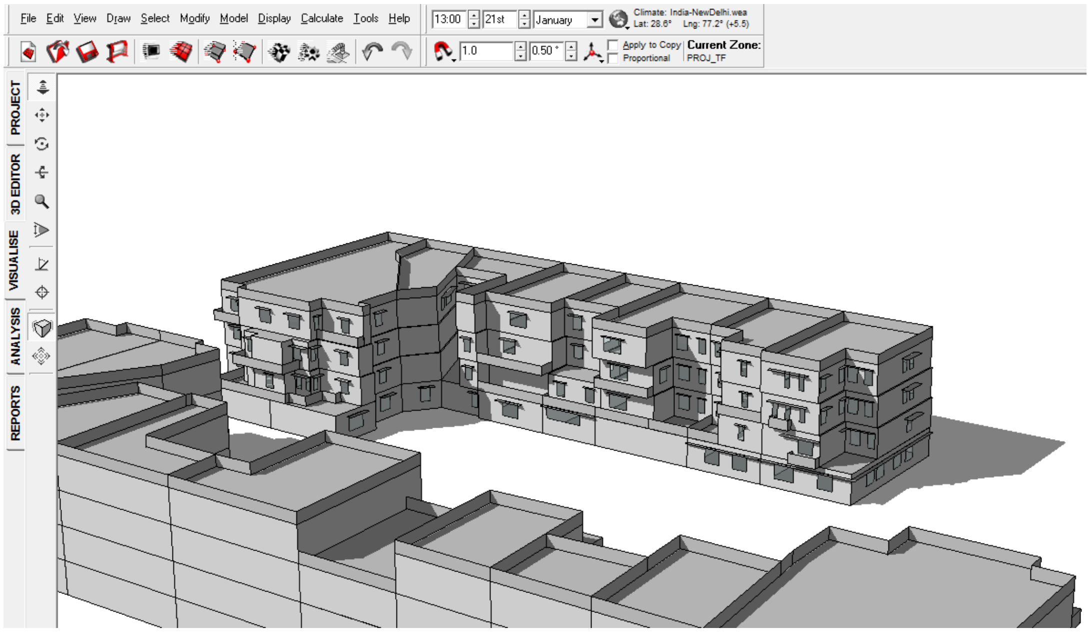


FIGURE 79: SHADOW RANGE ON 21ST JANUARY 1 PM WITHOUT VIADUCT

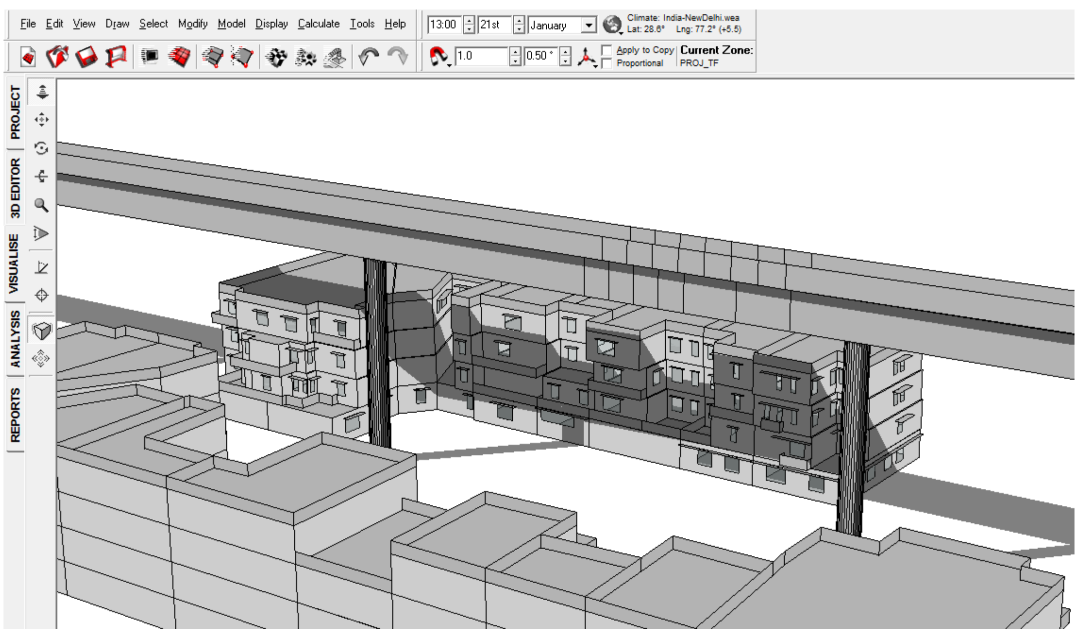


FIGURE 80: SHADOW RANGE ON 21ST JANUARY 1 PM WITH VIADUCT

FIGURE 79 represents the shadow caused to the buildings. On the basis of the above image, the Block – 219 is casting shadow on the Blocks – 217, 216 & 215. FIGURE 80 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second & first floor of Blocks – 211, 212, 213, 215 & 217, third, second, first & ground floor of Block – 216 and second, first & ground floor of Block – 214 thereby obstructing the direct sunlight falling on the back side of the buildings, which itself is acting as a shade for the back side of the buildings on 21st January 1 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

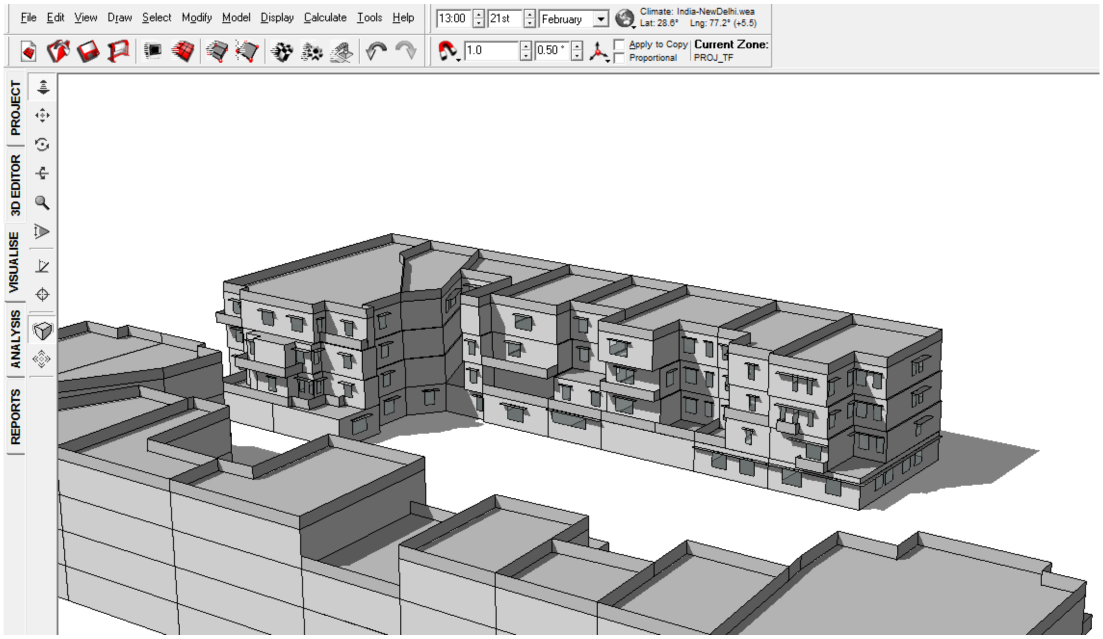


FIGURE 81: SHADOW RANGE ON 21ST FEBRUARY 1 PM WITHOUT VIADUCT

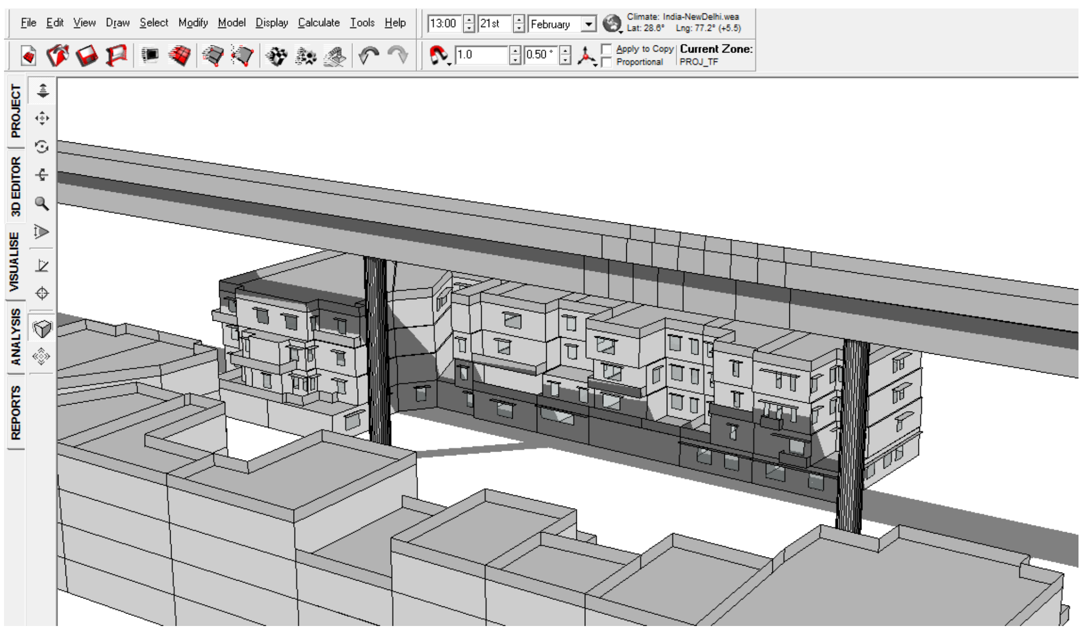


FIGURE 82: SHADOW RANGE ON 21ST FEBRUARY 1 PM WITH VIADUCT

FIGURE 81 represents the shadow caused to the buildings. On the basis of the above image, the Block – 219 is casting shadow on the Blocks – 217 & 216. FIGURE 82 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the second, first & ground floor of Blocks – 211, 212, 213, 214, 215, 216 & 217 and third floor of Blocks – 219 & 220 and second, first & ground floor of Block – 214 thereby obstructing the direct sunlight falling on the back side of the buildings, which itself is acting as a shade for back side of the buildings on 21st February 1 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

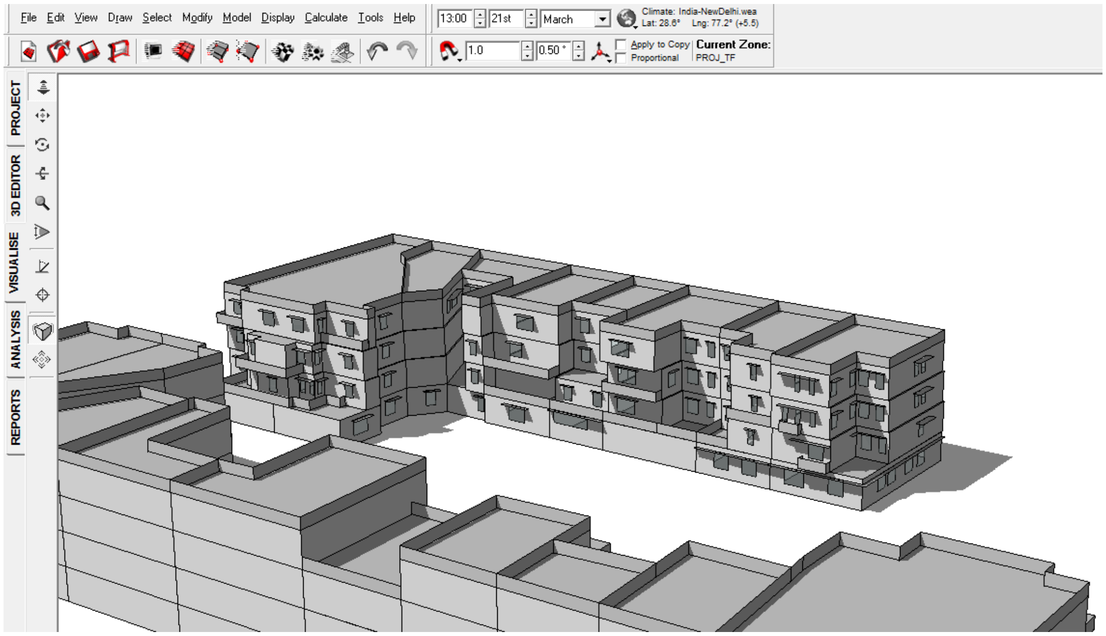


FIGURE 83: SHADOW RANGE ON 21ST MARCH 1 PM WITHOUT VIADUCT

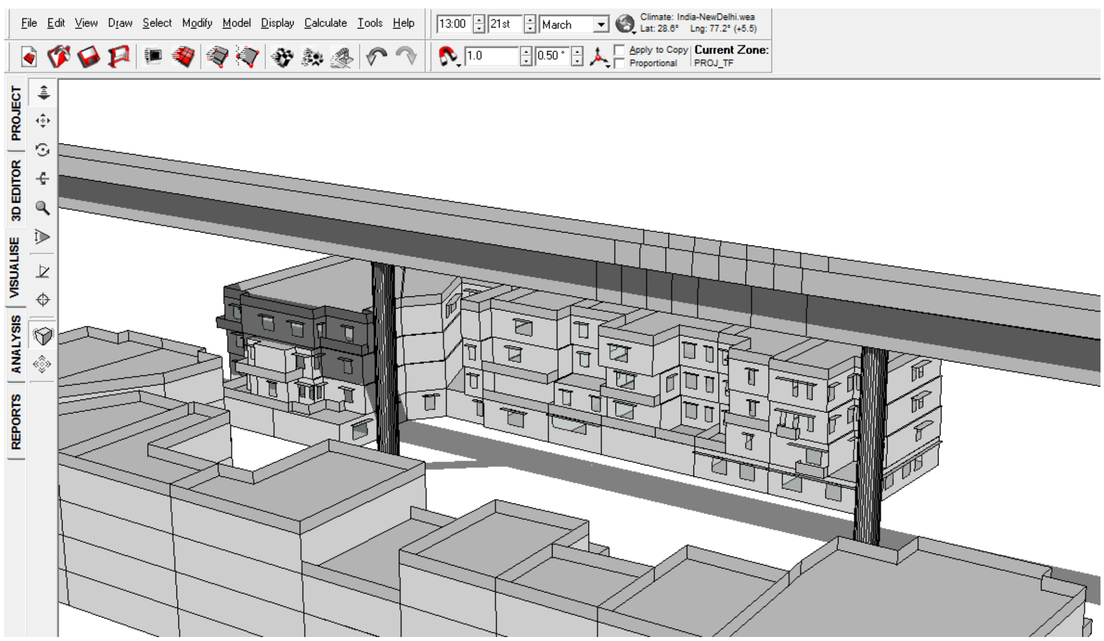


FIGURE 84: SHADOW RANGE ON 21ST MARCH 1 PM WITH VIADUCT

FIGURE 83 represents the shadow caused to the buildings. On the basis of the above image, the Block – 219 is casting shadow on the Block – 217. FIGURE 84 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second & first floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st March 1 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

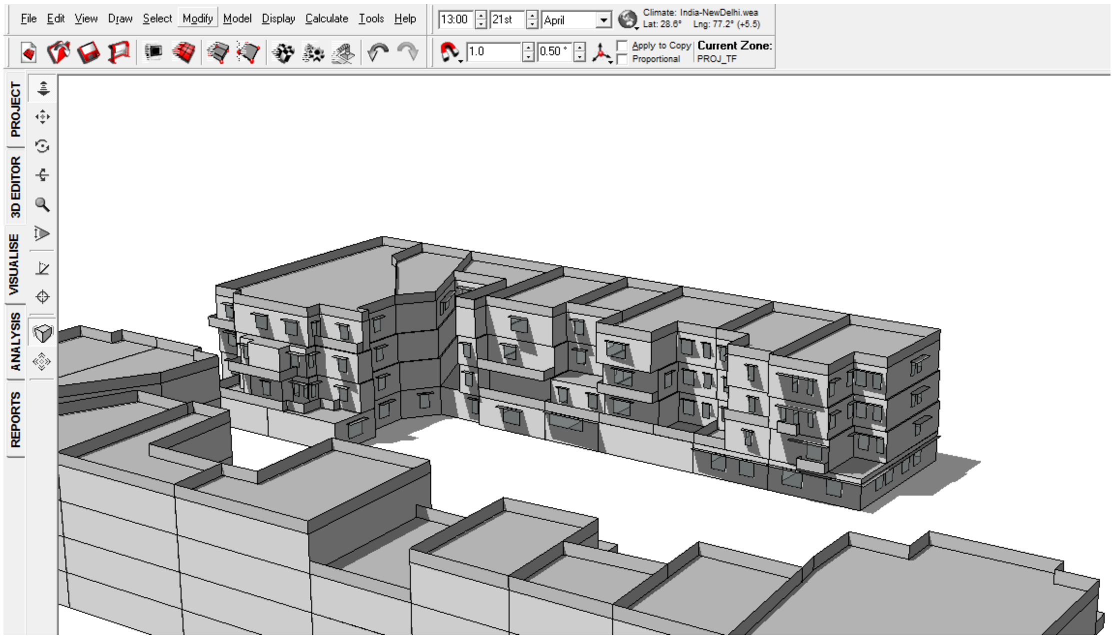


FIGURE 85: SHADOW RANGE ON 21ST APRIL 1 PM WITHOUT VIADUCT

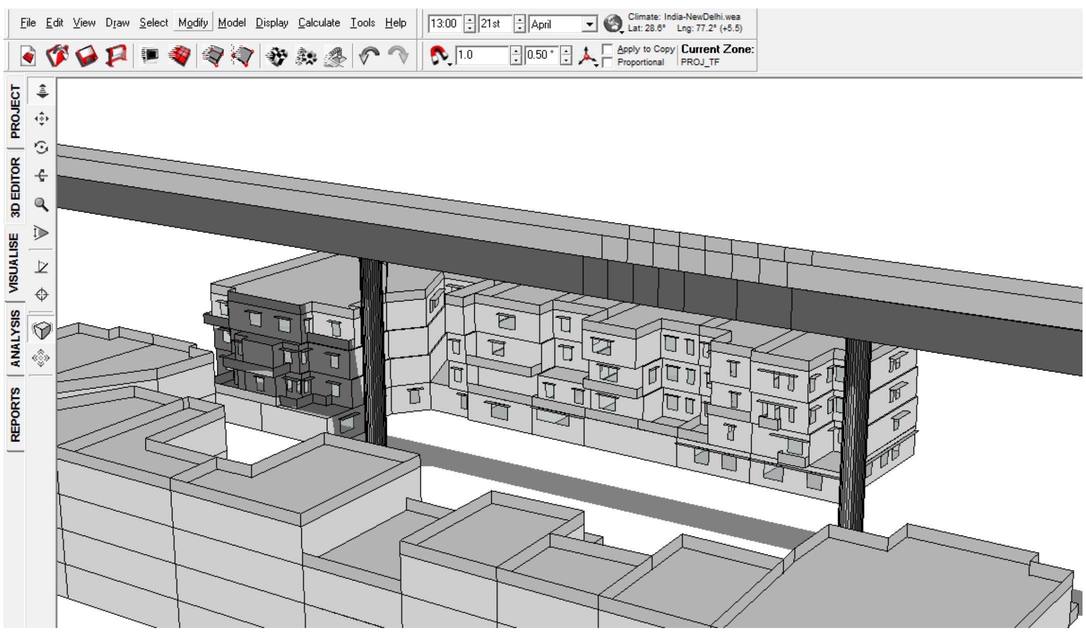


FIGURE 86: SHADOW RANGE ON 21ST APRIL 1 PM WITH VIADUCT

FIGURE 85 represents the shadow caused to the buildings. On the basis of the above image, the building is not casting any shadow on the nearby buildings but most of the windows is shaded by the overhang. FIGURE 86 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second, first & ground floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st April 1 PM.

GreenTree Building Energy P.Vt. Ltd.
DELHI NCR

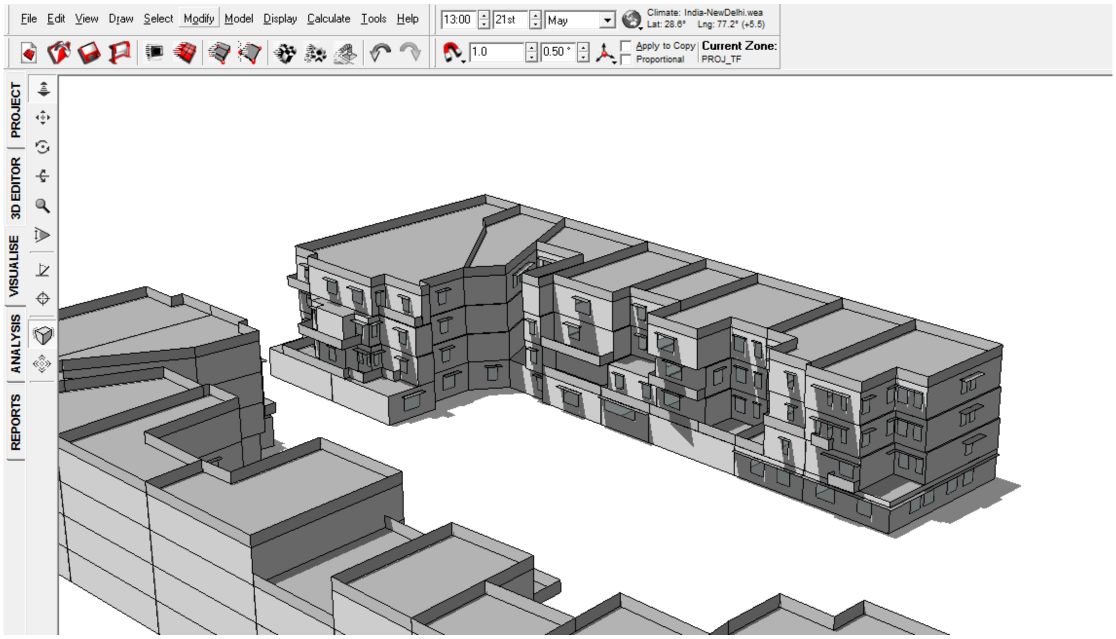


FIGURE 87: SHADOW RANGE ON 21ST MAY 1 PM WITHOUT VIADUCT

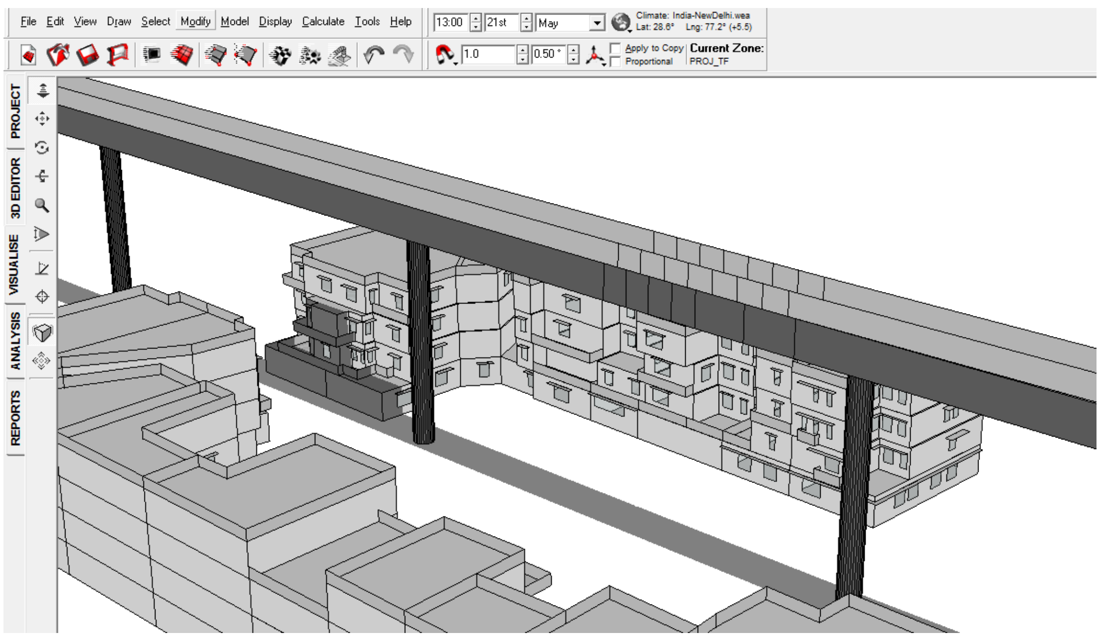


FIGURE 88: SHADOW RANGE ON 21ST MAY 1 PM WITH VIADUCT

FIGURE 87 represents the shadow caused to the buildings. On the basis of the above image, the building is not casting any shadow on the nearby buildings but most of the windows is shaded by the overhang. FIGURE 88 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the second, first & ground floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st May 1 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

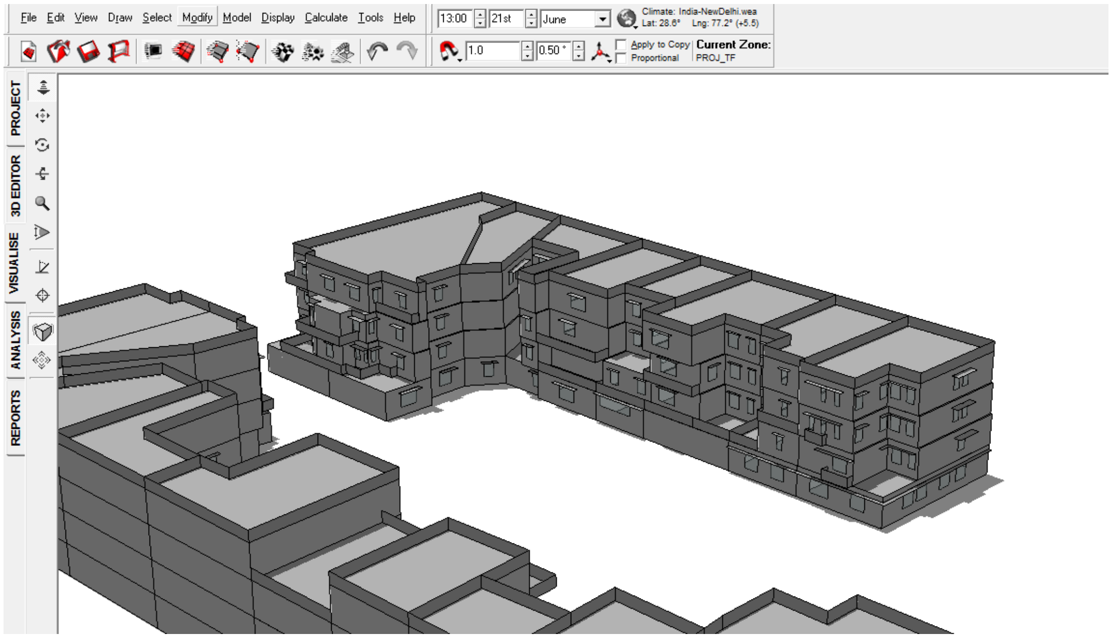


FIGURE 89: SHADOW RANGE ON 21ST JUNE 1 PM WITHOUT VIADUCT

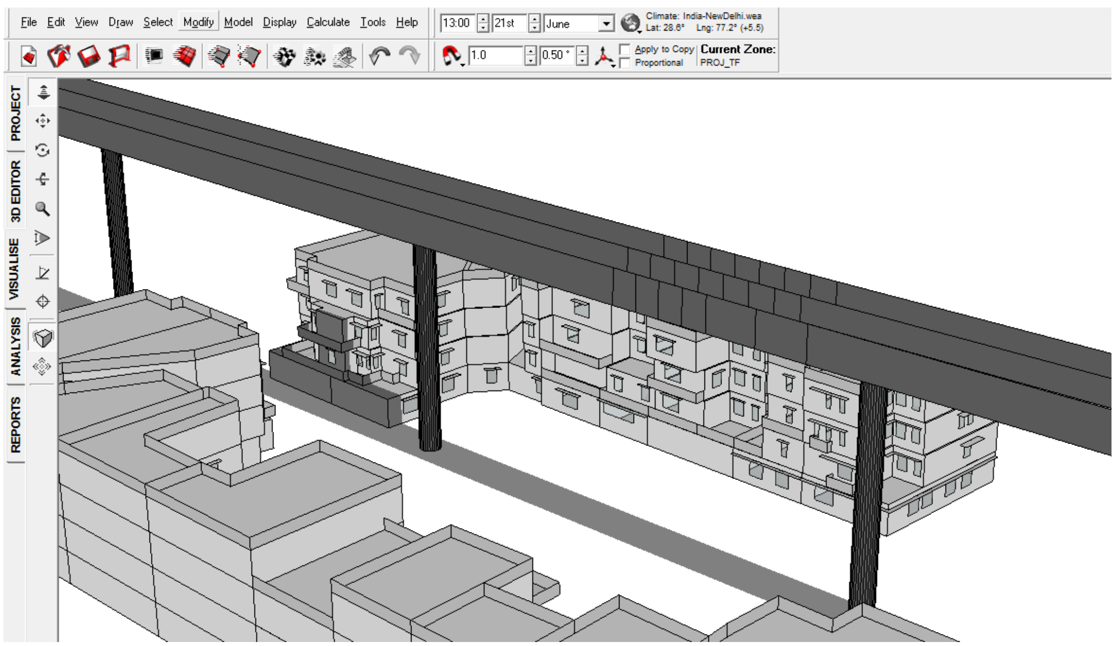


FIGURE 90: SHADOW RANGE ON 21ST JUNE 1 PM WITH VIADUCT

FIGURE 89 represents the shadow caused to the buildings. On the basis of the above image, the building is not casting any shadow on the nearby buildings but most of the windows is shaded by the overhang. FIGURE 90 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, and the Viaduct is casting shadow on the second, first & ground floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st June 1 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

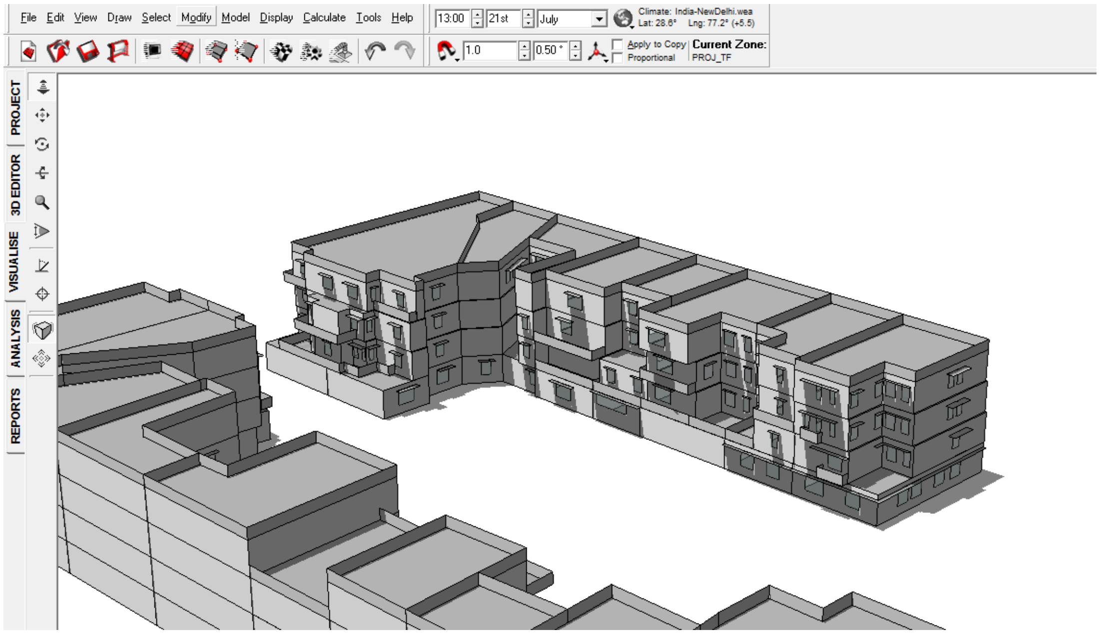


FIGURE 91: SHADOW RANGE ON 21ST JULY 1 PM WITHOUT VIADUCT

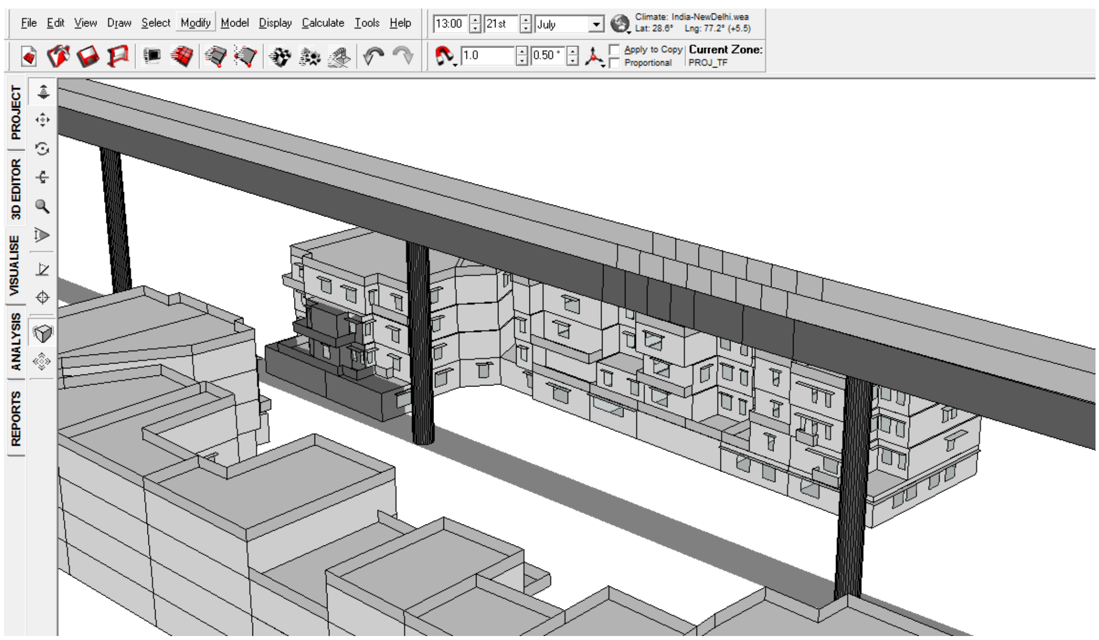


FIGURE 92: SHADOW RANGE ON 21ST JULY 1 PM WITH VIADUCT

FIGURE 91 represents the shadow caused to the buildings. On the basis of the above image, the building is not casting any shadow on the nearby buildings but most of the windows is shaded by the overhang. FIGURE 92 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the second, first & ground floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st July 1 PM.

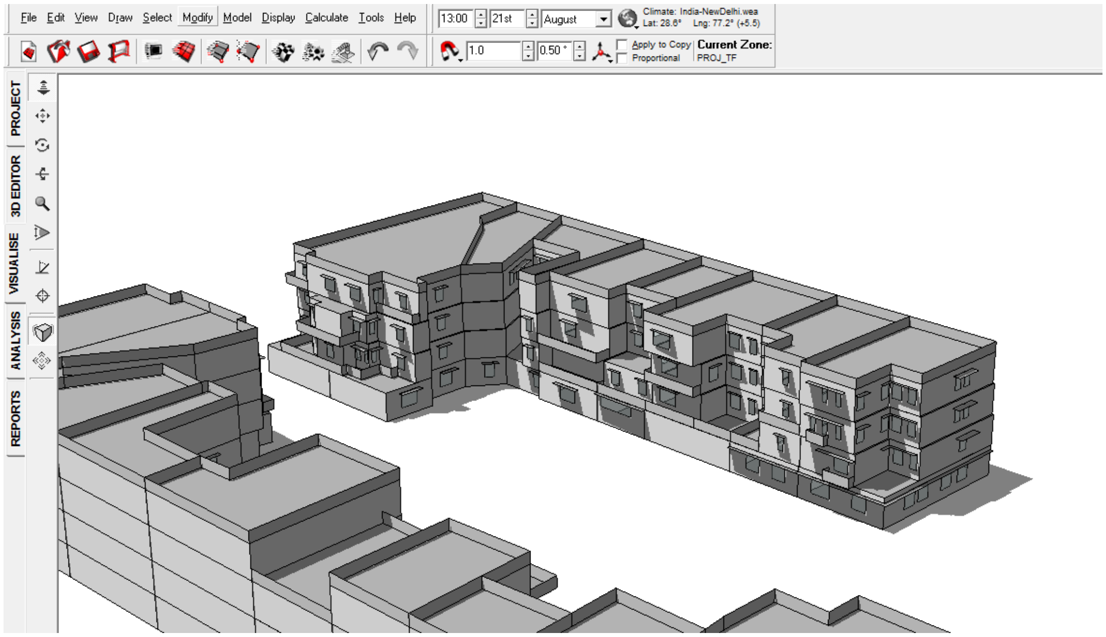


FIGURE 93: SHADOW RANGE ON 21ST AUGUST 1 PM WITHOUT VIADUCT

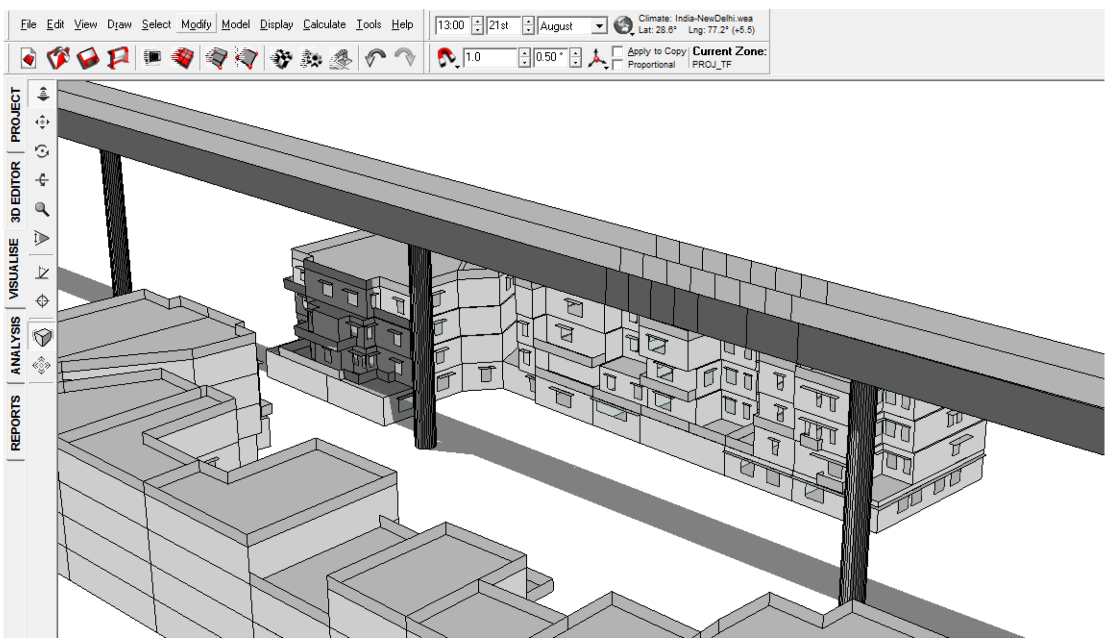


FIGURE 94: SHADOW RANGE ON 21ST AUGUST 1 PM WITH VIADUCT

FIGURE 93 represents the shadow caused to the buildings. On the basis of the above image, the building is not casting any shadow on the nearby buildings but most of the windows is shaded by the overhang. FIGURE 94 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second, first & ground floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st August 1 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

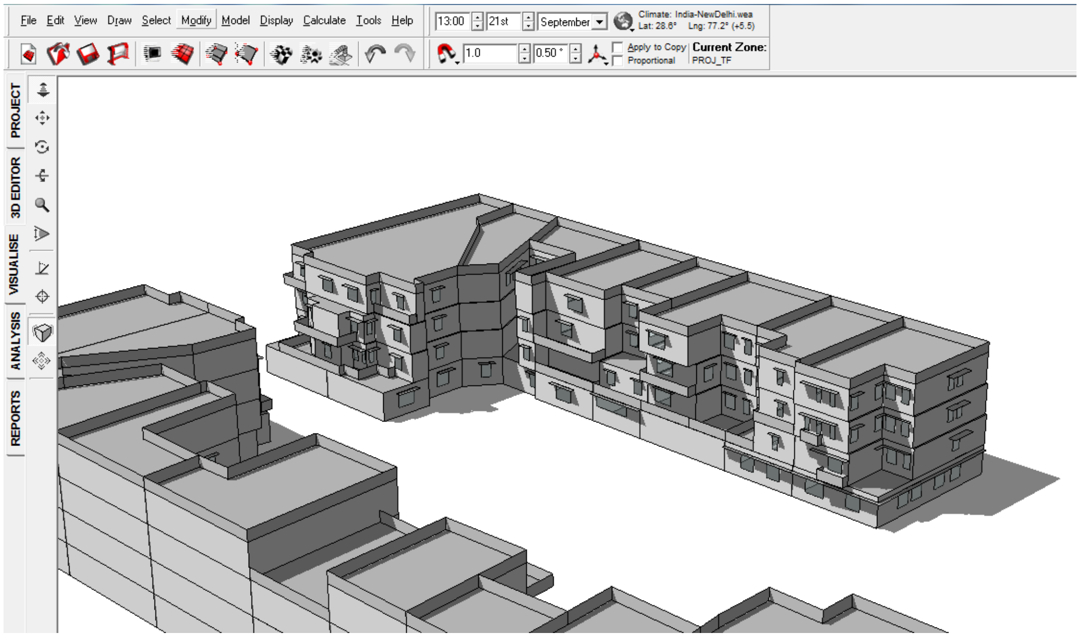


FIGURE 95: SHADOW RANGE ON 21ST SEPTEMBER 1 PM WITHOUT VIADUCT

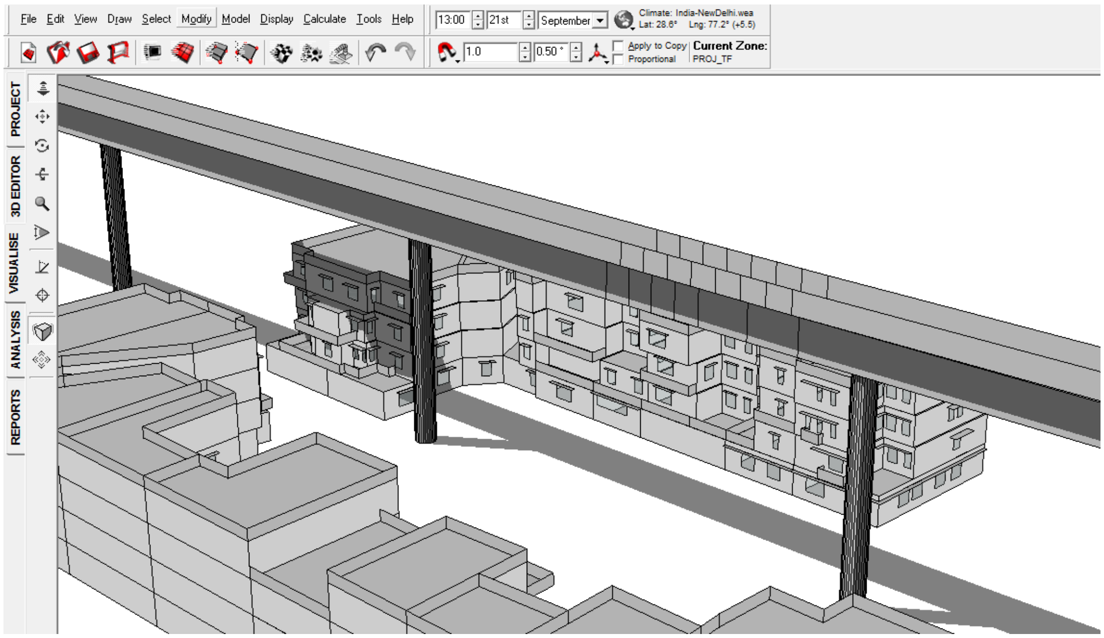


FIGURE 96: SHADOW RANGE ON 21ST SEPTEMBER 1 PM WITH VIADUCT

FIGURE 95 represents the shadow caused to the buildings. On the basis of the above image, the building is not casting any shadow on the nearby buildings but most of the windows is shaded by the overhang. FIGURE 96 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second, first & ground floor of Block – 220 and third, second & first floor of Block – 219 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st September 1 PM.

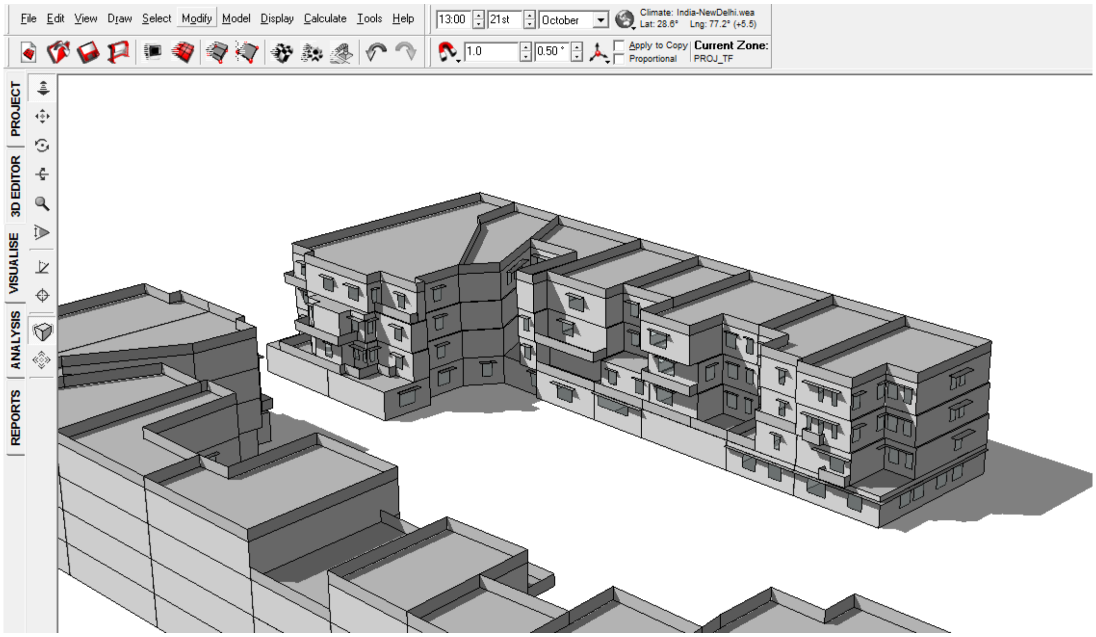


FIGURE 97: SHADOW RANGE ON 21ST OCTOBER 1 PM WITHOUT VIADUCT

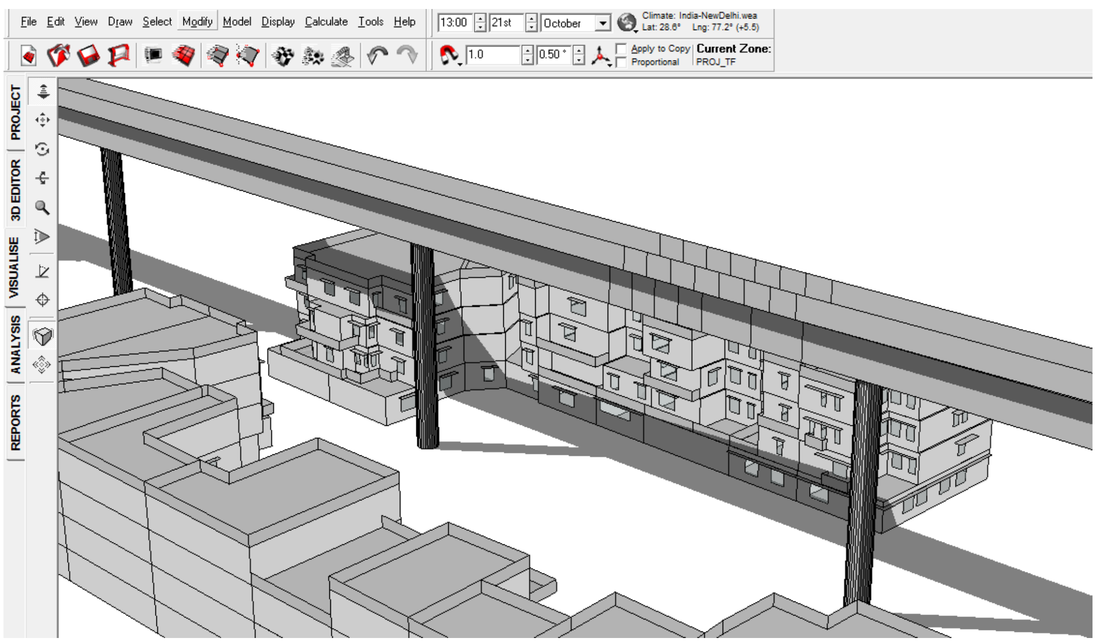


FIGURE 98: SHADOW RANGE ON 21ST OCTOBER 1 PM WITH VIADUCT

FIGURE 97 represents the shadow caused to the buildings. On the basis of the above image, Block – 220 is casting shadow on the Blocks – 217 & 216. FIGURE 98 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the second, first & ground floor of Block – 220 and third floor of Block – 219 and ground floor of Blocks – 211 to 217 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st October 1 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI
NCR

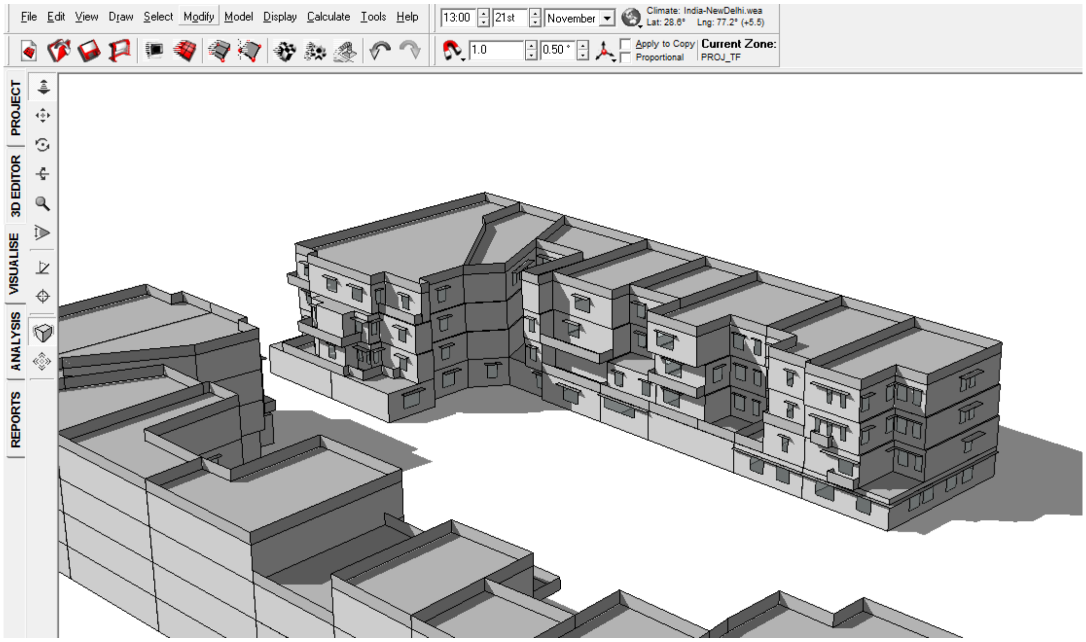


FIGURE 99: SHADOW RANGE ON 21ST NOVEMBER 1 PM WITHOUT VIADUCT

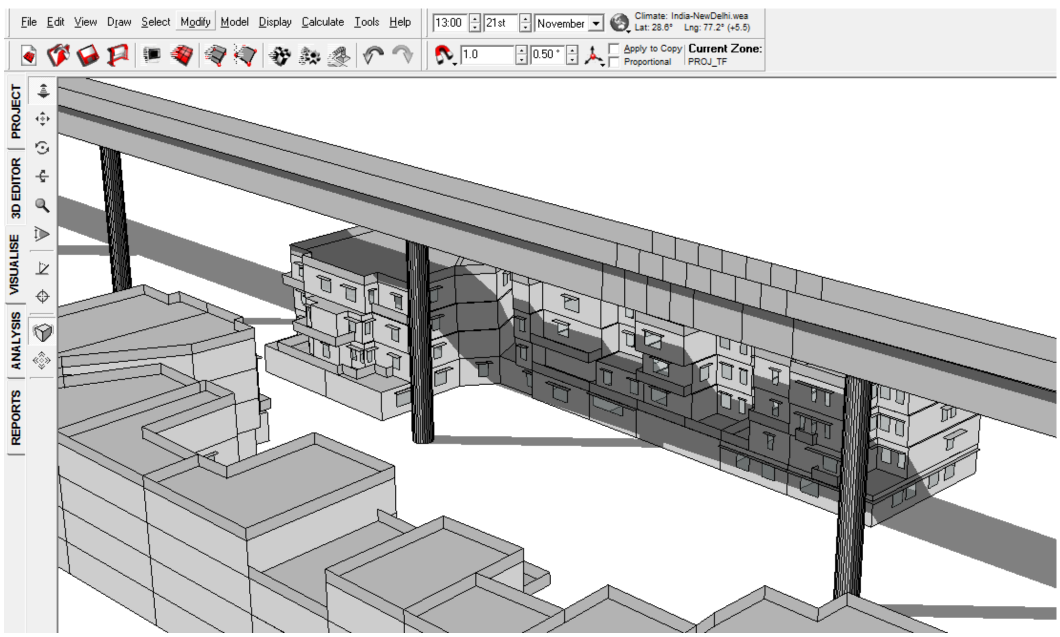


FIGURE 100: SHADOW RANGE ON 21ST NOVEMBER 1 PM WITH VIADUCT

FIGURE 99 represents the shadow caused to the buildings. On the basis of the above image, Block – 220 is casting shadow on the Blocks – 217, 216 & 215. FIGURE 100 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second, first & ground floor of Blocks – 211 to 213, 216 & 217 and second, first & ground floor of Blocks – 214 & 215 thereby obstructing the direct sunlight falling on the back side of the buildings, which itself is acting as a shade for the back side of the buildings on 21st November 1 PM.

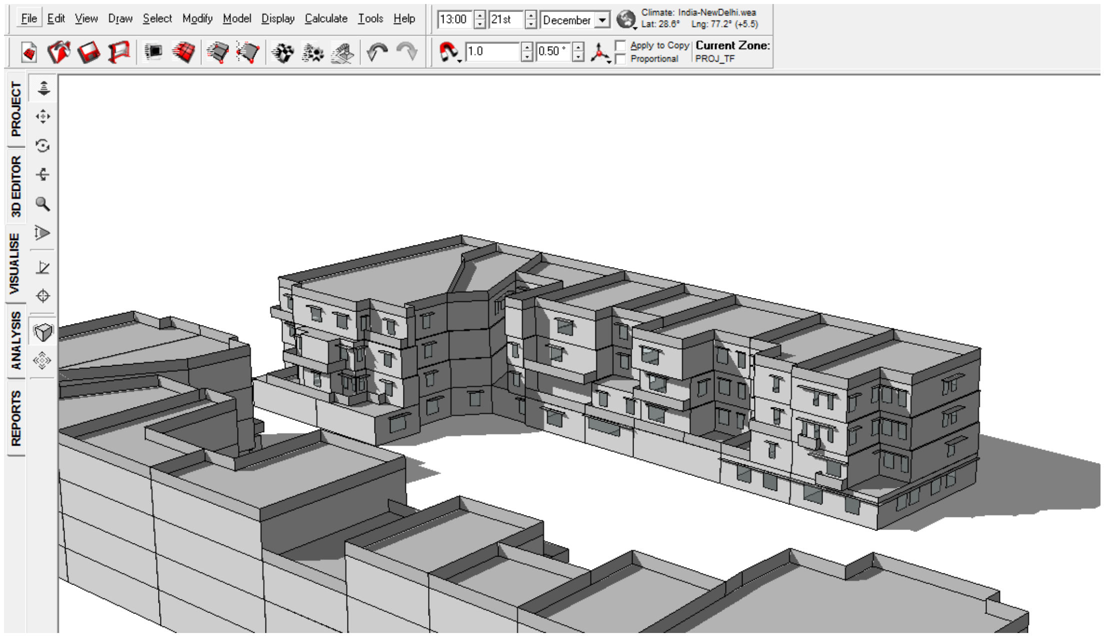


FIGURE 101: SHADOW RANGE ON 21ST DECEMBER 1 PM WITHOUT VIADUCT

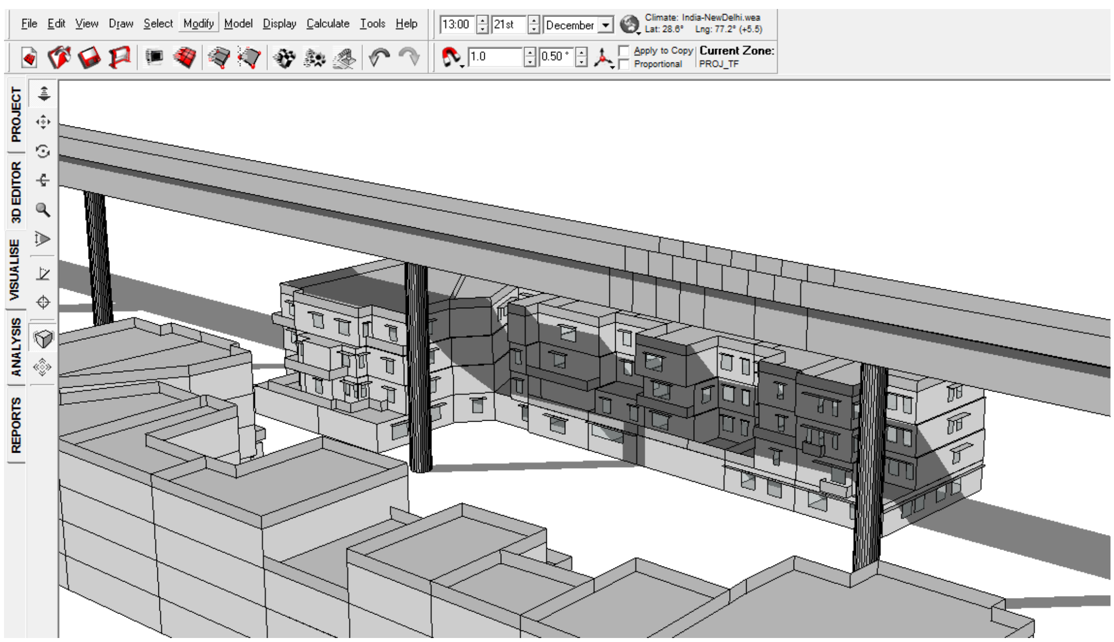


FIGURE 102: SHADOW RANGE ON 21ST DECEMBER 1 PM WITH VIADUCT

FIGURE 101 represents the shadow caused to the buildings. On the basis of the above image, Block – 220 is casting shadow on the Blocks – 217, 216 & 215. FIGURE 102 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, Viaduct is casting shadow on the third, second & first floor of Block – 211 to 213, 215 to 217, second & first floor of Block – 214 and third floor of Block – 220 thereby obstructing the direct sunlight falling on the back side of the buildings, which itself is acting as a shade for the back side of the buildings on 21st December 1 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

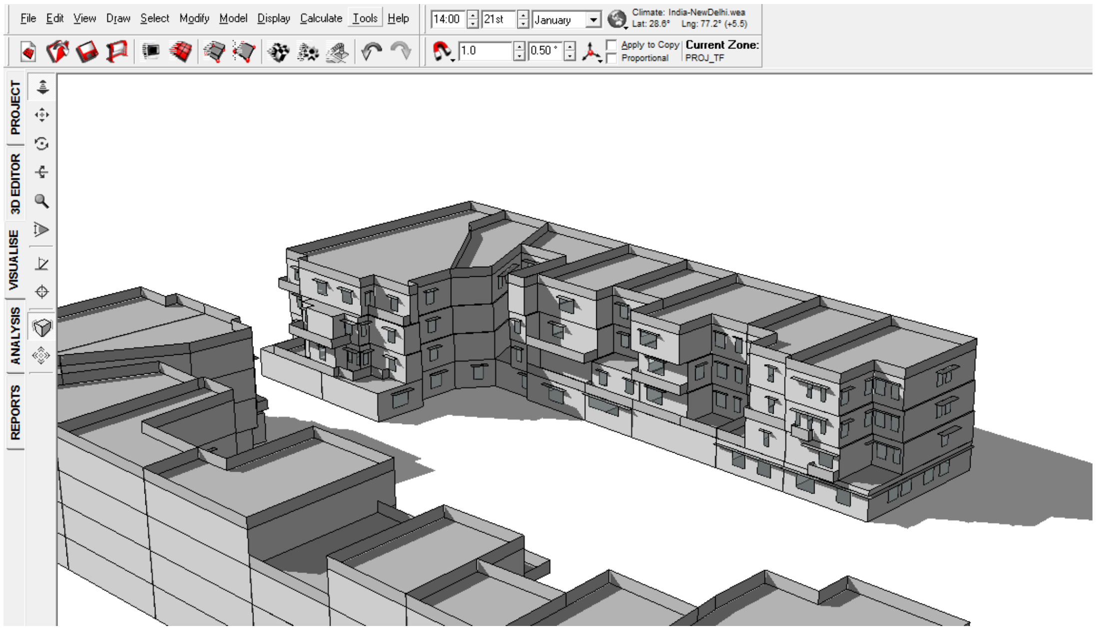


FIGURE 103: SHADOW RANGE ON 21ST JANUARY 2 PM WITHOUT VIADUCT

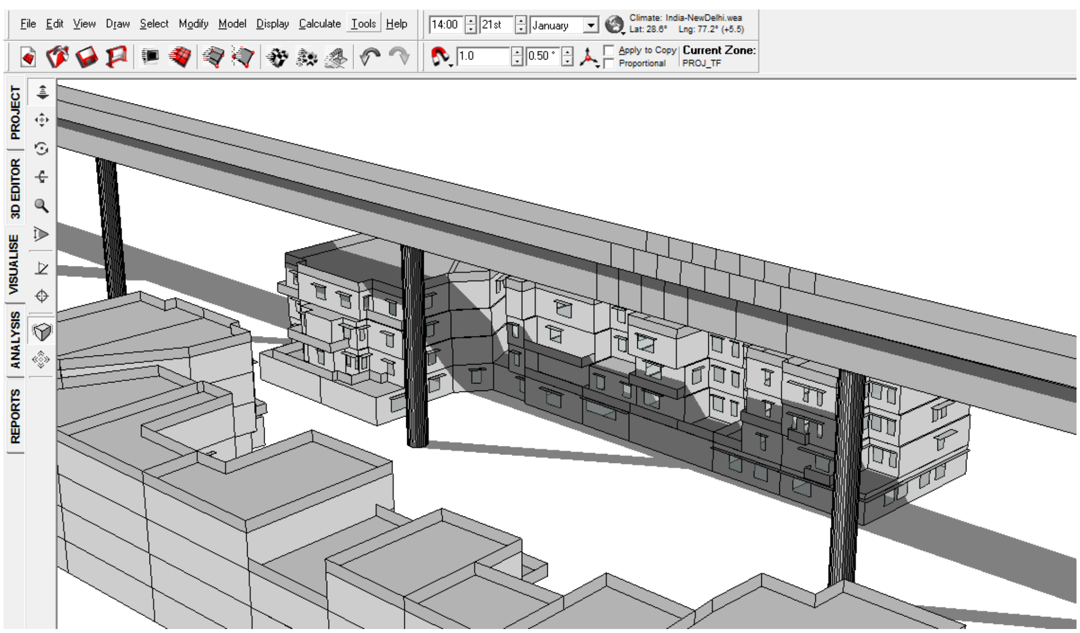


FIGURE 104: SHADOW RANGE ON 21ST JANUARY 2 PM WITH VIADUCT

FIGURE 103 represents the shadow caused to the buildings. On the basis of the above image, Block – 220 is casting shadow on the Blocks – 217, 216 & 215. FIGURE 104 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the second, first & ground floor of Blocks – 211 to 213, 215 to 217, second & first floor of Block – 214 and third & second floor of Block – 220 thereby obstructing the direct sunlight falling on the back side of the buildings, which itself is acting as a shade for the back side of the buildings on 21st January 2 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

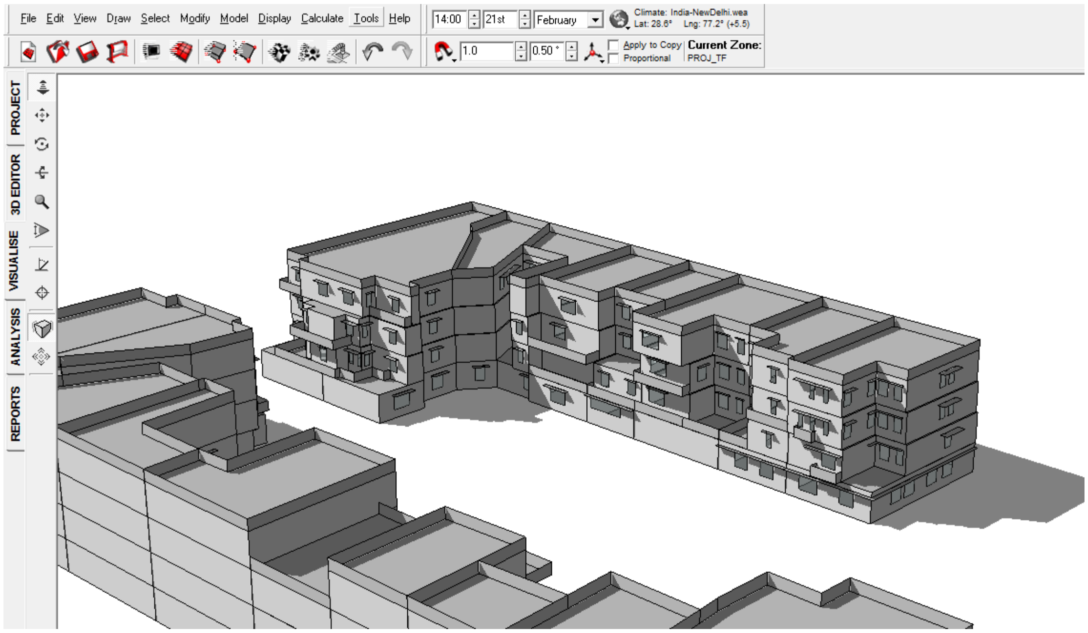


FIGURE 105: SHADOW RANGE ON 21ST FEBRUARY 2 PM WITHOUT VIADUCT

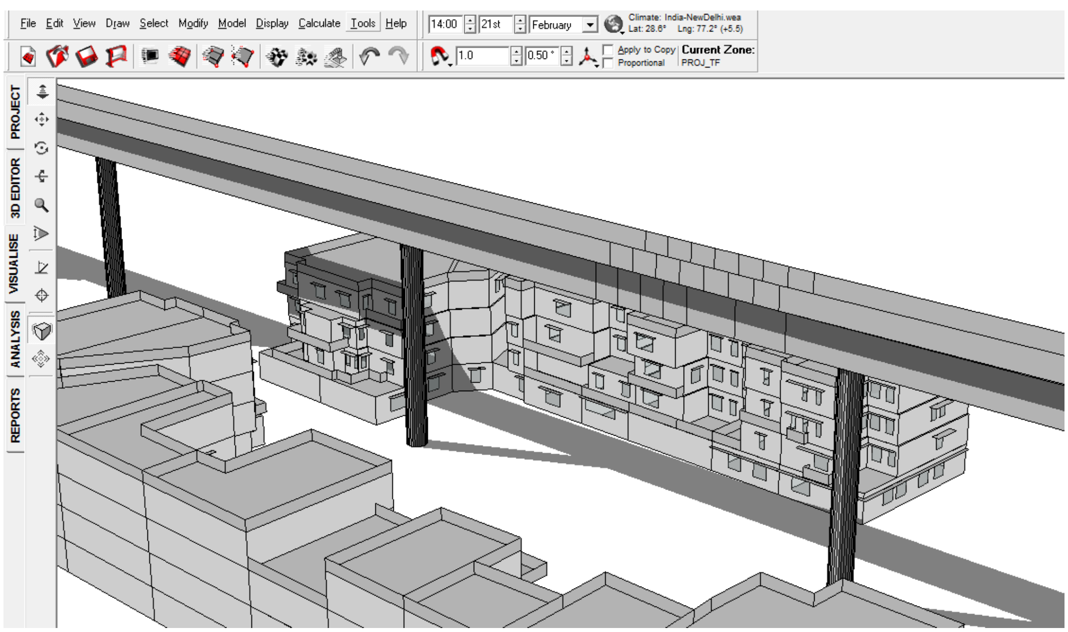


FIGURE 106: SHADOW RANGE ON 21ST FEBRUARY 2 PM WITH VIADUCT

FIGURE 105 represents the shadow caused to the buildings. On the basis of the above image, Block – 220 is casting shadow on the Blocks – 217, 216 & 215. FIGURE 106 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second, first & ground floor of Block – 220 and third floor of Block – 219 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st February 2 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

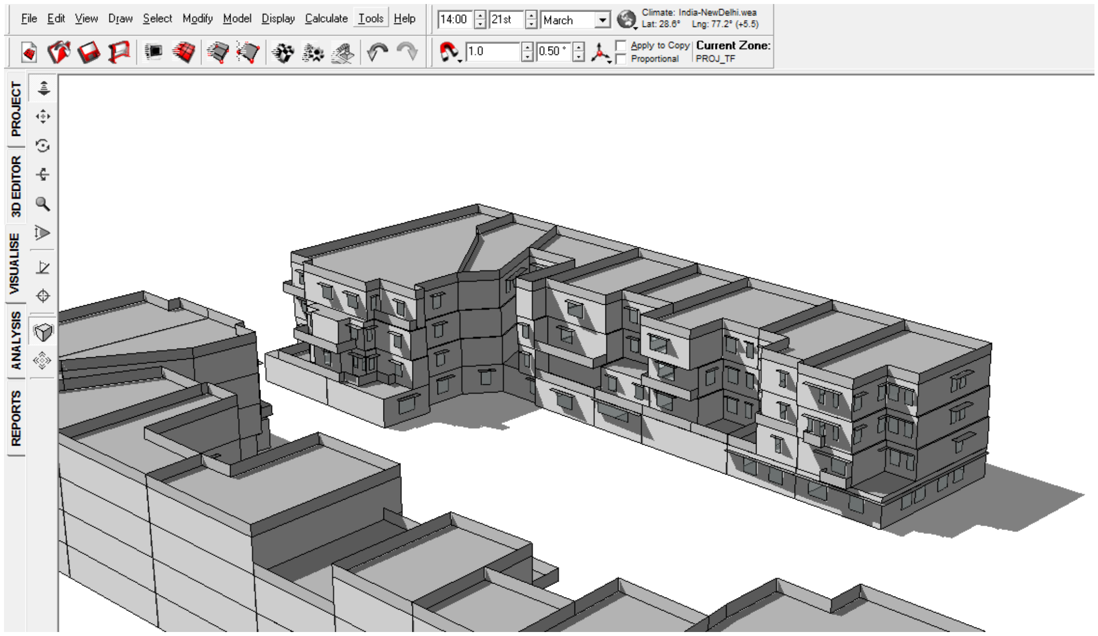


FIGURE 107: SHADOW RANGE ON 21ST MARCH 2 PM WITHOUT VIADUCT

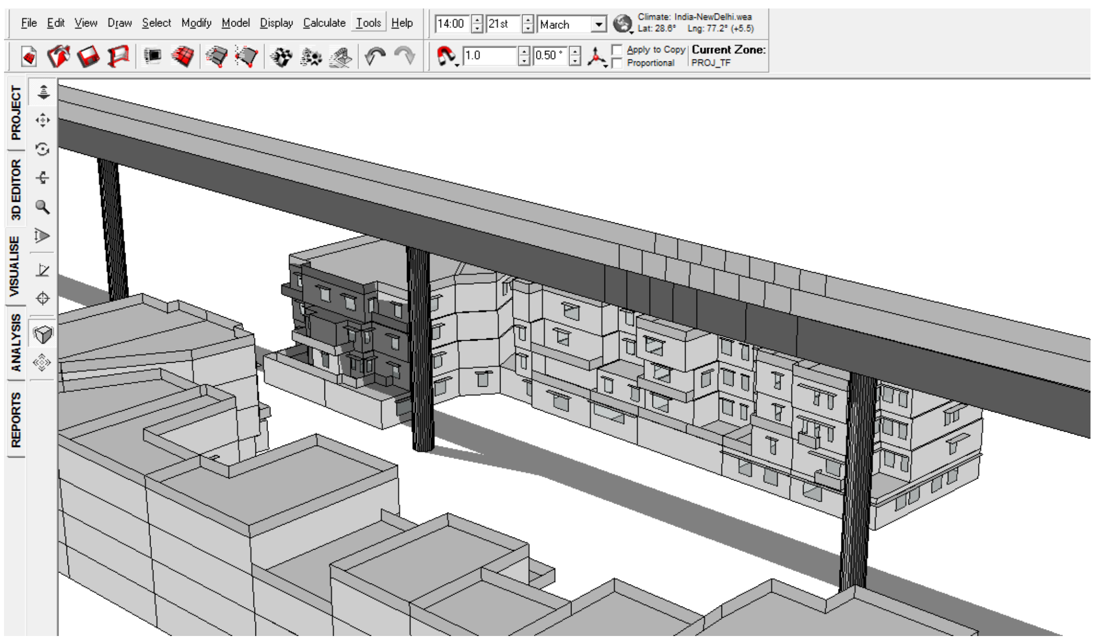


FIGURE 108: SHADOW RANGE ON 21ST MARCH 2 PM WITH VIADUCT

FIGURE 107 represents the shadow caused to the buildings. On the basis of the above image, Block – 220 is casting shadow on the Blocks – 217 & 216. FIGURE 108 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second & first floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st March 2 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

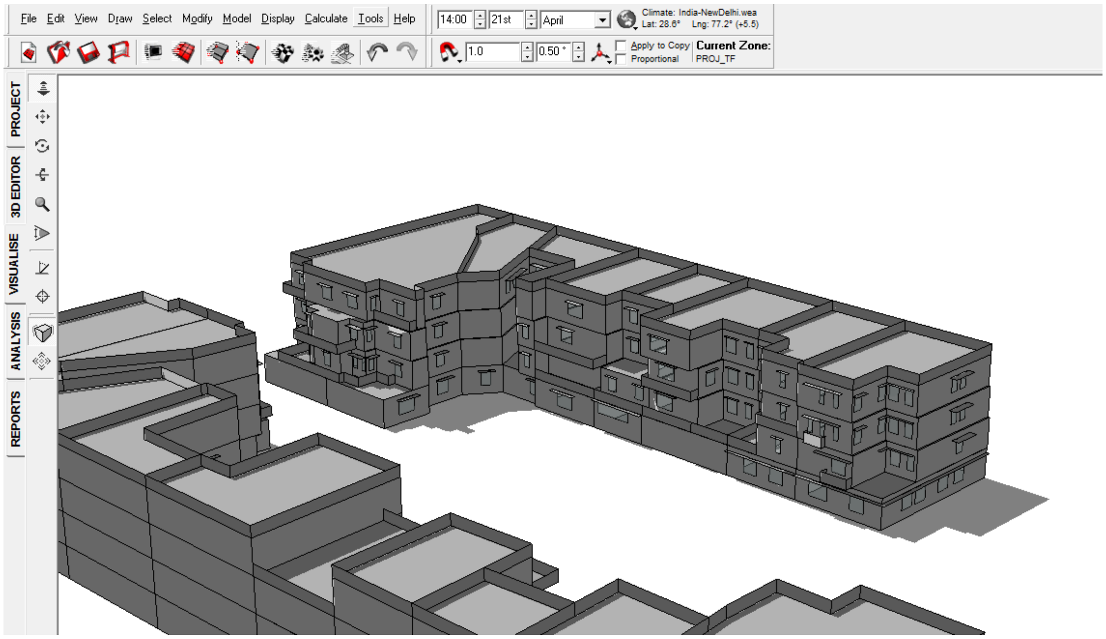


FIGURE 109: SHADOW RANGE ON 21ST APRIL 2 PM WITHOUT VIADUCT

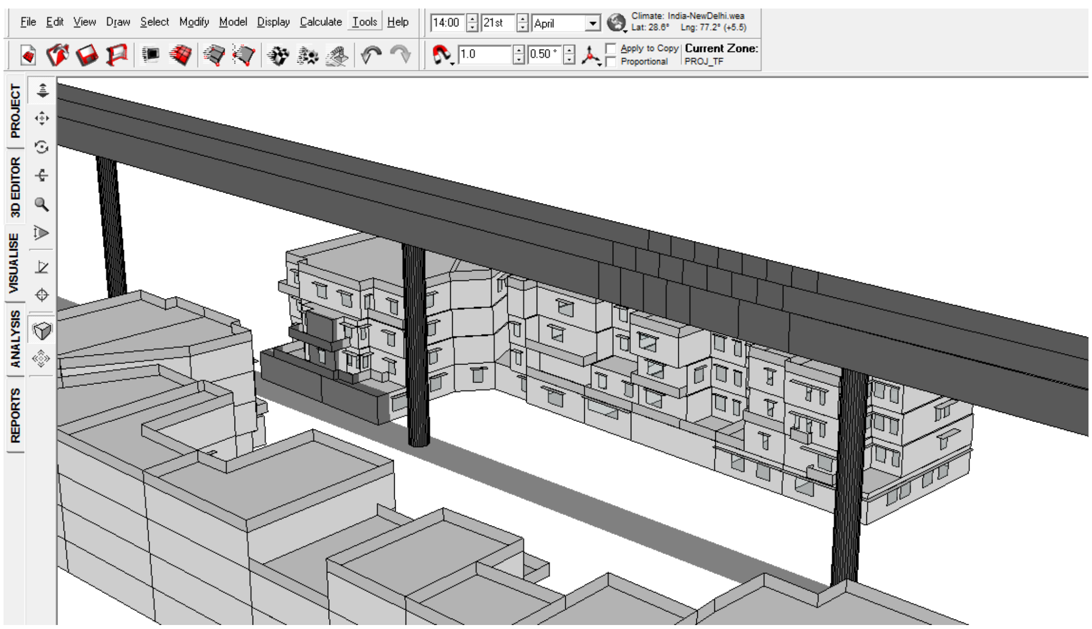


FIGURE 110: SHADOW RANGE ON 21ST APRIL 2 PM WITH VIADUCT

FIGURE 109 represents the shadow caused to the buildings. On the basis of the above image, the buildings is not casting any shadow to the nearby buildings but most of the windows are shaded by the overhang. FIGURE 110 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the second, first & ground floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st April 2 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

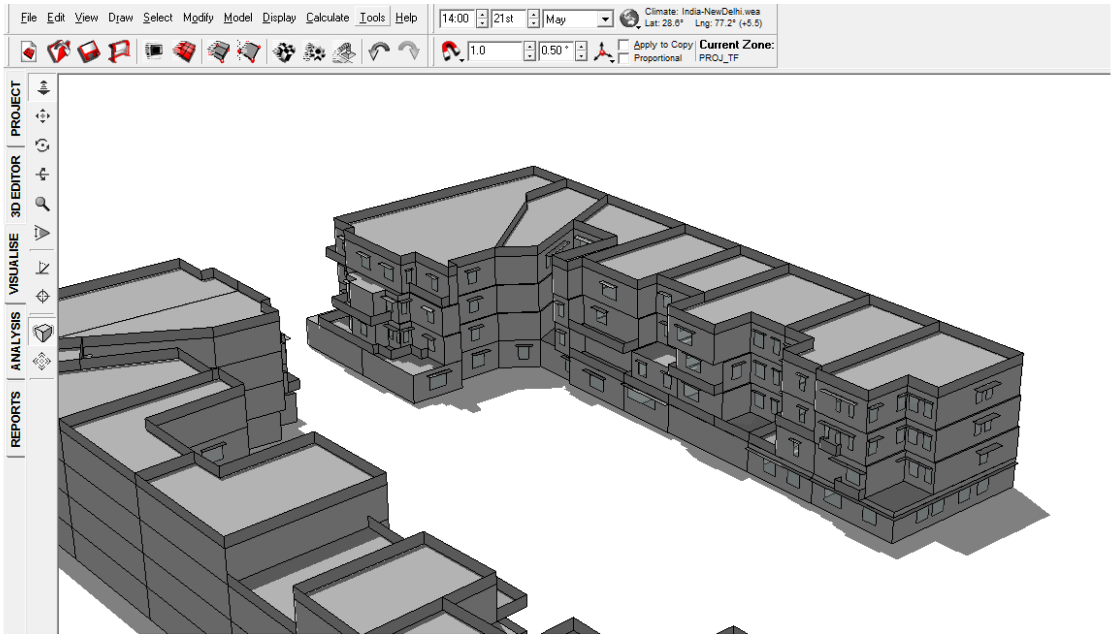


FIGURE 111: SHADOW RANGE ON 21ST MAY 2 PM WITHOUT VIADUCT

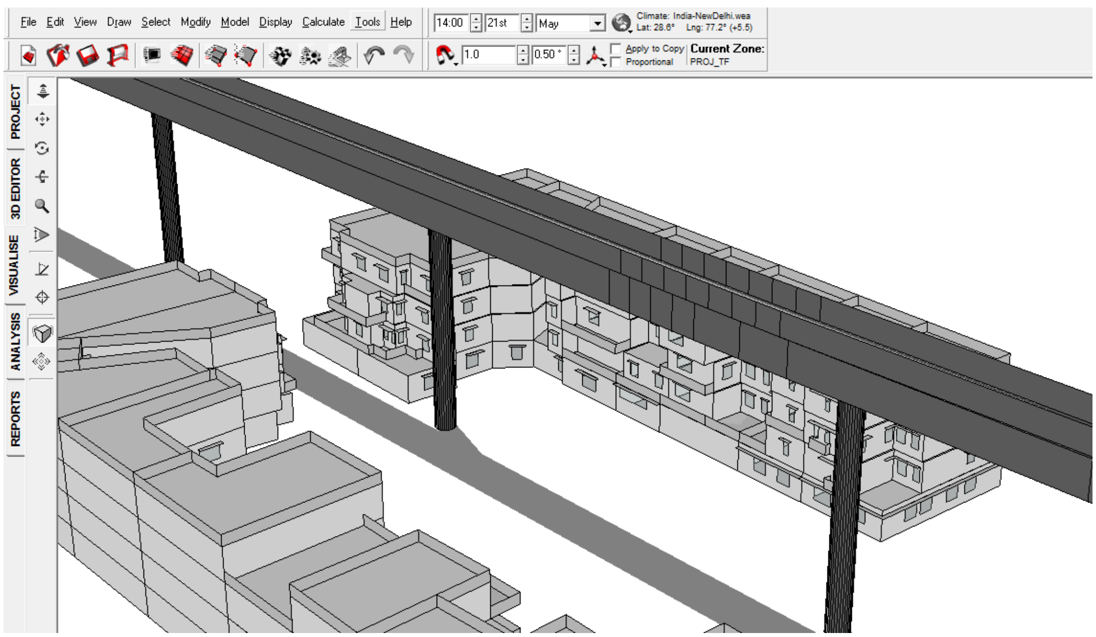


FIGURE 112: SHADOW RANGE ON 21ST MAY 2 PM WITH VIADUCT

FIGURE 111 represents the shadow caused to the buildings. On the basis of the above image, the buildings is not casting any shadow to the nearby buildings but most of the windows are shaded by the overhang. FIGURE 112 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is not casting shadow on the façade of the buildings on 21st May 2 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

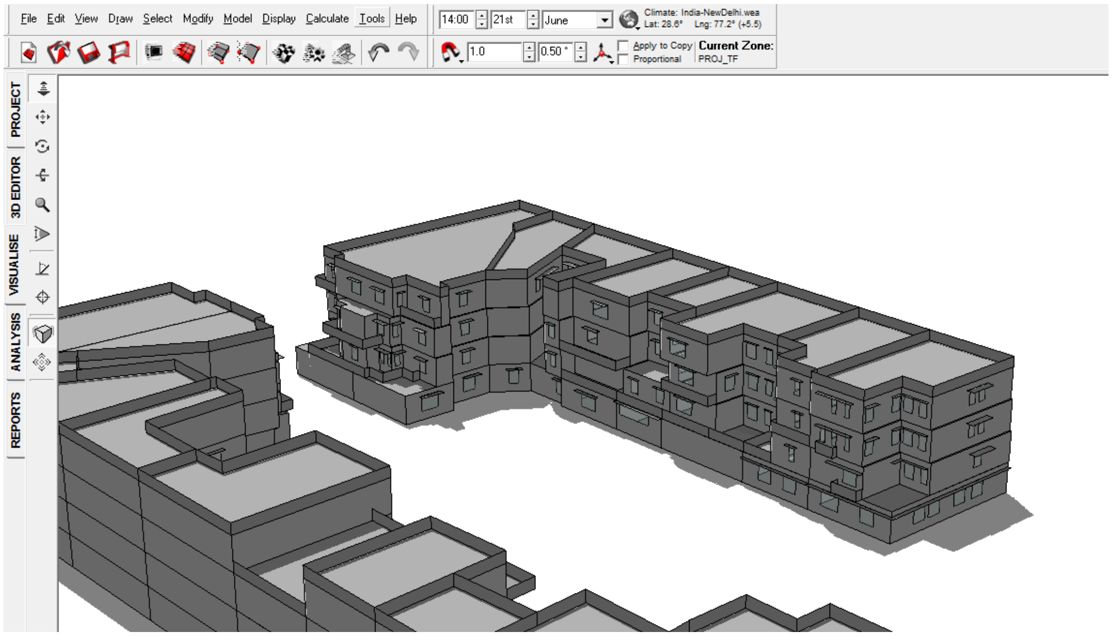


FIGURE 113: SHADOW RANGE ON 21ST JUNE 2 PM WITHOUT VIADUCT

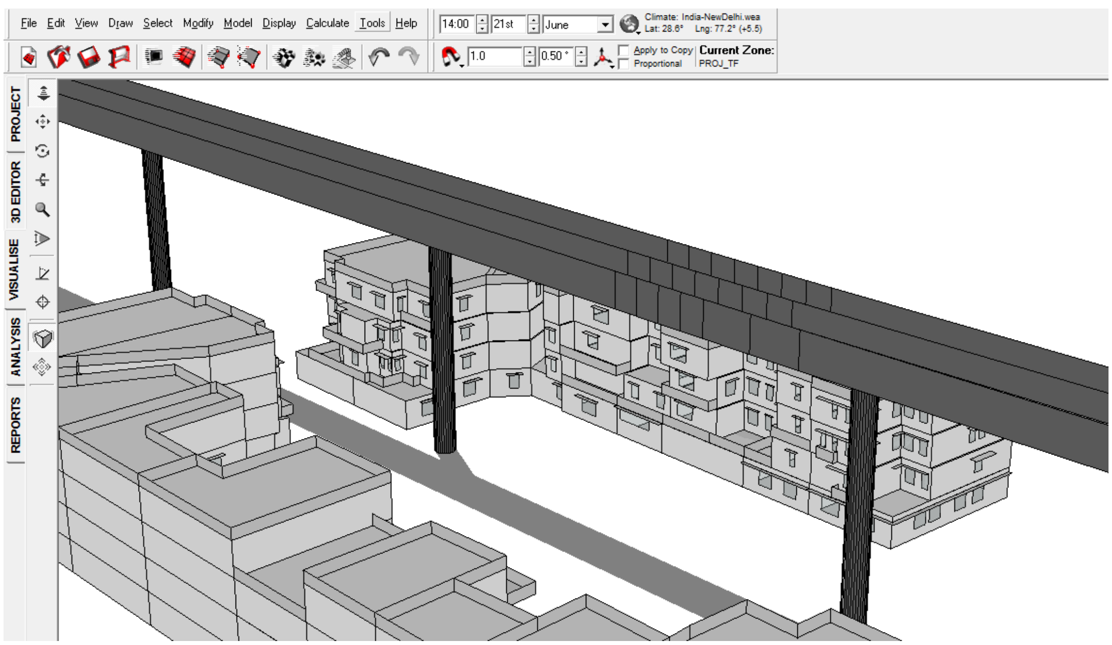


FIGURE 114: SHADOW RANGE ON 21ST JUNE 2 PM WITH VIADUCT

FIGURE 113 represents the shadow caused to the buildings. On the basis of the above image, the buildings is not casting any shadow to the nearby buildings but most of the windows are shaded by the overhang. FIGURE 114 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is not casting shadow on the façade of the buildings on 21st June 2 PM.

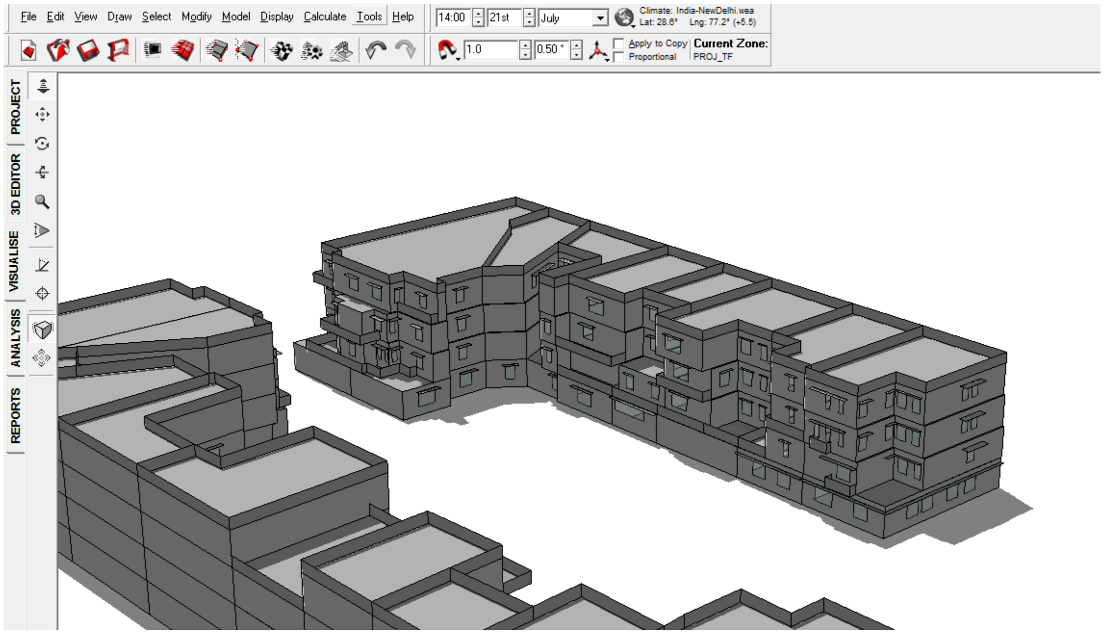


FIGURE 115: SHADOW RANGE ON 21ST JULY 2 PM WITHOUT VIADUCT

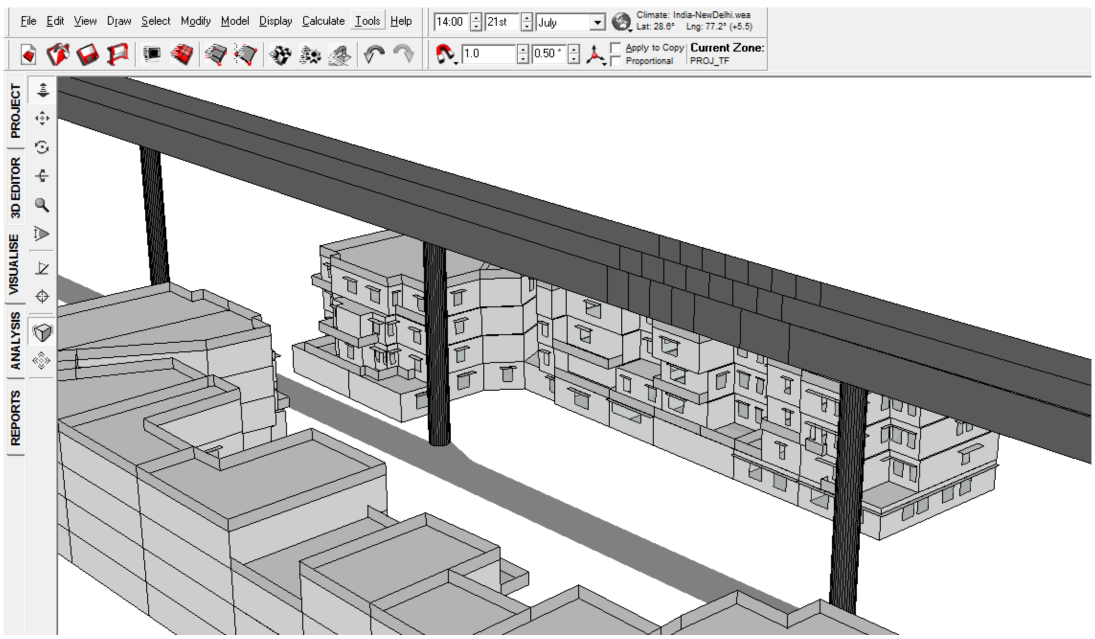


FIGURE 116: SHADOW RANGE ON 21ST JULY 2 PM WITH VIADUCT

FIGURE 115 represents the shadow caused to the buildings. On the basis of the above image, the buildings is not casting any shadow to the nearby buildings but most of the windows are shaded by the overhang. FIGURE 116 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is not casting shadow on the façade of the buildings on 21st July 2 PM.

GreenTree Building Energy Pvt. Ltd. DELHI NCR

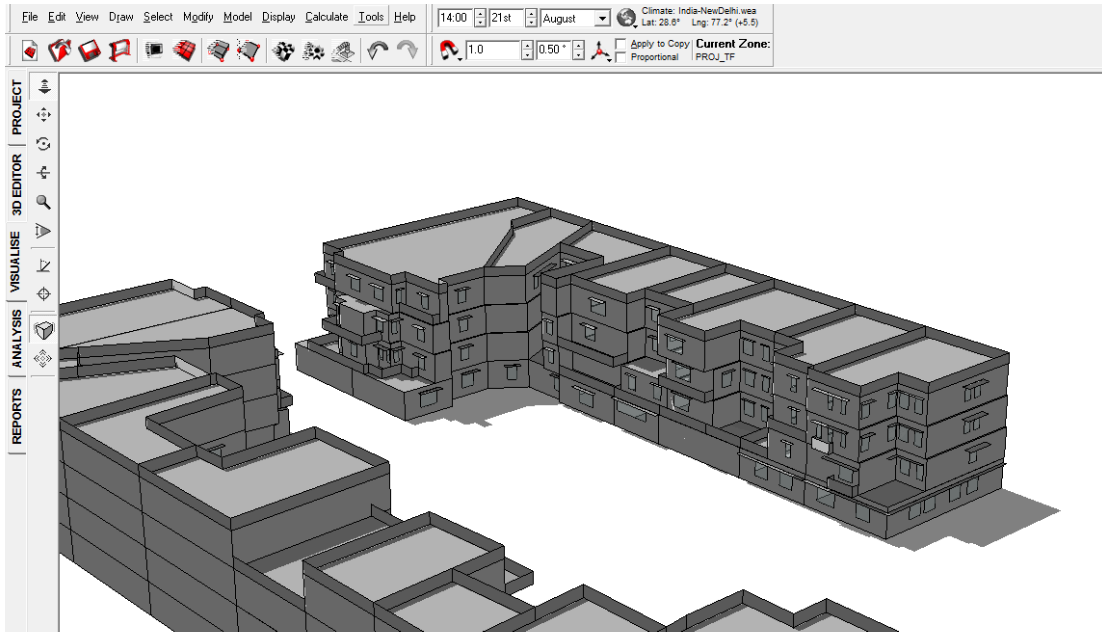


FIGURE 117: SHADOW RANGE ON 21ST AUGUST 2 PM WITHOUT VIADUCT

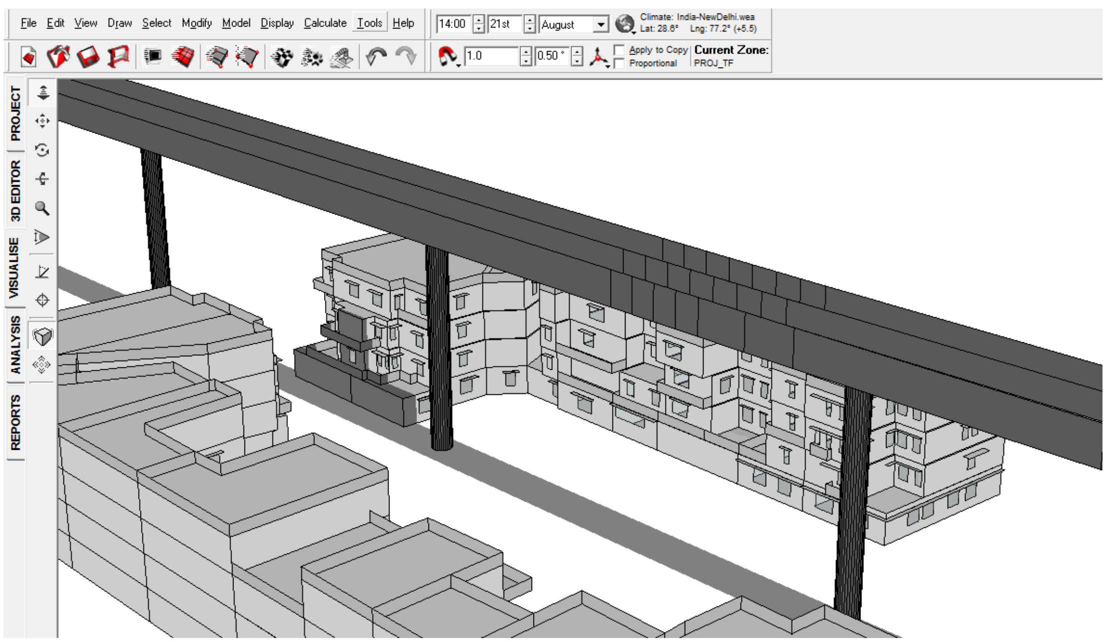


FIGURE 118: SHADOW RANGE ON 21ST AUGUST 2 PM WITH VIADUCT

FIGURE 117 represents the shadow caused to the buildings. On the basis of the above image, the buildings is not casting any shadow to the nearby buildings but most of the windows are shaded by the overhang. FIGURE 118 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the second, first & ground floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st August 2 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

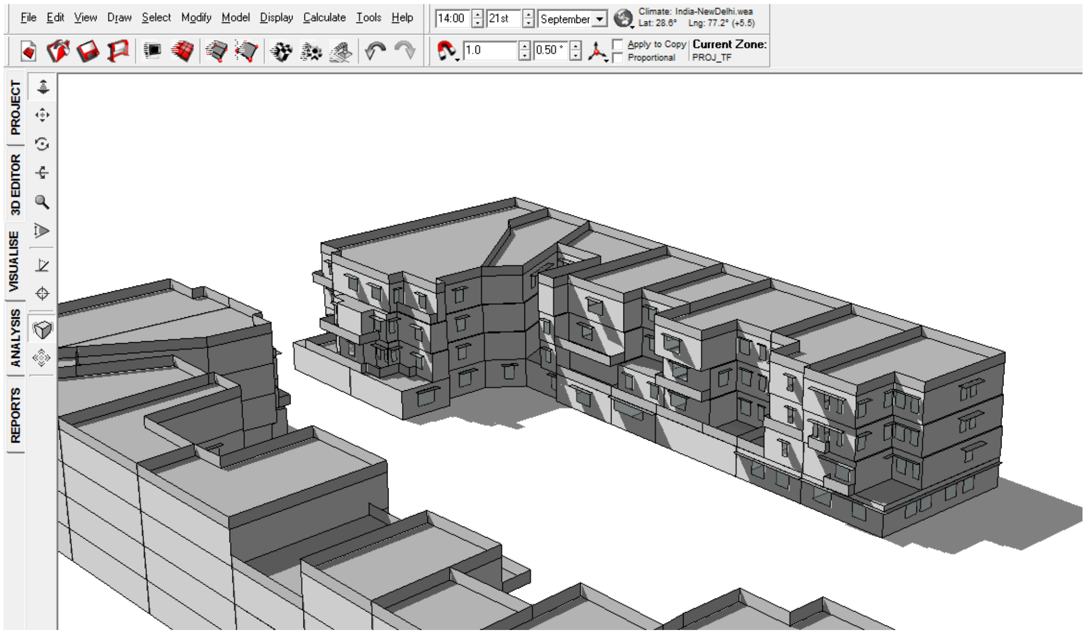


FIGURE 119: SHADOW RANGE ON 21ST SEPTEMBER 2 PM WITHOUT VIADUCT

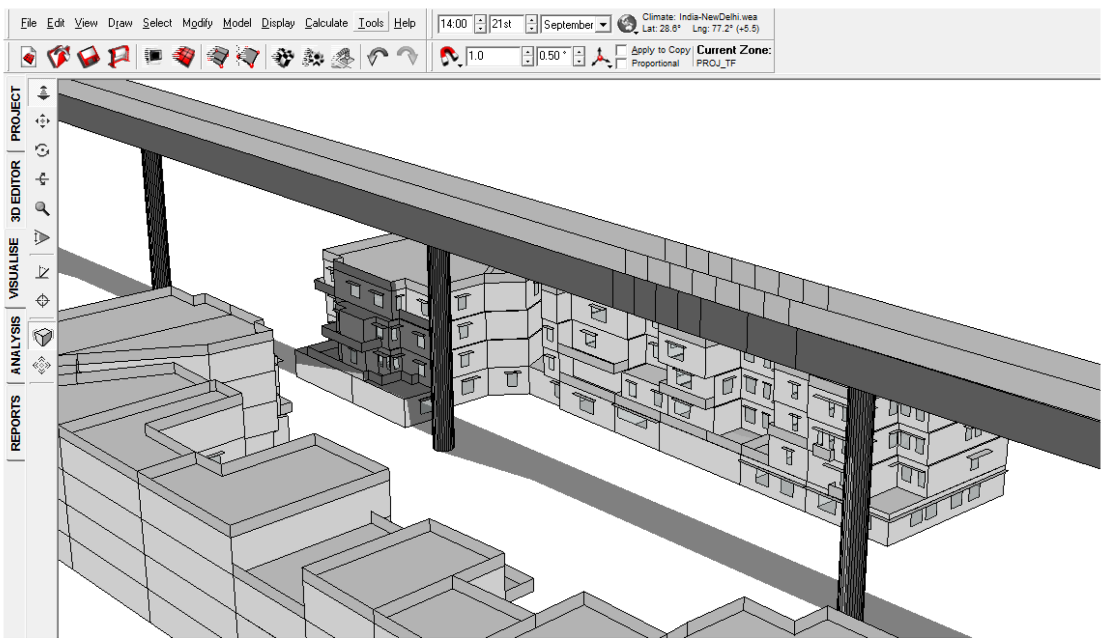


FIGURE 120: SHADOW RANGE ON 21ST SEPTEMBER 2 PM WITH VIADUCT

FIGURE 119 represents the shadow caused to the buildings. On the basis of the above image, the buildings is not casting any shadow to the nearby buildings but most of the windows are shaded by the overhang. FIGURE 120 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second, first & ground floor of Block – 220 and third, second & first floor of Block – 219 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st September 2 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

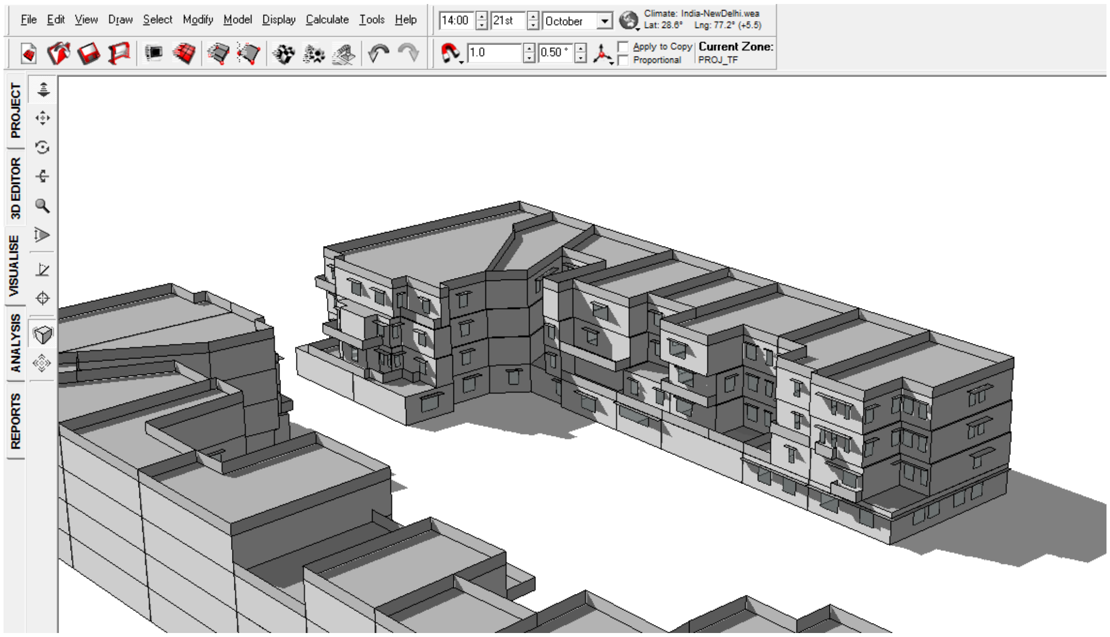


FIGURE 121: SHADOW RANGE ON 21ST OCTOBER 2 PM WITHOUT VIADUCT

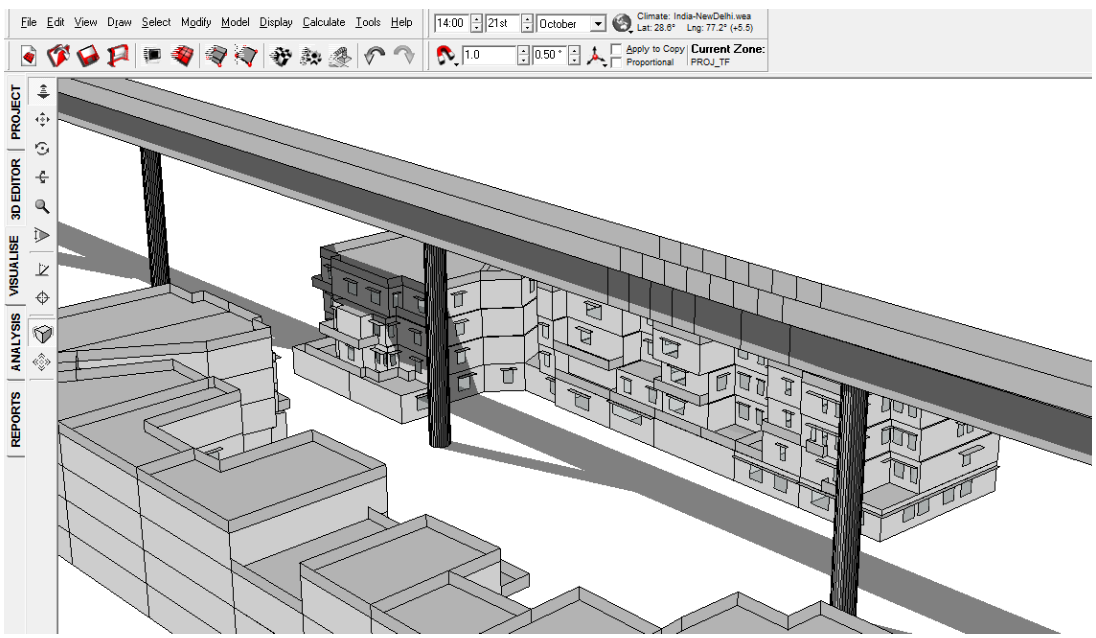


FIGURE 122: SHADOW RANGE ON 21ST OCTOBER 2 PM WITH VIADUCT

FIGURE 121 represents the shadow caused to the buildings. On the basis of the above image, Block – 220 is casting shadow on the Blocks – 217, 216 & 215. FIGURE 122 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second, first & ground floor of Block – 220 and third, second & first floor of Block – 219 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st October 2 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

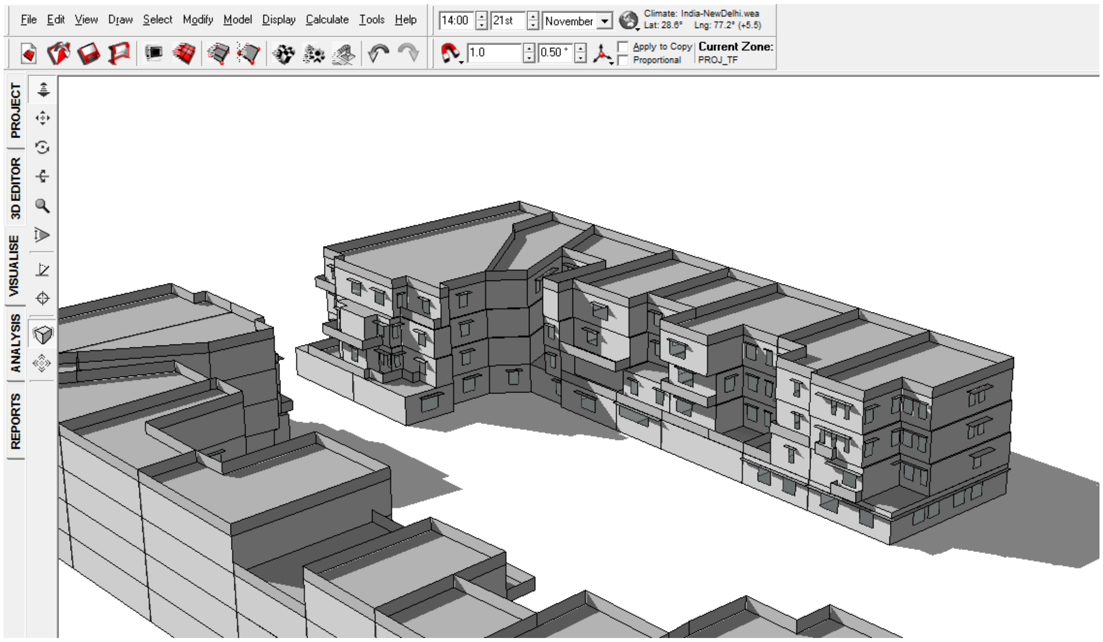


FIGURE 123: SHADOW RANGE ON 21ST NOVEMBER 2 PM WITHOUT VIADUCT

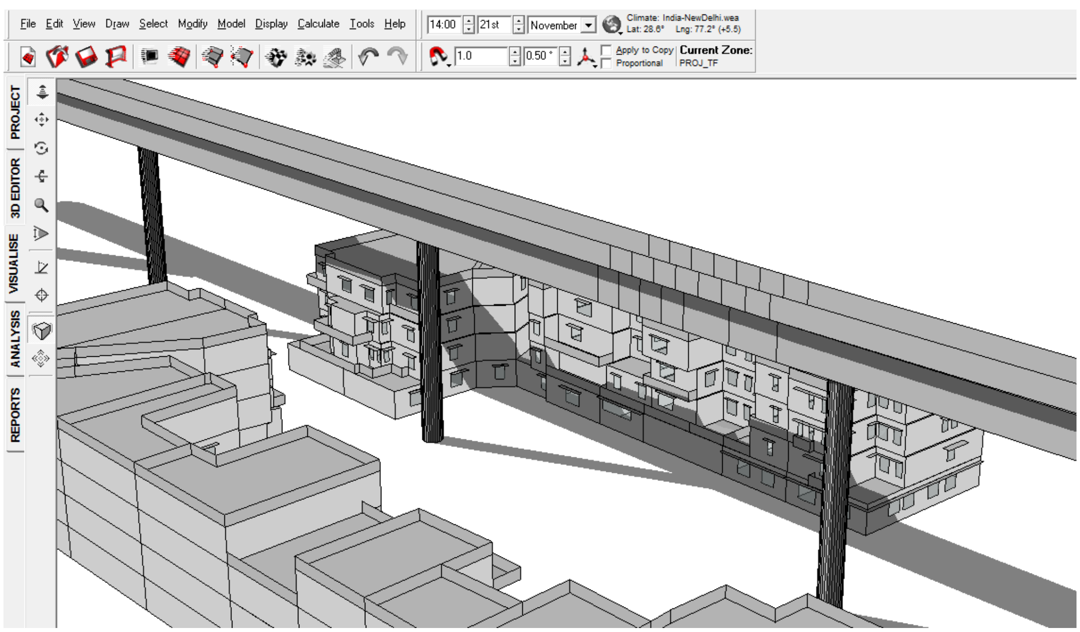


FIGURE 124: SHADOW RANGE ON 21ST NOVEMBER 2 PM WITH VIADUCT

FIGURE 123 represents the shadow caused to the buildings. On the basis of the above image, Block – 220 is casting shadow on the Blocks – 217, 216 & 215. FIGURE 124 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the first & ground floor of Blocks – 211 to 217 and third, second & first floor of Block – 220 thereby obstructing the direct sunlight falling on the back side of the buildings, which itself is acting as a shade for the back side of the buildings on 21st November 2 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

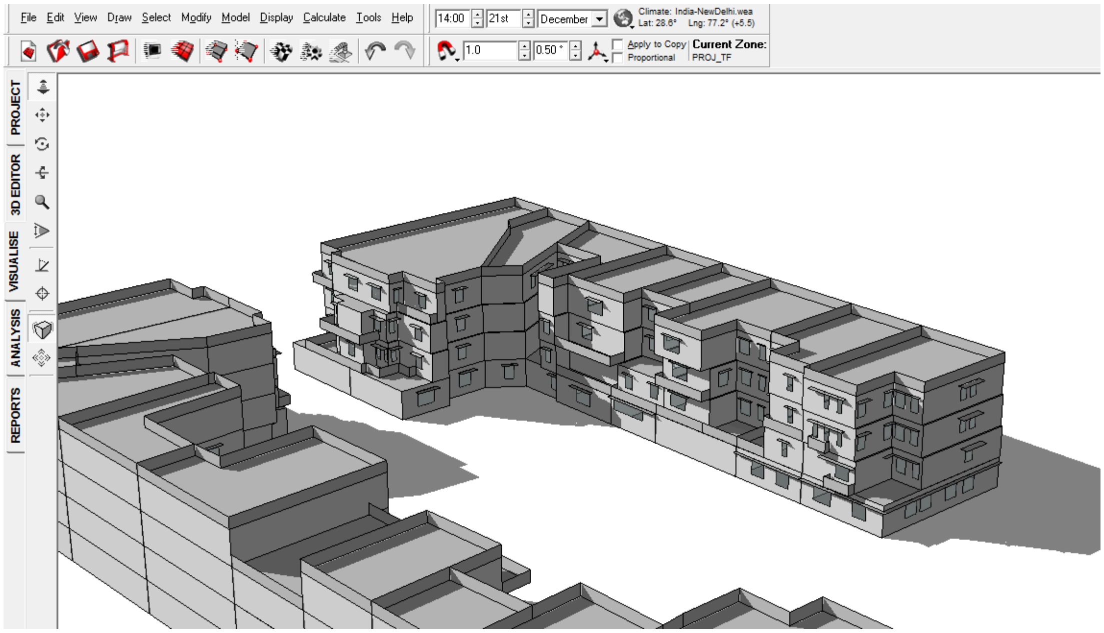


FIGURE 125: SHADOW RANGE ON 21ST DECEMBER 2 PM WITHOUT VIADUCT

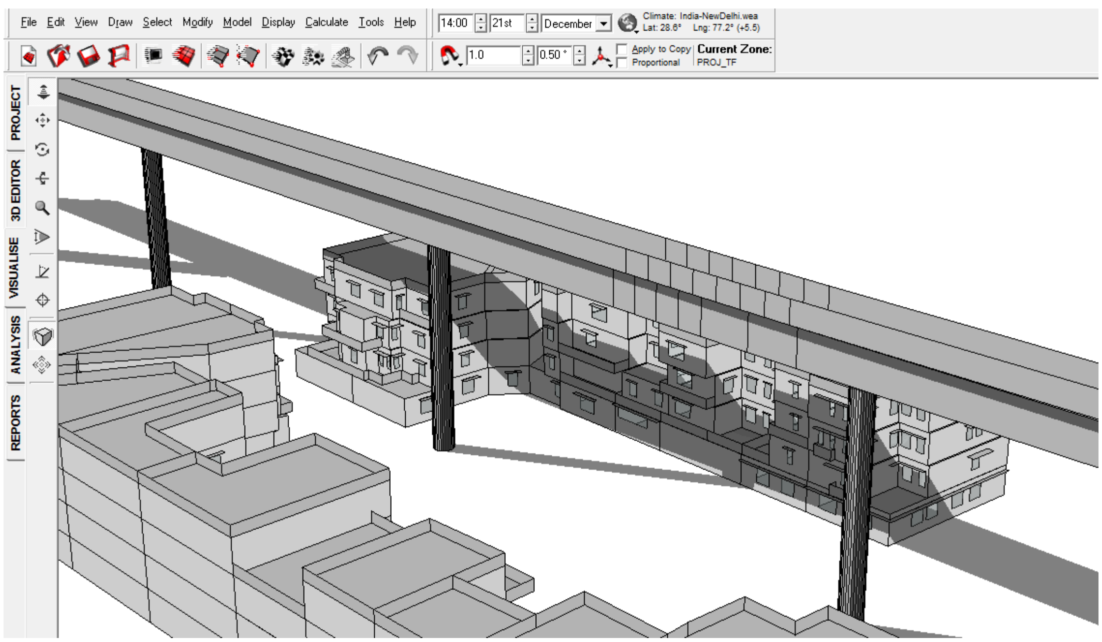


FIGURE 126: SHADOW RANGE ON 21ST DECEMBER 2 PM WITH VIADUCT

FIGURE 125 represents the shadow caused to the buildings. On the basis of the above image, Block – 220 is casting shadow on the Blocks – 217, 216 & 215. FIGURE 126 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second, first & ground floor of Blocks – 211, 213 & 217, second, first & ground floor of Blocks – 212, 215 & 216, first & ground floor of Block – 214 and second & third floor of Block – 220 thereby obstructing the direct sunlight falling on the back side of the buildings, which itself is acting as a shade for the back side of the buildings on 21st December 2 PM. 214

GreenTree Building Energy Pvt. Ltd. DELHI NCR

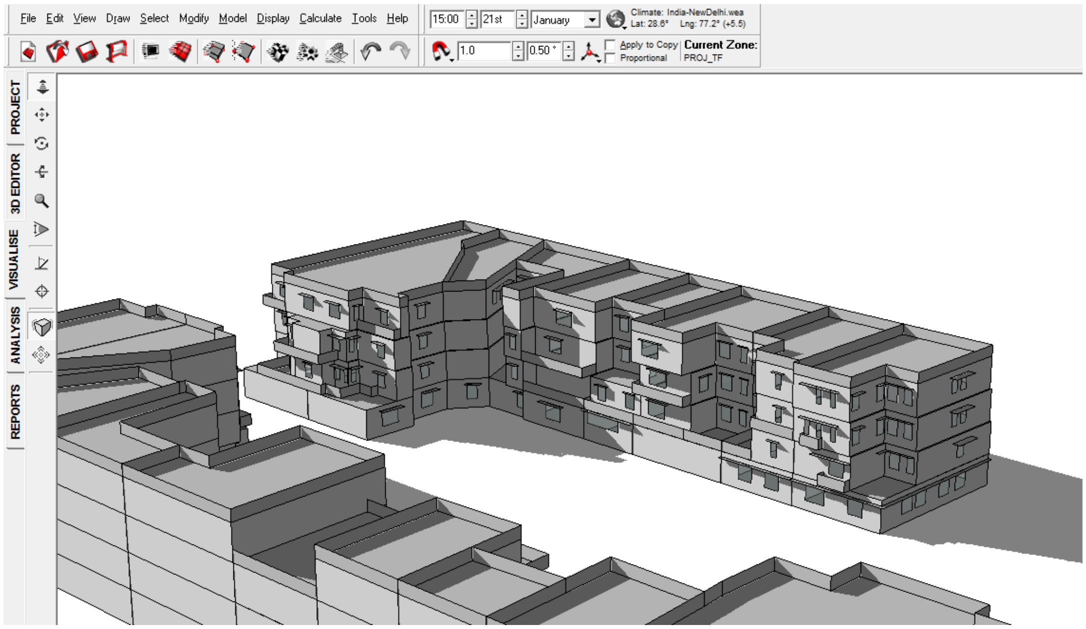


FIGURE 127: SHADOW RANGE ON 21ST JANUARY 3 PM WITHOUT VIADUCT

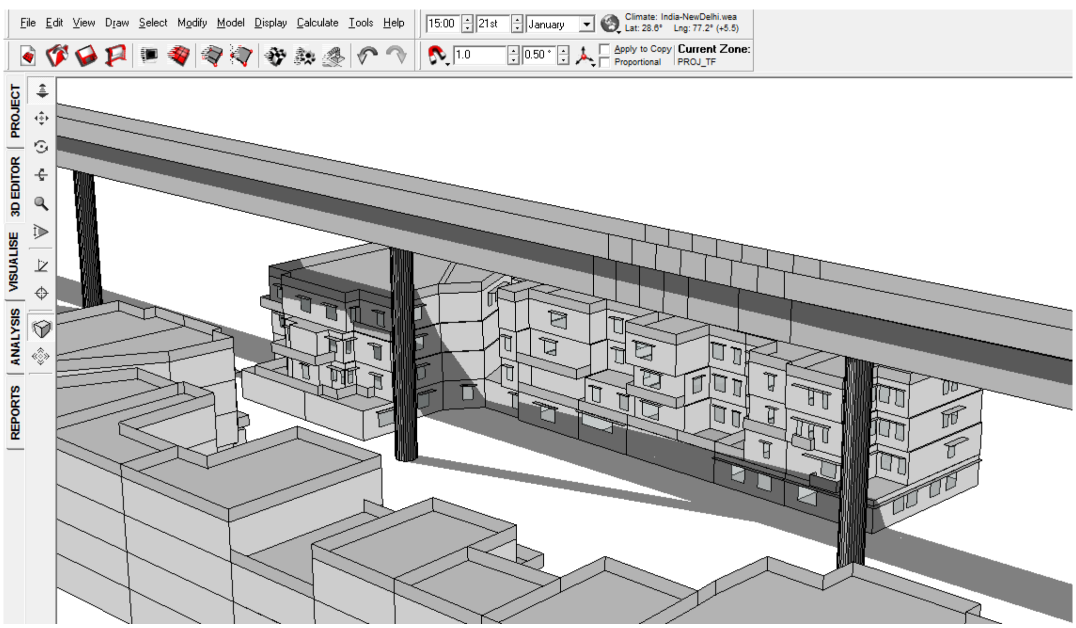


FIGURE 128: SHADOW RANGE ON 21ST JANUARY 3 PM WITH VIADUCT

FIGURE 127 represents the shadow caused to the buildings. On the basis of the above image, Block – 220 is casting shadow on the Blocks – 217, 216, 215 & 214. FIGURE 128 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the ground floor of Blocks – 211 to 217 and third, second & first floor of Block – 220 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st January 3 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

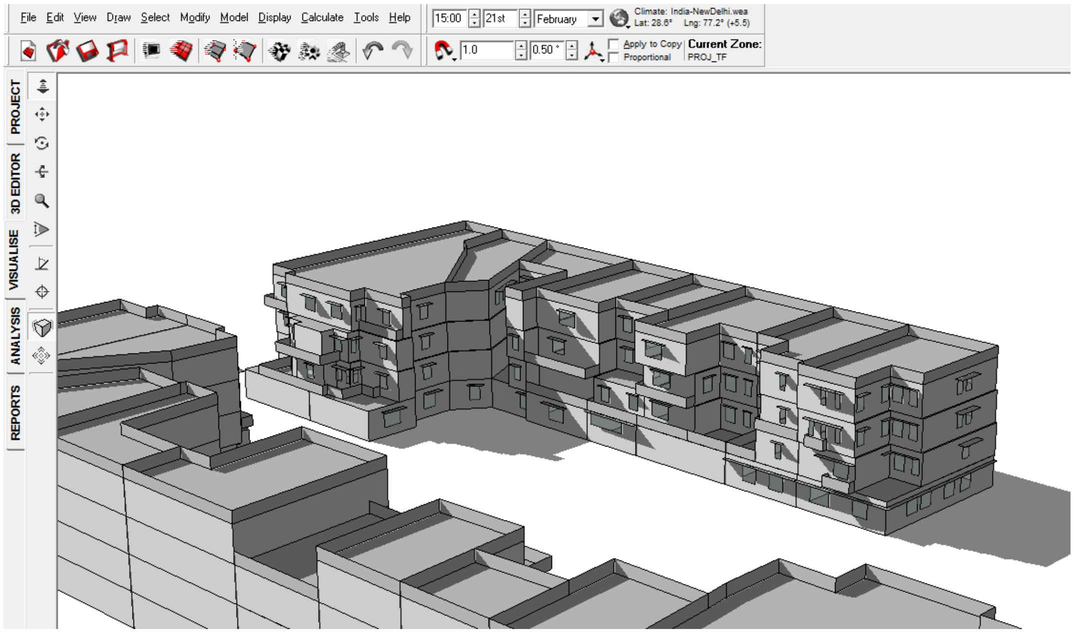


FIGURE 129: SHADOW RANGE ON 21ST FEBRUARY 3 PM WITHOUT VIADUCT

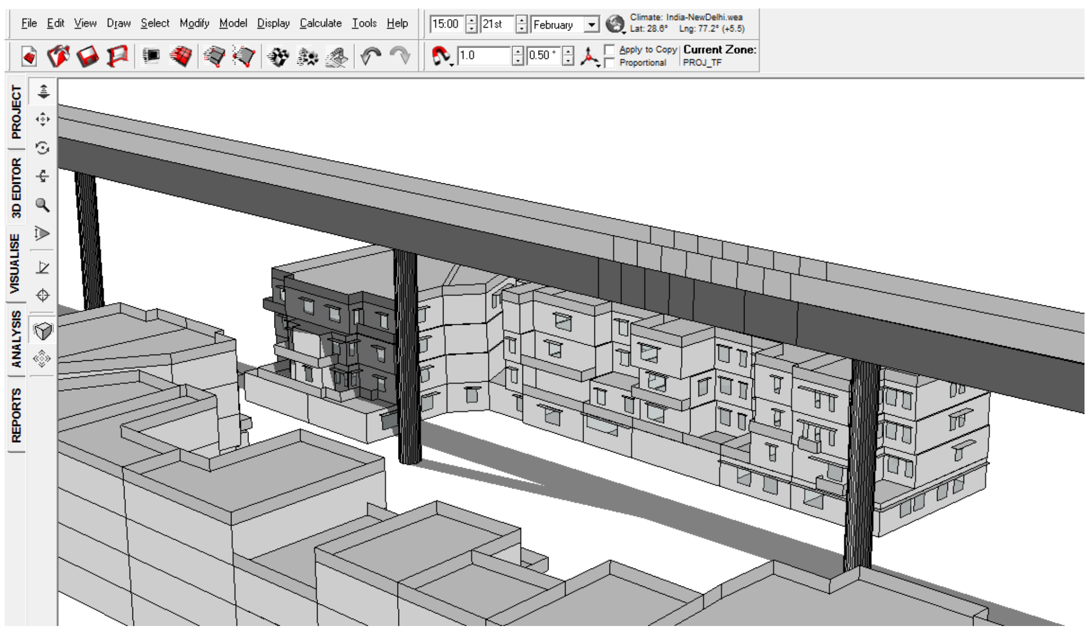


FIGURE 130: SHADOW RANGE ON 21ST FEBRUARY 3 PM WITH VIADUCT

FIGURE 129 represents the shadow caused to the buildings. On the basis of the above image, Block – 220 is casting shadow on the Blocks – 217, 216 & 215. FIGURE 130 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second, first & ground floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st February 3 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

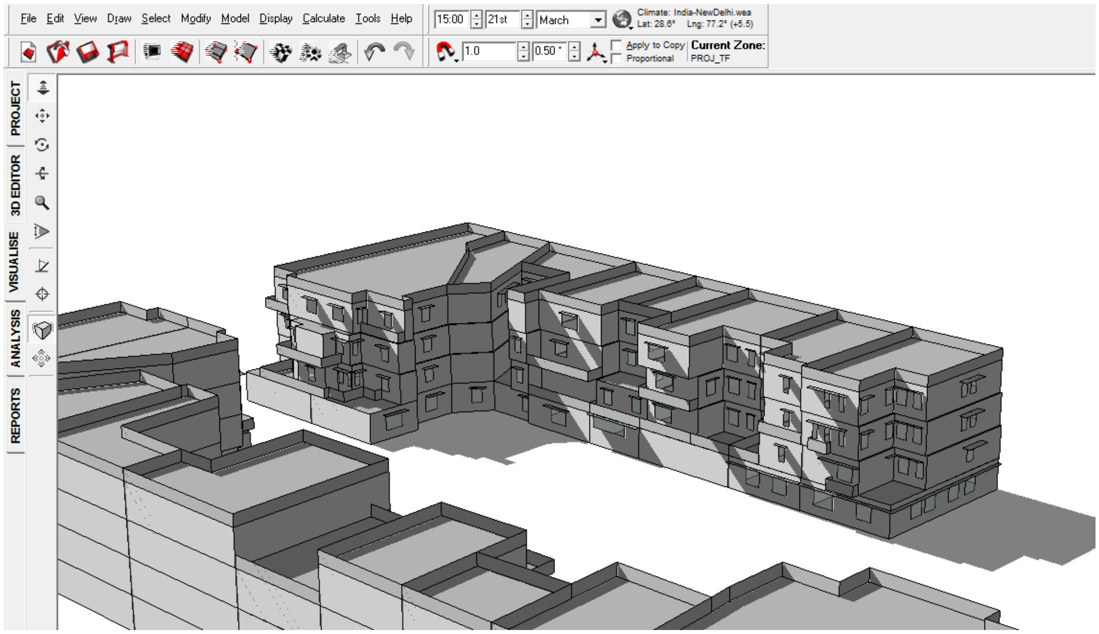


FIGURE 131: SHADOW RANGE ON 21ST MARCH 3 PM WITHOUT VIADUCT

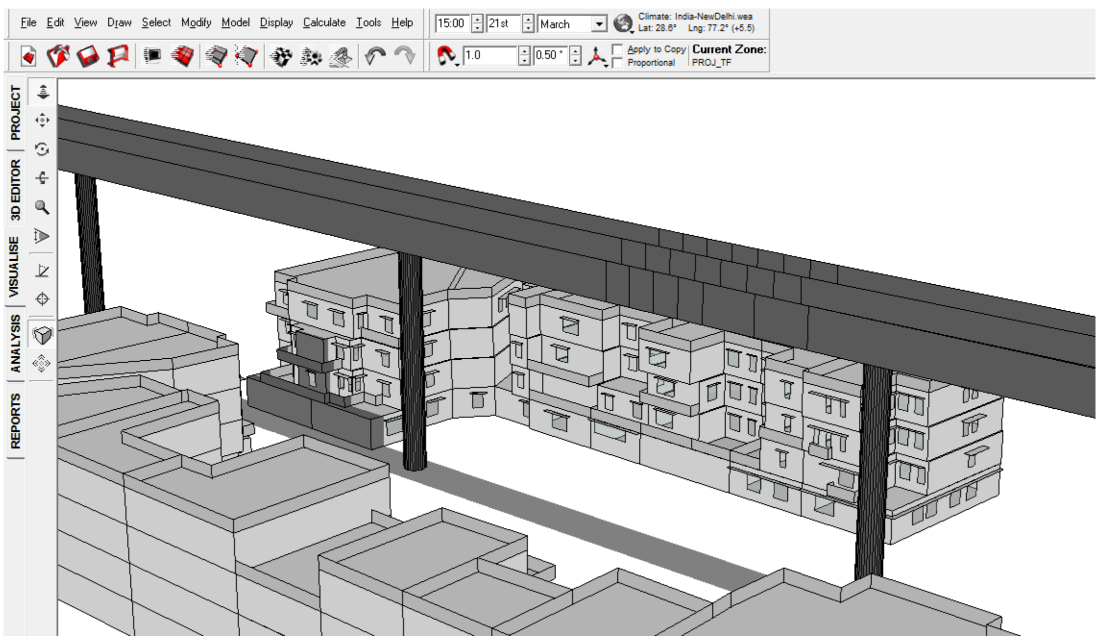


FIGURE 132: SHADOW RANGE ON 21ST MARCH 3 PM WITH VIADUCT

FIGURE 131 represents the shadow caused to the buildings. On the basis of the above image, Block – 220 is casting shadow on the Blocks – 217, 216 & 215. FIGURE 132 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the second, first & ground floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st March 3 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

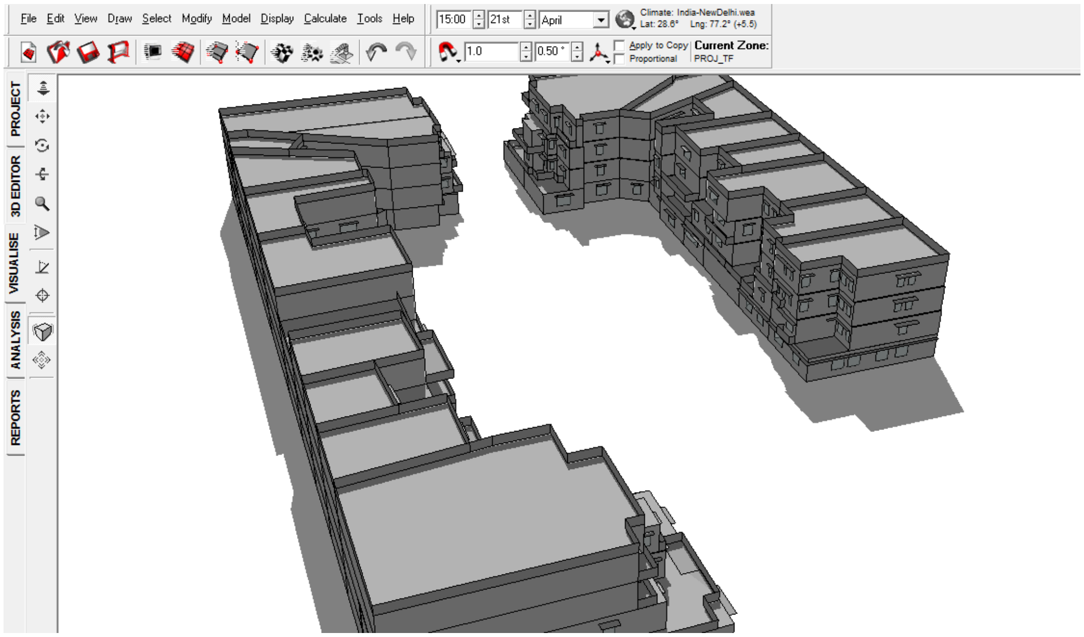


FIGURE 133: SHADOW RANGE ON 21ST APRIL 3 PM WITHOUT VIADUCT

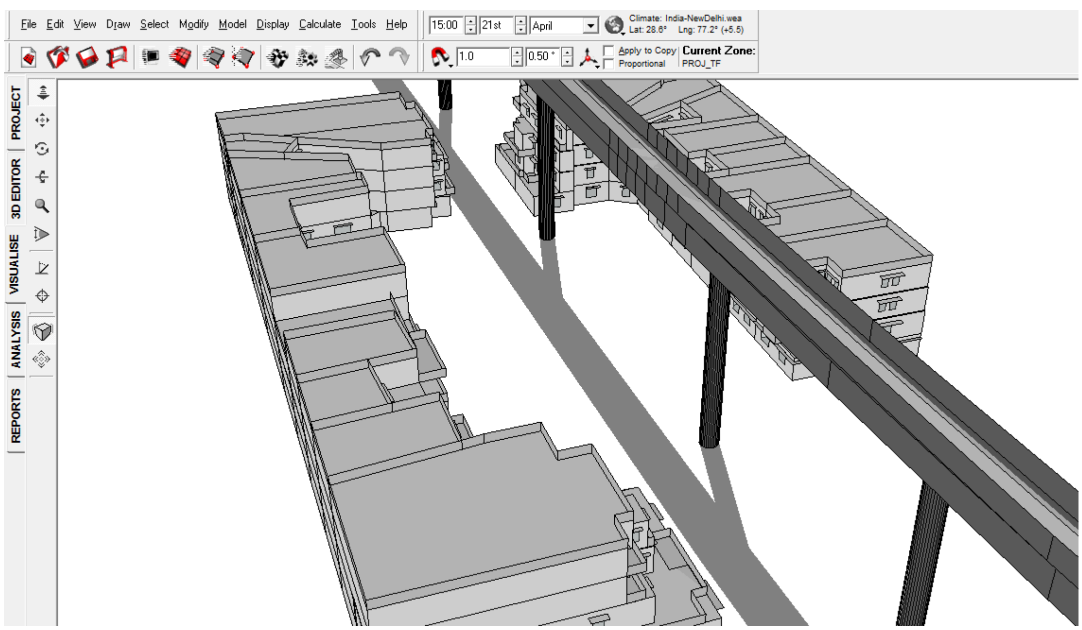


FIGURE 134: SHADOW RANGE ON 21ST APRIL 3 PM WITH VIADUCT

FIGURE 133 represents the shadow caused to the buildings. On the basis of the above image, most of the windows is shaded by the overhang. FIGURE 134 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is not casting shadow on the façade of the buildings on 21st April 3 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

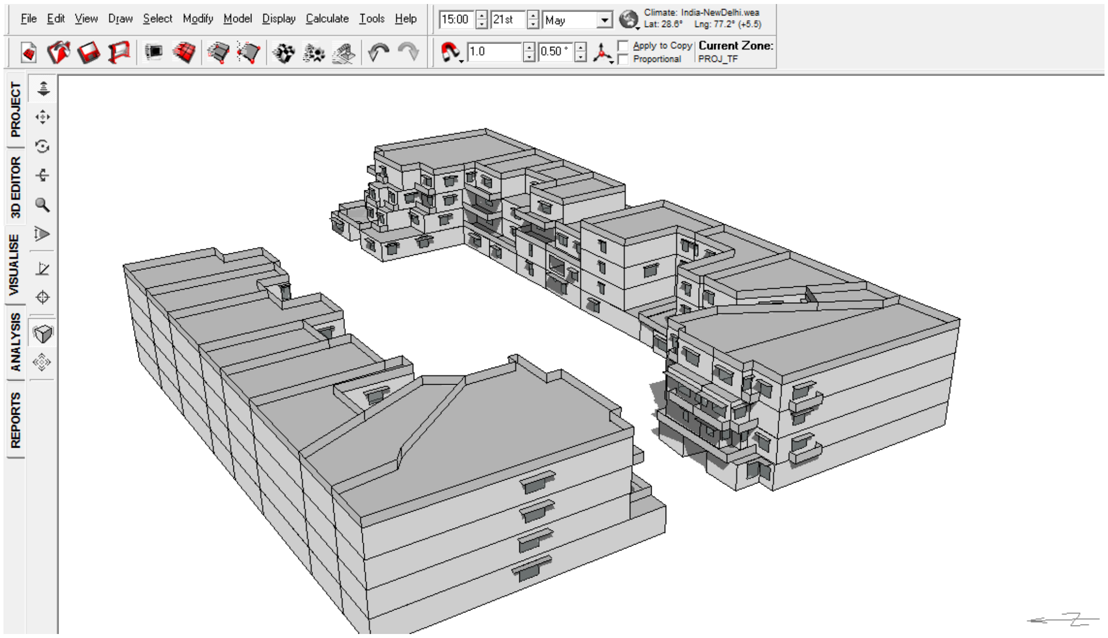


FIGURE 135: SHADOW RANGE ON 21ST MAY 3 PM WITHOUT VIADUCT

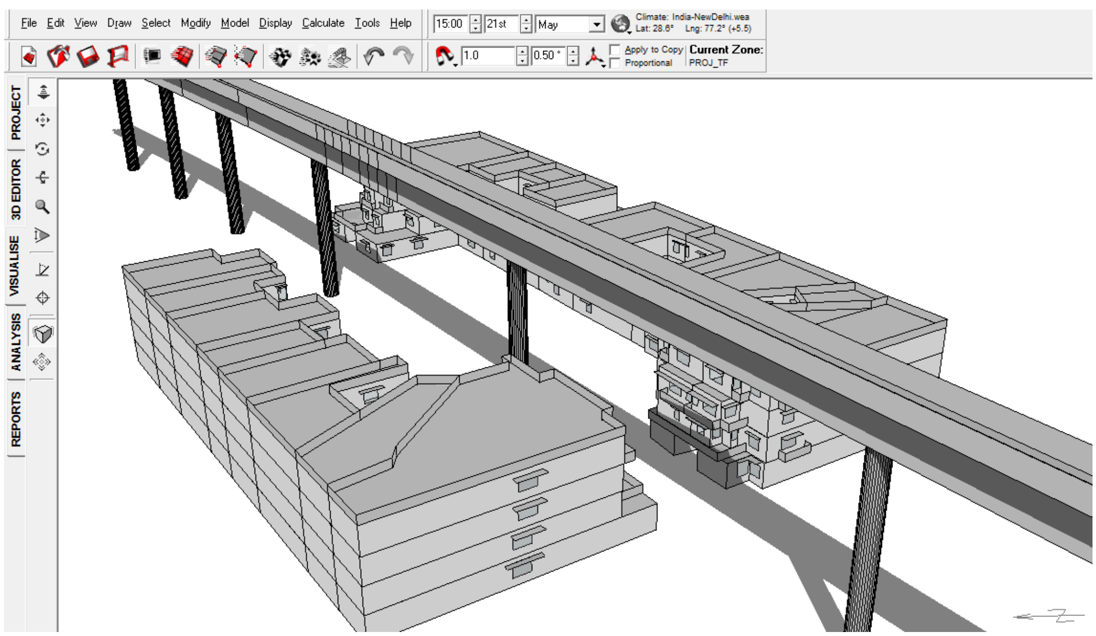


FIGURE 136: SHADOW RANGE ON 21ST MAY 3 PM WITH VIADUCT

FIGURE 135 represents the shadow caused to the buildings. On the basis of the above image, building is not casting any shadow on the nearby buildings but most of the windows is shaded by the overhang. FIGURE 136 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the ground floor of Blocks – 195, 196, 209 & 210 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st May 3 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

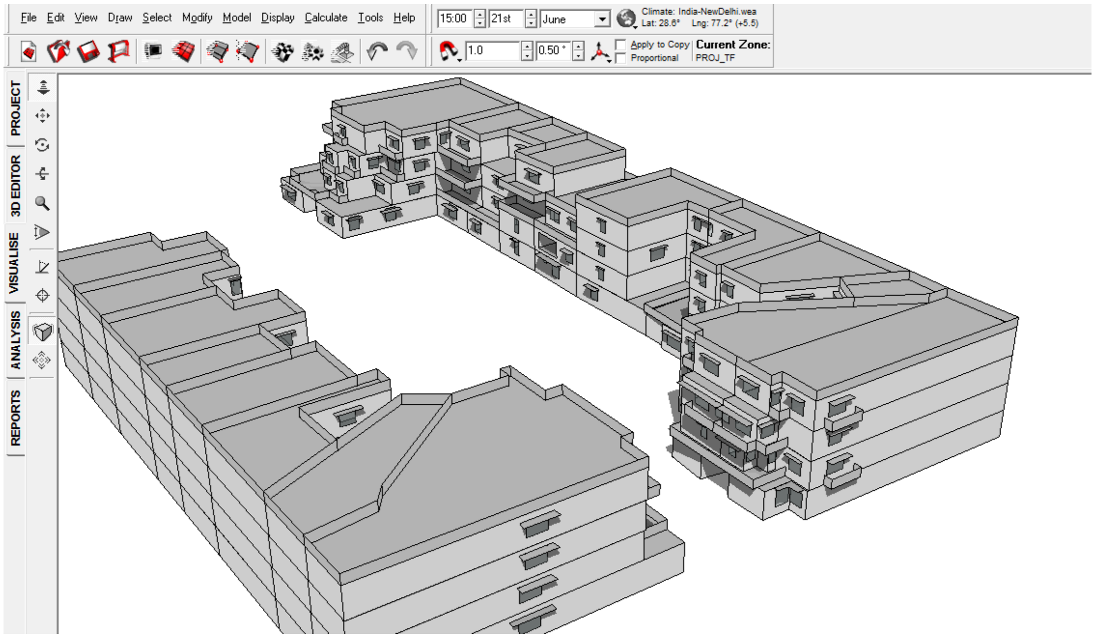


FIGURE 137: SHADOW RANGE ON 21ST JUNE 3 PM WITHOUT VIADUCT

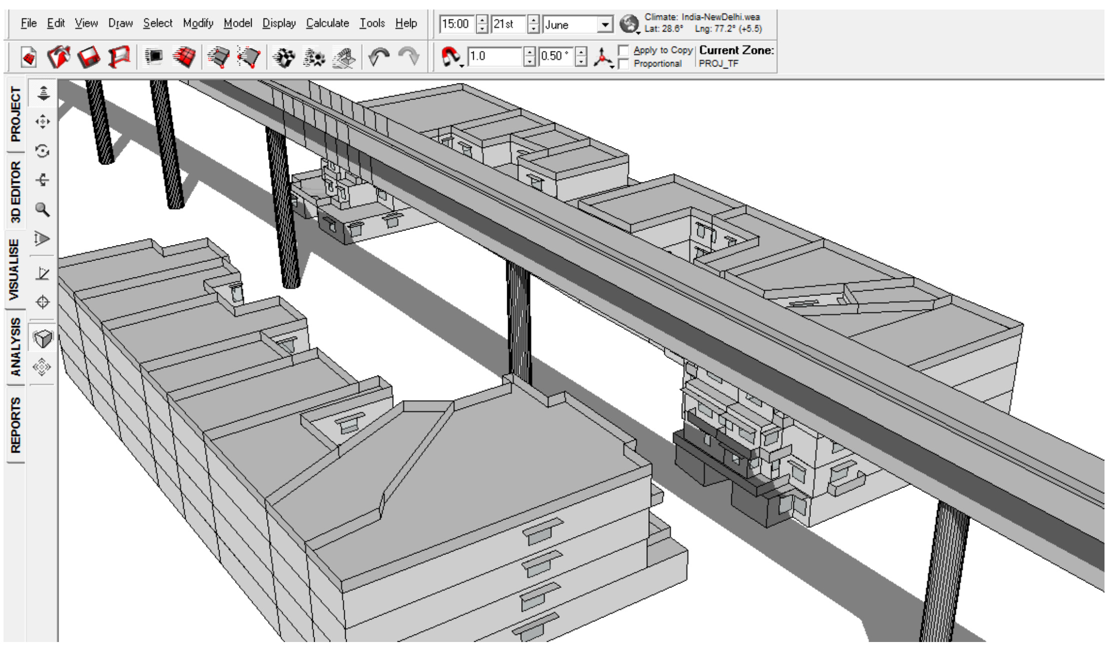


FIGURE 138: SHADOW RANGE ON 21ST JUNE 3 PM WITH VIADUCT

FIGURE 137 represents the shadow caused to the buildings. On the basis of the above image, building is not casting any shadow on the nearby buildings but most of the windows is shaded by the overhang. FIGURE 138 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the ground floor of Blocks – 195 & 196 and ground floor of Blocks – 209 & 210 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st June 3 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

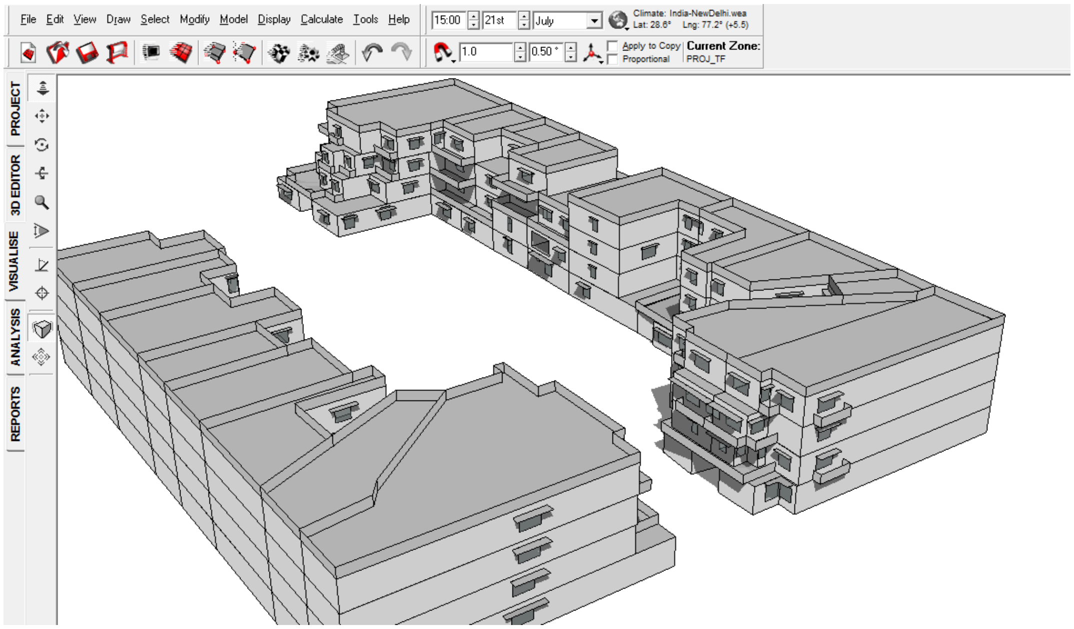


FIGURE 139: SHADOW RANGE ON 21ST JULY 3 PM WITHOUT VIADUCT

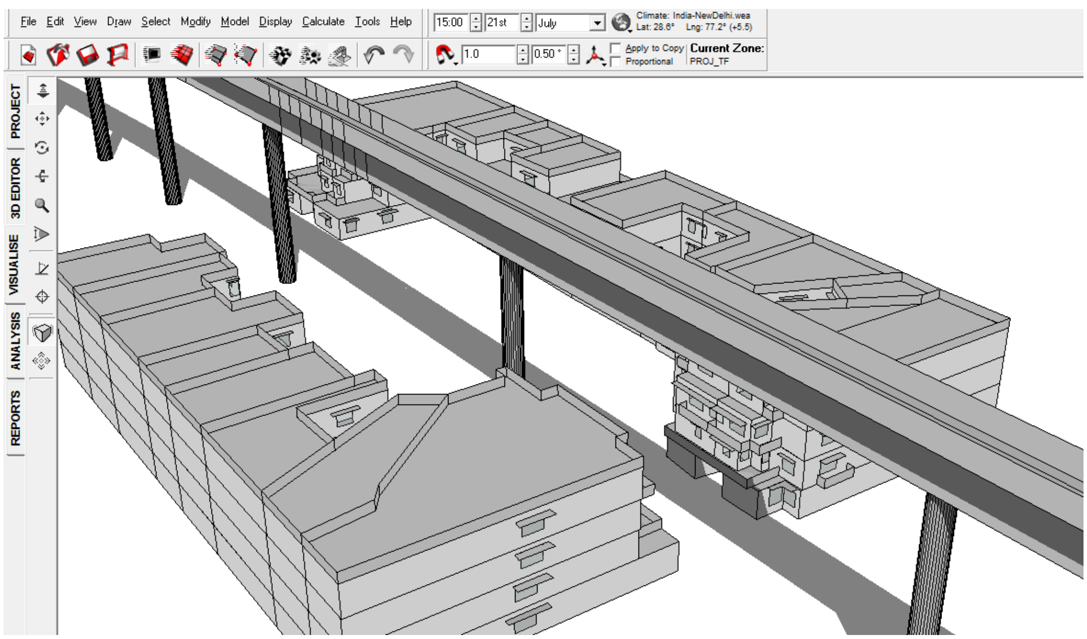


FIGURE 140: SHADOW RANGE ON 21ST JULY 3 PM WITH VIADUCT

FIGURE 139 represents the shadow caused to the buildings. On the basis of the above image, building is not casting any shadow on the nearby buildings but most of the windows is shaded by the overhang. FIGURE 140 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the ground floor of Blocks – 195 & 196 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st July 3 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

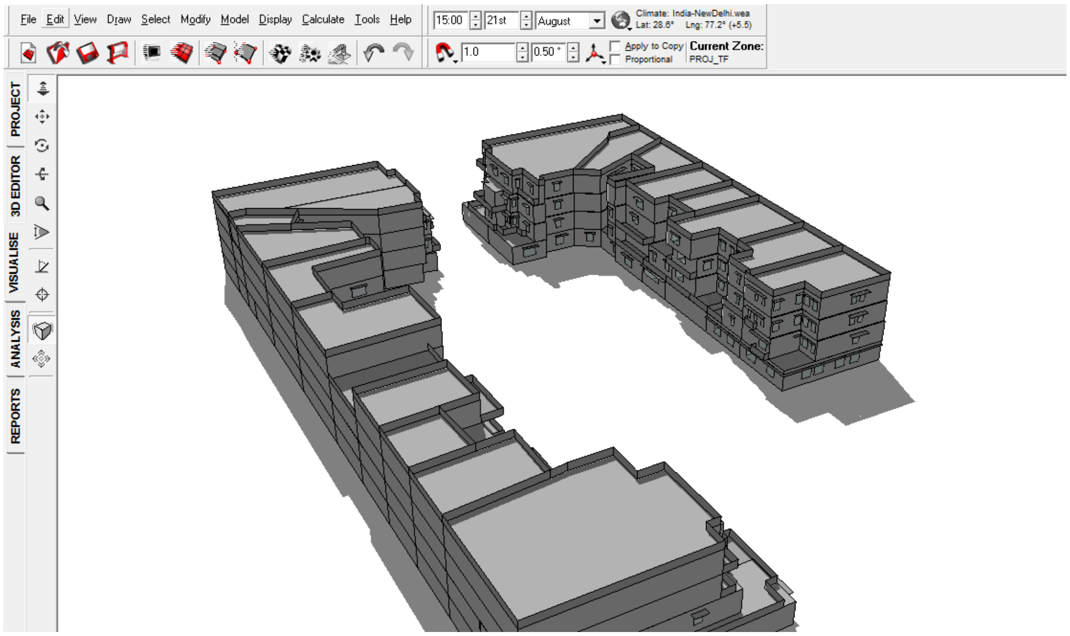


FIGURE 141: SHADOW RANGE ON 21ST AUGUST 3 PM WITHOUT VIADUCT

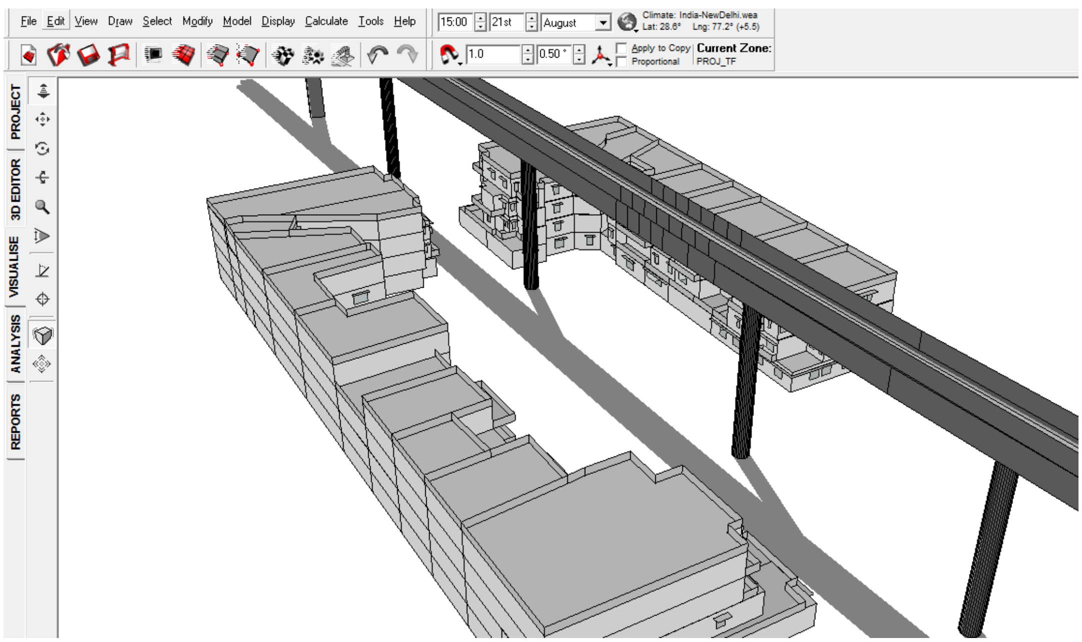


FIGURE 142: SHADOW RANGE ON 21ST AUGUST 3 PM WITH VIADUCT

FIGURE 141 represents the shadow caused to the buildings. On the basis of the above images, most of the windows is shaded by the overhang. FIGURE 142 represents the shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above images, the Viaduct is not casting shadow on the façade of the buildings on 21st August 3 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

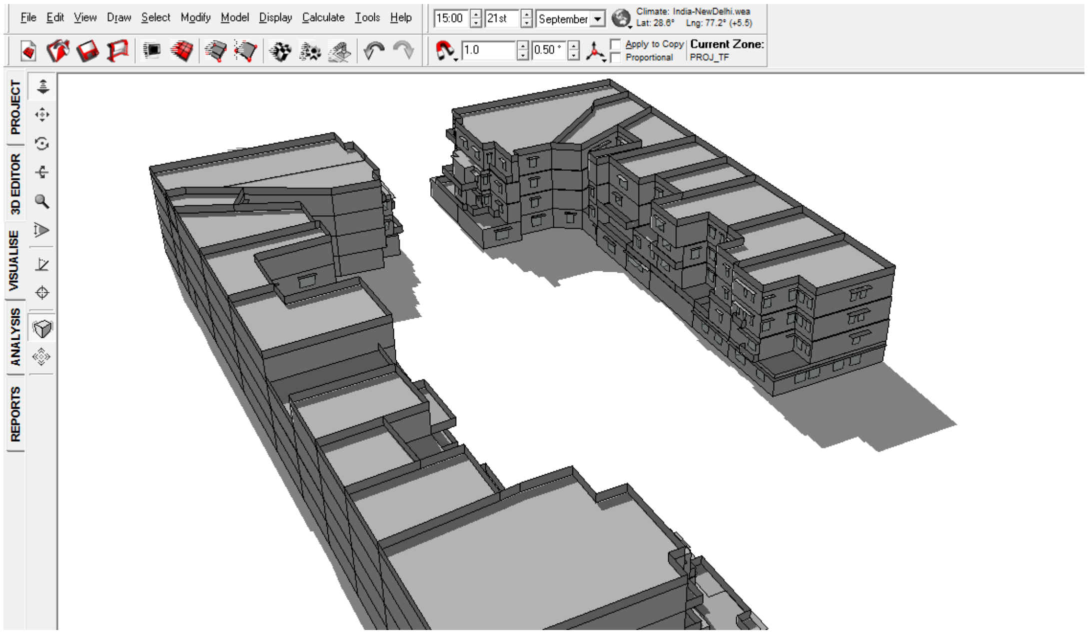


FIGURE 143: SHADOW RANGE ON 21ST SEPTEMBER 3 PM WITHOUT VIADUCT

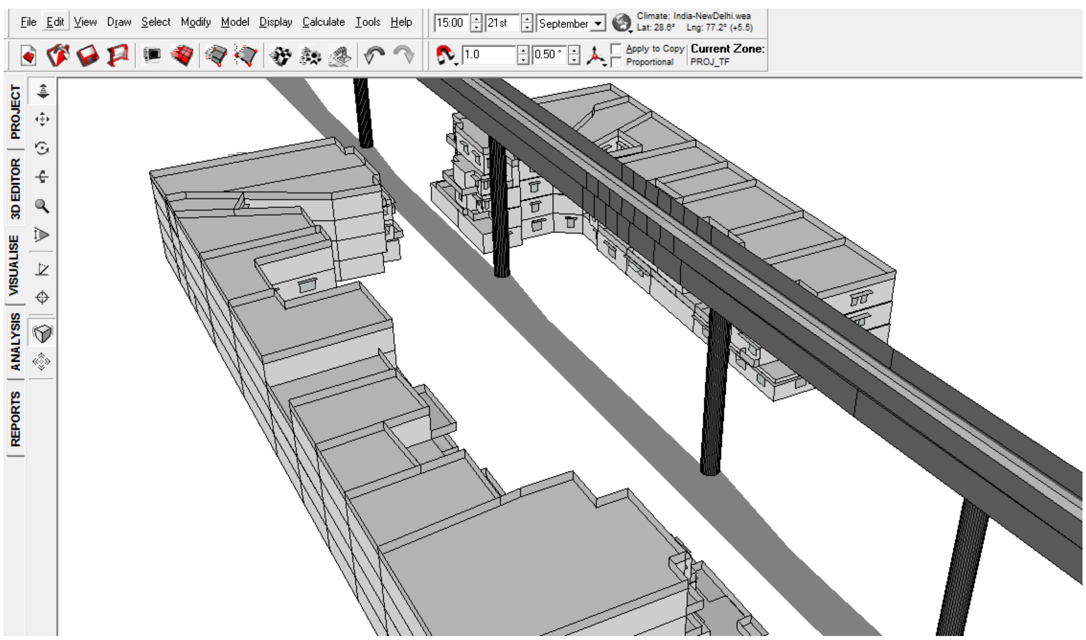


FIGURE 144: SHADOW RANGE ON 21ST SEPTEMBER 3 PM WITH VIADUCT

FIGURE 143 represents the shadow caused to the buildings. On the basis of the above image, most of the windows is shaded by the overhang. FIGURE 144 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is not casting shadow on the façade of the buildings on 21st September 3 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

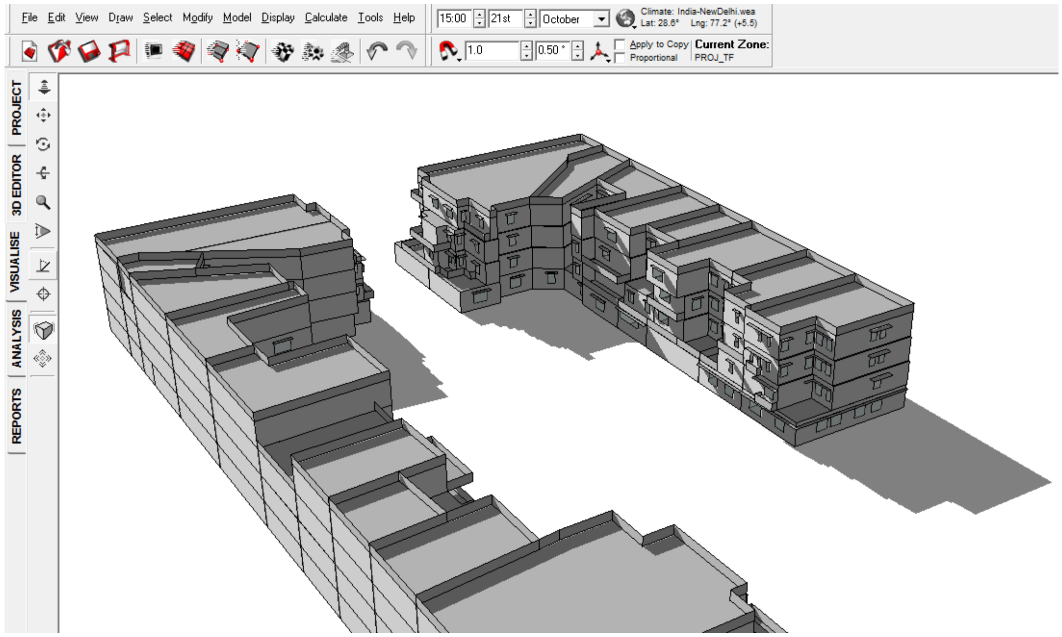


FIGURE 145: SHADOW RANGE ON 21ST OCTOBER 3 PM WITHOUT VIADUCT

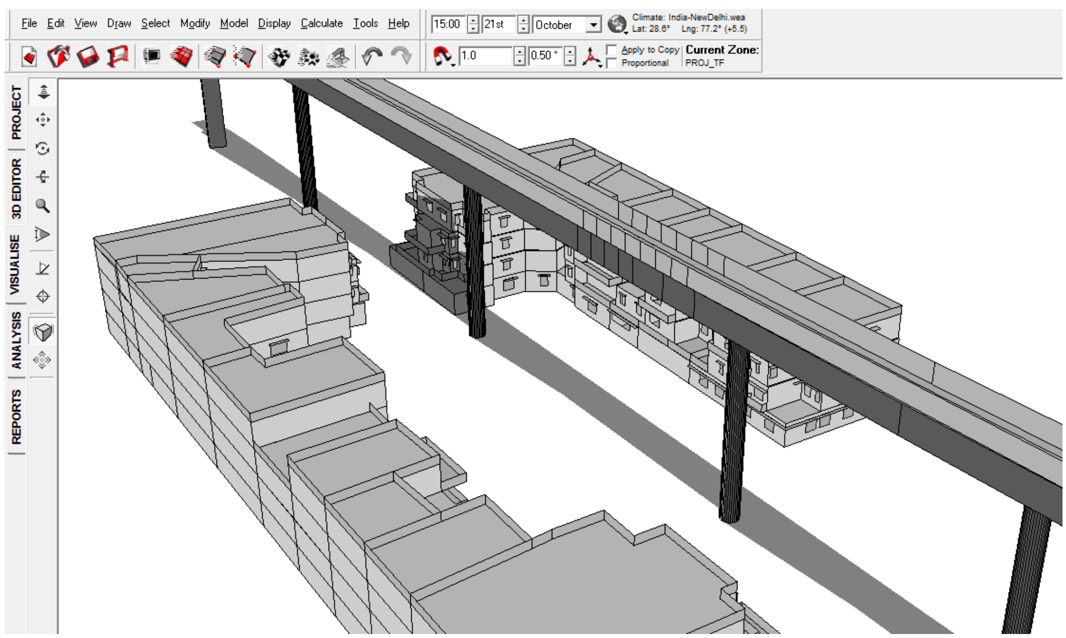


FIGURE 146: SHADOW RANGE ON 21ST OCTOBER 3 PM WITH VIADUCT

FIGURE 145 represents the shadow caused to the buildings. On the basis of the above image, Block – 220 is casting shadow on the Blocks – 217, 216, 215 & 214. FIGURE 146 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second, first & ground floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st October 3 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

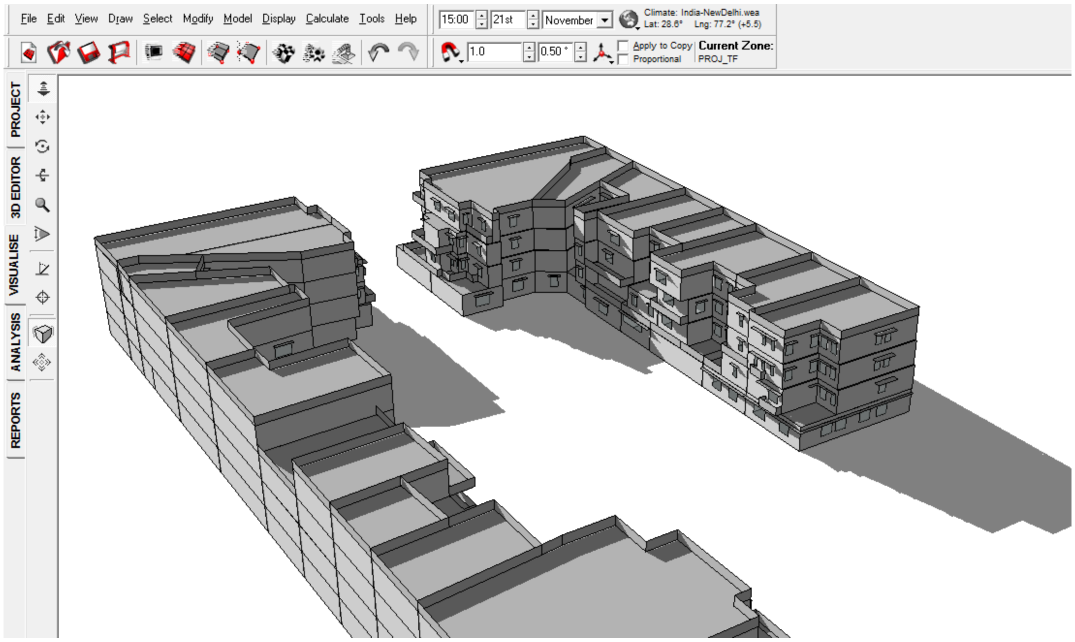


FIGURE 147: SHADOW RANGE ON 21ST NOVEMBER 3 PM WITHOUT VIADUCT

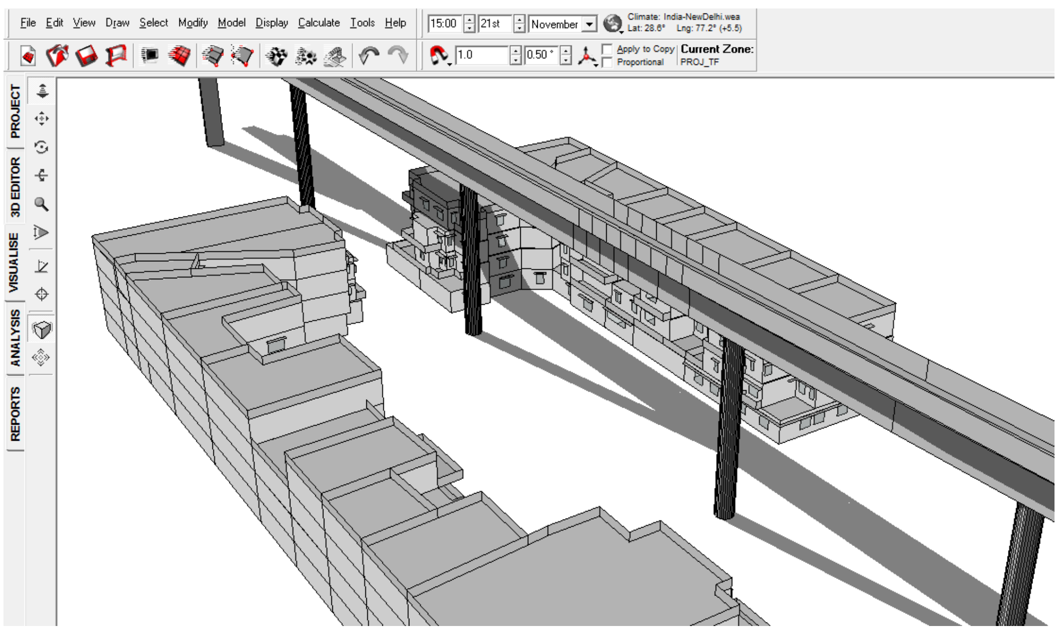


FIGURE 148: SHADOW RANGE ON 21ST NOVEMBER 3 PM WITH VIADUCT

FIGURE 147 represents the shadow caused to the buildings. On the basis of the above image, Block – 220 is casting shadow on the Blocks – 217, 216, 215 & 214. FIGURE 148 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the third, second, first & ground floor of Block – 220 and third floor of Block – 219 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st November 3 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

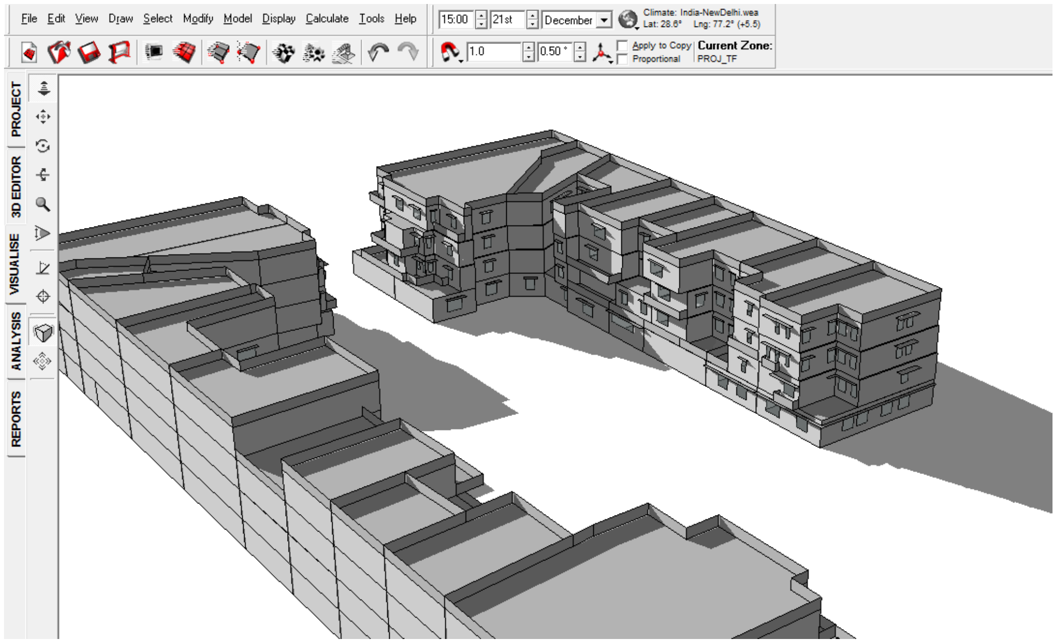


FIGURE 149: SHADOW RANGE ON 21ST DECEMBER 3 PM WITHOUT VIADUCT

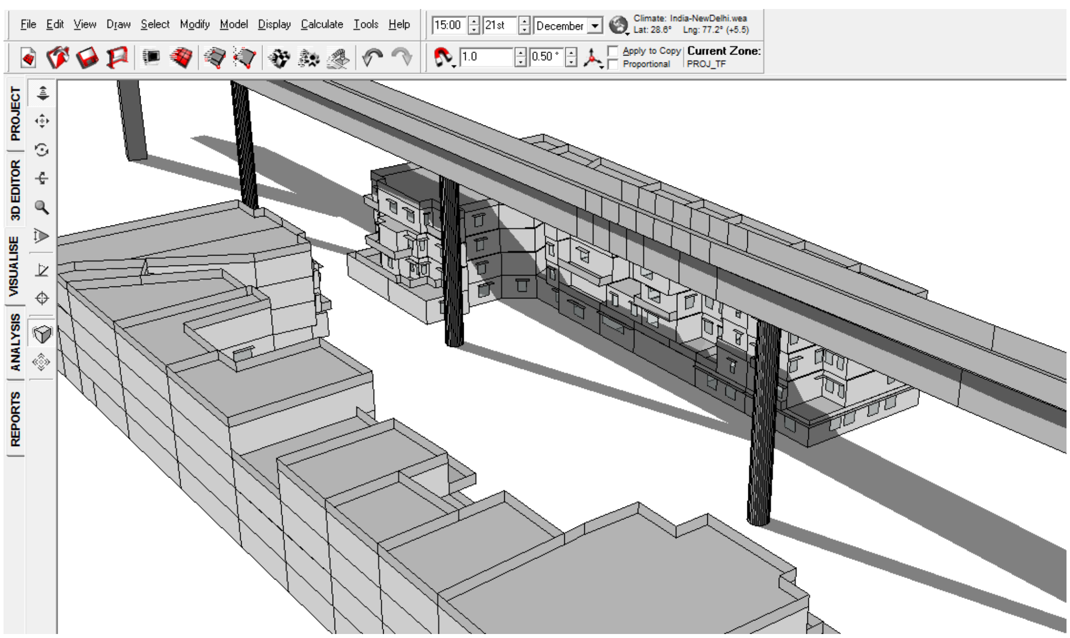


FIGURE 150: SHADOW RANGE ON 21ST DECEMBER 3 PM WITH VIADUCT

FIGURE 149 represents the shadow caused to the buildings. On the basis of the above image, Block – 220 is casting shadow on the Blocks – 217, 216, 215 & 214. FIGURE 150 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on the first & ground floor of Blocks – 211, 212, 213, 214, 215, 216 & 217, third, second & first floor of Block – 220 and third floor of Block – 219 thereby obstructing the direct sunlight falling on the back side of the buildings, which itself is acting as a shade for the back side of the buildings on 21st December 3 PM.

Green Tree Building Energy Pvt. Ltd.
DELHI NCR

2.5 Shadow Analysis 3 – Annual Evening Time (4PM to 5PM)

As per our annual shadow analysis during the evening time (i.e. from 4.00 PM to 5.00 PM), the "Building A & B" is shaded most of the time due to the same building itself. Thus the proposed RRTS viaduct creates a minimal shadow effect on the surrounding buildings.

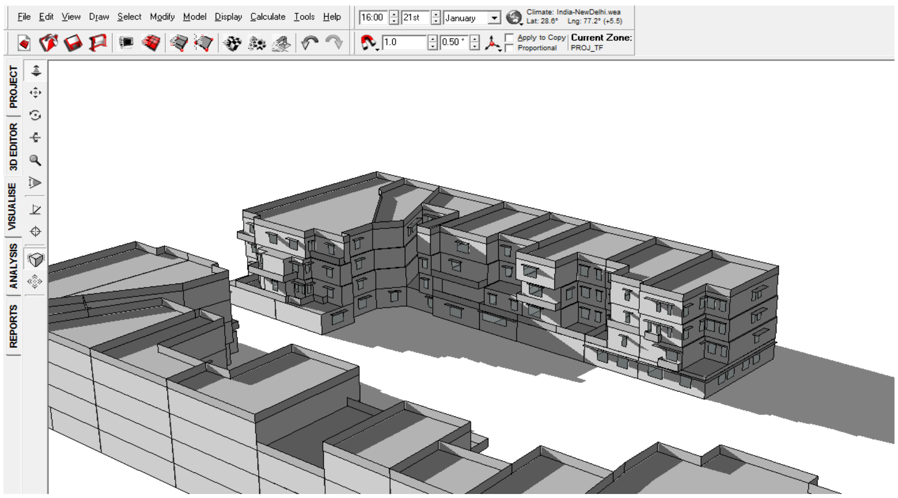


Figure 151: Shadow Range on 21st January 4 PM without viaduct

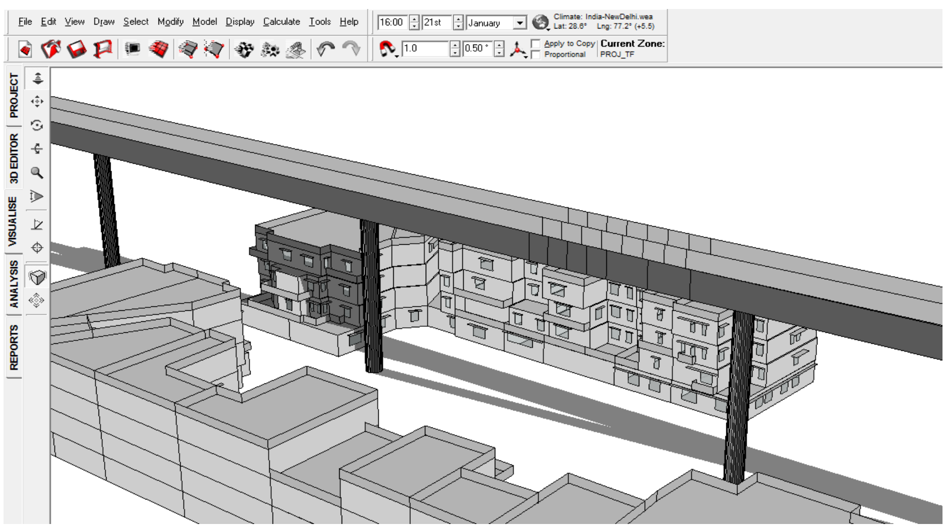


Figure 152: Shadow Range on 21st January 4 PM with viaduct

Figure 151 represents the shadow caused to the buildings. On the basis of the above image, Block – 220 is casting shadow on the Blocks – 217, 216, 215, 214 & 213. Figure 152 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on third, second, first & ground floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st January 4 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

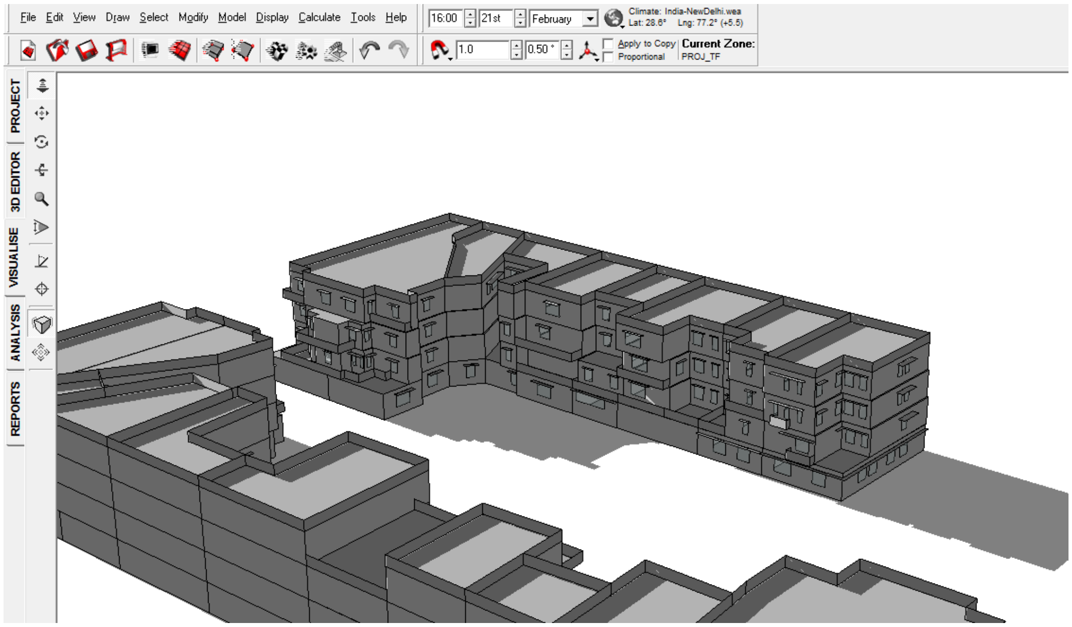


FIGURE 153: SHADOW RANGE ON 21ST FEBRUARY 4 PM WITHOUT VIADUCT

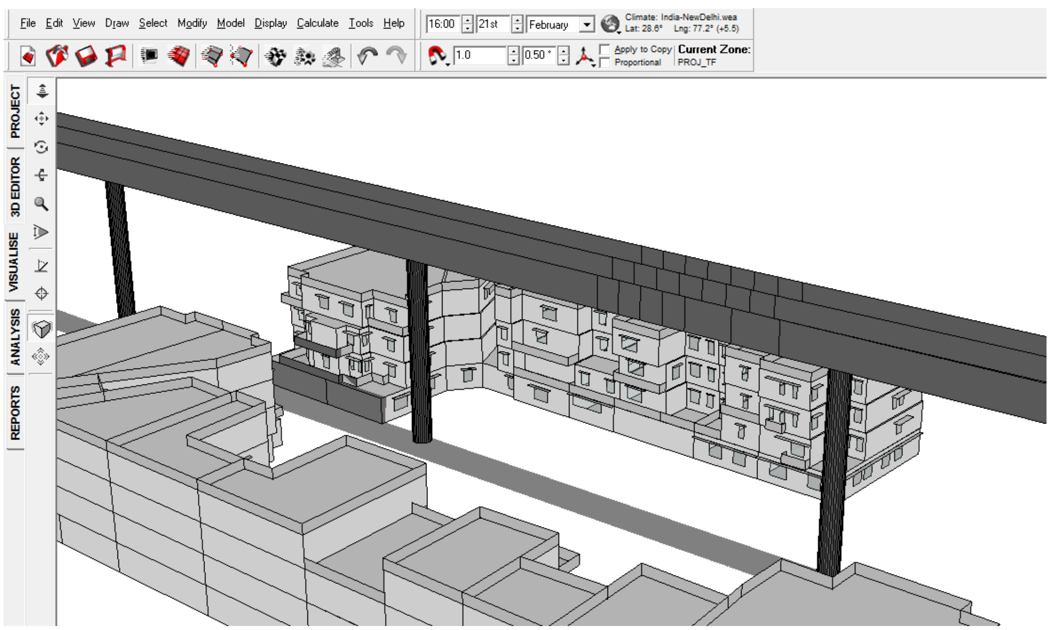


FIGURE 154: SHADOW RANGE ON 21ST FEBRUARY 4 PM WITH VIADUCT

FIGURE 153 represents the shadow caused to the buildings. On the basis of the above image, most of the windows are shaded by the overhang. FIGURE 154 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on ground floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st February 4 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI
NCR

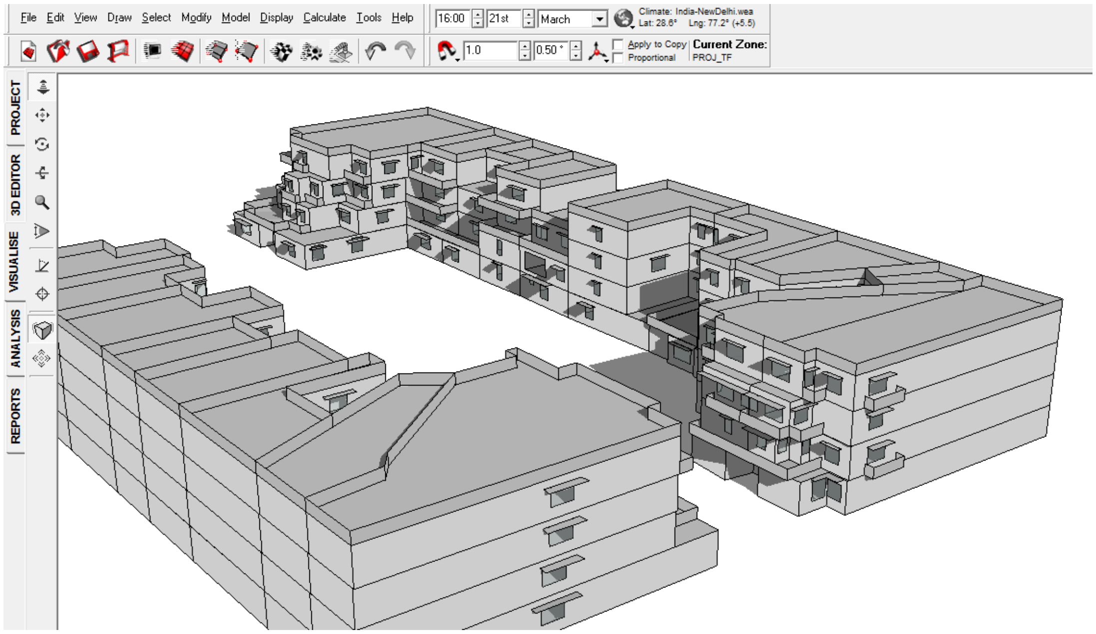


FIGURE 155: SHADOW RANGE ON 21ST MARCH 4 PM WITHOUT VIADUCT

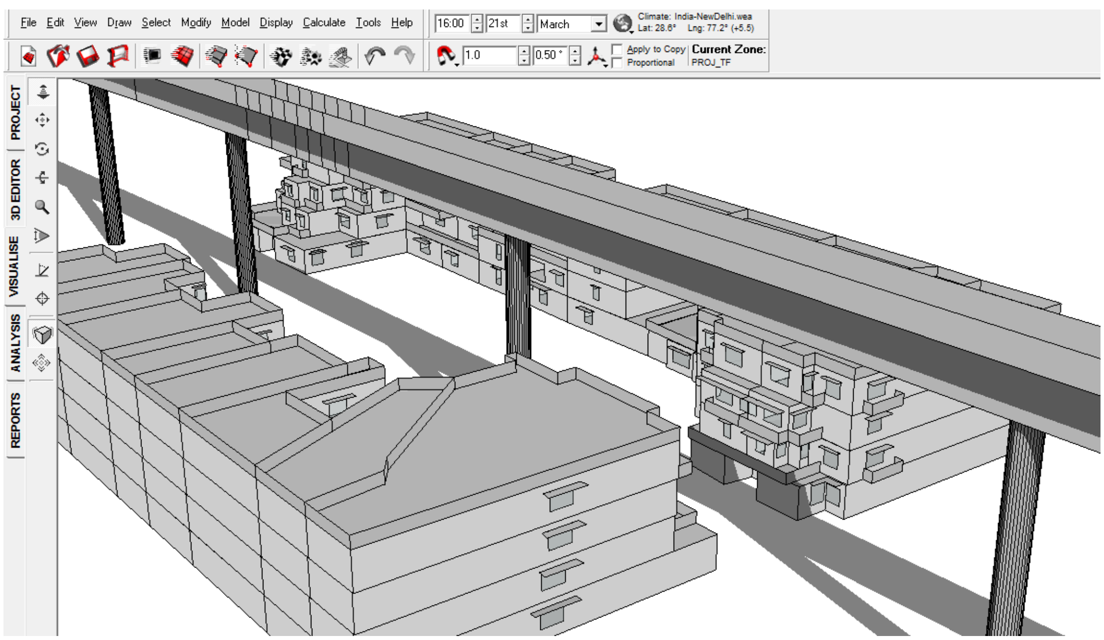


FIGURE 156: SHADOW RANGE ON 21ST MARCH 4 PM WITH VIADUCT

FIGURE 155 represents the shadow caused to the buildings. On the basis of the above image, most of the windows are shaded by the overhang. FIGURE 156 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on ground floor of Blocks – 195 & 196 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st March 4 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

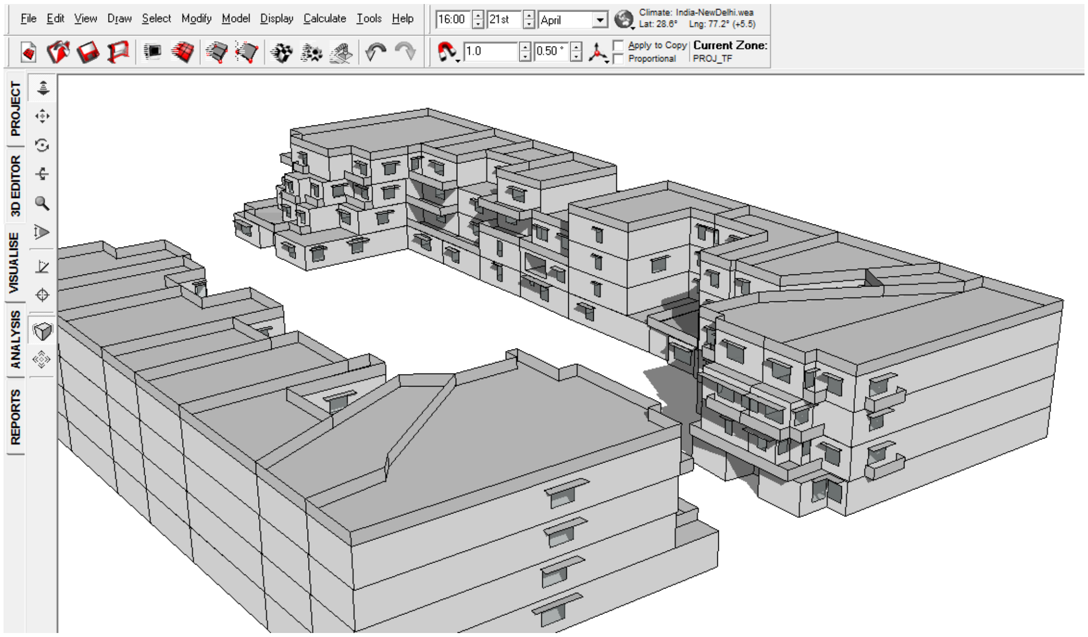


FIGURE 157: SHADOW RANGE ON 21ST APRIL 4 PM WITHOUT VIADUCT

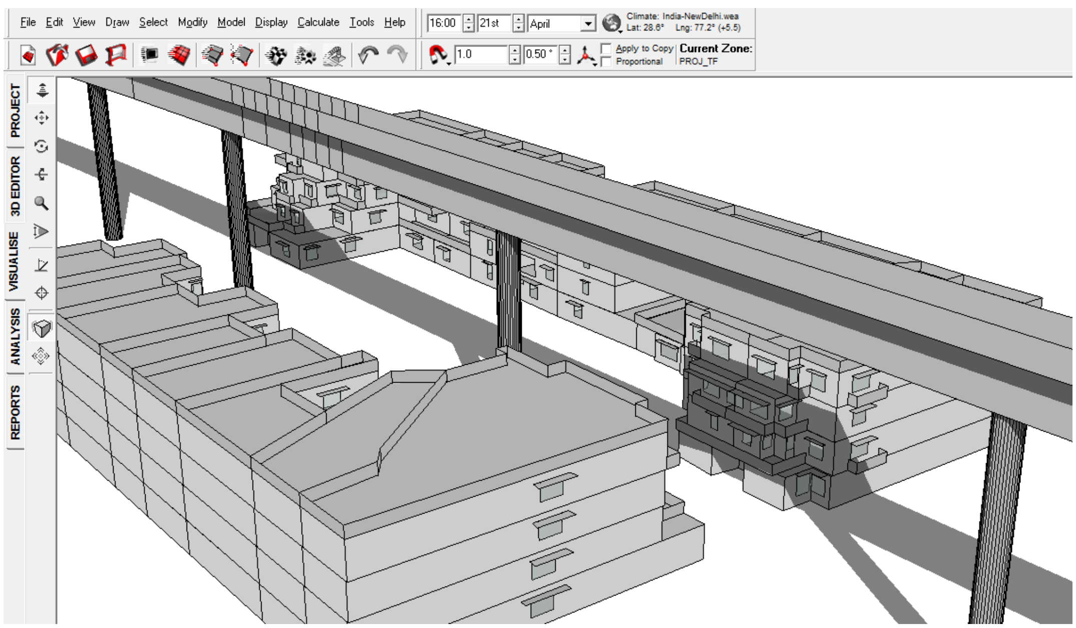


FIGURE 158: SHADOW RANGE ON 21ST APRIL 4 PM WITH VIADUCT

FIGURE 157 represents the shadow caused to the buildings. On the basis of the above image, the building is not casting any shadow on the nearby buildings. FIGURE 158 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on second, first & ground floor of Blocks – 195 & 196 and first & ground floor of Blocks – 209 & 210 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st April 4 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

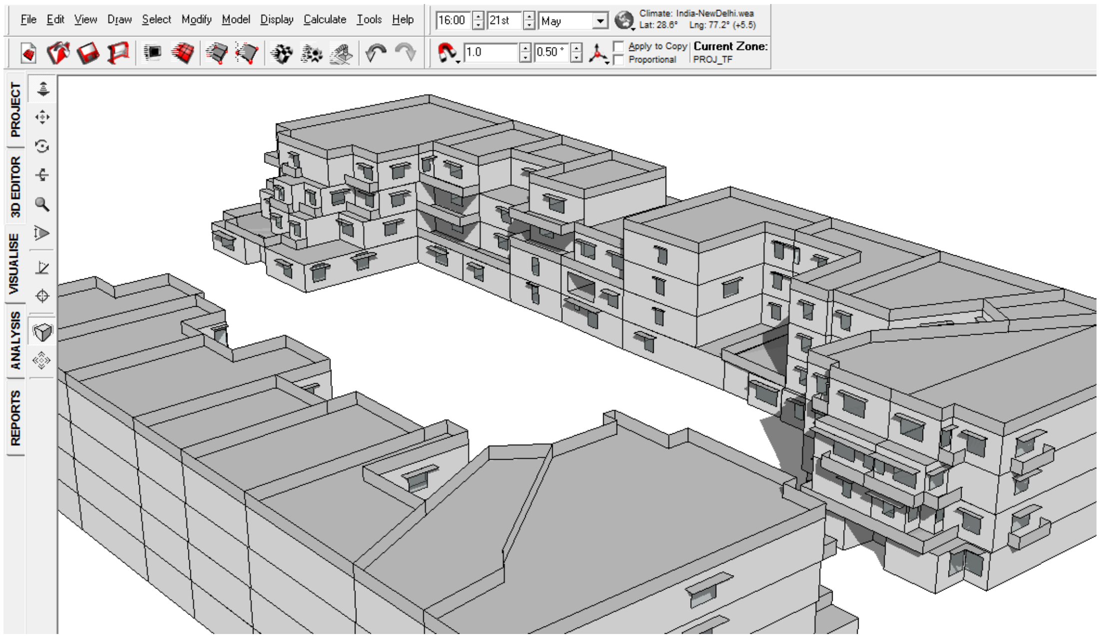


FIGURE 159: SHADOW RANGE ON 21ST MAY 4 PM WITHOUT VIADUCT

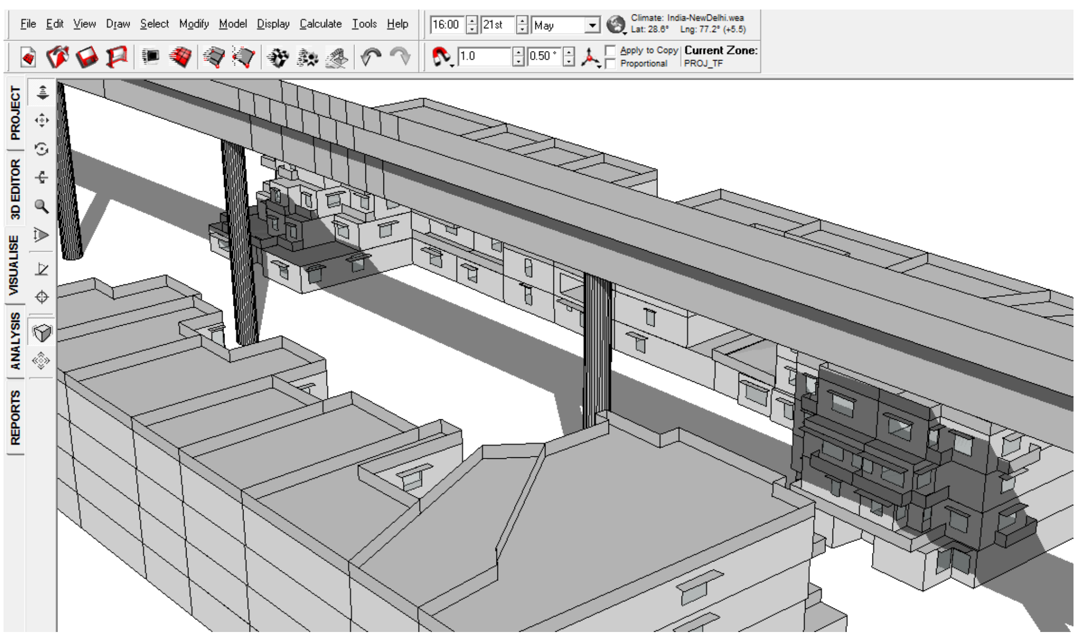


FIGURE 160: SHADOW RANGE ON 21ST MAY 4 PM WITH VIADUCT

FIGURE 159 represents the shadow caused to the buildings. On the basis of the above image, the building is not casting any shadow on the nearby building. FIGURE 160 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on third, second, first & ground floor of Blocks – 195 & 196 and second, first & ground floor of Blocks – 209 & 210 thereby obstructing the direct sunlight falling on the on the façade of the building, which itself is acting as a shade for the façade on 21st May 4 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

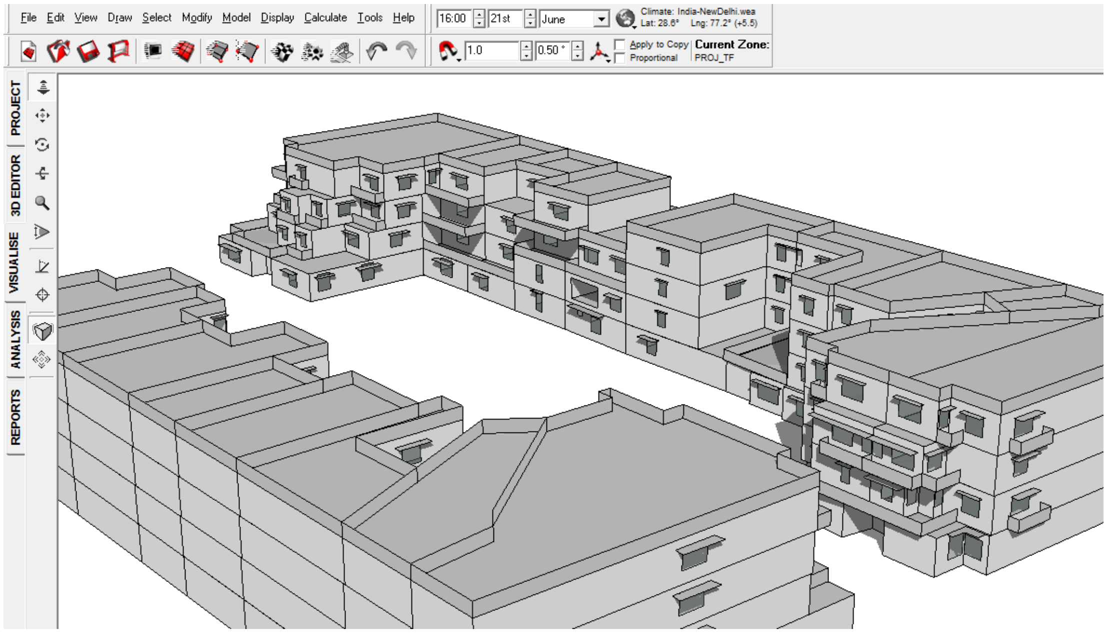


FIGURE 161: SHADOW RANGE ON 21ST JUNE 4 PM WITHOUT VIADUCT

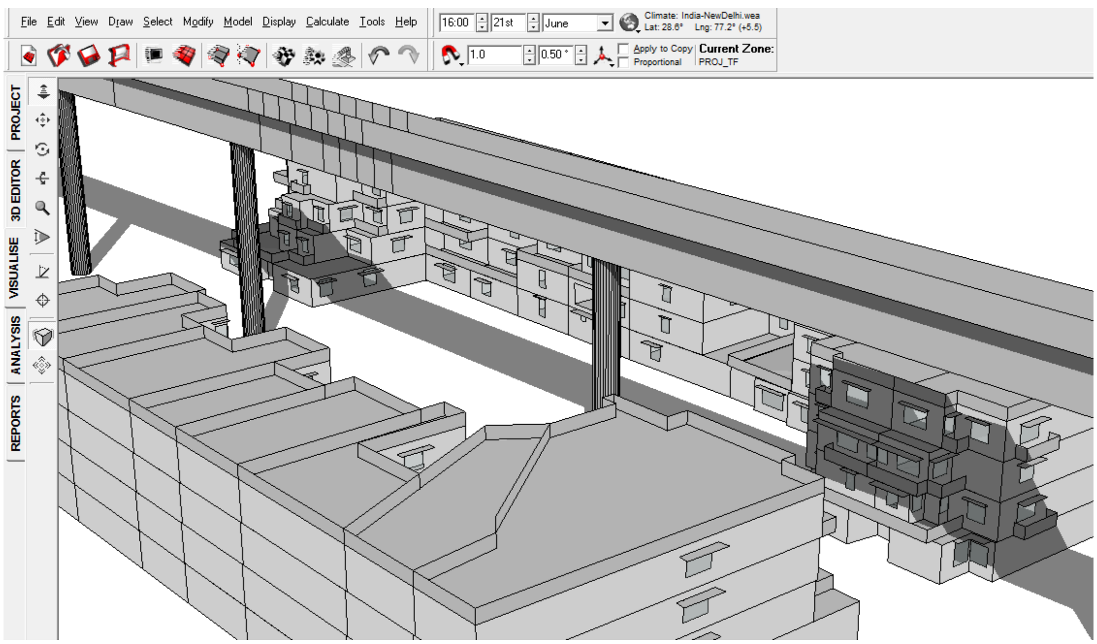


FIGURE 162: SHADOW RANGE ON 21ST JUNE 4 PM WITH VIADUCT

FIGURE 161 represents the shadow caused to the buildings. On the basis of the above image, the building is not casting any shadow on the nearby buildings. FIGURE 162 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on third, second, first & ground floor of Blocks – 195 & 196 and second, first & ground floor of Blocks – 209 & 210 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st June 4 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

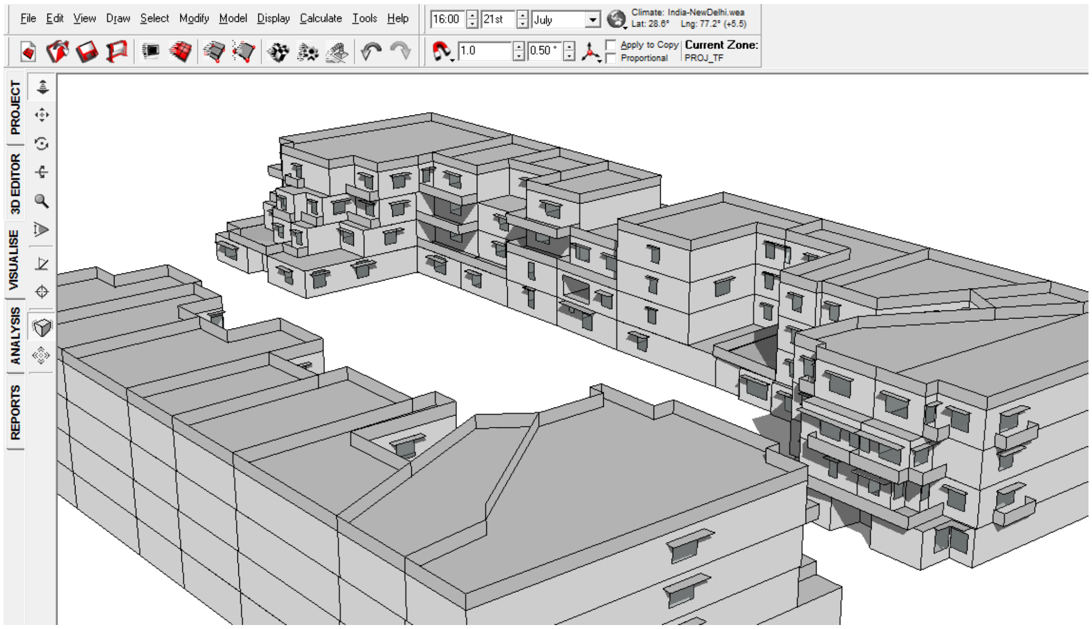


FIGURE 163: SHADOW RANGE ON 21ST JULY 4 PM WITHOUT VIADUCT

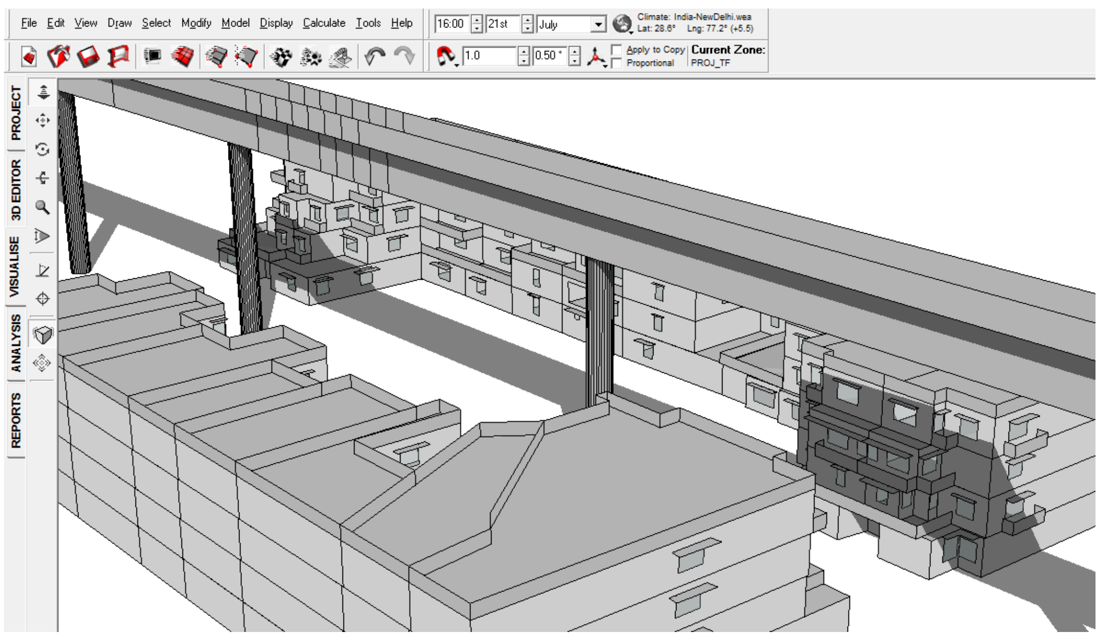


FIGURE 164: SHADOW RANGE ON 21ST JULY 4 PM WITH VIADUCT

FIGURE 163 represents the shadow caused to the buildings. On the basis of the above image, the building is not casting any shadow on the nearby buildings. FIGURE 164 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on third, second, first & ground floor of Blocks – 195 & 196 and second, first & ground floor of Blocks – 209 & 210 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st July 4 PM.

GreenTree Building Energy P.Vt. Ltd.
DELHI
NCR

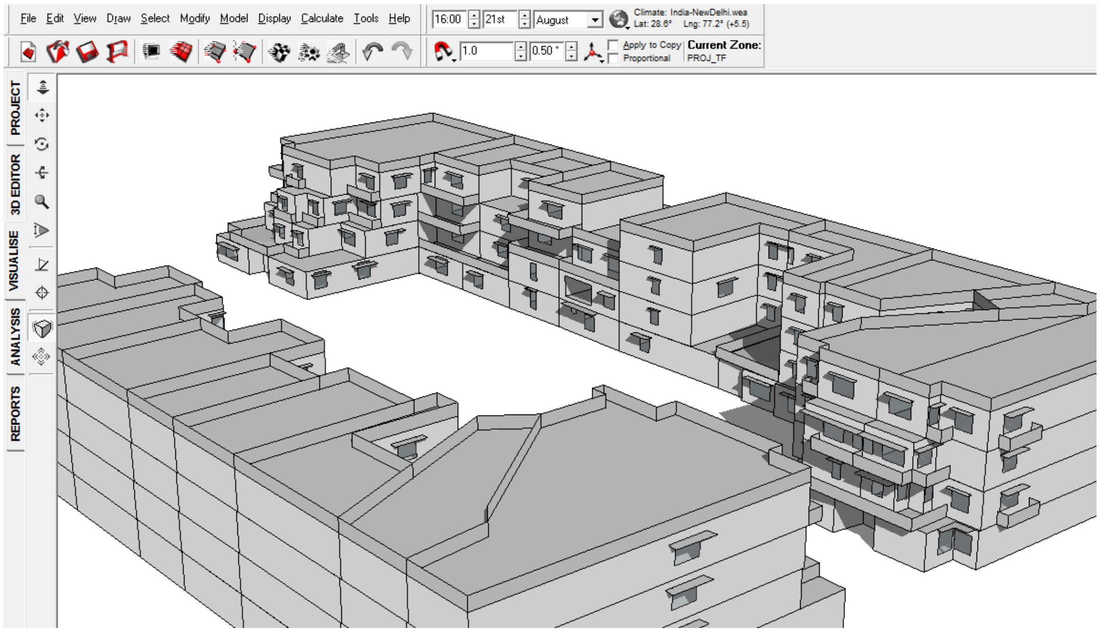


FIGURE 165: SHADOW RANGE ON 21ST AUGUST 4 PM WITHOUT VIADUCT

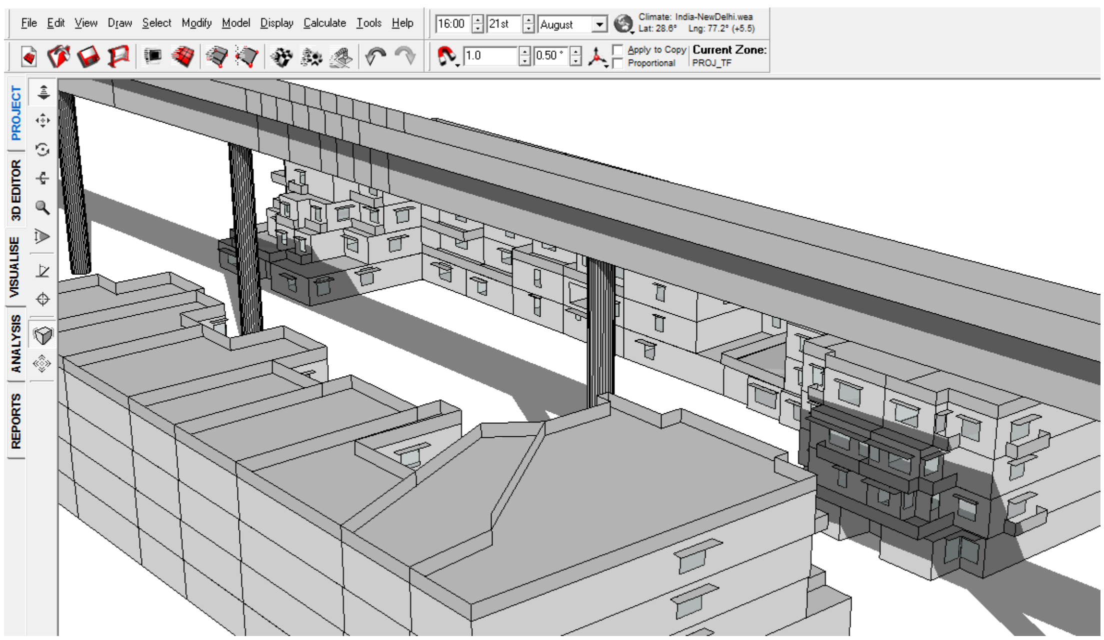


FIGURE 166: SHADOW RANGE ON 21ST AUGUST 4 PM WITH VIADUCT

FIGURE 165 represents the shadow caused to the buildings. On the basis of the above image, Block – 195 is casting shadow on the Blocks – 199, 200 & 201. FIGURE 166 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on second, first & ground floor of Blocks – 195 & 196 and first & ground floor of Blocks – 209 & 210 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st August 4 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

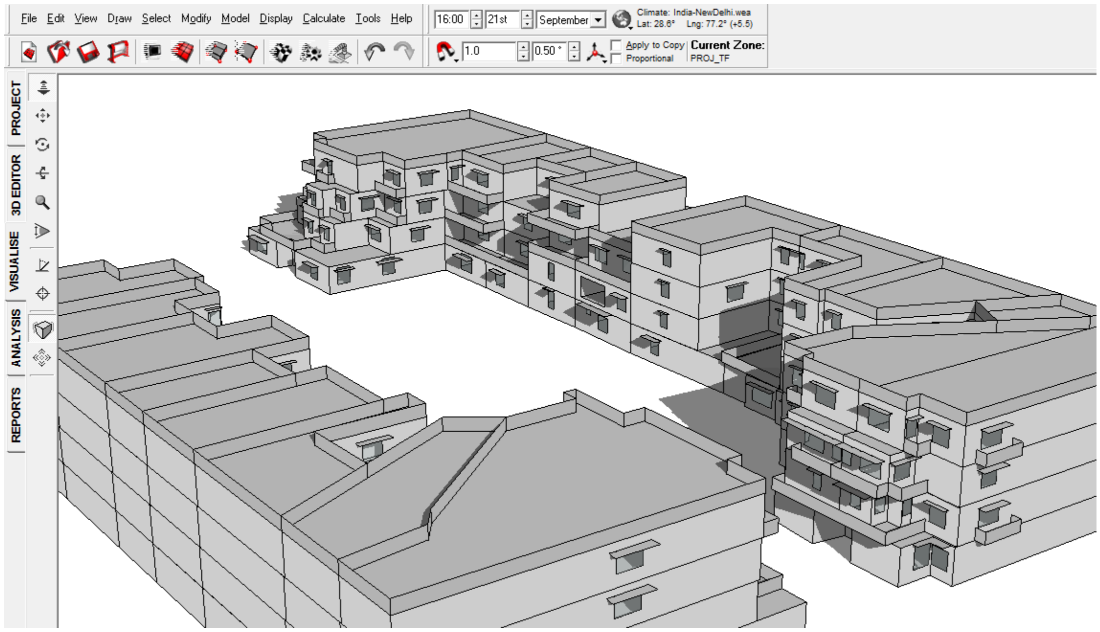


FIGURE 167: SHADOW RANGE ON 21ST SEPTEMBER 4 PM WITHOUT VIADUCT

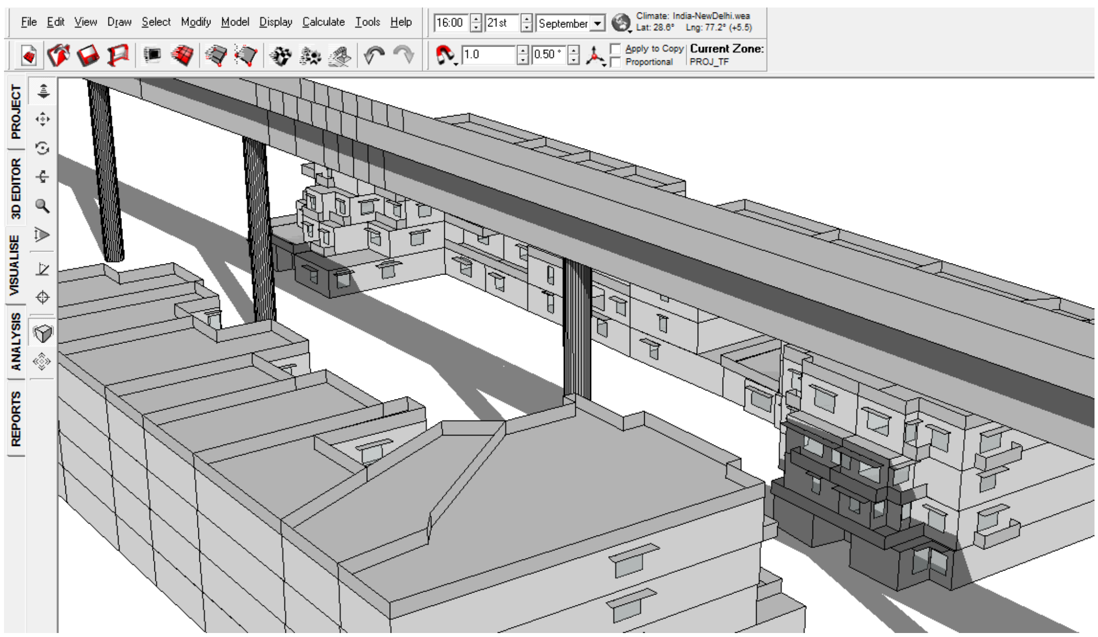


FIGURE 168: SHADOW RANGE ON 21ST SEPTEMBER 4 PM WITH VIADUCT

FIGURE 167 represents the shadow caused to the buildings. On the basis of the above image, Block – 195 is casting shadow on the Blocks – 199, 200 & 201. FIGURE 168 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on second, first & ground floor of Blocks – 195 & 196 and ground floor of Blocks – 209 & 210 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st September 4 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

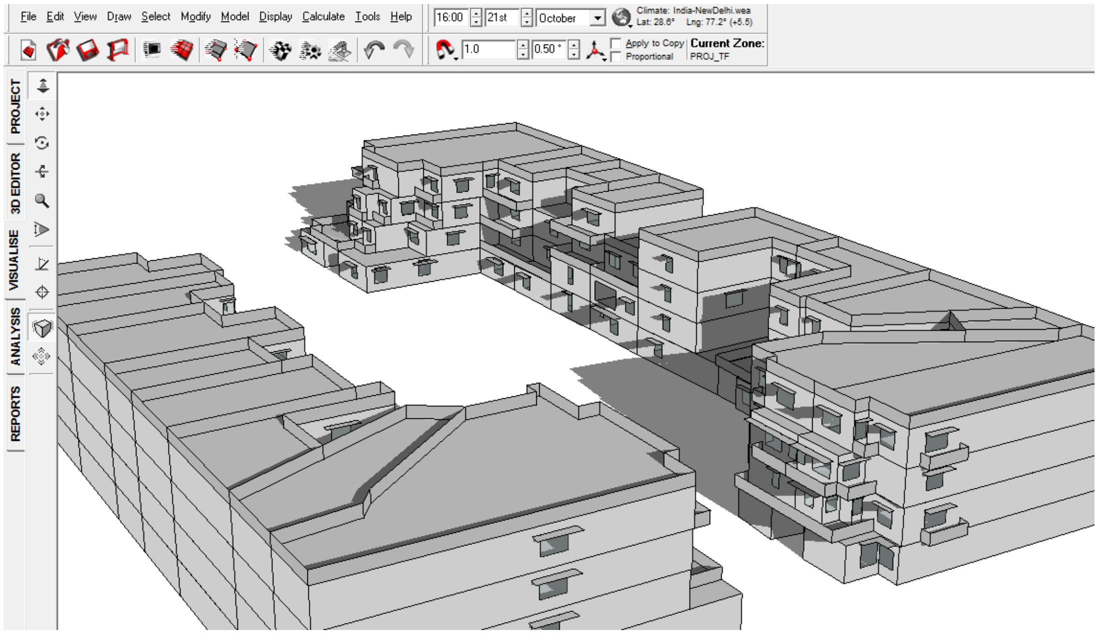


FIGURE 169: SHADOW RANGE ON 21ST OCTOBER 4 PM WITHOUT VIADUCT

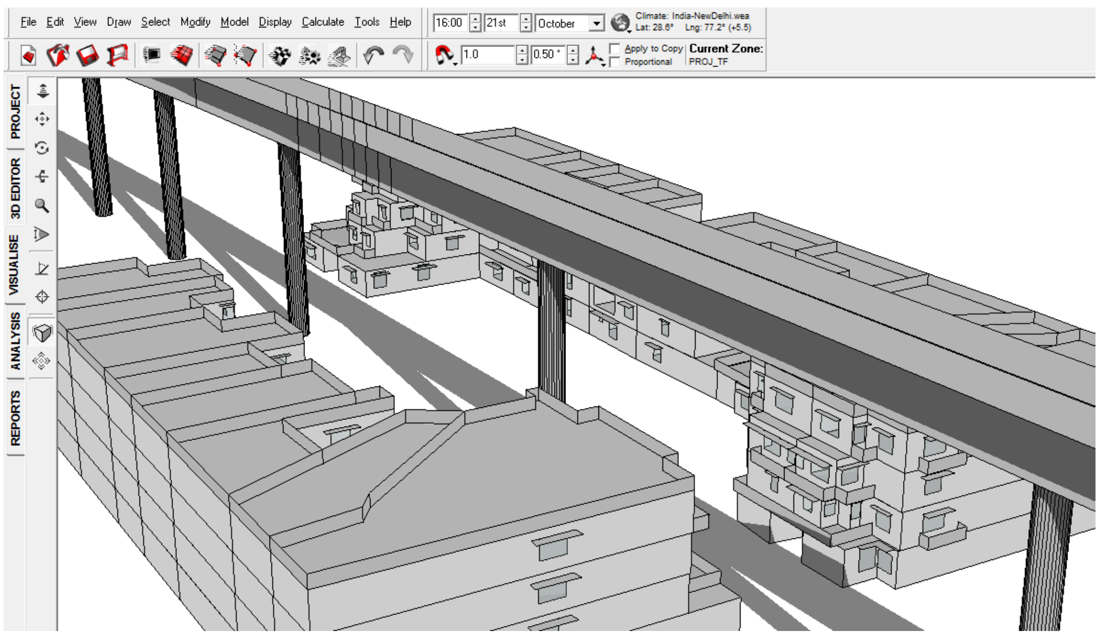


FIGURE 170: SHADOW RANGE ON 21ST OCTOBER 4 PM WITH VIADUCT

FIGURE 169 represents the shadow caused to the buildings. On the basis of the above image, Block – 195 is casting shadow on the Blocks – 199, 200, 201 & 202. FIGURE 170 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on ground floor of Blocks – 195 & 196 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st October 4 PM.

GreenTree Building Energy Pvt. Ltd. DELHI NCR

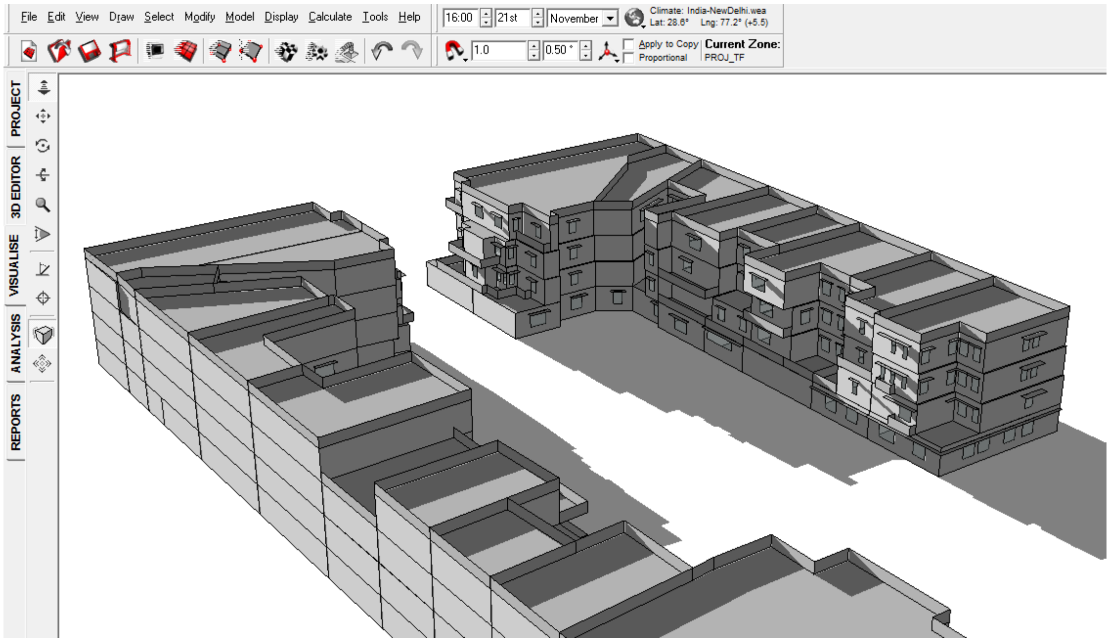


FIGURE 171: SHADOW RANGE ON 21ST NOVEMBER 4 PM WITHOUT VIADUCT

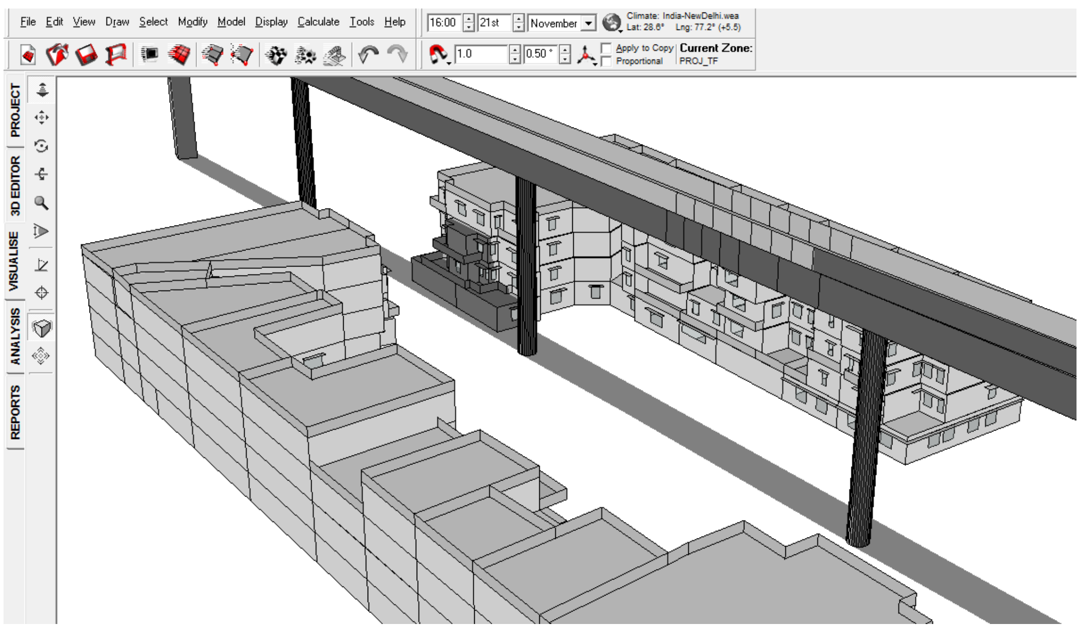


FIGURE 172: SHADOW RANGE ON 21ST NOVEMBER 4 PM WITH VIADUCT

FIGURE 171 represents the shadow caused to the buildings. On the basis of the above image, Blocks – 219 & 220 is casting shadow on the Blocks – 211 to 217. FIGURE 172 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on second, first & ground floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st November 4 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

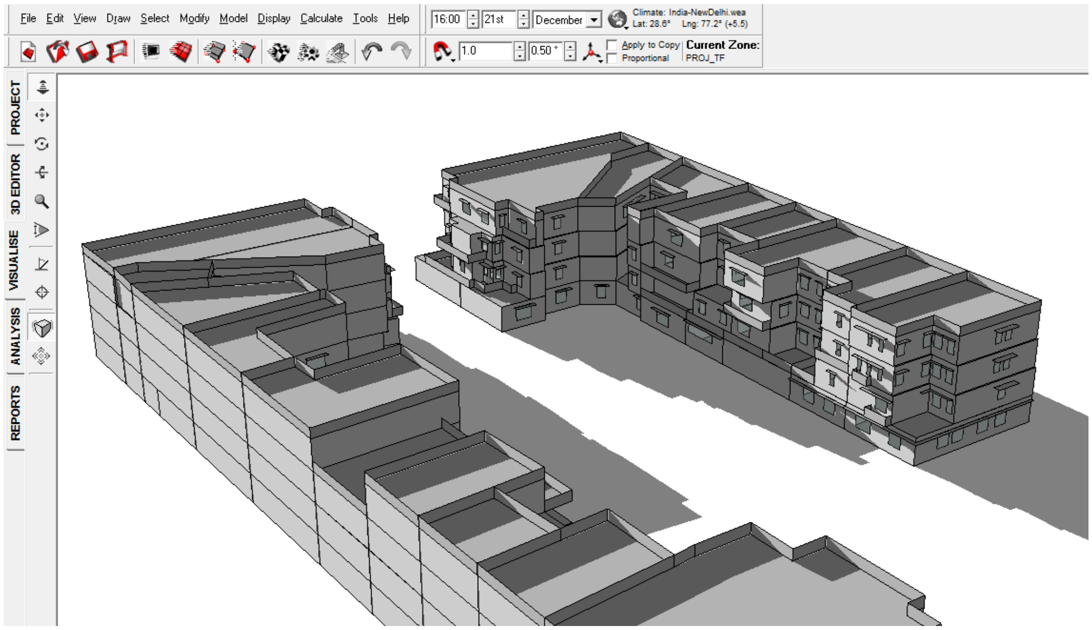


FIGURE 173: SHADOW RANGE ON 21ST DECEMBER 4 PM WITHOUT VIADUCT

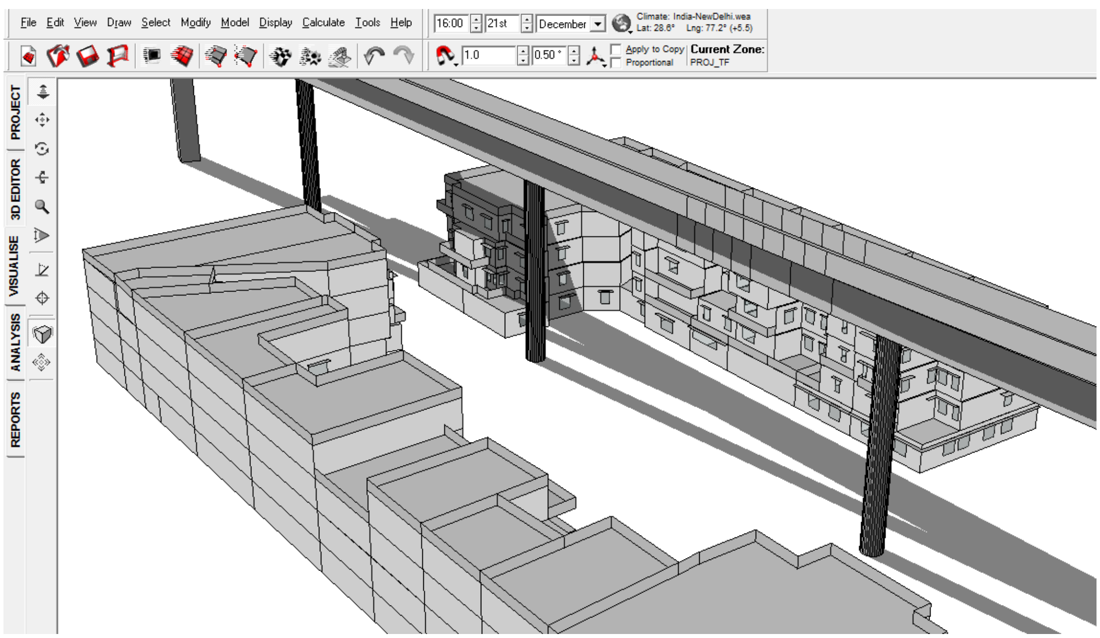


FIGURE 174: SHADOW RANGE ON 21ST DECEMBER 4 PM WITH VIADUCT

FIGURE 173 represents the shadow caused to the buildings. On the basis of the above image, Blocks – 219 & 220 is casting shadow on the Blocks – 211 to 217. FIGURE 174 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on third, second, first & ground floor of Blocks – 219 & 220 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st December 4 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

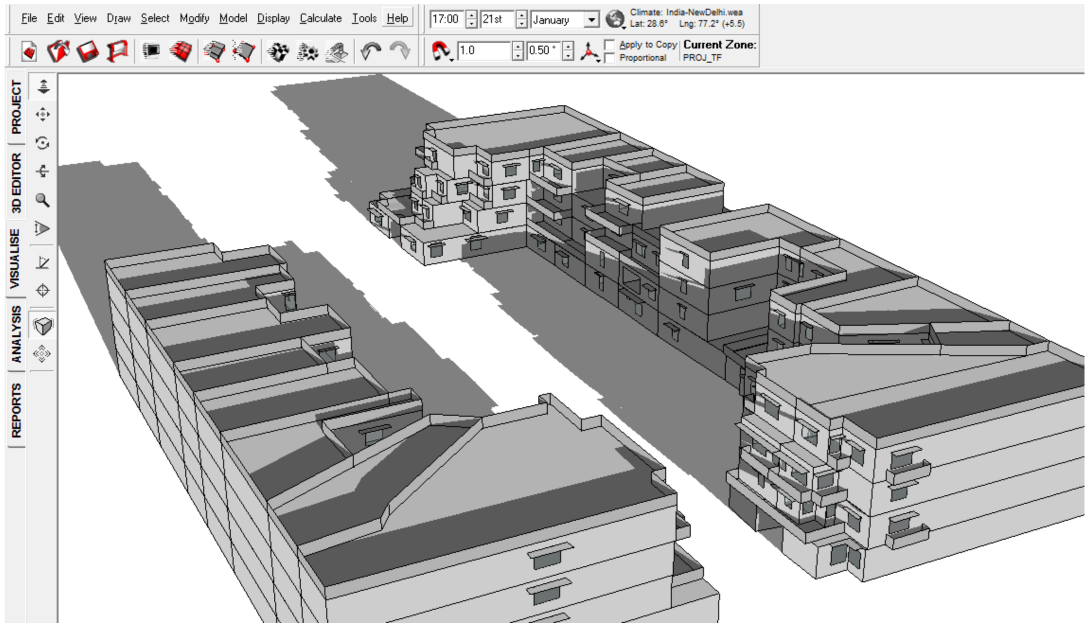


FIGURE 175: SHADOW RANGE ON 21ST JANUARY 5 PM WITHOUT VIADUCT

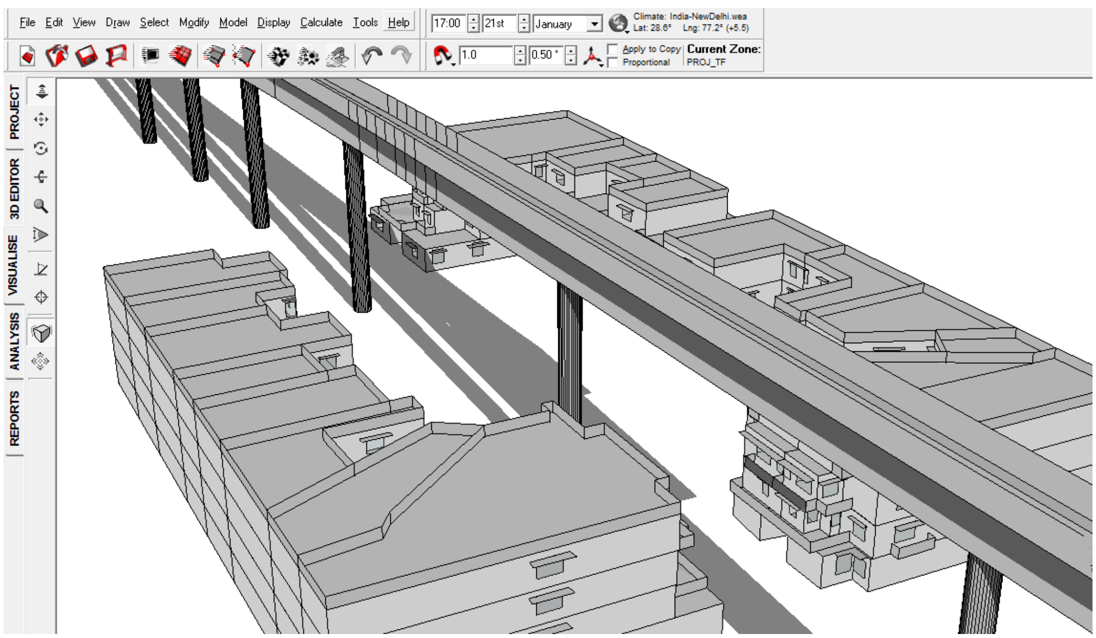


FIGURE 176: SHADOW RANGE ON 21ST JANUARY 5 PM WITH VIADUCT

FIGURE 175 represents the shadow caused to the building. On the basis of the above image, Blocks – 219 & 220 is casting shadow on the Blocks – 211 to 217 in Building – B & Block – 195 is casting shadow on the Blocks – 199 to 210. FIGURE 176 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow ground floor of Blocks – 209 & 210 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st January 5 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

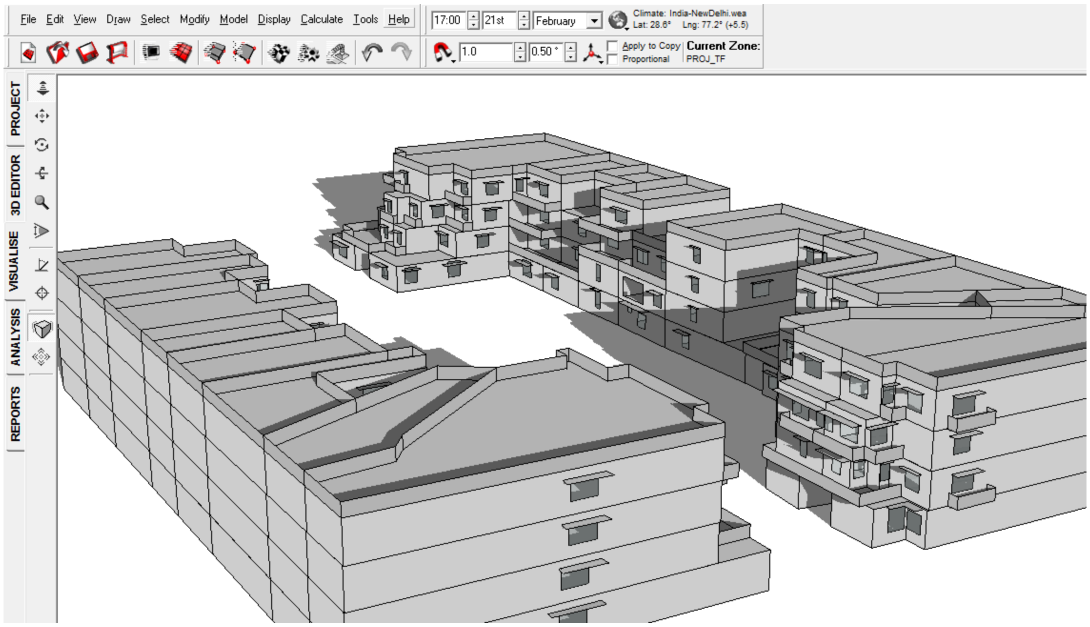


FIGURE 177: SHADOW RANGE ON 21ST FEBRUARY 5 PM WITHOUT VIADUCT

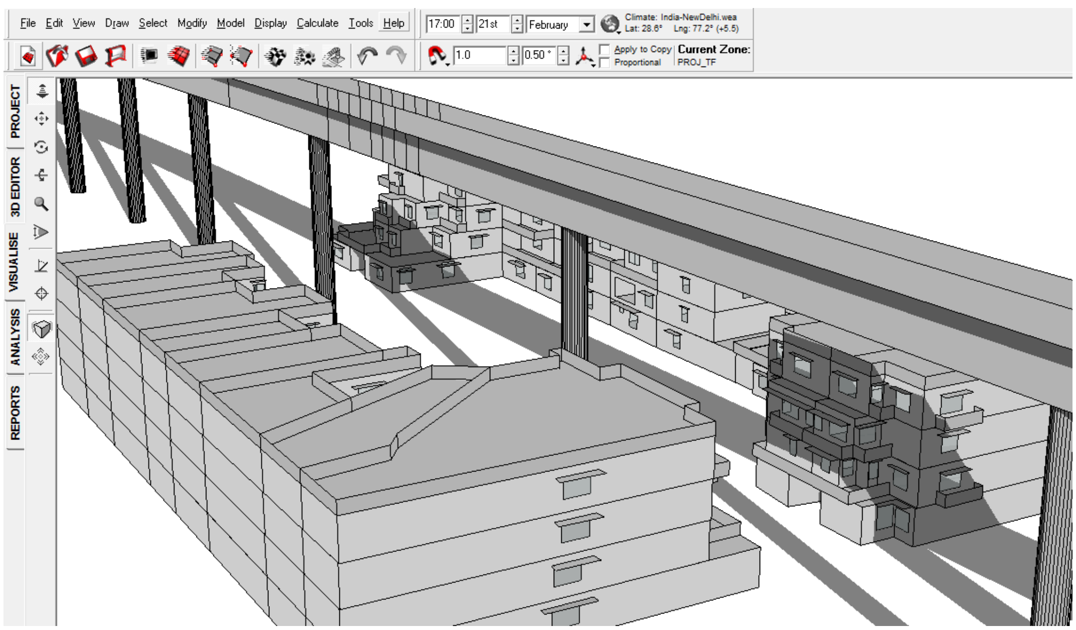


FIGURE 178: SHADOW RANGE ON 21ST FEBRUARY 5 PM WITH VIADUCT

FIGURE 177 represents the shadow caused to the buildings. On the basis of the above image, Block – 195 is casting shadow on the Blocks – 199 to 203. FIGURE 178 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on third, second, first & ground floor of Blocks – 195 & 196 and second, first & ground floor of Blocks – 209 & 210 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st February 5 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

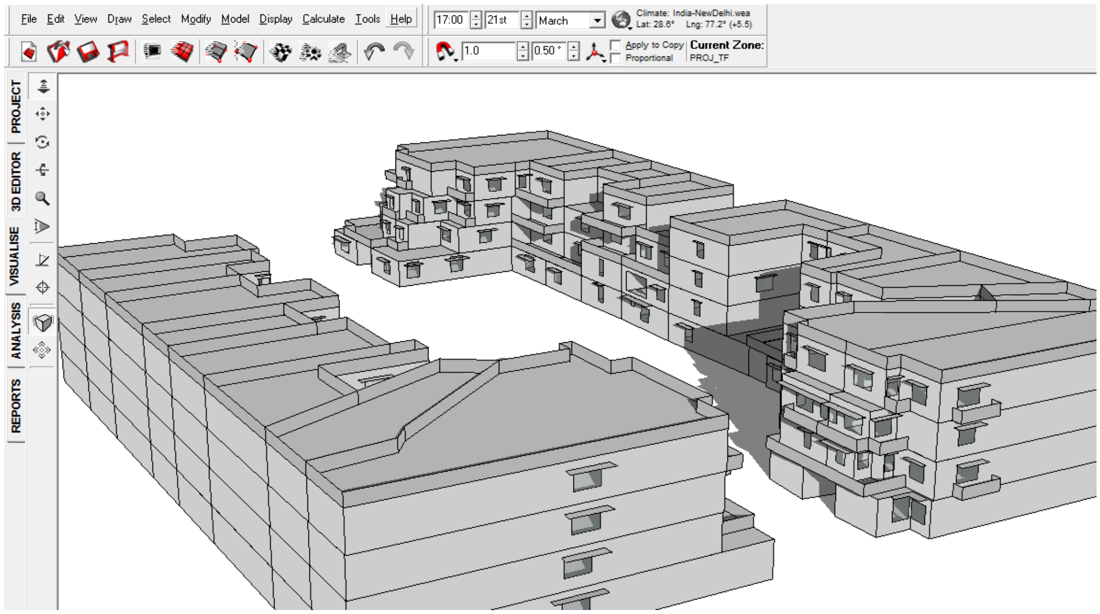


FIGURE 179: SHADOW RANGE ON 21ST MARCH 5 PM WITHOUT VIADUCT

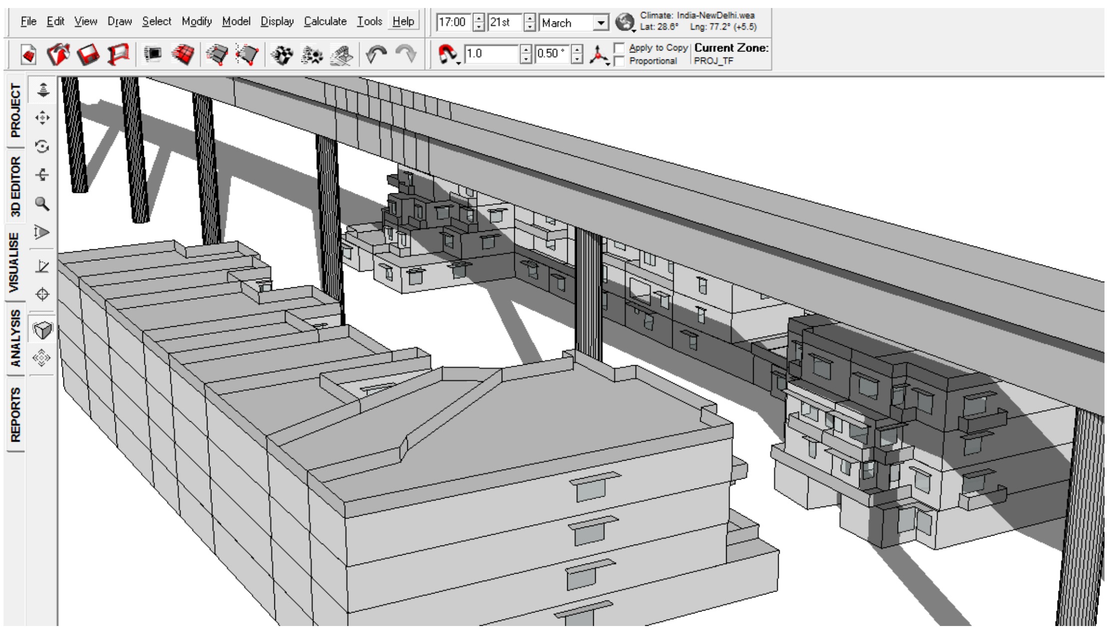


FIGURE 180: SHADOW RANGE ON 21ST MARCH 5 PM WITH VIADUCT

FIGURE 179 represents the shadow caused to the buildings. On the basis of the above image, Block – 195 is casting shadow on the Blocks – 199 to 202. FIGURE 180 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on third, second, first & ground floor of Blocks – 195 & 196 and third, second & first floor of Blocks – 209 & 210, ground floor of Blocks – 199, 202 to 206, ground & first floor of Blocks – 200 & 201 and third, second & first floor of Blocks – 209 & 210 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st March 5 PM.

GreenTree Building Energy Pvt. Ltd. DELHI NCR

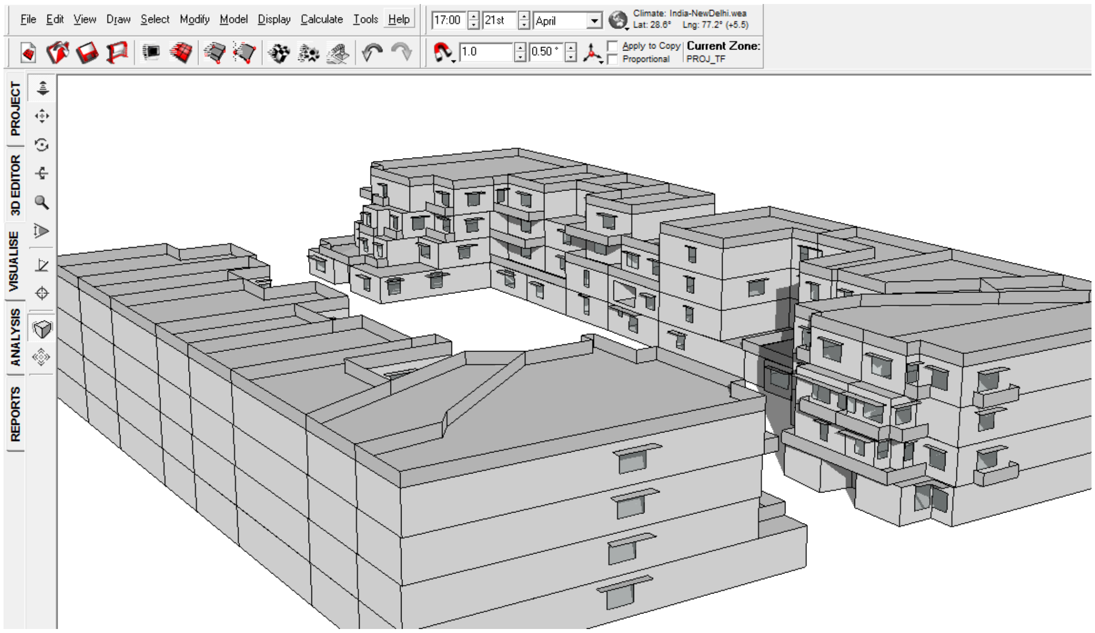


FIGURE 181: SHADOW RANGE ON 21ST APRIL 5 PM WITHOUT VIADUCT

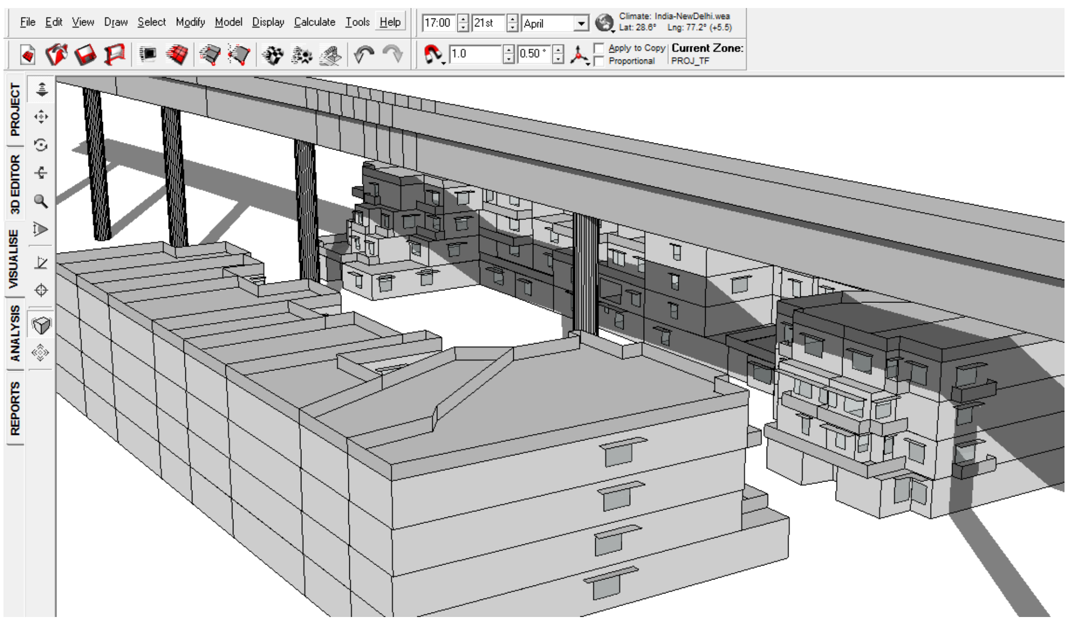


FIGURE 182: SHADOW RANGE ON 21ST APRIL 5 PM WITH VIADUCT

FIGURE 181 represents the shadow caused to the buildings. On the basis of the above image, Block – 195 is casting shadow on the Blocks – 199 to 201. FIGURE 182 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on third floor of Blocks – 195 & 196 and second, first & ground floor of Blocks – 199 to 206 and third, second & first floor of Blocks – 209 & 210 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st April 5 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

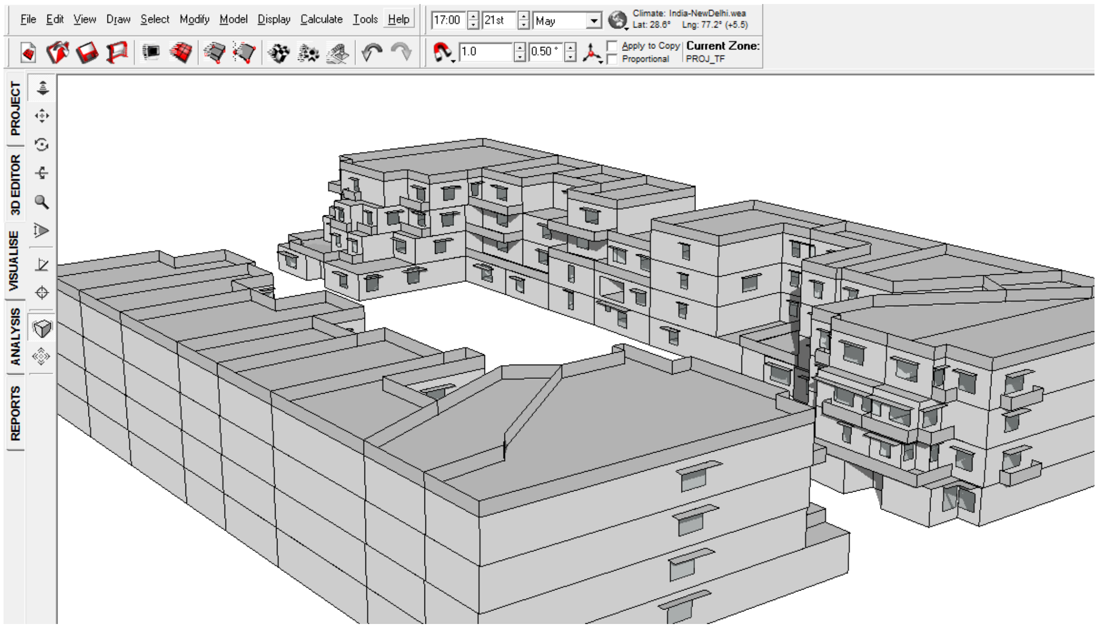


FIGURE 183: SHADOW RANGE ON 21ST MAY 5 PM WITHOUT VIADUCT

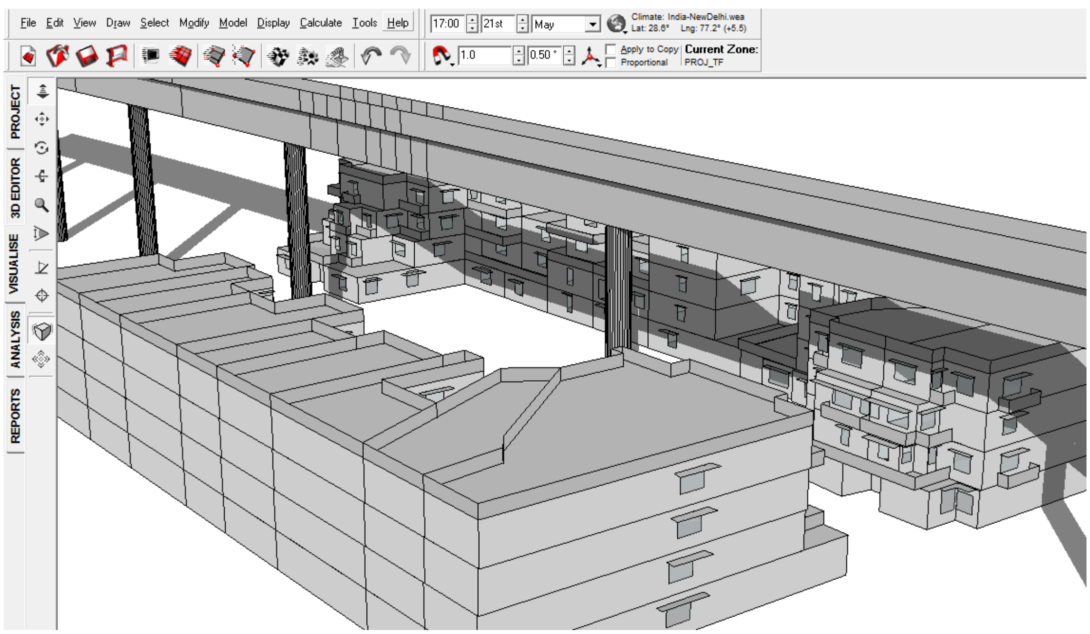


FIGURE 184: SHADOW RANGE ON 21ST MAY 5 PM WITH VIADUCT

FIGURE 183 represents the shadow caused to the buildings. On the basis of the above image, Block – 195 is casting shadow on the Blocks – 199 to 201. FIGURE 184 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on third floor of Blocks – 195 & 196 and second, first & ground floor of Blocks – 199 to 206 and third, second & first floor of Blocks – 209 & 210 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st May 5 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

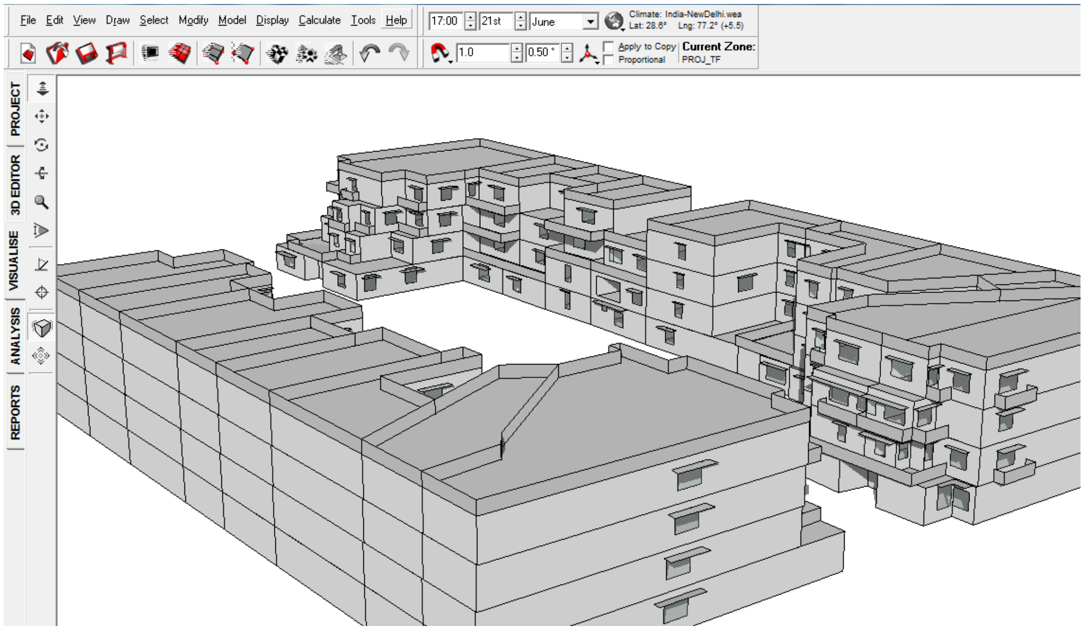


FIGURE 185: SHADOW RANGE ON 21ST JUNE 5 PM WITHOUT VIADUCT

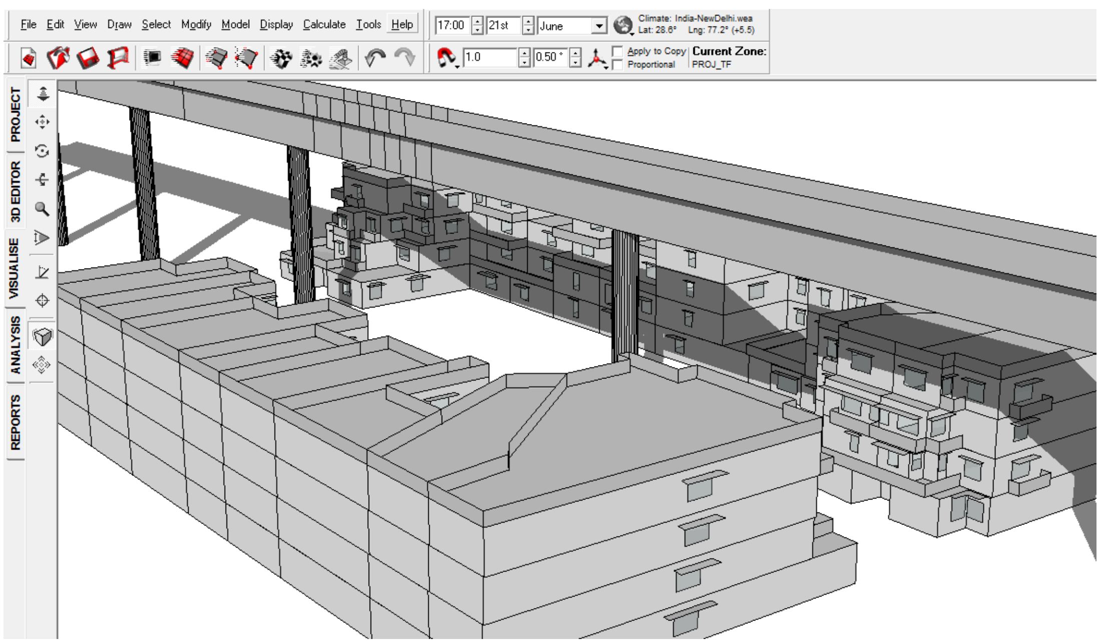


FIGURE 186: SHADOW RANGE ON 21ST JUNE 5 PM WITH VIADUCT

FIGURE 185 represents the shadow caused to the buildings. On the basis of the above image, Block – 195 is casting shadow on the Blocks – 199 to 201. FIGURE 186 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on third floor of Blocks – 195 & 196 and second, first & ground floor of Blocks – 199 to 206 and third & second floor of Blocks – 209 & 210 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st June 5 PM.

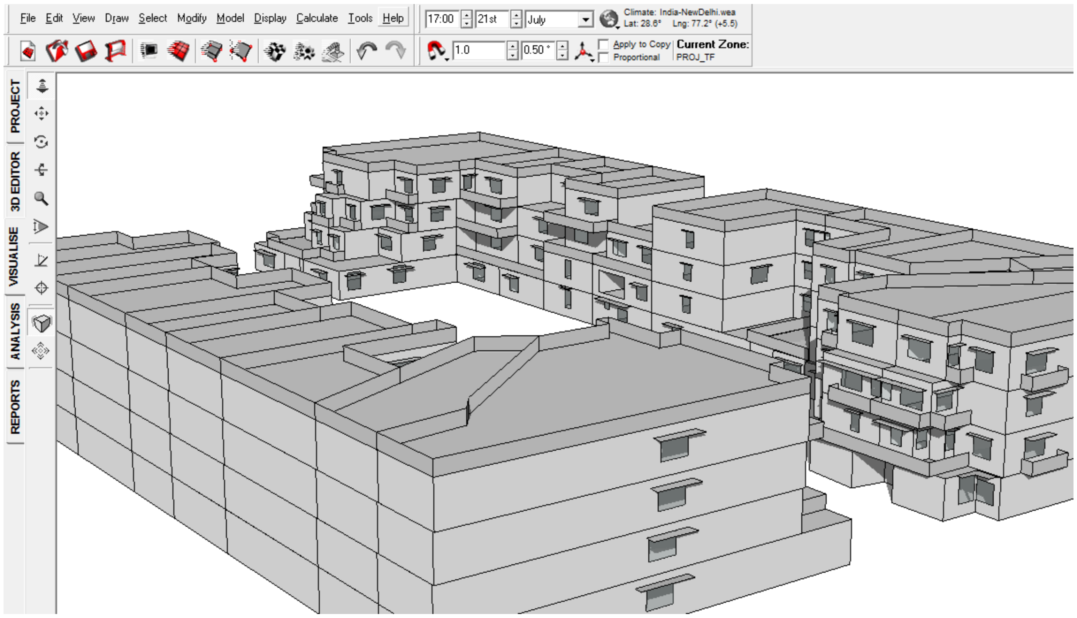


FIGURE 187: SHADOW RANGE ON 21ST JULY 5 PM WITHOUT VIADUCT

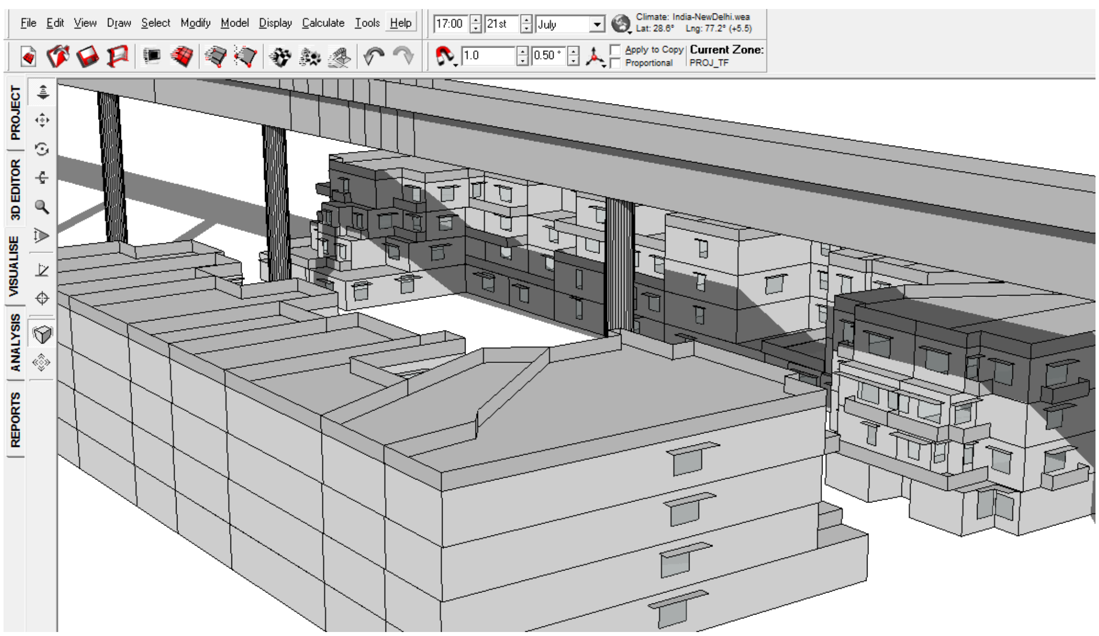


FIGURE 188: SHADOW RANGE ON 21ST JULY 5 PM WITH VIADUCT

FIGURE 187 represents the shadow caused to the buildings. On the basis of the above image, Block – 195 is casting shadow on the Blocks – 199 to 201. FIGURE 188 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on third floor of Blocks – 195 & 196 and second, first & ground floor of Blocks – 199 to 206 and third, second & first floor of Blocks – 209 & 210 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st July 5 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

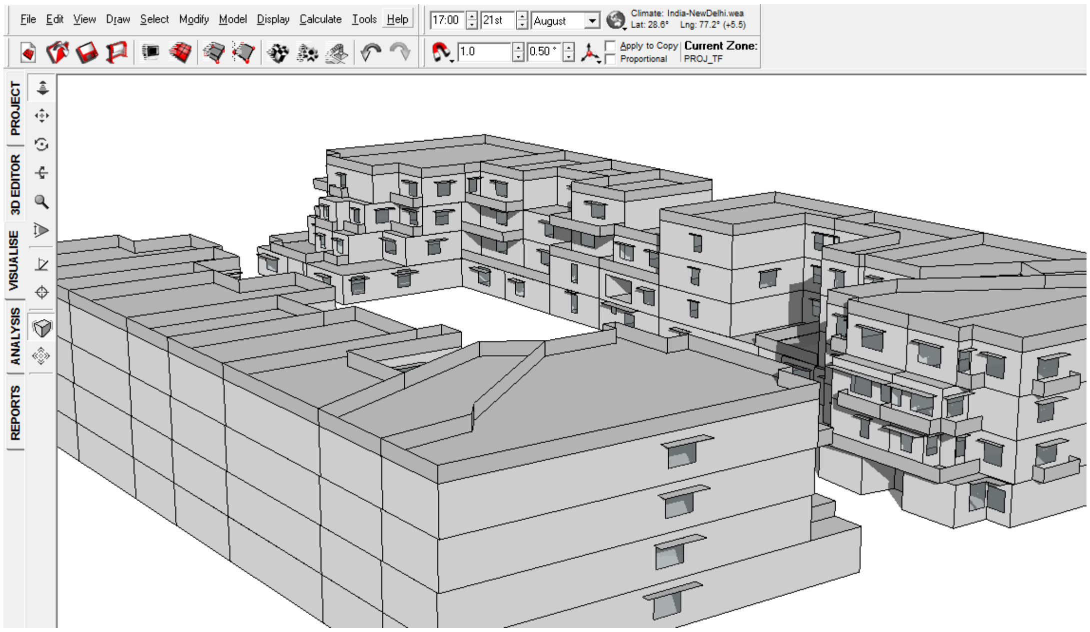


FIGURE 189: SHADOW RANGE ON 21ST AUGUST 5 PM WITHOUT VIADUCT

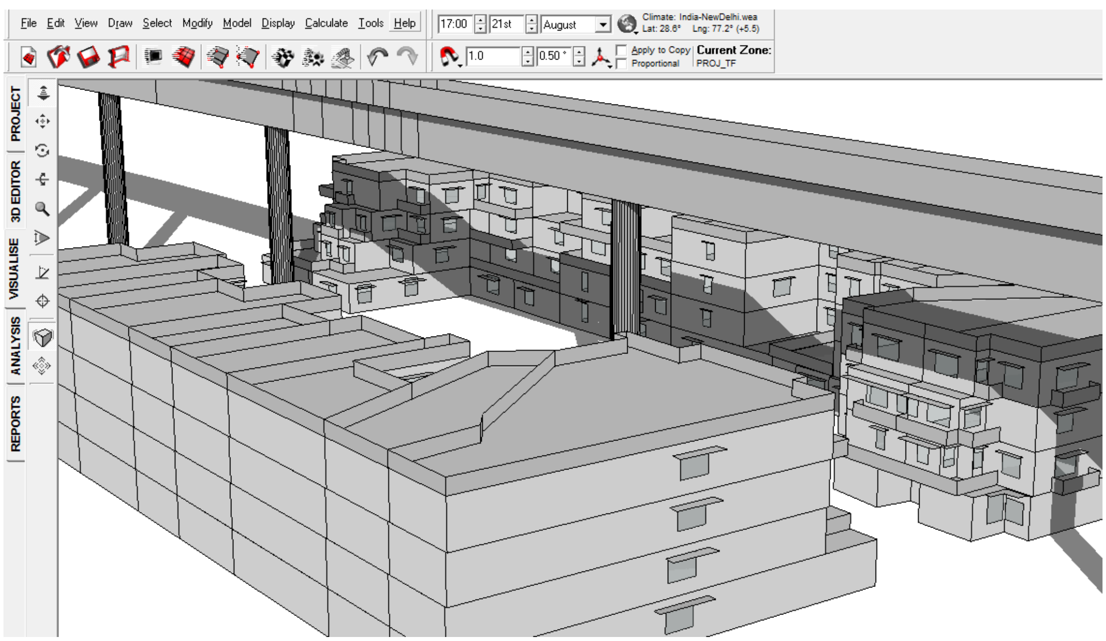


FIGURE 190: SHADOW RANGE ON 21ST AUGUST 5 PM WITH VIADUCT

FIGURE 189 represents the shadow caused to the buildings. On the basis of the above image, Block – 195 is casting shadow on the Blocks – 199 to 201. FIGURE 190 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on third floor of Blocks – 195 & 196 and second, first & ground floor of Blocks – 199 to 206 and third, second & first floor of Blocks – 209 & 210 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st August 5 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

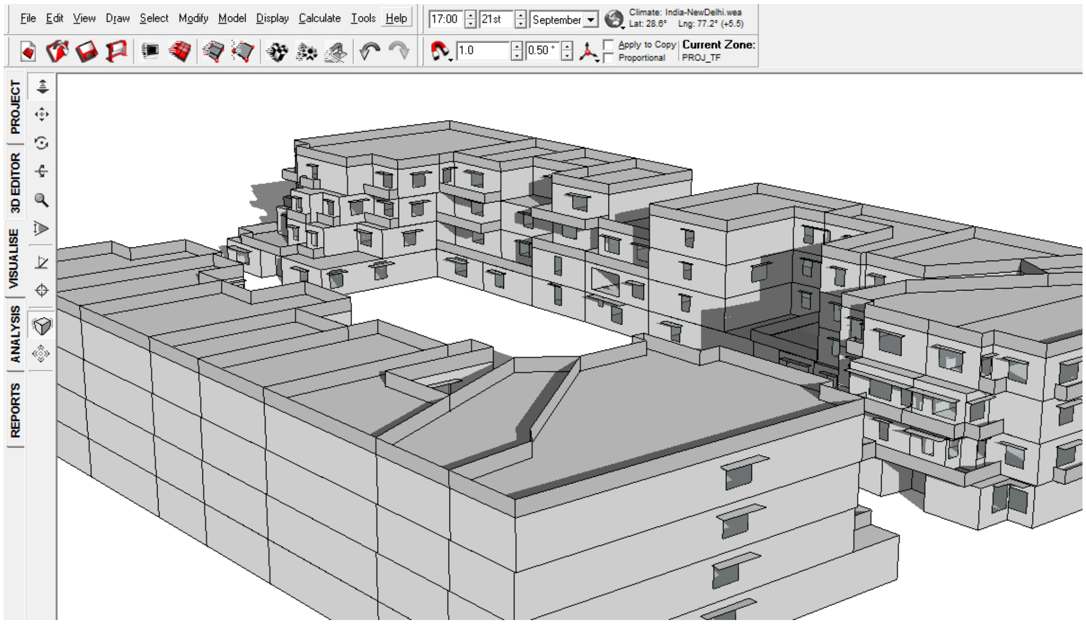


FIGURE 191: SHADOW RANGE ON 21ST SEPTEMBER 5 PM WITHOUT VIADUCT

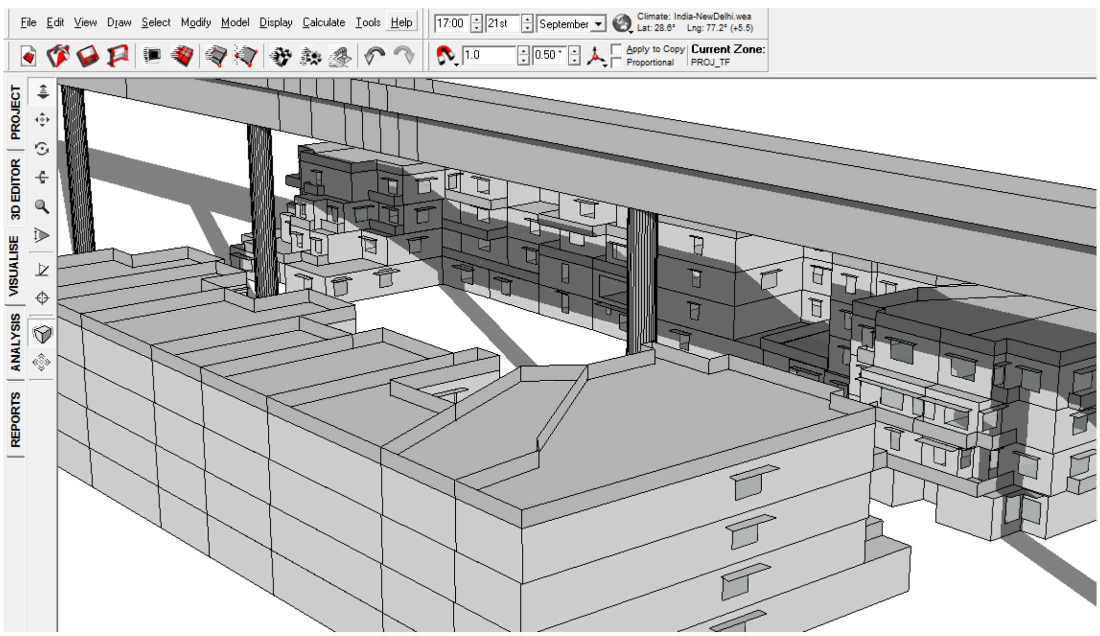


FIGURE 192: SHADOW RANGE ON 21ST SEPTEMBER 5 PM WITH VIADUCT

FIGURE 191 represents the shadow caused to the buildings. On the basis of the above image, Block – 195 is casting shadow on the Blocks – 199 to 202. FIGURE 192 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on third floor of Block – 195, third, second, first & ground floor of Block – 196, ground floor of Block – 199, third, second & first floor of Block – 210, second & third floor of Block – 209 and second & first floor of Blocks – 200 to 206 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st September 5 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

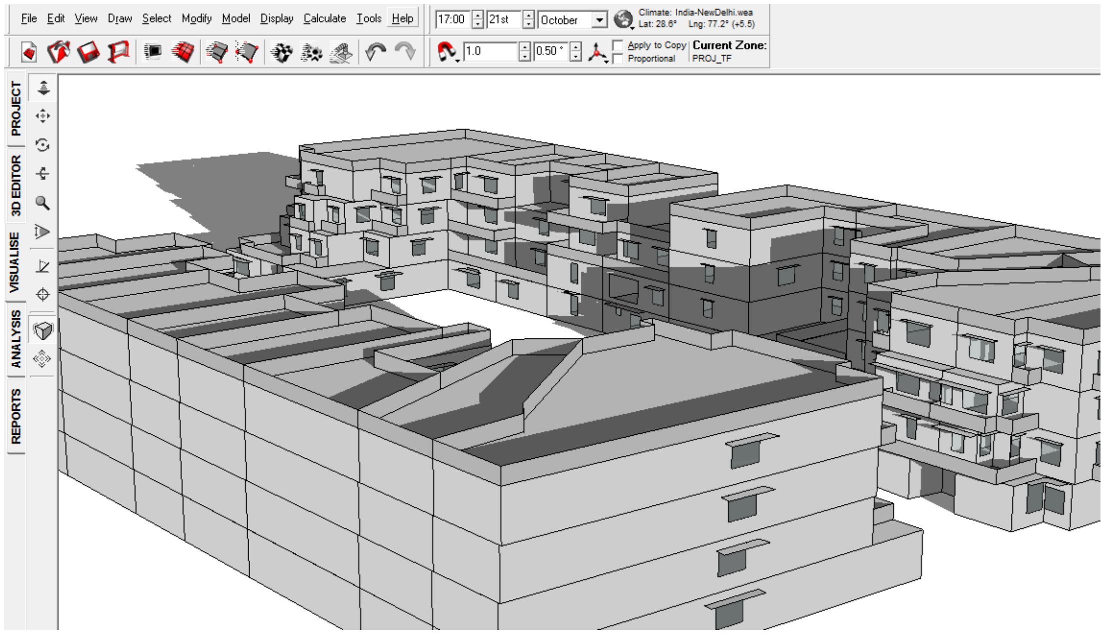


FIGURE 193: SHADOW RANGE ON 21ST OCTOBER 5 PM WITHOUT VIADUCT

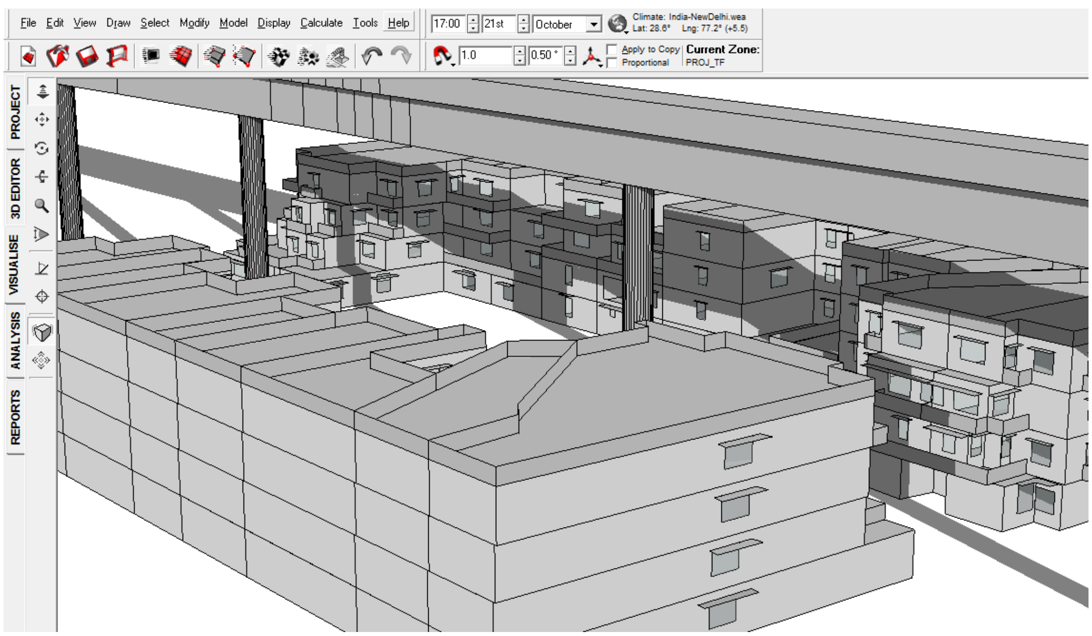


FIGURE 194: SHADOW RANGE ON 21ST OCTOBER 5 PM WITH VIADUCT

FIGURE 193 represents the shadow caused to the buildings. On the basis of the above image, Block – 195 is casting shadow on the Blocks – 199 to 204. FIGURE 194 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on second, first & ground floor of Block – 195, third & second floor of Blocks – 209 & 210, third, second & first floor of Block – 200 to 203, 206 and third, second, first & ground floor of Blocks – 204 & 205 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st October 5 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

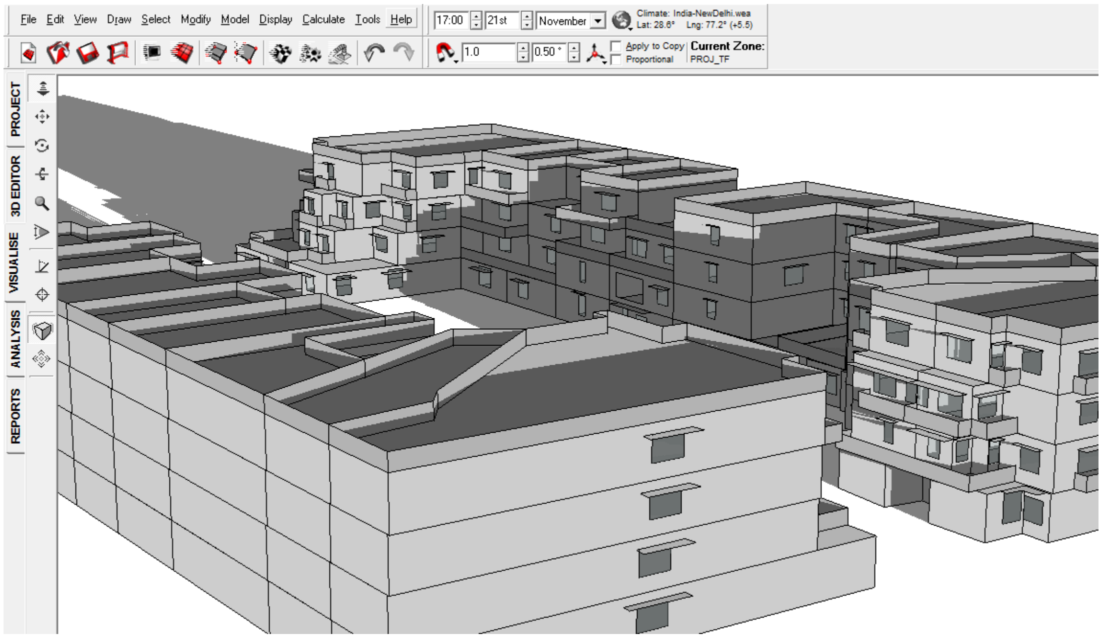


FIGURE 195: SHADOW RANGE ON 21ST NOVEMBER 5 PM WITHOUT VIADUCT

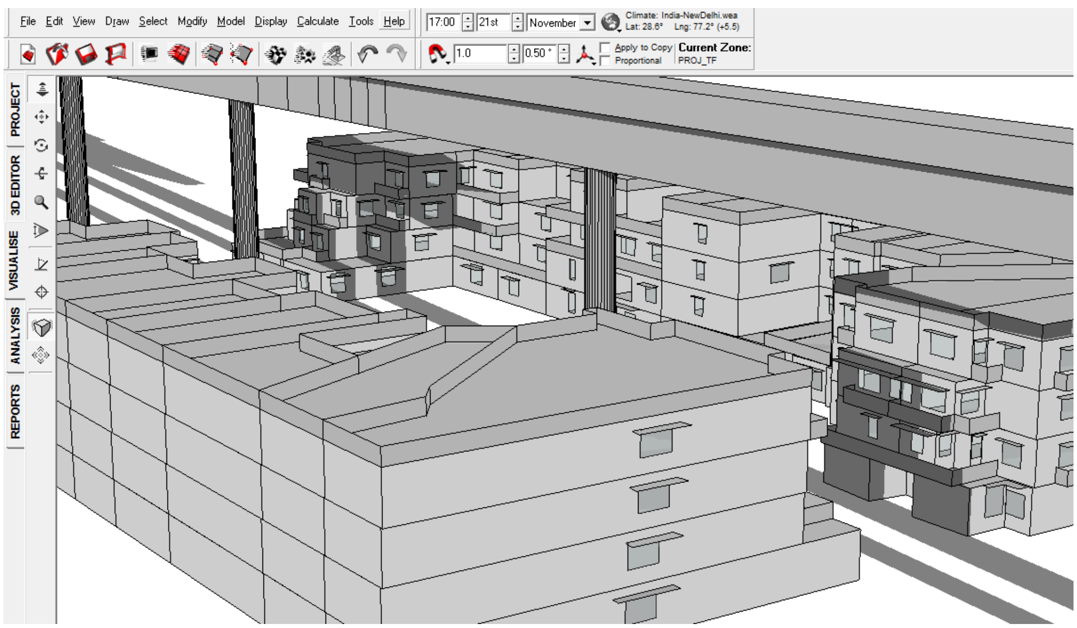


FIGURE 196: SHADOW RANGE ON 21ST NOVEMBER 5 PM WITH VIADUCT

FIGURE 195 represents the shadow caused to the buildings. On the basis of the above image, Block – 195 is casting shadow on the Blocks – 199 to 206. FIGURE 196 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is casting shadow on second, first & ground floor of Block – 195 & 196 and third, second, first & ground floor of Blocks – 209 & 210 thereby obstructing the direct sunlight falling on the façade of the building, which itself is acting as a shade for the façade on 21st November 5 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

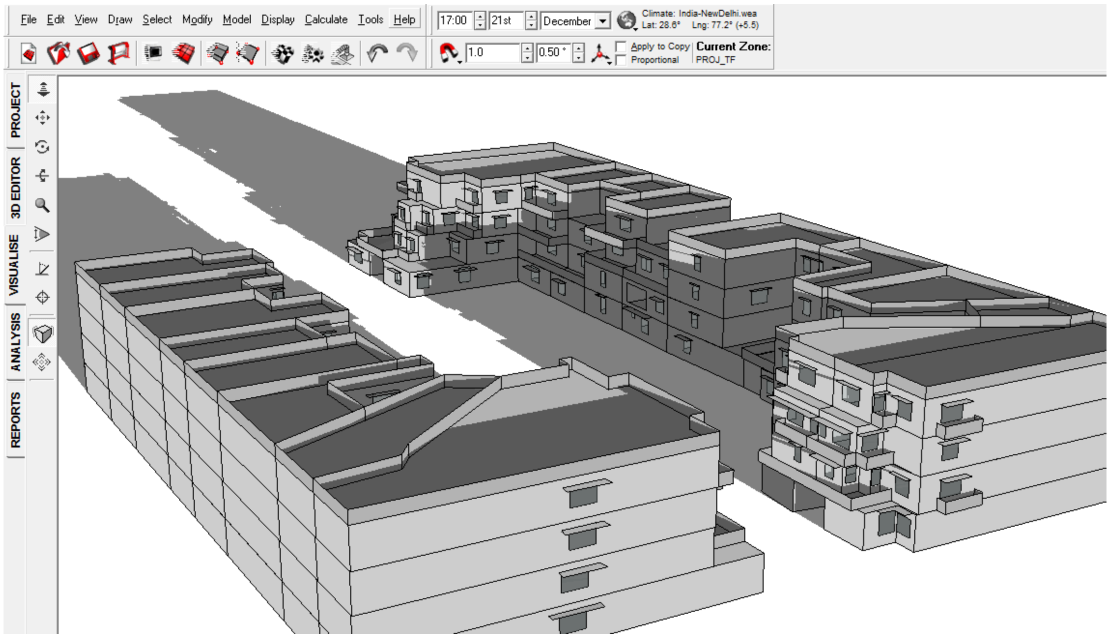


FIGURE 197: SHADOW RANGE ON 21ST DECEMBER 5 PM WITHOUT VIADUCT

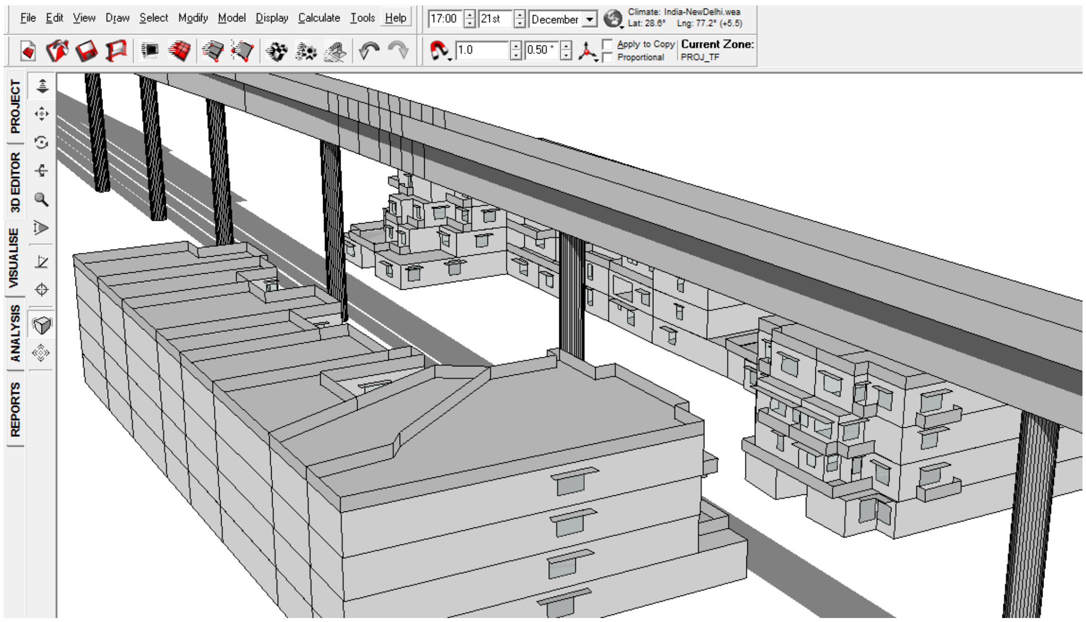


FIGURE 198: SHADOW RANGE ON 21ST DECEMBER 5 PM WITH VIADUCT

FIGURE 197 represents the shadow caused to the buildings. On the basis of the above image, Block – 195 is casting shadow on the Blocks – 199 to 201 & 210. FIGURE 198 represents shadow caused to the buildings by the proposed RRTS Viaduct. On the basis of the above image, the Viaduct is not casting shadow on the façade of the buildings on 21st December 5 PM.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

3.0 INFERENCE – SHADOW ANALYSIS

In addition to the above shadow analysis, we have analyzed six months to study the casting of shadow on the surrounding building due to the RRTS viaduct (Design case) and due to the surrounding buildings (Base case) in 15 mins interval. The details of the shadow casted by the RRTS viaduct is mentioned in the below table:

Spring Equinox	-	21st March
Summer Solstice	-	21st June
Autumn Equinox	-	21st September
Winter Solstice	-	21st December
January	-	21st January
February	-	21st February

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

Inference Table

Building Name	Floors	Spring Equinox – 21st March			Summer Solstice – 21st June			Autumn Equinox – 21st September			Winter Solstice – 21st December			21st January			21st February		
		With Viaduct	Without Viaduct	Net hours	With Viaduct	Without Viaduct	Net hours	With Viaduct	Without Viaduct	Net hours	With Viaduct	Without Viaduct	Net hours	With Viaduct	Without Viaduct	Net hours	With Viaduct	Without Viaduct	Net hours
Building - A																			
196	G	0.75	0	0.75	1.25	1.25	0	1.5	0.5	1	0	0	0	0	0	0	0.5	0	0.5
	F	0.50	0	0.50	1.5	1	0.5	1.25	0.25	1	0	0	0	0	0	0	0.5	0	0.5
	S	0.50	0	0.50	1	0	1	1.25	0.25	1	0	0	0	0	0	0	0.5	0	0.5
	T	0.50	0	0.50	1.25	0	1.25	1	0	1	0	0	0	0	0	0	0.25	0	0.25
195	G	0.75	0.75	0	1.25	1.25	0	0.75	0.75	0	0	0	0	0	0	0	0.5	0.5	0
	F	0.50	0.50	0	1.5	1.5	0	0.75	0.75	0	0	0	0	0	0	0	0.5	0.5	0
	S	0.50	0.50	0	1	0.75	0.25	1	1	0	0	0	0	0	0	0	0.5	0.5	0
	T	0.50	0.50	0	1.25	1.25	0	1	1	0	0	0	0	0	0	0	0.25	0.25	0
199	G	0.25	0.25	0	0.75	0.75	0	0.5	0.5	0	0	0	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200	G	0.25	0.25	0	0.75	0.75	0	0.5	0.5	0	0	0	0	0	0	0	0	0	0
	F	0.25	0.25	0	0.5	0.5	0	0.5	0.5	0	0	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0.25	0.25	0	0	0	0	0	0	0	0	0	0
	T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201	G	0.25	0.25	0	0.75	0	0.75	0.5	0.5	0	0	0	0	0	0	0	0	0	0
	F	0.25	0.25	0	0.5	0.5	0	0.5	0.5	0	0	0	0	0	0	0	0	0	0
	S	0	0	0	0.25	0.25	0	0.25	0.25	0	0	0	0	0	0	0	0	0	0
	T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
202	G	0.25	0.25	0	0.75	0	0.75	0.5	0.5	0	0	0	0	0	0	0	0	0	0
	F	0	0	0	0.5	0	0.5	0.5	0.5	0	0	0	0	0	0	0	0	0	0
	S	0	0	0	0.25	0	0.25	0.25	0.25	0	0	0	0	0	0	0	0	0	0
	T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
203	G	0.25	0.25	0	0.75	0	0.75	0.5	0	0.5	0	0	0	0	0	0	0	0	0
	F	0	0	0	0.5	0	0.5	0.5	0	0.5	0	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0.25	0.25	0	0	0	0	0	0	0	0	0	0
204	G	0.25	0	0.25	0.75	0	0.75	0.5	0	0.5	0	0	0	0	0	0	0	0	0
	F	0	0	0	0.5	0	0.5	0.5	0	0.5	0	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0.25	0	0.25	0	0	0	0	0	0	0	0	0
	T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
205	G	0.25	0	0.25	0.75	0	0.75	0.5	0	0.5	0	0	0	0	0	0	0	0	0
	F	0	0	0	0.25	0	0.25	0.25	0.25	0	0	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0.25	0.25	0	0	0	0	0	0	0	0	0	0
	T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
206	G	0.25	0	0.25	0.75	0	0.75	0.5	0	0.5	0	0	0	0	0	0	0	0	0
	F	0	0	0	0.25	0	0.25	0.25	0	0.25	0	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0.25	0	0.25	0	0	0	0	0	0	0	0	0
	T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
210	G	0.50	0	0.50	1.5	0.75	0.75	1	0.25	0.75	0	0	0	0.25	0	0.25	0.5	0	0.5
	F	0.75	0	0.75	1.25	0	1.25	1	0	1	0	0	0	0	0	0	0.25	0	0.25
	S	0.50	0	0.50	1.25	0	1.25	0.75	0	0.75	0	0	0	0	0	0	0.25	0	0.25
	T	0.25	0	0.25	0.5	0	0.5	0.5	0	0.5	0	0	0	0	0	0	0	0	0
209	G	0.50	0.50	0	1.5	0.75	0.75	1	0.25	0.75	0	0	0	0.25	0	0.25	0.5	0	0.5
	F	0.75	0.75	0	1.25	1.25	0	0.75	0.75	0	0	0	0	0	0	0	0.25	0.25	0
	S	0.50	0.50	0	1.25	1.25	0	0.75	0.75	0	0	0	0	0	0	0	0.25	0.25	0
	T	0.25	0.25	0	0.5	0.5	0	0.5	0.5	0	0	0	0	0	0	0	0	0	0

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

Building Name	Floors	Spring Equinox – 21st March			Summer Solstice – 21st June			Autumn Equinox – 21st September			Winter Solstice – 21st December			21st January			21st February		
		With Viaduct	**Without Viaduct**	**Net hours**	**With Viaduct**	**Without Viaduct**	**Net hours**	**With Viaduct**	**Without Viaduct**	**Net hours**	**With Viaduct**	**Without Viaduct**	**Net hours**	**With Viaduct**	**Without Viaduct**	**Net hours**	**With Viaduct**	**Without Viaduct**	**Net hours**
Building - B																			
211	**G**	3.50	1.75	1.75	1.25	0	1.25	4.25	0	4.25	2	0	2	2.25	0.5	1.75	2	2	0
	F	4.25	1.00	3.25	0.75	0	0.75	3.75	0	3.75	3.75	0	3.75	4	3.5	0.5	4.75	2.25	2.5
	S	3.50	0.25	3.25	0	0	0	3.25	0	3.25	4.25	0	4.25	4.25	3	1.25	4.25	1.5	2.75
	T	2.75	0	2.75	0	0	0	2.75	0	2.75	4.75	0	4.75	4.25	2.25	2	3.75	0.75	3
212	**G**	1.75	0	1.75	1.25	0	1.25	2	0	2	2	0	2	2	0	2	2	2	0
	F	3.00	3.00	0	0.75	0.75	0	3	3	0	3.75	0	3.75	3.75	1.25	2.5	3.5	0.5	3
	S	2.75	2.75	0	0	0	0	2.75	2.75	0	4	0	4	4	0.75	3.25	3.75	1.25	2.5
	T	2.50	2.50	0	0	0	0	2.5	2.5	0	4.25	0	4.25	4.5	0	4.5	3.5	2	1.5
213	**G**	1.75	0	1.75	1	0	1	2	0	2	2.5	0.5	2	2.25	0	2.25	2	0	2
	F	2.50	0.50	2.00	0.5	0.5	0	2.5	0	2.5	3.5	3.25	0.25	3.75	3.25	0.5	3.25	1.5	1.75
	S	2.25	0	2.25	0	0	0	2.5	0	2.5	3.75	2.5	1.25	4	2.75	1.25	3.5	1	2.5
	T	2.50	0	2.50	0	0	0	2.25	0	2.25	4.5	0.25	4.25	4.5	2.25	2.25	3.75	0.25	3.5
214	**G**	1.75	0	1.75	1	0	1	2.25	0	2.25	2.5	2.5	0	2.75	0.25	2.5	2.25	0	2.25
	F	1.50	0	1.50	0.25	0.25	0	2.25	0.25	2	3	0.25	2.75	3	0.5	2.5	2.75	0	2.75
	S	1.50	1.50	0	0	0	0	1.75	1.75	0	2.75	1.25	1.5	2.75	1	1.75	2.75	0	2.75
	T	2.00	2.00	0	0	0	0	1.5	1.5	0	3	0.5	2.5	3	0.25	2.75	2.75	0	2.75
215	**G**	2.00	0	2.00	1	0	1	2	1	1	4	2.25	1.75	3	1.75	1.25	2.5	0	2.5
	F	1.75	0.50	1.25	0	0	0	2	0.5	1.5	4.75	3.25	1.5	3.5	1.75	1.75	2.5	1.25	1.25
	S	1.75	0	1.75	0	0	0	1.75	0	1.75	3.75	0.75	3	3.5	0.5	3	2.5	0	2.5
	T	2.00	0	2.00	0	0	0	2	0	2	4.25	0	4.25	3	0	3	3	0	3
216	**G**	2.00	0	2.00	0.75	0.75	0	2	0.25	1.75	3.25	1.5	1.75	2.25	2.25	0	3	0.5	2.5
	F	2.50	1.75	0.75	0.25	0.25	0	2.25	2.25	0	5.75	4.75	1	6.25	6.25	0	4	4	0
	S	2.75	2.50	0.25	0	0	0	2.25	1.75	0.5	5.25	4.5	0.75	5.5	5.5	0	4.25	4.25	0
	T	2.50	2.50	0	0	0	0	2.5	2.5	0	5.25	4.5	0.75	5.25	5.25	0	3.75	3.75	0
217	**G**	3.00	0.50	2.50	0.75	0	0.75	2.75	0.75	2	2.5	2.25	0.25	3.5	2.5	1	3.5	2.5	1
	F	2.75	2.00	0.75	0	0	0	3.75	2	1.75	5	4.5	0.5	4	3.5	0.5	5	4.5	0.5
	S	2.75	1.50	1.25	0	0	0	1.5	0	1.5	5.25	4.5	0.75	4.25	3.75	0.5	4.75	4.25	0.5
	T	3.00	1.00	2.00	0	0	0	1	0	1	5.25	4.5	0.75	5	4.5	0.5	4	3.5	0.5
220	**G**	0.75	0.50	0.25	5.5	3.5	2	4.75	3.25	1.5	1.75	1.25	0.5	1.5	1.5	0	1.25	1.25	0
	F	2.00	1.75	0.25	5.25	3.75	1.5	5.25	3.75	1.5	2	2	0	2.5	2.5	0	1.5	1.5	0
	S	2.50	2.25	0.25	5.25	3.75	1.5	6	4.5	1.5	2.75	2.75	0	3.5	3.5	0	1.75	1.75	0
	T	3.50	3.50	0	4.5	2.5	2	6.25	4.5	1.75	4	3.25	0.75	4.5	4.5	0	3	3	0
219	**G**	0.75	0	0.75	1.5	0.5	1	1.5	0.25	1.25	1.25	0	1.25	1	0	1	0.75	0.25	0.5
	F	2.00	1.75	0.25	3.5	3.5	0	2.5	2.5	0	1.25	0	1.25	1.25	0	1.25	1.75	0	1.75
	S	2.75	2.00	0.75	4.25	4.25	0	2.75	2.75	0	1.25	0	1.25	1.5	0	1.5	2.25	0	2.25
	T	3.25	1.75	1.50	4.5	4.5	0	3.25	3.25	0	2	0	2	2.25	0	2.25	3	0	3

GreenTree Building Energy Pvt. Ltd. DELHI NCR

Inference Table – Effective Shading Hours (Considering 50% of Shading due to surrounding trees)

Building Name	Floors	Spring Equinox – 21st March			Summer Solstice – 21st June			Autumn Equinox – 21st September			Winter Solstice – 21st December			21st January			21st February		
		With Viaduct	Without Viaduct	Net hours	With Viaduct	Without Viaduct	Net hours	With Viaduct	Without Viaduct	Net hours	With Viaduct	Without Viaduct	Net hours	With Viaduct	Without Viaduct	Net hours	With Viaduct	Without Viaduct	Net hours
Building - A																			
196	G	0.75	0.375	0.375	1.25	1.875	NA	1.5	1.25	0.25	0	0	0	0	0	0	0.5	0.25	0.25
	F	0.5	0.25	0.25	1.5	1.75	NA	1.25	0.875	0.375	0	0	0	0	0	0	0.5	0.25	0.25
	S	0.5	0.25	0.25	1	0.5	0.5	1.25	0.875	0.375	0	0	0	0	0	0	0.5	0.25	0.25
	T	0.5	0.25	0.25	1.25	0.625	0.625	1	0.5	0.5	0	0	0	0	0	0	0.25	0.125	0.125
195	G	0.75	1.125	NA	1.25	1.875	NA	0.75	1.125	NA	0	0	0	0	0	0	0.5	0.75	NA
	F	0.5	0.75	NA	1.5	2.25	NA	0.75	1.125	NA	0	0	0	0	0	0	0.5	0.75	NA
	S	0.5	0.75	NA	1	1.25	NA	1	1.5	NA	0	0	0	0	0	0	0.5	0.75	NA
	T	0.5	0.75	NA	1.25	1.875	NA	1	1.5	NA	0	0	0	0	0	0	0.25	0.375	NA
199	G	0.25	0.375	NA	0.75	1.125	NA	0.5	0.75	NA	0	0	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200	G	0.25	0.375	NA	0.75	1.125	NA	0.5	0.75	NA	0	0	0	0	0	0	0	0	0
	F	0.25	0.375	NA	0.5	0.75	NA	0.5	0.75	NA	0	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0.25	0.375	NA	0	0	0	0	0	0	0	0	0
	T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
201	G	0.25	0.375	NA	0.75	0.375	0.375	0.5	0.75	NA	0	0	0	0	0	0	0	0	0
	F	0.25	0.375	NA	0.5	0.75	NA	0.5	0.75	NA	0	0	0	0	0	0	0	0	0
	S	0	0	0	0.25	0.375	NA	0.25	0.375	NA	0	0	0	0	0	0	0	0	0
	T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
202	G	0.25	0.375	NA	0.75	0	0.75	0.5	0.75	NA	0	0	0	0	0	0	0	0	0
	F	0	0	0	0.5	0	0.5	0.5	0.75	NA	0	0	0	0	0	0	0	0	0
	S	0	0	0	0.25	0	0.25	0.25	0.375	NA	0	0	0	0	0	0	0	0	0
	T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
203	G	0.25	0.375	NA	0.75	0	0.75	0.5	0.25	0.25	0	0	0	0	0	0	0	0	0
	F	0	0	0	0.5	0	0.5	0.5	0.25	0.25	0	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0.25	0.375	NA	0	0	0	0	0	0	0	0	0
204	G	0.25	0.125	0.125	0.75	0	0.75	0.5	0.25	0.25	0	0	0	0	0	0	0	0	0
	F	0	0	0	0.5	0	0.5	0.5	0.25	0.25	0	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0.25	0.125	0.125	0	0	0	0	0	0	0	0	0
	T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
205	G	0.25	0.125	0.125	0.75	0	0.75	0.5	0.25	0.25	0	0	0	0	0	0	0	0	0
	F	0	0	0	0.25	0	0.25	0.25	0.375	NA	0	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0.25	0.375	NA	0	0	0	0	0	0	0	0	0
	T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
206	G	0.25	0.125	0.125	0.75	0	0.75	0.5	0.25	0.25	0	0	0	0	0	0	0	0	0
	F	0	0	0	0.25	0	0.25	0.25	0.125	0.125	0	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0.25	0.125	0.125	0	0	0	0	0	0	0	0	0
	T	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
210	G	0.5	0.25	0.25	1.5	1.5	0	1	0.75	0.25	0	0	0	0.25	0.125	0.125	0.5	0.25	0.25
	F	0.75	0.375	0.375	1.25	0.625	0.625	1	0.5	0.5	0	0	0	0	0	0	0.25	0.125	0.125
	S	0.5	0.25	0.25	1.25	0.625	0.625	0.75	0.375	0.375	0	0	0	0	0	0	0.25	0.125	0.125
	T	0.25	0.125	0.125	0.5	0.25	0.25	0.5	0.25	0.25	0	0	0	0	0	0	0	0	0
209	G	0.5	0.75	NA	1.5	1.5	0	1	0.75	0.25	0	0	0	0.25	0.125	0.125	0.5	0.25	0.25
	F	0.75	1.125	NA	1.25	1.875	NA	0.75	1.125	NA	0	0	0	0	0	0	0.25	0.375	NA
	S	0.5	0.75	NA	1.25	1.875	NA	0.75	1.125	NA	0	0	0	0	0	0	0.25	0.375	NA
	T	0.25	0.375	NA	0.5	0.75	NA	0.5	0.75	NA	0	0	0	0	0	0	0	0	0

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

Building Name	Floors	Spring Equinox – 21st March			Summer Solstice – 21st June			Autumn Equinox – 21st September			Winter Solstice – 21st December			21st January			21st February		
		With Viaduct	**Without Viaduct**	**Net hours**	**With Viaduct**	**Without Viaduct**	**Net hours**	**With Viaduct**	**Without Viaduct**	**Net hours**	**With Viaduct**	**Without Viaduct**	**Net hours**	**With Viaduct**	**Without Viaduct**	**Net hours**	**With Viaduct**	**Without Viaduct**	**Net hours**
Building - B																			
211	**G**	3.5	3.5	0	1.25	0.625	0.625	4.25	2.125	2.125	2	1	1	2.25	1.625	0.625	2	3	NA
	F	4.25	3.125	1.125	0.75	0.375	0.375	3.75	1.875	1.875	3.75	1.875	1.875	4	5.5	NA	4.75	4.625	0.125
	S	3.5	2	1.5	0	0	0	3.25	1.625	1.625	4.25	2.125	2.125	4.25	5.125	NA	4.25	3.625	0.625
	T	2.75	1.375	1.375	0	0	0	2.75	1.375	1.375	4.75	2.375	2.375	4.25	4.375	NA	3.75	2.625	1.125
212	**G**	1.75	0.875	0.875	1.25	0.625	0.625	2	1	1	2	1	1	2	1	1	2	3	NA
	F	3	4.5	NA	0.75	1.125	NA	3	4.5	NA	3.75	1.875	1.875	3.75	3.125	0.625	3.5	2.25	1.25
	S	2.75	4.125	NA	0	0	0	2.75	4.125	NA	4	2	2	4	2.75	1.25	3.75	3.125	0.625
	T	2.5	3.75	NA	0	0	0	2.5	3.75	NA	4.25	2.125	2.125	4.5	2.25	2.25	3.5	3.75	NA
213	**G**	1.75	0.875	0.875	1	0.5	0.5	2	1	1	2.5	1.75	0.75	2.25	1.125	1.125	2	1	1
	F	2.5	1.75	0.75	0.5	0.75	NA	2.5	1.25	1.25	3.5	5	NA	3.75	5.125	NA	3.25	3.125	0.125
	S	2.25	1.125	1.125	0	0	0	2.5	1.25	1.25	3.75	4.375	NA	4	4.75	NA	3.5	2.75	0.75
	T	2.5	1.25	1.25	0	0	0	2.25	1.125	1.125	4.5	2.5	2	4.5	4.5	0	3.75	2.125	1.625
214	**G**	1.75	0.875	0.875	1	0.5	0.5	2.25	1.125	1.125	2.5	3.75	NA	2.75	1.625	1.125	2.25	1.125	1.125
	F	1.5	0.75	0.75	0.25	0.375	NA	2.25	1.375	0.875	3	1.75	1.25	3	2	1	2.75	1.375	1.375
	S	1.5	2.25	NA	0	0	0	1.75	2.625	NA	2.75	2.625	0.125	2.75	2.375	0.375	2.75	1.375	1.375
	T	2	3	NA	0	0	0	1.5	2.25	NA	3	2	1	3	1.75	1.25	2.75	1.375	1.375
215	**G**	2	1	1	1	0.5	0.5	2	2	0	4	4.25	NA	3	3.25	NA	2.5	1.25	1.25
	F	1.75	1.375	0.375	0	0	0	2	1.5	0.5	4.75	5.625	NA	3.5	3.5	0	2.5	2.5	0
	S	1.75	0	1.75	0	0	0	1.75	0.875	0.875	3.75	2.625	1.125	3.5	2.25	1.25	2.5	1.25	1.25
	T	2	1	1	0	0	0	2	1	1	4.25	2.125	2.125	3	1.5	1.5	3	1.5	1.5
216	**G**	2	1	1	0.75	1.125	NA	2	1.25	0.75	3.25	3.125	0.125	2.25	3.375	NA	3	2	1
	F	2.5	1.25	1.25	0.25	0.375	NA	2.25	3.375	NA	5.75	7.625	NA	6.25	9.375	NA	4	6	NA
	S	2.75	3.875	NA	0	0	0	2.25	2.875	NA	5.25	7.125	NA	5.5	8.25	NA	4.25	6.375	NA
	T	2.5	3.75	NA	0	0	0	2.5	3.75	NA	5.25	7.125	NA	5.25	7.875	NA	3.75	5.625	NA
217	**G**	3	2	1	0.75	0.375	0.375	2.75	2.125	0.625	2.5	3.5	NA	3.5	4.25	NA	3.5	4.25	NA
	F	2.75	3.375	NA	0	0	0	3.75	3.875	NA	5	7	NA	4	5.5	NA	5	7	NA
	S	2.75	2.875	NA	0	0	0	1.5	0.75	0.75	5.25	7.125	NA	4.25	5.875	NA	4.75	6.625	NA
	T	3	2.5	0.5	0	0	0	1	0.5	0.5	5.25	7.125	NA	5	7	NA	4	5.5	NA
220	**G**	0.75	0.875	NA	5.5	6.25	NA	4.75	5.625	NA	1.75	2.125	NA	1.5	2.25	NA	1.25	1.875	NA
	F	2	2.75	NA	5.25	6.375	NA	5.25	6.375	NA	2	3	NA	2.5	3.75	NA	1.5	2.375	NA
	S	2.5	3.5	NA	5.25	6.375	NA	6	7.5	NA	2.75	4.125	NA	3.5	5.25	NA	1.75	2.625	NA
	T	3.5	5.25	NA	4.5	4.75	NA	6.25	7.625	NA	4	5.25	NA	4.5	6.75	NA	3	4.5	NA
219	**G**	0.75	0.375	0.375	1.5	1.25	0.25	1.5	1	0.5	1.25	0.625	0.625	1	0.5	0.5	0.75	0.625	0.125
	F	2	2.75	NA	3.5	5.25	NA	2.5	3.75	NA	1.25	0.625	0.625	1.25	0.625	0.625	1.75	0.875	0.875
	S	2.75	3.375	NA	4.25	6.375	NA	2.75	4.125	NA	1.25	0.625	0.625	1.5	0.75	0.75	2.25	1.125	1.125
	T	3.25	3.375	1.6875	4.5	6.75	NA	3.25	4.875	NA	2	1	1	2.25	1.125	1.125	3	1.5	1.5

NA – Not Applicable

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

Finally, in reference to the above analysis/ study, we are concluding that on an average viaduct is casting shadow for 1.31 hours over the whole six months. In which there are few situations that the shadow casted by the nearby buildings, trees & viaduct. So excluding the building shaded area & trees, the average hours of blocks shaded due to viaduct is only **0.37 hours** (22 Minutes)**.**

The trees surrounded by the buildings (In Park) itself casting shadows on the building façade. Please refer the below attached images. Thereby the shadow casting on the buildings by the viaduct will not affect the building occupant's health & well-being.

FIGURE 199: TREE COVERING – BUILDING – A

FIGURE 200: TREE COVERING – BUILDING – B

GreenTree Building Energy Pvt. Ltd.
DELHI
NCR

4.0 WIND ANALYSIS

4.1 METHODOLOGY

The prime intent of this section is to study the effect of wind caused by the Stabling Yard alignment of Delhi Meerut RRTS Viaduct in the surrounding buildings near Siddharth Extension Pocket – C (Between Sarai Kale Khan Station and Stabling Yard).

The study has been done by comparing the base case and design case. The base case involves the Buildings without RRTS Viaduct and the design case involves the Building with the proposed RRTS Viaduct and analyzing the effect of wind caused by the RRTS Viaduct in the proposed site.

The model has been created in Rhinoceros software and the analysis were performed in Autodesk Flow Design.

The following were the parameters considered during the analysis:

- Average Wind Speed of the location – 6.7 miles per hour or 3 meter per second.
- Predominate Wind Direction – From West to East
- Weather File – New Delhi

Please find the Wind rose diagram for the proposed location:

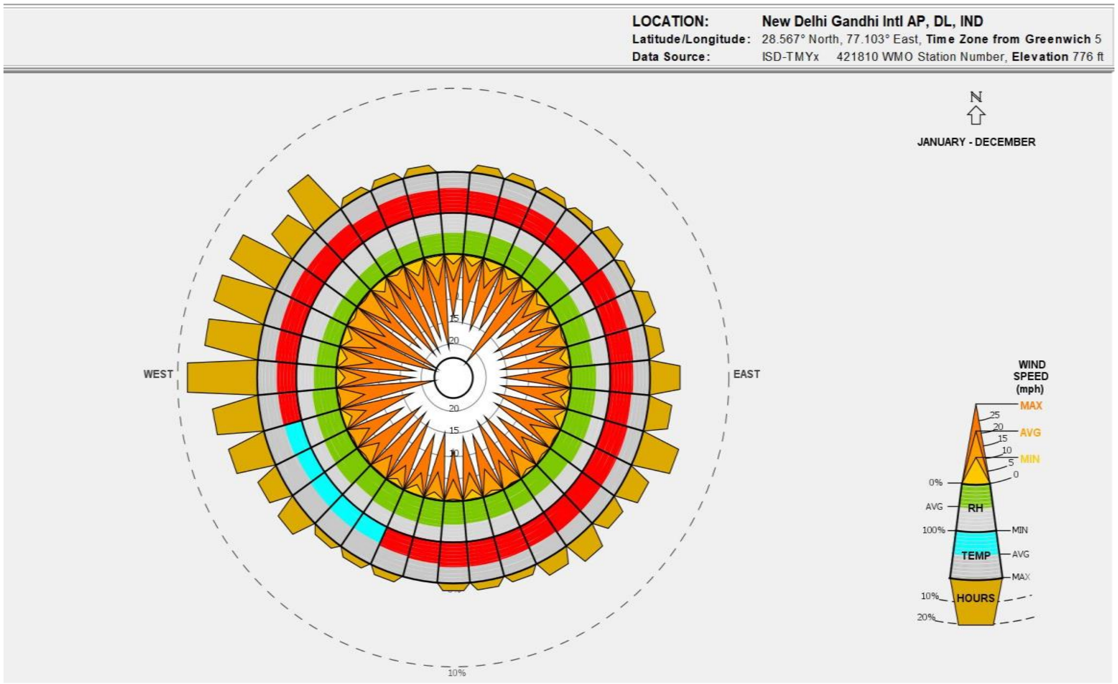


FIGURE 201: WIND ROSE DRAWING

Clerr

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

The above drawing shows the wind direction, Wind Velocity and Frequency of Occurrence along with concurrent average Dry Bulb Temperature and Relative Humidity. The outer ring shows the percentage of hours when the wind comes from each direction. On the next ring the height and color of the bars shows the average temperature of the wind coming from that direction (light blue is in the comfort zone, blue is cool or cold, and red is warm or hot). The next smaller ring shows average humidity (light green is comfortable, yellow is dry, and green is humid). The innermost circle shows the wind velocities that come from each direction; the tallest brown triangle is the maximum velocity for that period, medium brown is the average velocity, and the smallest light brown triangle is the minimum velocity.

4.2 3D Views

Please find the three Dimensional model of the buildings and the proposed viaduct.

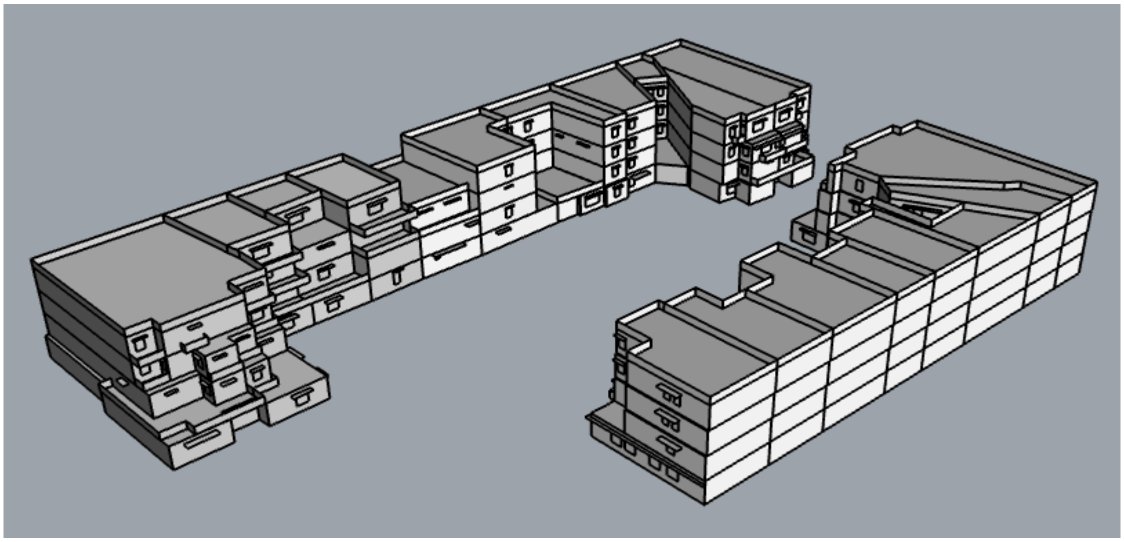


Figure 202: 3D view without Viaduct

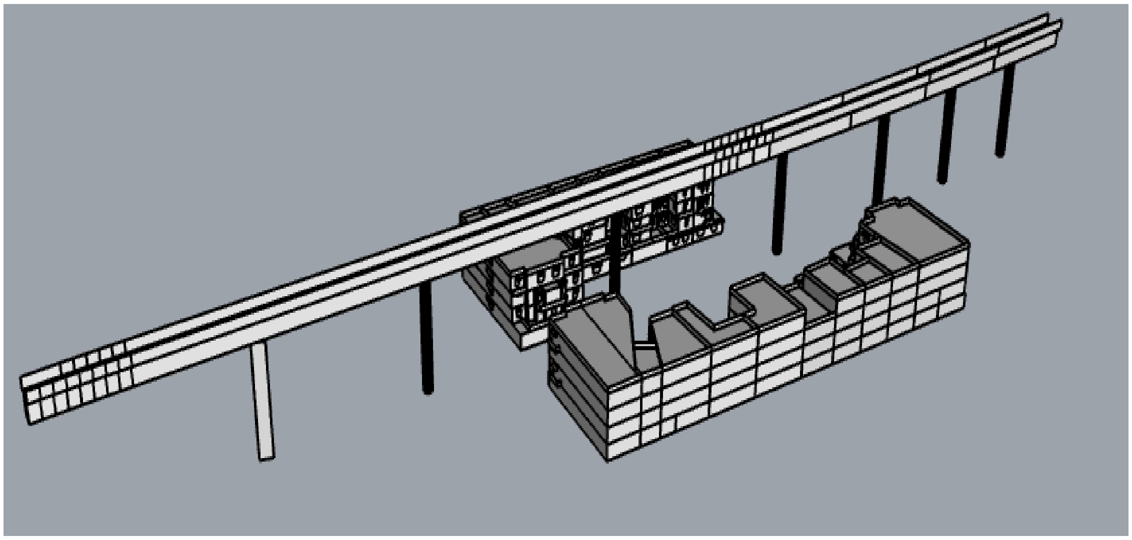


Figure 203: 3D view with Viaduct

GreenTree Building Energy Pvt. Ltd. DELHI NCR

4.3 Wind Analysis

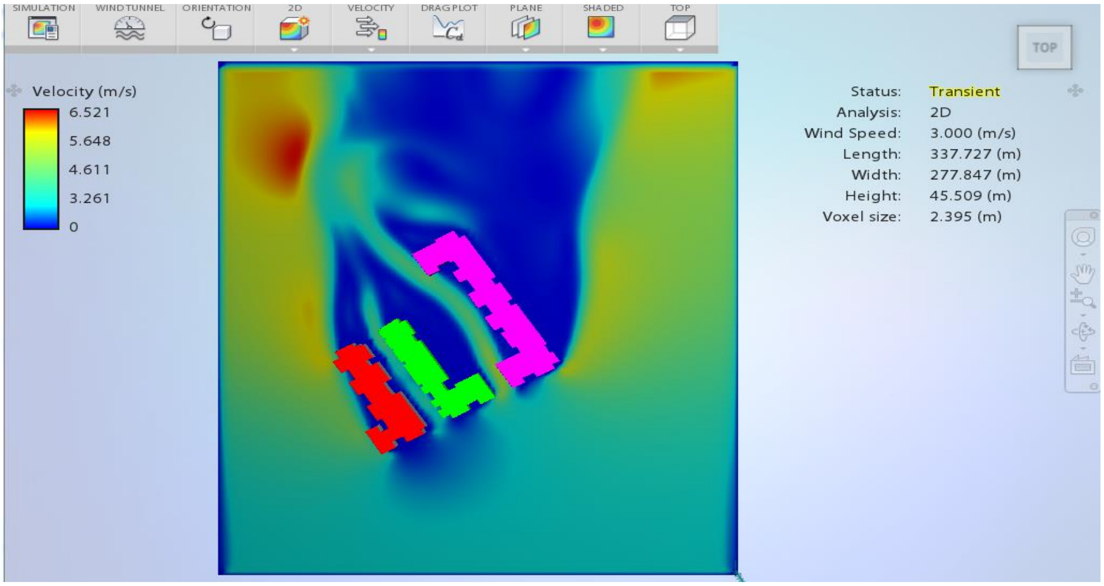


Figure 204: Wind Analysis result - Without Viaduct

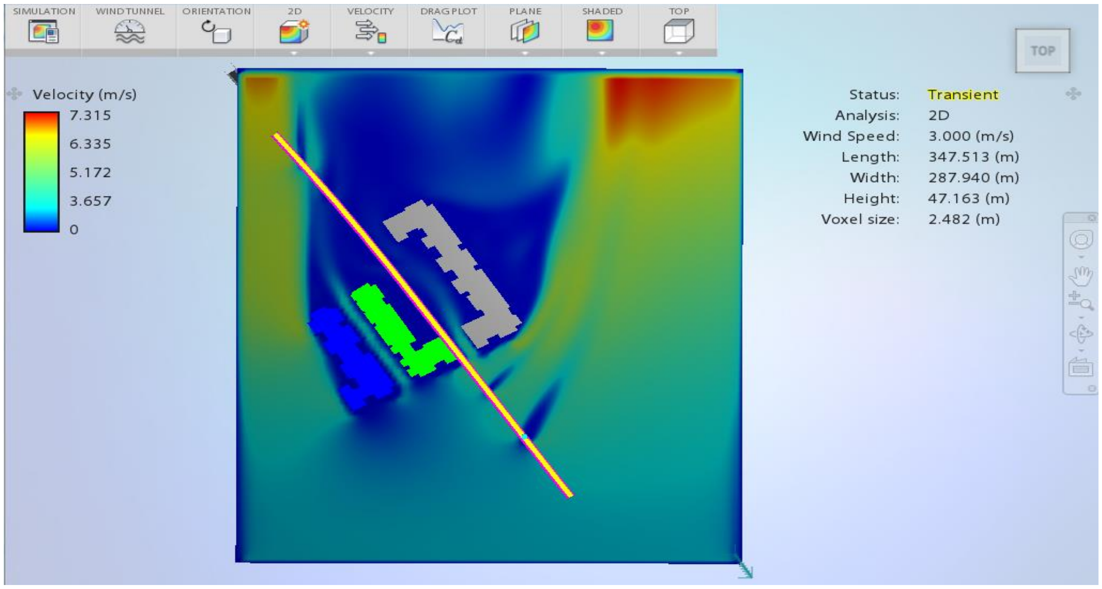


Figure 205: Wind Analysis result – With Viaduct

The Figure 204 represents the actual condition of the site without the inclusion of Viaduct and Figure 205 represents the condition of the site after the inclusion of Viaduct. The above images clearly shows that in between the buildings, the channeled flow effect is occurring where the wind gusts passing, resulting in a "canyoning" effect. But after inclusion of Viaduct, it is clearly visible that the channeled flow effect is much reduced.

GreenTree Building Energy Pvt. Ltd.
DELHI NCR

5.0 Inference – Wind analysis

Finally, in reference to the above wind analysis/ study, we are concluding that via duct doesn't cause any negative effect on the wind. Instead, the proposed viaduct is reducing the canyoning effect caused in between the buildings.

GreenTree Building Energy Pvt. Ltd.
DELHI
NCR

GreenTree Building Energy Pvt Ltd
B-67, Sector 67, Noida-201301, Uttar-Pradesh (India)
Contact: +91-9811122522 | contact@greentree.global | Web: www.greentree.global
Locations: Delhi-NCR | Mumbai | Kolkata | Lucknow | Dehradun

...FORUM (F...

ATTENDANCE SHEET

Meeting with Flat owners of Pocket-C, Siddharth Extension regarding alignment passing through Siddharth Extension

Date: 12.June.2021

SN	Name	Designation	Mobile No.	Email Address	Signature
1	Ashu Sharma	209-A, Pkt-C,	9811273442		Ashu
2	Deepti Lamba	195-B. Poc C.	9873182152		Deepti
3	Winnie	220 A Pocket C	8882762674		Winnie
4	J.K. Joshi	209B/C	9811007309		JKJoshi
5	Sukhwinder Singh	219A/Pkt. C	8800787711		[illegible]
6	Anu Bajpai	220-B Pocket-C	98101-17003 93505-29765	anubajpai805 @gmail.com	AB
7	Nikhil Bhatnagar	196-C 195-C	9810018680 9999843464	Sumit Kumar226 @yahoo.com	[illegible]
8	ARUN KUMAR GOYAL	220 - A	9818797628 9971071836	ARUNGOYAL@HOTMAIL.COM	[illegible]
9	SUKESH KAKKAR	219 - B	9313217709	K.K.mitra@lloyd insulation.com	[illegible]
10	TARUN NARANG	195 - D	9999890777	tarunnarang-777@gmail.com	[illegible]
11	Dr Ajita / NOVA	210B.	9650991185 9990052345	gnovahu@gmail.com ajita_nav@yahoo.com	A Rao
12	on Behalf of Mr V.H.RAO				
13	Geetika	209 A	9654839276	geetikagoswami@gmail.com gita1815@gmail.com	[illegible]
14	SANJAY MAHESHWARI	195- A	9810003059	SHIKHASANJAY77@GMAIL.COM	Sanjay

(183

Date: 14/08/2021

ATTENDANCE SHEET OF Flat owners

Meeting with Flat owners of Pocket-C, Siddharth Extension

Sub: Regarding crossing of alignment from C-Block, Sidhartha Extension

SN	Name	Designation	Mobile No.	Email Address	Signature
1	SUKESH	Flat No. 219B	9313217709	kk.mitra@lloydinsulation.com	
2		290D	9811625952		
3	Sukhwinder Singh	219A.	880078771	--	
4	DR ARUN KUMAR GOYAL	220 A	9818797628	arungoyal@hotmail.com	
5	WINNIE	220A	8882782674	wgoyal8@gmail.com	
6	Dr Ritwik	190 A Pkt-C Siddharth Extn	9810607291/ 8595990364	ritwikchakraborty29@gmail.com	
7					
8					
9					
10					
11					
12					
13					
14					

(153)

152

ATTENDANCE SHEET

...ting with Flat owners of Pocket-C, Siddharth Extension regarding alignment passing through Siddharth Extension

...e: 12.June.2021

SN	Name	Designation	Mobile No.	Email Address	Signature
15	Abhishek Banerjee 220-C (TK Chakraborty)	220-C Owner-Representative	9643718914, 9868496237	abhishek71212@gmail.com	
16	Arvind Tripathi	196A & 196B	9971133566	atripathi17@rediffmail.com	[signature]
17	SACHIN LAMBA	195-B	9899404745	lamba_sachin@hotmail.com	[signature]
18	RAM MEHROTRA	210D Vice President, Reliance Ind Ltd	9910377700	r.am.mehrotra@ril.com	[signature]
19	YC Srivastava	CE/C NCRTC		yogesh.srivastava@ncrtc.in	[signature]
21	Y.P. Saxena	GGM/Finance, NCRTC		yp.saxena@ncrtc.in	
22	Dhanesh Gupta	GGM/Contracts Dispute Resolution NCRTC		dhanesh.gupta@ncrtc.in	
23	Subodh Kumar	CPM/Delhi, NCRTC		subodh.kumar@ncrtc.in	
24	R.K. Jala	DGM/Land, NCRTC		rk.jala@ncrtc.in	[signature]
25	Khusiram	TA/Civil, NCRTC		khusiram_os@ncrtc.in	
26	Vishal Singh	Secretarial Assistant, NCRTC		vishal.singh-os@ncrtc.in	Vishal
27					
28					
29					

Meeting with Flat owners of Pocket-C, Siddharth Extension regarding alignment passing through Siddharth Extension

144

ATTENDANCE SHEET

Date: 02.03.2021

From Siddhartha Extension:- Sr. Citizen

SN	Name	Designation	Mobile No.	Email Address	Signature
1	Sh. Subodh Kumar	CPM.	9717647842	subodh.kumar @ncrtc.in	
2	RK Jala.	Dy GM/L			
3	V.D. Sharma	Sr. Citizen.	9650855744		
4	M.L. Ahuja	"	9811207228		
5	M.C. Gupta	"	9810854275	mcgupta272@yahoo.co.in	
6	M.M. Gupta	President SFSCNF	9312229681	mmgupta7@gmail.com	
7	Khushi Ram	TA/Civil	8629000631	khusi.ram_os@NCRTC	
8					
9					
10					

DRAFT MINUTES OF THE MEETING WITH NCRTC OFFICIALS AND MEMBERS OF SIDDARTHA EXTENSION SENIOR CITIZENS' WELFARE FORUM (REGD.) IN REGARD TO THE PROPOSED NCRTC DELHI MEERUT VIADUCT THROUGH A PART OF THE COLONY

In continuation to the meeting dated 21.10.2020 another Meeting was held between the officials of NCRTC and Sidhartha Extension Senior Citizens' Welfare Forum(Regd.) & RWA, on 10st November, 2020 at 11.00 AM in Porta Cabin (Near Gate No.3) Sidhartha Extension Pocket 'C', in regard to the proposed NCRTC Delhi Meerut Rapid Metro Viaduct passing through a part of the colony. Following were present :

FROM NCRTC

1. Sh. Subodh Kumar, APM/NCRTC (M. 9717647842)
2. RK Jala, DyGM/Land (M. 9881347000)
3. Khushiram, TA/Civil (M. 8699000631)
4. (M.)
5. (M.)

FROM SESCWF & RWA

1. M.C. Gupta 212-B. & 212 C (M. 9810854235)
2. M.M. Gupta 213-D PRESIDENT SESCWF (M. 9312229681)
3. M.L. Ahuja 197-A & 213-A (M. 9811207228)
4. A. S. LAMBA 208-D (M. 9811134447)
5. MRS K. KAPUR 212 A (M. 9818204602)
6. V.H. RAO. 210 B. (M. 9990052345)
7. V.D. Sharma. 217-A. (M. 9650855744)
8. Shyam Singh 167-D (M. 9873282447)
9. Surjit Singh 186-B GENL. SECY SERWA (M. 9878608498)
10. Sunder Shyam Verma 200-D (M. 9810216734) 9810117003
11. Anu Bajpai, 220 B-
12.

It was discussed as under :